An Easy Course in Using the HP 19BII



By Chris Coffin Illustrated by Robert L. Bloch Learn to use your HP 19BII for:

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- NFV JRR • FMRR
 - Second mortgages
- Leases
 - - Retirement
 - Depreciation
 - IRA's Savings
 - Com. property analysis

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by Chris Coffin and Dan Coffin Illustrations by Robert L. Bloch

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0. TO BEGIN

Read This First!



Time is an investment. If you spend it wisely, it will give you **ENORMOUS** returns.

Invest your time in this book.

It covers exactly what you need to know to use your HP 19BII effectively —and quickly. If you have time to *use* this machine, you have time to *learn* it first (<u>it doesn't take that long</u>). And you've already finished the toughest part of this Course (getting started), so just keep going.

In this book, you'll see many applications in financial analysis. But as you read, keep in mind that the goal here is not just to memorize a set of keystrokes and formulas. You're also going to get an understanding of the fundamental *principles*, so that whenever you encounter a new problem, you'll be able to analyze it and solve it confidently. That skill is the most valuable asset of all.



1. LOOKING UNDER THE HOOD

What's In This Machine?

Your HP 19BII is a loyal and friendly calculator engine—congratulations on a great choice! It represents a new generation of calculators, with more power and flexibility than ever before. It can do all sorts of things for you, from analyzing investments to remembering appointments to customizing formulas.

You simply need to tell it what to do.... And that brings up the next question....

What's Not In This Machine?

As sophisticated as technology is nowadays, it still hasn't progressed to the point where the machine can speak to you in your own language. For now, you must "speak" *its* "language," translating your everyday calculation problems into forms it can understand.

Of course, this means that you must define each problem correctly for *yourself* first. And often this is the hardest part, so don't overlook this very important step.

But once you've done that—set a problem up so that *you* understand it clearly—it's quite simple to translate it for your HP 19BII. In fact, learning to operate it is a lot like learning to drive a car: It all seems strange at first, but after some training and practice, you'll be doing things quite automatically—without even thinking much about them.

That training and practice is what this book is going to give you.

What's In This Book?

This book is indeed your Drivers' School for the HP-19BII. After learning about your machine's controls and buttons, you'll take it through the Course for extensive "road training." There you'll encounter lots of explanations, diagrams, quizzes and answers. Once you complete those, you'll be ready to drive anywhere your vehicle can go (and that's <u>a lot</u> of places).

What makes the Course is Easy is the fact that you're allowed to choose your own speed and route. So don't worry about how fast you're moving. It's not a race; you can go over the same stretch of road again and again until you're comfortable with it. You'll get some rest areas, to stop and review where you've been, and some alternate "routes," in case you already know certain things and don't need to practice them.

What's Not In This Book?

You won't find equal time given to everything, because some things just don't need as much explanation. Anyway, if you want a complete description of everything, you already have it right there in your Owner's Manual. That's what it's there for—as a reference manual to let you conveniently look up keys, functions, and quick examples.

But this book is *not* a reference manual. It's an entirely different approach, a tutorial approach meant to be taken as presented. So start here and "stay on the road!" Then, when you finish, a good reference source like the Owner's Manual will be much clearer and more useful to you.



You may be more interested in, say, real estate lending than in leasing, or in securities rather than personal finance. Well, there are example problems in each of these areas in this Course. But do yourself a favor: Don't skip over the ones that aren't in your favorite area!

"Why not?"

Because you're going to find that most financial problem-solving boils down to the same basic concepts—just expressed in different words. There are often far more differences in the *terminology* of the various financial disciplines than in their underlying calculations.

So don't skip over the problems that don't seem exactly fitted to your most immediate everyday work. That would be cheating yourself out of part of your investment. Every financial problem has something to teach you about the Time Value of Money, and the more practice you get with it, the more fluent you'll become in its language, and the more skilled you'll soon be in every area of financial problem-solving.



2. IN THE DRIVER'S SEAT

Turning the Key

Opening up your HP 19BII, the sheer number of keys—on *two* keyboards—may be a bit daunting. Is it that complicated to use?

Not at all.

The ON Button

Turn the machine on. The ON button is at the lower left of the righthand keyboard.

The OFF Button

Now turn it off, by pressing the OFF button.... But there is no OFF button—just press ON again.

A key whose meaning alternates between two opposites like this is called a *toggle key*. You'll see more such toggle keys, and they all behave in this on-again-off-again way. Toggle keys help to reduce the number of keys (after all, you have enough keys as it is).

(If you're already familiar with the keyboards and the display, you can skip ahead now to page 21.)

<u>A Good First Setting</u>

At this point, there's no telling what might be in the display. So to be sure you're starting from the same point as this Course, you're going to do a few preparatory keystrokes.

Don't worry if you don't understand these yet—you will soon. But you can't very well learn until you get the machine ready to learn with, right? So, turn your machine on, and...

Do This: Press the *gold key* (denoted here as), then the EXIT key. Now press (that gold key again), then the (NPUT) key.

Next, press the DISP key, then *the upper-left blank white key* (right under the display), then (2) and (INPUT).

Finally, press (that gold key once again), then the \div key.

If you've done everything right, the machine will probably beep, and then you'll see this:



(If this doesn't work the first time, just try it all again.)

The Display

Even when things are going wrong, the display usually tries to tell you what's going on. When in doubt, look at the display for clues.

(If you already know all about the display, what it's telling you and how to adjust it, then skip ahead now to page 19).

<u>The Viewing Angle</u>

Can you see and read the display comfortably? It's hard to read if it's aimed at the wrong angle—but you can adjust that angle.

Try It: With the machine on, *press and hold down* the ON key. Then press and hold the \pm or the key and watch how the viewing angle varies. Play around with it until you find a comfortable angle.

Messages and How to Clear Them

The **ERROR**: $\div \Theta$ is a good example of a *message*—usually telling you of an error or asking you for something. A message just *temporarily covers* part of the display. To get rid of it, simply press the \bigcirc key.

Do that now ().

<u>The Number Lines</u>

Now your display should look like this:



The display uses its top three lines to show numbers (and messages).

Try This: Press 3 [INPUT] 2 [INPUT] 1. See how numbers stack up?



<u>The Menu Line</u>

The very bottom line is the Menu Line. Each of the selections on the Menu Line is associated with the blank white key directly beneath it.

The Menu Line is the best way to tell "where" your calculator is. For example, the menu you're seeing this right now (above) is the *MAIN Menu*, the "home base" starting point. After all, it probably makes sense to start this "Driver's Course" from home.

The Keyboards

Now look at the keys (if you already know the basics of the keyboards, go ahead and jump now to page 21).

The Calculating Keyboard

Look first at the right-hand keyboard. This is where you'll find the keys for your arithmetic and other number-oriented operations. The digit and math keys are here, as are (N) and (), which you've seen already.

Notice that *the white keys* (including the blank white menu keys) are most directly related to "crunching" numbers.

The dark-grey keys, on the other hand, are more for controlling the display and moving numbers around. HP has designed the key colors this way, to make it easier for your eyes to find the right keys.

<u>The Typing Keyboard</u>

Look now at the left-hand keyboard, the "typing" keyboard. These keys are for spelling out words and names—much like a typewriter. You have a space bar at the bottom, plus some handy typing operations such as [NS] and [DEL]—all for typing *characters* (letters and symbols) into your display.

And, just like a typewriter, many keys have second ("shifted") characters too.So....where's the "shift" key?

The **Key**

The gold key on the right-hand keyboard is the shift key (shown here as). It's no coincidence that each key's "shifted" meaning is printed *in gold* right above it.

Try This: Press the ■ (shift) key. What happens? The → annunciator appears (a little signal up there in the Annunciator Area), telling you that the next key you press will produce its gold letter or operation.

Press again. The <u>A</u> disappears. Is a *toggle* key—like the ON/OFF key—because it alternates its meaning.

Type a few gold characters from the left-hand keyboard. As you do, notice these things about the **key**:

Unlike a typewriter, you don't hold it down while pressing the key you're "shifting." Just press and release the key, then press the key you want. The _ will always tell you when the _ is in effect.

But the $_$ is cancelled *after every use;* you need to repress the for every gold character you want. is *not* a "Caps Lock" key.

(Press EXIT), as the display tells you to, when you've finished "playing with the typewriter.")

Pop Quiz

Yes—a quick little stop-and-check point.

Make sure you know these things before you go on. The answers are on the next page, but don't look until you need to. Along with those answers, you'll find page numbers for re-reading, just in case. Take your time—and who cares if you re-read? It's *your* Course.

- 1. What's a toggle key? Name two such keys.
- 2. How many lines does the display have? How are they used?
- 3. What's an annunciator?
- 4. What's a message? How do you get rid of it?
- 5. What will happen to your calculator if you forgot to turn it off before leaving for Nepal?

Pop Answers

- 1. A toggle key is like a light switch: hit it once to turn something on; hit it again to turn it off. ON and are two such keys (see pages 15 and 20 for review).
- 2. The display has four lines. The top three lines show numbers (and messages, sometimes). The bottom line is the Menu Line, which tells you your current calculation choices (to review all this, see pages 17-18).
- **3.** An annunciator is a little signal, a status indicator that appears in the Annunciator area, above the display's top line, to keep you informed of the current "doings" of the machine.

You generally can't and shouldn't do anything about it—just understand what it means. For example, the shift annunciator, __, means that any key with a gold operation written above it will now produce that operation if pressed (page 20).

4. A message is a phrase or question that appears temporarily *in front of* the upper part of the display, to notify you of an error or ask you to do something. When you want a message to go away, just press () (page 17).

5. After about 10 minutes, it will turn itself off. Then, when you come back and turn it on, its display (and memory) will be the same as when you left—so don't lose any sleep over it.





3. LEARNING TO DRIVE

Warming Up the Arithmetic Engine

Basics first:

Arithmetic truly is the "engine" of any calculator. No matter how else you use your HP 19BII, it should certainly be able to add 2+2.

(At this point, if you're already very comfortable with doing arithmetic including percentages, negative numbers, and display settings on your HP 19BII—then feel free to go on now to page 46.)



Ready to "crunch" a few numbers, then?

As you know, most arithmetic happens on the bottom number line (the display line right *above* the Menu Line). So turn your machine on (if it's not on already) and look at that line....

Clear For Departure?

You're starting with some numbers already in the display. Do you need to clear anything before starting a new calculation?

Try It:	Press 25 🗰 🕱 and see the result: 5.00	
	That 1.00 didn't mess up anything, did it?	

- Again: What if you now want to find $\sqrt{495,616}$? Should you clear away that **5.00**?
- Nope: Full speed ahead: (495616), (ans.: 704.00). Notice how the 5.00 just rode up above, out of your way.

Anytime you finish a calculation, the machine knows it. And it will automatically "bump" that result upwards when you begin the next calculation. You don't need to clear anything!

You don't need to clear the display if you've just <u>completed</u> a calculation.

OK?



OK, But:	What if you decide to scrap a calculation midway—when it's <i>not</i> complete?
	Suppose you're trying to find $\sqrt{495,616}$, as you did on the previous page, but you mistakenly key in 496561 and right then you discover your goof. How do you fix it?
Two Ways:	
#1:	To back the wrong digits out, just use the \bigcirc key. It's a simple backspace key, so
	First, back out the wrong digits: ()
	Now key them in correctly: 5616 and finish the problem: E X
Or, #2:	To simply start over, you can clear the entire Calculator Line in one "swell foop:" Press CLEAR (that's the gold— shifted—version of the 🗭 key).

Not too tough, eh? Now that you know how to clear things if necessary, you're ready to start "driving around...."

How Many Digits Do You Have?

As you begin, notice that the display is showing exactly two digits past the decimal point on every number. Since the HP 19BII is a financiallyoriented calculator, this simply makes good cents.*

But is this the best precision you can get?

Not by a long shot.

In fact, every number has 12 digits, no matter how many you can see at the moment. For example, that **704.00** you just computed, is really

704.00000000.

(Count 'em—there should be a total of 12 digits.)

You just aren't allowed to see beyond those first two zeros right now.

* Couldn't resist—sorry.

Notice This: Key in 210.987854321 and press INPUT (to tell the machine you've "finished").
Here's what you'll see: 210.99
"What gives? Why did the number change?"
It didn't change. The calculator merely changed its presentation to you.
The entire 210.987654321 is still in the machine, but the display has been instructed to show you only the first 2 decimal places, rounded like this, to represent the entire number as accurately as possible.
Therefore the display rounds the number 210.987... up to 210.99. But if the 7 had been a 4 or smaller, the number would have been rounded down to 210.98.

Again, the point of all this is: It's the display doing the editing—for your eyes only. *Your machine will always do all your arithmetic with* 12 digits in each number.



How Many Digits Do You See?

Here's how your display probably looks right now:



Now, how do you tell the display to *change* its "editing policy?" What if you want to see 4 decimal places rather than 2?

Say the Word: Press the DISP key. Here's what you'll see:



When in doubt, follow the display's directions: You want to FIX the number of decimal places at four. So press the blank key under **FIX**.... Then follow the next set of directions: Press **(INPUT**).... Voilá!



Your display now shows this:



Just For Laughs: Set your display to show you ALL the decimal places that aren't merely trailing zeros.

Solution:

Press DISP, then **ALL**. Here's the result:



Now you see ALL decimal places except unnecessary trailing zeroes. The 704.0000 becomes simply 704, and the 210.9877 reveals its true identity.

(Now go back to dollars and cents format, by FIXing 2 decimal places. You know how, right?)

Simple Arithmetic: A Matter of Choice

At this point, you have a choice to make. As you probably know, the HP 19B11 offers you two different ways to do arithmetic.

Do This: Press (MODES), then select MORE from the *menu* (i.e. press the blank menu key under MORE —on the far right). You'll see these two choices: **ALG** and **RPN**

Try each one: First, press **MLG** (notice how your display then echoes your choice: **ALGEBRAIC** MODE).

ALGebraic arithmetic uses the = key. For example, to add 2 and 3, you would press 2+3=(do it now)... As you can see, this method imitates the way in which you might *say* the problem to yourself: "Two plus three equals..."

Now try the other method: Press MODES MORE REN (your display now echoes this choice: RPN MODE).

RPN stands for Reverse Polish Notation, so-named for the Polish mathematician who developed the efficient logic it uses. In this "reverse" method of arithmetic, you give the operation *last*, thus eliminating the need for an = key.

To add 2 and 3, for example, press 2 ENTER 3 + (in RPN mode, the = key acts as the ENTER key).

So, why the choice—and which way is best for you?

Long ago, HP calculators adopted the less conventional RPN style of calculation, because it's simply more efficient (for series of calculations it requires fewer keystrokes than the ALGebraic method—and no parentheses). So most users who took the time to learn RPN soon "swore by it" and became loyal to HP calculators as a result.

However, many other persons prefer to do arithmetic in the "left-toright" ALGebraic method. And since, for a long time, HP built only RPN calculators, these persons missed out on the many other great features of HP machines.

Then, when HP *did* build some ALGebraic machines (as part of its new generation of calculators), the situation became reversed: RPN users began to wish that *they* could enjoy the latest technology and features —but without having to switch from their beloved RPN.

Well, you know the rest of the story: HP is now offering a choice within the same machine—so you don't have to "un-learn" the method of arithmetic you're now using. It's that simple.

So choose the way that's easiest for you (press MODES) MORE, then either ALG or RPN)....

...And then, once you've made your choice:

If you chose **RFN**, go now to page 40; otherwise, just turn the page....

Arithmetic with the = Key (ALGebraic Mode)

This method of arithmetic doesn't take much practice to learn. The basic rule of thumb is: "saying it = doing it."

Here's a good set of examples (and remember that you can use the • or CLEAR keys to back out or clear any mistakes):

Example:	Calculate 342-173+13
Solution:	Press 342-173+13= Answer: 182.00
	See? You just press the keys just as you would say the problem to yourself—left to right. And as you proceed, you automatically get intermediate results (do the problem again and watch what happens after you press the (+) key). Then the (=) key gives your final result.
Example:	Find $101.00 - 47.50 \times 2$
Solution:	Press $101-47.5\times2=$ Answer: 107.00 This left-to-right rule works even when you <i>mix</i> multiplication (and/or division) with addition (and/or subtraction)! And notice that you don't need to key in any trailing zeroes (i.e. 101.00 is just 101).
Example: What's 342 - (173 + 13)?

Solution: Press 342-((173+13))= <u>Answer</u>: 156.00

If parentheses appear in the written problem, use them in your calculator, too. And notice how the (173+13 changes to 186.00 when you close the parentheses.

Example: Calculate $\frac{101.00 - (47.50 \times 2)}{64 - (25 \times \frac{3}{4})}$

Solution: 101-(47.5×2)/ (64-(25×(3/4=

<u>Answer</u>: **0.13** (Reminder: This is just the first two decimal places, with the second digit rounded. To see more digits, you know how to adjust the display, right?)

Notice that the keystrokes include an extra set of parentheses (around the entire denominator of the problem). After all, that's what is meant by that big horizontal line between the numerator and denominator.

Notice also that at the very end, you don't actually need to close a parenthetical expression with the right parenthesis. The = key says that you're finished, so the calculator closes all the open parentheses for you.

Changing the Sign of a Number

Try This:	Find 34 × (–19)	
Solution:	Press 34×–19= <u>Answer</u> : -646.00	
	This is the simplest way to key in a negative number And again, you <i>do</i> it just as you <i>say</i> it: "34 times negative 19 equals" (those parentheses in the problem are sim- ply to clarify things—they're optional).	

But there's another way to do it, also.

Like This:	Suppose now that you want to change that -646.00 into 646.00 .
Solution:	Press the +/-) key.
	That's the "change sign" key. It changes the sign of the number you're working on. Notice that this +/- key is a <i>toggle</i> key—with alternating meanings.

So there are *two* ways to make a number negative in ALGebraic mode, the — key and the +/- key.

<u>Playing the Percentages</u>

Do you realize how easy it is to do percentage calculations on this HP 19B11? Yes, even these—everybody's *least* favorite math problems are a breeze.

Watch:	What's 25% more tha	an 134?
Solution:	134+25%=	<u>Answer</u> : 167.50

See? Whenever you want to *increase or decrease* a number by some known percentage, you just *add or subtract that percentage*—again, just as you would say it.

And how do you find an unknown percentage of any given number?

Example:	What's 40% of \$21.95?	
Piece of Cake:	Press 21.95×40%=	<u>Answer</u> : 8.78

To *increase* or *decrease* by a known percentage, you add or subtract. To simply find some percentage of a number, you multiply. What could be easier? Try a few more problems on your own....

Notice in all cases that the machine evaluates the percentage as soon as it can—just as it does with parentheses.

The History Stack

By now, you've probably noticed something: When you start a new problem, your previous results simply "bump upwards," don't they?

Do This: Press 1=2=3=4=. You have just "finished" four arithmetic problems, one after another.

Now notice the arrow keys, (+) and (+), and also the (-) (\times) and (-) (-) (\times) (\times) and (-) (-) (\times) (-)

Now rearrange them back to their original order and press 5=. Can you now roll five results around? Try it....

Nope. This *History Stack* holds only the *last four results*. But it truly is a "Stack" of your recent calculating History, no? And notice that regardless whether you can *see* all four of those numbers, they're still there.

So the History Stack will let you see the results of previous calculations.



Problem: Your gross incomes and total taxes for the last three years were as follows (not really—just suppose):

<u>Gross Income</u>	<u>Total Taxes</u>
\$ 81,500.00	\$ 28,525.00
96,850.00	39,708.50
103,700.00	38,887.50

In which year were your total taxes highest *in proportion* to your income?

Solution: To find this out, you'll need to do three separate calculations, one for each year:

(Result: 0.35—the fraction you paid three years ago).

Next, press: **39708.5**÷**96850**= (<u>Result</u>: **0.41**—two years ago).

And: 38887.5.:103700= (<u>Result</u>: **0.38**—last year).

Just by looking at the Stack, you can see that you paid the biggest fraction two years ago, right?

Skip now to page 46.

Arithmetic with the ENTER Key (RPN Mode)

This method of arithmetic takes a little practice to learn—but the rewards are *definitely* worth the trouble.

Here's a good set of examples (and remember that you can use the • or CLEAR keys to back out or clear any mistakes):

Example:	Calculate 342-173+13		
Solution:	Press 342ENTER 173-13+ Answer: 182.00		
	Get the idea? When you key in the numbers you're going to combine, you separate them with the ENTER key. And the operation comes <i>last</i> .		
Another:	What's $2 \times (101.00 - 47.50)$?		
Solution:	101[INPUT]47.5-2X <u>Answer</u> : 107.00		
	<i>Notice</i> that you can use the [INPUT] key as an (ENTER) key also—just for convenience!		
	And notice that you don't need to key in any trailing zeroes (i.e. 101.00 is just 101).		

But the most important point to notice is this: You don't need parentheses, because you do the calculations inside the parentheses first.

One More:	Find $\frac{101.00 \times (47.50 - 2)}{64 + (25 \times \frac{3}{4})}$	
Solution:	47•5ENTER2—101X 3ENTER4÷25X64+ ÷	

<u>Answer</u>: **55.53** (Reminder: This is just the first two decimal places, with the second digit rounded. To see more digits, you can adjust the display, right?)

See how you work from the inner parentheses outward —and how your intermediate results simply "float up above" until you're ready to use them? Do the problem again, and pay special attention to what's going on *above* the calculation line....

...Now do the problem a *third* time, and this time, notice what ENTER does: It makes a copy of the bottom number, thus allowing you to separate numbers that you need to key in "back-to-back" (without an operation between them). Don't over-use ENTER! In this problem, you need it only between the 47.5 and the 2 and between the 3 and the 4. You *don't* need it (and it would be wrong) anywhere else.

Changing the Sign of a Number

Try This:	Find 34 × (–19)	
Solution:	Press 34 (INPUT) 19+/-)X	<u>Answer</u> : -646.00
	That's how you make a positiv the (+/-) key.	ve number negative—with

But if it's already negative, then...

Hmmm: Suppose you now want to make that -646.00 into a 646.00.

Guess What: Just press the +/- key.

Like the shift key, the +/- ("change sign") key is a *toggle* key—a key with alternating meanings.



Playing the Percentages

Do you realize how easy it is to do percentage calculations on the HP 19BII? Yes, even these—everybody's *least* favorite math problems are a breeze.

Example:	What's 40% of \$21.95?	
Piece of Cake:	Press 21.95 ENTER 40%	<u>Answer</u> : \$8.78

The 🔀 operation needs two numbers—just like other arithmetic. The first number you key in is the "whole;" the second number is the "part" —the percentage of the "whole" that you want to find.

Watch:	What's 25% more than 134?
Solution:	134(INPUT)25%+ <u>Answer</u> : 167.50

Notice how the 🔀 calculation leaves the "whole" intact afterwards—so that you can conveniently add it to the "part" if you wish. What could be easier?

Try a few more problems on your own.

<u>The RPN Stack</u>

By now, you've probably noticed how your previous and intermediate results simply "bump upwards." What's happening here?

Do This: Press 1 [INPUT 2 [INPUT 3 [INPUT 4 — to pretend that you've just done some arithmetic problems, one after another.

Now notice the arrow keys, (+) and (+), and also the (-) $(\times 2)$ and (-) (+) (

You can use these keys to make the four most recent results "roll around"—change sequence—in the Stack ([X2y] swaps the bottom two values). Try them....

Now arrange them back to the way they started and press 5. Can you now roll five results around? Try it....

Nope. The Stack holds only the *last four results*. But notice that regardless whether you can *see* all four of those numbers, they're still there.

So the Stack will let you see *and re-use* the results of previous calculations....

Problem: Your gross incomes and total taxes for the last three years were as follows (not really—just suppose):

<u>Gross Income</u>	<u>Total Taxes</u>
\$ 81,500.00	\$ 28,525.00
96,850.00	39,708.50
103,700.00	38,887.50

In which year were your total taxes highest *in proportion* to your income? What was the difference between this highest fraction and the lowest?

Solution: To find this out, you'll need to do three separate calculations, one for each year:

(Result: **0.35**—the fraction you paid three years ago).

Next, press: **39708**.5 ENTER **968**50÷ (<u>Result</u>: **9.41**—two years ago).

And: 38887.5ENTER 103700÷ (<u>Result</u>: 0.38—last year).

Just by looking at the Stack, you can see that you paid the biggest fraction two years ago and the smallest fraction three years ago, right? Then, to find the difference, just rearrange the Stack and subtract: $\boxed{R+X+Y}$

More Math If You Want It

At this point, you may well be satisfied with your level of arithmetic on the HP 19B11:

- clearing the display and changing its number formatting;
- addition, subtraction, multiplication and division;
- negative numbers;
- percentages;
- moving around the Stack a little bit.

If that's enough for you, skip now to the end of this chapter (page 53)....



On the other hand, you may be interested to know about some of the other, "higher math" operations this machine offers you. If so, "stick around" and work through the next few pages (the examples will have both ALGebraic and RPN solutions).



Try This: What's 2,000,000 × 2,000,000 ?

 Solution:
 Press 2000000X200000= (ALG mode)

 or
 2000000ENTERX
 (RPN mode)

Answer: 4.00E12

As you may know, this shorthand way of writing very large (or very small numbers) is *scientific notation*. You would read this as "four-point-zero-zero times ten to the twelfth power." The E means "...times ten to the..."

Notice the little gold E above the +/- key. It's there so you can also use scientific notation when you *key in* numbers.

Go For It:	Find "two million times two million time, you're not allowed to use t	n" once again—but this he 0 key.
Solution:	Press 2 E 6 X 2 E 6 = or 2 E 6 ENTER X	(ALG mode) (RPN mode)

Saves a few O's, doesn't it? Anyway, whether you like this notation or not, just be sure to recognize the **E** when your calculator uses it.

You might be surprised at the useful things you can do with some other MATH functions in your HP 19B11....

Try One:	A bank account earns 6% per year, compounded con- stantly. If you put \$100 into this account and let it grow for 6 months, how much would you have then?	
Solution:	: The formula for continuous compounding is	
	Ending balance = (Beginning balance) (e^{rt}) ,	
	where r is the yearly rate (in decimal form) and t is the number of years. The other number, e , is the natural logarithm base. You will also see e^{rt} written as $exp(rt)$, i.e. the "exponential of rt ."	
	In this problem, $r = .06$ (that's 6%, written as a decimal) and $t = 0.5$ (half a year). So, compute (rt):	
	•06ו5= (the ALGebraic way), or •06ENTER•5× (the RPN way). Result: •03	
	Now exponentiate this: Press $MATH$ LOGS EXP. This is e^{rt} (or $exp(rt)$). So now multiply by your beginning balance: $\times 100 = (ALG)$, or $100 \times (RPN)$ Answer: \$103.05	

Notice that the **EXP** function *doesn't care* whether you're using ALGebraic or RPN arithmetic. And that's true in general: When you select an operation from a menu like this, it simply operates on your current number—no matter how that number got there.

Try Another:The answer from the previous problem is not exactly\$103.05. Prove this to yourself—press

See? It's really **103.045453395**. Your *display* is rounding its presentation of the number—"for your eyes only," because you've set a FIX 2 display setting.

If you truly want to round (i.e. actually *change*) the number *to match your current display setting*, you can use do this: **EXIT** (to leave the **LUES** Menu), then press **END**.

Nothing much seems to happen, right? Ah, but now SHOW full precision (SHOW), and see 103.05.

That's a different number than before: there are no more hidden digits out past the second decimal place.

Again, notice that it doesn't matter which kind of arithmetic you use. The function simply operates on the current number.

A Trig or Two:	What's $sin(180^\circ)$? And what's $sin \pi$? How do you tell the machine when you want degrees and when you want radians?
Like This:	Press $MODES$, then the DFR selection. See the (2 π) annunciator appear at the top of the display? That means you're in <i>radians</i> mode for trig calculations. But simply press DFR again, and you turn it off and return to <i>degrees</i> mode.
	So, to solve the problem, press EXIT (to get out of the MODES Menu and back to the MATH Menu), then: 180 TRIS SIN. Result: 0.00 That's sin(180°).
	Now switch to radians mode (press MODES DVR EXITEXIT) grab a PIT, and TRIG SIN again. Result: -2.07E-13. This is what your HP 19BII gives as $\sin \pi$ radians—a very small number (so it's shown here in scientific notation).

"But shouldn't the sine of π radians—like sin(180°)—be exactly zero?"

Yes, but you didn't compute the sine of *exactly* π radians. You computed the sine of 3.14159265359 radians. The real π has an *infinite number of digits*—a lot more than the 12 digits your calculator can hold.

Nobody can compute the sine of exactly π radians. Your HP 19BII is giving the correct answer for the 12 digits it is using.

OK: What are the lengths of the legs of this right triangle? What's the length of the arc?



Hmm...: Your first problem is to convert that angle into decimal degrees, rather than degrees, minutes and seconds. So **EXIT** the TRIG Menu and select **CONV**.

Next, key in (57.1745) (to represent the angle in degrees, minutes and seconds), and press **SHR**.* <u>Result</u>: **57.30** The angle is 57.30°

Now, you *could* go back to the TRIG Menu and use SIN and COS calculations to compute the triangle legs, but instead, press **MURE** and use this handy triangle menu: Store the angle by pressing **C**. Then key in and store the radius: (1) **R**. Make sure you're in *degrees* mode (use the toggle, **D**. Make sure you're in *degrees* mode (use the toggle, **D**. Make sure you're ready to compute: The horizontal leg: **MORD** The vertical leg: **MORD Result**: **XCOORD=0.54** The vertical leg: **MORD**

For the arc length, since the radius is 1, just convert the angle to radians: MORE 2880 Answer: 1.00

^{*}You are converting "to decimal HouRs" here, which may seem like a strange name, but notice that these functions work for *time* conversions as well as angle conversions.

Try This:	If you have 21 marbles in a bag, how many possible <i>combinations</i> of 6 marbles (never mind the order) can you draw out? How about <i>permutations</i> (where the order does matter) when you draw 3 at a time?
Solution:	Use a PROBability calculation: EXIT the CONVert Menu (from the previous problem) and press PROB .
	To find how many ways you can combine X objects, taken Y at a time, simply key in the values for X and Y. In this problem, $X = 21$ and $Y = 6$, so (21) (6) (6) (7) Now solve for the number of possible combinations by pressing (18.7). Result: C X, Y=54, 264.00
	For permutations, it's the same idea: 21 3 4 Now solve for the number of possible permutations by pressing P 8 . Y . <u>Result</u> : P X, Y=7, 980.00

The MATH Menu on your HP 19BII makes all this look pretty simple. Can you imagine trying to do such calculations yourself? You might end up...



...losing your marbles.

A Rest Stop



That about does it for this chapter on arithmetic and math. Things will get more interesting soon, but you needed to know these things first:

- You know when and how to clear the calculator line;
- You know that the machine always keeps and uses 12 digits for each number in every arithmetic calculation;
- You know how to change the display setting (i.e. FIX and ALL) to see however many decimal places you want (up to 11).
- You know how to key in and use negative numbers;
- You know how ridiculously easy it is to do percentage problems;
- You know about the Stack and how it shows previous results.

And, if you went through the More Math section,

- You know about Scientific Notation;
- You know about the MATH Menu, including exponentiation, trigonometry and probability.

And of course, no matter what,

- You know you'll have an arithmetic quiz now....

Arithmetic Quiz*

Solve these on your HP 19BII. As usual, the solutions are on the next pages, with some page references for review (and you'll see new twists, too). In some problems, it won't matter whether you use ALG or RPN arithmetic—the keystrokes are the same either way. But for any problems where the two methods do have different keystrokes, both solutions will be given (ALGebraic first).

1. Find
$$\frac{\frac{100}{75}}{(25 \times 64) + (34 \times (-19))}$$

Then find $\frac{(25 \times 64) + (34 \times (-19))}{100/75}$ by two different methods.

- 2. Which is greater: $\frac{4}{7}$ or $\frac{6.281}{11}$?
- **3.** 4.00E12 is "4 trillion" (a very large number). How much is4.00E-12? How would you key this in?
- 4. Suppose that this year's income is 35% more than last year's, but next year's will be only 85% of this year's. If last year's was \$25,000, what will next year's be?

*For more practice with RPN arithmetic specifically, see also Appendices D and E in your HP Owner's Manual.

- Calculate (-19) × (-19) by three different methods, two of which don't use the ⊠ key.
- **6.** Compute $\sqrt{4096}$ two different ways. Then find $\sqrt[4]{4096}$.

7. Find
$$\left(\frac{1-1.1^{-10}}{.1}+100\right)(1.1^{10})$$

(If you skipped the section called **More Math If You Want It**, you'll probably want to skip problems **8-10**,too.)

8. Find
$$\frac{\log\left(12^2 + \frac{2704}{3}\right)}{e^3}$$

- **9.** What's $\operatorname{Arccot}(3\pi/4)$? Express your answer in degrees, minutes and seconds.
- 10. If sixteen U.S. states and five Canadian provinces meet to decide how to stop acid rain, how many ways are there to cast just the minimum majority of "no" votes to prevent any action?

Arithmetic Quiz Solutions

1. (100+75+(((25×64))+((34×-19))=(ALG),or 100ENTER75+25ENTER64×34ENTER19+/-×++ Answer (to 8 decimal places): 0.00139762

The easiest way to solve the second part is to "flip" the first answer with the $\boxed{1/x}$ key, taking the reciprocal of the current number. Answer (to 2 decimal places): 715.50

Of course, the other way is to start from scratch: $25\times64+(34\times-19)+(100+75=)$ (ALG), or $25ENTER64\times34ENTER19+/-X+100ENTER75++$

(To review basic arithmetic methods, re-read pages 32-45).

2. To compare, find both answers: $4\div7=(ALG)$, or $4ENTER7\div$ and $6\cdot281\div11=(ALG)$, or $6\cdot281ENTER11\div$.

If you're looking only at the first two decimal places, they look identical (0.57). But ask the DISPlay to FIX more than three decimal places, and you'll see the difference: $\frac{4}{7}$ is greater (see page 30 to brush up on FIX).

 This is "four times ten to the negative twelfth power," or "four trillionths." Written out fully, it would be 0.000000000004. To key this in, you would press 4 E – 12.

- 4. 25000+35%×85%=(ALG), or 25000ENTER35%+85% Answer: \$28,687.50 (See page 37 or 43 to review % calculations)
- 5. (a) 19+/-X-19= (ALG), or 19+/-ENTERX (RPN) Answer: 361.00
 - (b) $19+/-2x^2$. The x^2 key squares the current number.

(c) 19+/- (ALG), or 19+/-ENTER(2) (RPN).
 The (ALG), where the second power. (-19)² is "negative nineteen raised to the second power."

- 6. (a) 4096 X. The X key operates on the current number. Answer: 64.00
 - (b) 4096 (ALG), or 4096 (ENTER $\cdot 5$). The "square root" is the one-half (.5) power.
 - (c) $(4096 12 \sqrt{x} = (ALG), or$ $(4096 ENTER 12 \sqrt{x} - (RPN).$ $\sqrt[1]{4096}$ is the same as $4096^{\frac{1}{12}}$. <u>Answer</u>: **2.00**

8. 12 X2+(2704÷3= MAIN MATH LOFS LOF ÷3 EXP = (ALG), or

12 X2 2704 ENTER 3 ÷ + MAIN MATH LUGS LUG 3 EXF ÷ (RPN)

Answer (to 4 decimal places): 0.1503

(To review the MATH Menu, re-read pages 47-52).

9. There's no cot (cotangent) function among the trig functions, but

$$\cot(x) = \tan\left(\frac{1}{x}\right)$$

In other words,
$$\operatorname{Arccot}\left(\frac{4\pi}{3}\right) = \operatorname{Arctan}\left(\frac{3}{4\pi}\right)$$

Thus, to solve the problem:

MAIN MATH 3÷4÷ PI = TRIG ATAN EXIT CONV SHMS (ALG), or

Answer (to 4 decimal places): 13.2537

That's 13°25'37".

10. Essentially, the question is, "How many different combinations of 11 'no' votes—the minimum majority—are possible among the 21 voters?"

You want combinations, not permutations, because the voting order doesn't matter:

MAIN MATH FROM 21 88 11 97 C 897 Answer: C X, Y=352, 716.0000

There are well over a quarter-million ways to stymie any action. You wouldn't think so just by looking at the problem, would you? But your HP 19BII makes this kind of calculation a piece of cake.





4. YOUR FIRST BUSINESS TRIP

Road Signs: Menus and Their Keys

So much for arithmetic and math. The good news is: Most of the time, you won't need to do "manual" arithmetic on your HP 19BII—because it has so many built-in formulas. But you do need to know how to use those formulas.*

Up to now, you've just been "driving around the block." In other words, the Menu Line has generally looked like this:

FIN BUS SUM TIME SOLVE TEXT

This is "home"—the MAIN Menu. But now you're going to leave home and drive off for the road training you've been waiting for.

With the driving analogy, it may seem strange to be talking about maps, roads, and then *menus*, but it does make some sense: On the freeway, those big green signs showing lanes and exits are indeed a kind of menu. And how do you use these freeway menus? You choose the proper lane and exit—and you remember them for your return trip.

So you can think of the MAIN Menu on your HP 19BII as the "freeway," from which you may exit to, say, the **FINE** or **FINE** "highways." From those, you can exit onto still smaller "routes," and so on. Reaching your destination—the formula you want to use—is just a matter of reading the "road signs" in the calculator's Menu Line.

^{*}If you already know how to find these formulas and tools by navigating back and forth through the menus, then skip over now to page 67.

<u>A Menu Map</u>



- **Try This:** Look at the map above. This is one "major route" (the TIME Menu)—and its "suburbs." Use this map to guide you on a quick trip to the "place" called **TODAY**—starting from the MAIN Menu.
- **Solution:** Press **TIME CALC TOON!** See what happens? **TOON!** is a *calculation* that gives you the date and day of the week.

Notice that some menu selections are merely exits to get you onto a different "road." The selections at the *ends* of the roads are your actual destinations—where the HP 19BII does its calculations.

Next Question: How do you get "home" again?

Next Answer: You can *retrace* your road route—or you can "fly."

To retrace your route, use the EXIT key. Every time you press this key, you retrace your route back to the previous EXIT. Thus, you press EXIT to go from



and then EXIT once more to arrive "home" at the MAIN Menu.

To demonstrate how you can "fly" home, first go out to TODAY again.... Now press MAIN.

MAIN is the quick way home—the "When-All-Else-Fails-And-You-Can't-Figure-Out-Where-You-Are" key.

So never fear—no matter how lost you think you are, there's always a way to get back to a familiar route.

<u>Pages in a Menu</u>

A word about these "road signs" in the Menu Line: Sometimes there's just not enough room to list all the choices. What then?*

When this happens, the menu becomes more of the restaurant kind, because then it has more than one *page*.

Try This: Look at the menu map on the opposite page. Starting from your MAIN Menu, "move" through this map until your Menu Line looks like this:



Solution: Press MAIN FIN, DEPR, then MORE.... That MORE is an extra item—a "turn-the-page" key—that appears on every page of any multiple-page menu.

*Traffic engineers just use smaller writing on their road signs, but your HP 19B11 can't do that.



Road Signs: Menus and Their Keys

MAIN Routes vs. Side Trips

One more thing to notice about navigating through menus: Sometimes you can be working at one menu and need to take a short trip to do a "side calculation" at another menu—to get a number or adjust some mode, etc. But then you want to go back to the first menu and continue.

- Like This: Suppose you're setting the current time in your calculator. You press MAIN TIME SETM. But then you realize that the only clock you have is a decimal chronometer that started at midnight. If it now shows 10.43 hours, to what time should you set your HP 19BII?
- Hmm...This calls for a CONVert calculation. So you go to theMATH Menu, select CONV, then 10.43 MIMS....Result:10.25

Now just press EXITEXIT and voilá!—you're back at the TIME SET Menu directly—not at the MAIN Menu; the machine knows where you were before your CONVert calculation. So you just press **TIME** and you're done.

Except for MAIN and EXIT, any operation that's available to you on the keyboard (i.e. not via menu keys) is regarded as a temporary side trip. So while you do arithmetic, use the Stack, change the DISPlay setting, use the PRINTER or MATH Menus, etc., your HP 19BII doesn't forget "where you were" in the menu system—and it returns you there when you finish with the keyboard.

Playing "What-If?" with Menu Keys

So now you know the basics of *moving around* in the menus.

But of course, menu keys are not just "traveling keys." They're also keys that can give you *answers*—hard numbers. For example, you've already used the **motive** key to give you the date and day of the week.

But the real beauty of menu calculations is how they let you play with complicated formulas—which often have several different variables in them. And since each variable has its own key on the menu, *you can vary them*—one at a time—to see the effect on your answer.

This means that you can play the "What-If?" game that's so useful in making good decisions! You can ask questions like "*what if* the rent goes up by \$100?" "*What if* that interest rate were 2 points higher?"



And your calculator will show you the answers.

Watch This: From the MAIN Menu, press **BUS** and then **2005**:



And here's the problem you want to solve:

The retail trade per square foot in one shop was \$75 this year. Last year it was \$64. By what percentage did this trade increase in a year?

Related question: *What if* you were looking for a 20% increase—what level of trade would this have required this year?

Solution: 64 0L0 75 NEW 2CH

Answer: ***CHANGE=17.19** That was the actual percentage increase in the persquare-foot retail trade.

Now specify the 20% target increase: 20 **EXAMPLE** And find what the NEW trade (i.e. this year's) would have had to be in order to meet that target: **NEW**

Answer: NEW=76.80

The General Idea

See the basic pattern?

With the first calculation, you specified known values for two variables, OLD and NEW, and calculated the unknown variable, %CH. Then, for the second part, you specified your desired %CH and OLD values and calculated NEW instead.

You can calculate any one of the three values —if you know the other two.

And Notice:	You can <i>review</i> the current values in each of the variables—anytime you want.
Here's How:	Press RCL OLO and see: OLD=64.00 Press RCL NEW and see: NEW=76.80 Press RCL XCH and see: %CHANGE=20.00

You use the RCL key to *ReCall* values from variables. There are actually three storage *registers* built into the machine, registers named OLD, NEW, and %CH. This is where the calculator stores the values you give it when you're playing "What-If?"

That's the heart of it, then: You store values in all menu variables except one, then calculate that one. And you can play this "What-If?" with *any* of the menu variables.

Now press EXIT to back up one level to the BUSiness Menu... and try some more examples....

If:	A broker buys a property for \$12/ft ² and then sells it for \$15/ft ² . What's the markup as a percentage of cost?
	What is the markup as a percentage of price?
Solution:	From the BUSiness Menu, press MURC. This is the "MarkUp as a % of Cost" Menu.
	So use it: Press 12 COST and 15 PRICE. Then calculate: MCC
	Answer: MARKUP%C=25.00
	To find the markup as a percentage of price, go back to the BUSiness Menu (EXIT) and press MURP.
	Then press MRP.
	Answer: MARKUP%P=20.00
Hmmm...

Question: Why didn't you need to key in the **COST** and **FRICE** in the MU%P Menu, as you did in the MU%C Menu?

Answer: Simple: The **COST** and **FRICE** variable registers in the MU%P Menu *are the same* as in the MU%C Menu. That is, they are *shared variables*—shared between more than one menu.

Thus, since you had already stored the 12 and the 15 in the COST and PRICE registers, those values were still there, ready to calculate *either* MXC or MXP!

And they're still there now—which you can prove by recalling them:

Press RCL COST and see COST=12.00 Press RCL PRICE and PRICE=15.00



One More: If the appraised value of a property decreased by 36% this year and 25% last year, what was its total percentage decrease in value over these two years?

Solution: From the BUS Menu, choose the **XCHE** option. Then, since you don't have the actual values to work with, just start with a convenient number—say, 100—to represent the property's value two years ago: Press 100 **DLD**

One year later, the value was 36% less than that. That is, the %CH was -36. So press 36+/-

Now solve for the NEW level: **NEW**.... **NEW=64.00** So if the value was 100 two years ago, then it was just 64 one year later.

Now do the second year. The NEW value from the first year is the OLD value for the second year, so you would press 64 00L0. Next, you key in the value decrease in the second year: 25+/- 2014, and solve for the NEW (and that's the current) value: NEW.....NEW=48.00

So, what was the percent change for the two years? Your NEW level is now correct, but your OLD level needs to be 100 for the entire two-year period, right?

```
Press 100 OLD 2CH
Answer: %CHANGE=-52.00
```

The property's value dropped 52% over two years.

Review

That's what you need to know about menus and "moving around" in your HP 19BII. Just keep in mind these few important things:

- When in doubt, look at your display. It will orient you, showing you your current menu choices, error messages, instructions, etc.
- You can always get "Home" to the MAIN Menu quickly, via MAN.
- You can always "retrace your steps" (toward Home) with EXIT).
- When there are more than six menu items, you'll find a second "page" for that menu, by choosing MORE.
- You can play "What-If?" with the formulas you find in the menu system. Each variable is matched with a *register*, where you store the value you want to use in the formula.
- Even short quizzes can be helpful....



Menu Quiz

Take a "solo drive" with some percentage problems and with some "What-Iffing." Try these (the answers are on the next page, as usual):

- 1. There's a calculation key called **FATCE** in the **SOND** Menu. Your mission: Starting from the MAIN Menu, find it (don't bother to calculate with it), then report back to the MAIN Menu ASAP.
- 2. Using what you know about menus, see if you can figure out how to set the correct time and date in your calculator.
- **3.** If you're in the middle of an arithmetic problem and you suddenly decide to change menus ("move") for some reason, what happens to your calculation?
- 4. In general, what happens to your most recent calculation result when you change menus? How about the rest of the Stack?
- 5. A holder of a note wished to sell it and offered a 10% discount off of the face value. The buyer then turned around and re-sold the note by adding 10% to the price he had just paid for it. Did he sell it for face value?

- 6. The most severe drop in the history of the U.S. stock market occurred in the period between September 3, 1929 and July 8, 1932. During that time, an industrial stocks average fell from 452 to 58. If the same percentage drop happened with a beginning average level of, say, 2735, where would the bottom level be?
- 7. A football field is 100 yards long. If it's 45 yards wide and you increase both its width and its length by 9%, by what percentage would this increase its area?



Menu Quiz Answers

- 1. From the MAIN Menu, press **FIN SOND MORE**, and there on the second page of the **SOND** Menu, you'll see the choice called **FRICE**. Notice that, as usual, if you press **MORE** at this point, you'll flip-flop between the pages of the **SOND** Menu (see page 64 if you don't remember this). Then press **MAIN** to "fly home" again.
- 2. From the Main Menu, press **TIME** (obviously), and then **SET** (because you want to *set* the time and date). That brings you to another menu. Now, just pressing **DATE** or **TIME** on that menu *won't* set the correct time or date in the display. What do you do?

Ask for **HELF**! ...See? It shows you how to key in the number to represent the correct time and date. For example, if today is February 28, 1990, and it's 2:25 p.m., press 2.281990 **DATE**, then 2.25 (then **HFFK**) if necessary) and **TIKE** to get 2:25 in the afternoon. Now set your *correct* date and time, and watch the information in the display change.

- 3. Absolutely nothing happens to your calculation-in-progress try it: Press 2+3 (or 2ENTER 3, for RPN), change menus (e.g. EXIT), then = (or +, for RPN), to finish your addition.
- 4. When you change menus, your current calculation will remain undisturbed, but the values above it in the Stack may disappear.

 5.
 Use the MU%P Menu and, say, a \$100 note: Press 100 PRICE

 10 MRP COST
 Result: COST=90.00

That's what the buyer paid for the note. Then he re-sold it simply by adding 10% to this figure. That is, he used the MU%C Menu and, since the **90.00** was already stored in the COST register, he did this: 10 MEC CALL... Result: PRICE=99.00 That's not the face value.

6. This is a %CHG problem. From the BUS Menu, press KCHF, then
(452) OLO 58 NEW KCH. <u>Result</u>: %CHANGE=-87.17

That's the *percent change* of the 1929-1932 crash (negative because the change was *down*ward). Now key in the hypothetical high level, (2735) (10), and calculate what the corresponding low level would be: **NEW**.... <u>Result</u>: **NEW=350.95**

You need a %CHANGE calculation, so go to the %CHG Menu. Then start by computing the area before the enlargement:
(a) 5×100= (or (4) 5 ENTER 100× for RPN) Answer: 4,500.00 Press 010 — this is the OLD area.

Next, you need to find the dimensions of the enlarged field: $(100+9%)\times(45+9% = (for ALG), or$ 100ENTER9%+45ENTER9%+X (for RPN)Answer: 5,346.45 This is the NEW area; press NEW.

Finally, **CHANGE=18.81** (If you had *decreased* it, the %CH would have been negative).

Where Do You Want To Go Next?

You've come to a fork in the road.

Since you now know the basics of arithmetic and menus on your HP 19BII, it's really up to you now to decide where to read next.

Of course, the recommended choice is to keep going, straight through the book. Each topic takes only a short amount of time to cover, but it teaches you a lot about the calculator and how versatile and powerful it really is.



But granted, you may not be interested in all the topics, so here's where you can read the road signs and make your own choice.

(You'll find similar "forks in the road" at the ends of later chapters, too, so you'll have this kind of choice through the rest of the Course....)



The Bread Value Of Money: CURRency EXchanges

So you're going to continue with your first BUSiness trip? Fine. Then here's a look at another useful item on the BUS Menu....

Suppose you're an economist comparing the living standards of three countries—the United States, Costa Rica, and Peru. One way to do this is to compare average per-capita incomes to the costs of a basic food commodity—i.e. "daily bread," or something comparable.

There are several common foodstuffs you could choose as an indicator (and actually, wheat bread isn't one of these, since most countries use far more rice than wheat). Suppose you choose chicken.

That fine, but there's a slight problem: Annual income reports are usually given in U.S. dollars, while food prices (which may fluctuate daily) are not. So you need to do some conversions before making the comparisons. Here are the numbers you're using:

		Cost of Chicken	Exch. Rate	Avg. Annual Per-
Country	Currency	(per kg)	(per \$US)	Capita Incm. (\$US)
U.S.A.	Dollar	1.95	1.0000	\$17,800
Costa Rica	Colón	168.00	87.0000	\$ 1,810
Peru	Inti	45,000.00	18,000.0000	\$ 965

So how does the HP 19BII do currency conversions?...

From the MAIN Menu (remember that MAIN) will always get you there), press **EUS**, then **CURRE**. Here's what you'll see....



The idea is this: The HP 19BII lets you select the *names* of two currencies—and the conversion *rate* between them. Right now, the two selected names are US\$ and YEN, but that's not what you want. So press **SELCO**, and see this:

SELECT CURRENCY 1
US& CAN& DM FF UK£ MORE

Now choose **USE** from the menu of currency names—and notice how the display then verifies your choice and tells you what to do next....



Use MORE to "page" through the menu to find (and choose)



The Bread Value of Money: CURRency EXchanges

OK, now that your currency names are both correct, you're ready to ENTER A RATE.

Notice that the exchange is always in terms of *one* unit of Currency 1. That is, you always ask the calculator, "*One* unit of Currency 1 equals *how many* units of Currency 2?" So key in **18000**, press **EATE**, and notice again how the display will echo your choice.

Now, if a kilogram of chicken costs you 45,000 Intis in Peru, how much would that be in US dollars?

At this point, it's simply a matter of playing "What-If?" to find out:

45000 INTI USS <u>Answer</u>: US\$=2.50

And if chicken were to cost the *same* (in dollars) as it does in the US, what would that price be in Intis?

1.95 USE INTI Answer: INTI=35,100.00

See? You can go in either direction for the conversion. Simply key in one known currency value and then solve for its corresponding value in the other currency.

Easy, right? But the best news of all is this: Once you associate two given currency names with their corresponding conversion rate, you can *save* this combination for easy recall later. Press **CLETO** to see this:



As the instructions explain, simply by selecting one of these six blank menu keys, you can *store* a currencies/rate combination.

Try it: Press, say, the second blank key.... Instantly you're back at the main CURRency eXchange Menu.

And now suppose you convert some other currencies. For example, suppose you convert between Canadian dollars and German deutsche marks, pressing **SELCT CANES** OM (4) **FATE** (do this now). The display will show you this:

Ah, but you can *instantly* reset to US\$/INTI exchanges by pressing

You can save up to six such combinations on this store/recall Menu.

Try Another: Now compute the price of a kilogram of chicken in Costa Rica, using the data on page 80.

 Solution:
 At the CURRency EXchange Menu, press SELTI USE

 MORE MORE MORE MORE MORE MORE MORE (...there

 doesn't seem to be a built-in name for Colones). So

 use the final selection on the last page of the menu:

 CURRE.
 That's the "last-resort," the "generic" name to

 use when there's no better one.

Now enter the rate and solve the problem:

87 RATE 168 CURRE USS <u>Answer</u>: US\$=1.93

Save this exchange combination: Press **CETO**, then the first blank key on the menu. Now you have two such combinations to use whenever you need them.

As you can see, the prices of a kilogram of chicken in the three countries are "in the same ballpark," dollar-for-dollar:

U.S.: \$1.95 Costa Rica: \$1.93 Peru: \$2.50

But how hard are those dollars to *earn*? To see the *real* cost of this food in each country, you must compare it to the average income....

The Real Costs:	Calculate what a kilogram of chicken would cost in
	the U.S. if it cost the same in proportion to income
	as in Costa Rica and Peru.

Solution: 1.93+1810×17800=(ALG), or 1.93ENTER1810+17800×(RPN)

<u>Answer</u>: **\$18.98** That's the *real* cost (i.e. the relative cost) of a kilo of chicken in Costa Rica nearly 10 times the cost in the U.S.

2.50+965×17800=(ALG), or 2.50ENTER965÷17800×(RPN)

Answer: **\$46.11** That's the *real* cost (i.e. the relative cost) of a kilo of chicken in Peru—nearly 24 times the cost in the U.S.



Loaves and Fishes: Getting Your UNITS Right

The last item on the BUSiness Menu is **UNITE**. The idea behind it is very simple—to help you answer questions such as this:

- **Hmm...:** With seven one-pound fishes and eleven 26-oz. loaves of bread, to how many persons can you feed 100 grams of food?
- Ahh...: At the MAIN Menu (MAIN), select UNITS. You will see something like this:

UNIT CONVERSIONS

LENG AREA VOL MASS TEMP

To convert weight, or *mass*, press MASS, and then:

Press **26 02 L3**. <u>Result</u>: LB=1.63 This is the weight of each loaf of bread, in *pounds*. Then $\times 11+7=$ (ALG) or $11\times7+$ (RPN) <u>Result</u>: 24.88 —the total pounds of food you have.

Now: **LE GRAM**. <u>Result</u>: **GRAMS=11,283.11** That's how many grams of food you have, so now simply divide by 100: ÷100= (ALG) or 100÷ (RPN)....

You can feed a multitude—nearly 113 persons (112.83).

Get the idea? You just key in the value in the known units and solve for that same value in other units. It's very similar to the way you convert currencies.

For some more practice with both of those conversion menus, try this...

Conversion Quiz

- 1. At the close of foreign exchange trading today, the British pound sterling (£) would buy \$1.6325. The dollar was going for 1.7002 dm (deutsche marks), and the dm was trading for 93.4¥ (Yen). Find and store all six conversion rates between these four currencies.
- 2. Besides converting currencies, what other conversion uses might you find for the CURRency EXchange Menu?
- **3.** Which is more economical—a car that averages 12 kilometers per liter of fuel, or a car that averages 30 miles per gallon?
- 4. In certain sections of Tokyo, the real estate market is so ferocious that if you lay a \$1000 bill down on the ground, it will just pay for the area it covers(!) Calculate that price per square foot. What is it in Yen per square meter, assuming the currency exchange rates given in problem 1, above?

Conversion Quiz Solutions

1. First, do the ones you're given: Press MAN BUS CURE, then SELCT UK: US: 1.6325 RHE C.STO, then the first key on the Rate storage Menu.

Next: SELCT USE ON 1.7002 RATE C.STO, then select the second key on the Rate storage Menu (group all the dollar conversions together at the left, for convenience).

Next: SELCT OM MORE MORE MORE MORE MORE YEN 93.4 RATE C.STO. Select the fourth key on the Rate storage Menu.

Notice how you choose CURRENCY 1 to be the currency whose *unit* value (e.g. 1 dm, or 1 dollar) you know from the problem, thus making the input easier.

Now use these three known rates to calculate the others. The idea is to calculate in a currency chain, like this:

C.RCL US:0M () US: DM (<u>Result</u>: DM=1.70)

Now, keep that number there on the Stack, to use with the next rate: **C.R.L. OMEVE** (STO) **COMENT VEN** (Result: YEN=158.80)

Keep this number, too, to use as the new rate: SELCT USE MORE MORE MORE MORE VEN STO RATE C.STO. Now select the third key on the Rate storage Menu. Do likewise on the other two rates: **CRCL UKUS** 1 UKF USE (Result: US\$=1.63). Now, keep that number there on the Stack, to use with the next rate: **CRCL USEVE** STO USE VEN (Result: YEN=259.24) Keep this number, too, to use as the new rate: **SELCT UKF MORE MORE MORE MORE VEN STO RATE CLETO**. Store this rate on the **fifth** key on the Rate storage Menu.

CRCL UK:US 1 UK: US: (<u>Result</u>: US:=1.63). Now, keep that number right there on the Stack, to use with the next rate: **CRCL US:OM** (STO) US: **DM** (<u>Result</u>: DM=2.78) Keep this number, too, to use as the new rate: **SELCT UK: DM**

STO EATE C.STO. Store this rate on the **sixth** key on the Rate storage Menu.

Now, every day, as the currencies fluctuate, you can simply adjust each rate, thus keeping current on all these exchanges!

2. The CURRency EXchange Menu is really good for converting between *any* two known values. For example, you can use an exchange rate between the dollar and 1 share of a common stock or a mutual fund, or 1 carload of pork bellies, or 1 ounce of gold.... You get the idea—the possibilities are endless.

In fact, you can use the CURRency EXchange Menu to convert between *any* units—even physical units, like the UNITS Menu.

For example, you can convert between various lengths: 1 parsec = 153 trillion furlongs. Or, convert units of *time*: 1 day = 86,400 seconds, or 1 year = 26.09 fortnights, or 1 minute = 40 winks(?), etc.

3. This is a problem for the UNITS Menu:

Press MAN EUS UNITS, then LENG MORE 12 KM MILE Result: MILES=7.46

(The full precision is 7. 45645430685, as SHOW) tells you.)

So the car that gets 12 km/liter is getting 7.46 *miles*/liter. Now, how many gallons are in a liter?

Press EXIT FOL 1 LITER GAL <u>Result</u>: GALLONS=0.26 (The full precision is 0.264172052358)

So this car is getting about 7.46 miles/0.26 gallons of fuel, right? Now just do the division to get an answer in miles per gallon:

7•45645430685÷

•264172052358=(ALG),*

or x≥y Ri ↔ (RPN—isn't the RPN Stack great?)

Answer: 28.23 miles per gallon.

So while a 12 km/liter car is pretty good—28.23 miles/gallon—a 30 mpg car is still a little more economical.



*Changing sub-menus within the UNITS Menu seems to be a case where the RPN Stack is preserved, but the ALG Stack is not. While you could have *stored* the **7.46**... value in a *storage register*, then recalled it later, you may not yet have been introduced to storage registers, so the ALG solutions here are simply to re-enter earlier values by hand. 4. First of all, you need to decide on the dimensions of a \$1000 bill... To save you a trip to the bank (or your mattress), just assume that it's about 6.1250 inches by 2.5625 inches.

Knowing that, you can calculate its area in square inches and use the UNITS Menu to find the equivalent area in square feet: Press MAIN BUS UNITS AREA, then

6.125×2.5625=(ALG), or 6.125ENTER2.5625×(RPN) <u>Result</u>: 15.70 (The full precision is 15.6953125, as SHOW) tells you.)

Now **SERIN** to store this and **SERIN** to calculate.... <u>Result</u>: SQ.FT=0.11 (The full precision is 0.108995225694)

So the price of this precious real estate is "\$1000 per 0.11 sq. ft." Now just do the division:

÷1000= 1/x (ALG), or 1000 x2y÷ (RPN) Answer: 9,174.71 (Gulp) That's \$9,174.71 per square foot.... ...Quite a lot, really.

Next, find the dollars per square *meter*:

EXAMPLE 1 Result: SQ.METERS=0.09 Then: \Rightarrow 9174.71= $\sqrt[7]{x}$ (ALG), or $x \ge y = 0.00$ (RPN) Answer: 98,755.80 That's \$98,755.80 per square meter. Now hotfoot it over to the CURRency EXchange Menu and convert that dollar figure to Yen:

EXIT EXIT CURRY C.RCL US:YE STO US & YEN

Answer: YEN=15,682,290.26

This real estate costs 15,682,290.26¥/square meter.

Hope you brought your checkbook....



Checking the Map Again

Here's another "fork in the road."

As usual, the recommended choice is to keep going straight on through the book. But here's you chance to "skip around," if you wish.

Read the road signs now and make your own choice....





Time -

5. THE TIME VALUE OF MONEY: TVM

Problem Understanding = Problem Solving

Now that you know the basics of math and arithmetic, it's time to start on financial problem solving. But first, consider this:

> "You never really understand something until you can explain it to someone else."

This is certainly true for solving problems on your HP 19BII. To get it to solve your problems, you must explain the problem to it—in the "picture language" it understands. And of course, that means you need to figure out that picture *for yourself* first.

You must understand and define a problem for yourself before you can possibly "explain" it to your calculator.

This Course trains you to do exactly that—understand and define problems. That makes the actual button-pushing very easy—almost an afterthought. So don't be too impatient to start hitting keys here. Just park your calculator for a moment, sit back, and consider carefully the details that surround even simple finance calculations.

And don't skip over this part! Even if you've seen some of this before, it will pay you to review it now....

What Is TVM?

TVM, of course, stands for the Time Value of Money.

TVM assumes that money earns *interest* simply through the passage of time. When you're not using it, you're renting it out (loaning it) for someone else to use. Therefore, when you ask "How much money do I have?" you must also ask "What time is it?" Under TVM's assumption, the first question is meaningless without the second one.

So for the purposes of calculations, the old cliché is very useful:

Time is money.

Thus, even when *amounts* of money differ, they may still be equivalent because of the *time* difference between them. For example, if \$1.00 today earns 10% annual interest, it will be worth \$1.10 this time next year. And you can say this with an "equals" in it:

Time adds the extra Value to the Money. So (assuming that 10% annual interest rate), you could correctly view the face value of a dollar-bill as being any one of these equivalent amounts of money:

$$\$1.00_{\text{now}} = \$1.10_{\text{next year}} = \$2.59_{\text{ten years from now}}$$

How Does Interest Behave?

OK, so borrowed money earns interest over time. Everybody knows that. But *how*, exactly? If you were to watch the pennies of interest accrue in your bank account, what would the pattern look like?

It all depends on what kind of interest you're earning.

Basically, there are two forms of interest: **Simple** and **Compound**. Here's how they differ:

Simple Interest is the less common method: The amount of money earned periodically as interest is defined as a set percentage of the amount *originally loaned*.

Example:	Suppose you earn Simple Interest at 1% per month in your bank account (not bad). And suppose you deposit \$100.00 there for 12 months. How much interest will you earn over the entire 12 months?
Solution:	There will be exactly \$12.00 in interest, because you earn 1% of the <i>original</i> \$100.00 every month. That's \$1 per month for 12 months. Simple to calculate—just like the name— Simple Interest.

Compound Interest, on the other hand, is much more widely used: The amount of money earned as interest per period is defined as a set percentage of the amount owed *as of the beginning of that particular period*—including any past interest earned but not yet paid.

Example:	Take that same \$100.00 for 12 months, earning 1% per
	month, but this time it's Compound Interest. How
	much is earned over 12 months?

Solution: The first month is easy: 1% of \$100.00 = \$1.00 So after one month, the total amount owed is \$101.00.

> Now comes the second month: 1% of 101.00 = 1.01So after 2 months, the total owed is 102.01. Etc.:

<u>After</u>	Amount Owed	
Month 3	\$ 103.03	
Month 4	\$ 104.06	
Month 5	\$ 105.10	
Month 6	\$ 106.15	
Month 7	\$ 107.21	
Month 8	\$ 108.29	
Month 9	\$ 109.37	
Month 10	\$ 110.46	
Month 11	\$ 111.57	
Month 12	\$ 112.68	

So if it's not paid immediately, Compound Interest earns *more* than Simple Interest.

Again, here's the difference between the two types of interest:

With **Simple Interest**, no matter what month you're talking about, the interest earned in that month is always based upon the *original amount*—the amount owed *at the beginning of the loan*.

With **Compound Interest**, the interest earned in any given month is based upon the amount owed at the beginning of *that month*. Therefore, interest is earned not only on the original amount but also on all other interest already earned (but not yet paid). Hence the name, *Compound* Interest.

(Don't worry—you're going to put these ideas into practice in just a few more pages. Just grin and bear it for now; it's very important to cover these things first.)



Here's a pictorial summary of the behaviors of each of these types of interest: x_k





As you know (and illustrated here), Compound Interest grows faster than Simple Interest. That's why Compound Interest is used much more widely—and on your HP 19BII.

So you won't hear much more about Simple Interest here; anytime you see just the word "interest," it will mean Compound Interest.

Again, all this may seem obvious. But don't overlook these subtleties:

Subtlety #1: In either form of interest, there is only one time period which is the Defined Interest Period (D.I.P.), and only one Defined Interest Rate (D.I.R.) corresponding to that period. No other numbers can be used to calculate compounding interest. Don't be mislead by quoted annualized values! They may be nominal—not effective—rates.

The examples with the \$100.00 for 12 months stated specifically that interest accrues at 1% per month. Therefore the D.I.P. is 1 month, and the corresponding D.I.R. is 1%. But it's conventional to quote interest rates on an annual basis, using a simplified, "thumbnail" approximation, called a *nominal* rate. For example, a bank would quote the above rate as "12% A.P.R. (Annual Percentage Rate)."

That's the nominal rate. But now ask the bank for your *effective* (i.e. your actual) interest earned on \$100.00 over 12 months. They do not simply multiply your starting \$100.00 by 12% A.P.R. (that would be simple interest). Instead, they divide the quoted A.P.R. by the number of D. I. P.'s per year (12), to get the D.I.R.* Then they go through exactly the same compounding calculation as you did on page 99—one period at a time.

To put it succinctly: A *nominal* rate is a *simple-interest* annualized approximation often used to *quote* interest rates. The *effective* rate it stands for is then *calculated*—by *compounding* the D.I.R. for a year's worth of D.I.P.'s.

*Canadian lenders do it slightly differently. The Appendix shows you how to convert between the Canadian method and the U.S. method—which is used by the HP 19BII.

Subtlety #2:In your 12-month account problem, you never stopped
to ponder how much interest you had earned after,
say, 2.5 months, or 5.79 months, or 9.61 months.

And why not?

Because you weren't given any rules.

The D.I.R. and D.I.P. define only what the loan balance will be at *one point* in each period (the end). There must be other definitions to determine how that balance goes *between* points.

That's why the points on the graph on page 100 aren't connected with lines. Knowing only the D.I.R. and the D.I.P., nobody can tell you how those lines should be drawn. For all you know, those lines might be drawn like this:



Time

Or maybe interest might accrue like this....



...Or who-knows-what-else. All you know is the balance at one point in each Defined Interest Period.

"Then how <u>do</u> I picture my \$100.00 compound-interest bank account—if I can't draw a nice smooth curve of some kind?

"And what if I deposit into—or withdraw from—my account during those 12 months? How do I include that information in the picture?

"And how does this apply for other kinds of investments?"

Funny you should ask.... 🖙

Getting the Picture Right

Whether it's a note, mortgage, lease or another financial scenario, the underlying TVM principles are the same. But each financial industry may use its own set of terms, so it's best to omit the words altogether *draw a picture*—to analyze the scenario. The picture must show:

- The numerical *value* of the transaction;
- The *direction* of the transaction (*paying* or *receiving* the money), usually shown with (), or ±, or a debit/credit designation.
- The *time* of the transaction. Time adds value to money!

There are many ways to "draw the picture." Here are two of them:

<u>Using a T-Bar</u>

Suppose you invest \$100 now, then \$10 more at the end of every month for 6 months. In return you receive \$40 at the end of month 2, and then your original \$100, plus \$30 more, at the end of month 6. Here's how a *T-bar*—a chronological table of cash-flows—would represent this:

Month (m)	\$Cash-flow
0	(100.00)
1	(10.00)
2	(10.00) + 40.00
3	(10.00)
4	(10.00)
5	(10.00)
6	(10.00) + 100.00 + 30.00

To be sure you build a correct T-bar, follow these rules:

- "Either a borrower or a lender be!" When buying money market shares or putting money into a savings account, you're a *lender*. If you're taking out a mortgage to buy or build a piece of property, then clearly you're a *borrower*. The same scenario will look different, depending upon which view you take. So pick one perspective and *stick with it*.
- 2. The signs (negative vs. positive) of the cash-flows denote the directions of the transactions. A *positive* amount means that you *receive* money; a *negative* amount means you *pay* money.
- 3. The cash-flows proceed forward in time from top to bottom in the chart—and the *same period of time* separates each cash-flow. This period must be the D.I.P. (Defined Interest Period) to match the assumptions of your HP 19BII.
- 4. When multiple transactions occur simultaneously, *you combine them* into one net transaction. For example, these two scenarios are entirely equivalent:

m	\$	т	\$
0	(100.00)	0	(100.00)
1	(10.00)	1	(10.00)
2	(10.00) + 40.00	2	30.00
3	(10.00)	3	(10.00)
4	(10.00)	4	(10.00)
5	(10.00)	5	(10.00)
6	(10.00) + 100.00 + 30.00	6	120.00

Using a Cash-Flow Diagram

A *cash-flow diagram* is a good way to represent and understand an investment scenario *visually*. For example, observe how a cash-flow diagram would represent this same T-bar scenario:

Month (m)	\$Cash-flow
0	(100.00)
1	(10.00)
2	(10.00) + 40.00
3	(10.00)
4	(10.00)
5	(10.00)
6	(10.00) + 100.00 + 30.00


Of course, just as with T-bars, there are certain rules for drawing cashflow diagrams—and you'll notice a lot of similarities:

- 1. "Either a borrower or a lender be!" In drawing the diagram, *pick one perspective and stick with it.*
- 2. The cash-flows proceed forward in time from left to right on the diagram—and the *same period of time* separates each cash-flow. This period must be the D.I.P. (Defined Interest Period) to match the assumptions of your HP 19BII.
- 3. The *directions* of the vertical arrows denote the directions of the transactions. An *upward* arrow means that you *receive* money; a *downward* arrow means that you *pay* money:



4. Whenever multiple transactions occur simultaneously, you can net them together. This:



Whichever method you choose—T-bar or diagram—use it! You can't solve a problem if you can't describe it correctly first.



Discounting Cash-Flows

One of the real values of TVM is that you can use it to make the scenario simpler—actually *adjust* cash-flow amounts to get a clearer picture of the situation. Go back to your \$100.00 sitting in the bank account for 12 months. Of course, you can withdraw your money from the account at any time, but suppose you want to see your options for withdrawing at the end of each of the first six months. Here's how those six options look on T-bars:

т	\$	m	\$	т	\$
0	(100.00)	0	(100.00)	0	(100.00)
1	101.00	1	0.00	1	0.00
2	0.00	2	102.01	2	0.00
3	0.00	3	0.00	3	103.03
4	0.00	4	0.00	4	0.00
5	0.00	5	0.00	5	0.00
6	0.00	6	0.00	6	0.00
т	\$	m	\$	m	\$
0	(100.00)	0	(100.00)	0	(100.00)
1	0.00	1	0.00	1	0.00
2	0.00	2	0.00	2	0.00
3	0.00	3	0.00	3	0.00
4	104.06	4	0.00	4	0.00
5	0.00	5	105.10	5	0.00
6	0.00	6	0.00	6	106.15

Each of these withdrawal amounts is equivalent to any other, *considering the time involved*. This is indeed the *Time* Value of Money.

And here's how these same six variations look on cash-flow diagrams it's like playing "What-If?" with your withdrawal:



The point is, each of these scenarios is entirely equivalent. You are really just "sliding" one cash-flow (your proposed withdrawal) *across time*. The earlier in time the cash-flow's position becomes, the smaller its amount becomes. This process is called *discounting*, and it's one of the fundamental tools offered by TVM analysis.

To repeat: You can slide any cash-flow across a cash-flow diagram (or up/down the list of a T-bar) and retain complete accuracy as long as you adjust it according to the prevailing interest rate. If the cash-flow is sent forward in time, it increases in amount; if it goes back in time, it decreases (and is said to be *discounted*).

So here's what you know about the Time Value of Money so far:

- You know the difference between the two types of interest. Rates are often *quoted* with *nominal* (simple-interest) annual values but *calculated* via *effective* (compound-interest) periodic values;
- You know that the HP 19BII's TVM uses Compound Interest;
- You know how to draw T-bars and/or cash-flow diagrams;
- You know that you can slide cash-flows along the timeline and keep the picture entirely accurate, as long as you adjust those cash-flows according to the prevailing interest rate.

What you *don't* know (yet) is how to draw a diagram for your HP 19BII. After all, it's supposed to do the calculating. How can the machine possibly "see" or "understand" a picture that you've drawn on paper?



Discounting Cash-Flows

Drawing the Picture for Your Calculator

Time to rev up your machine. From the MAIN Menu, choose these menu selections: **FINETWE**.

You'll see something like this:



(Change the display setting back to FIX 2, also)

This is the TVM Menu. The first five selections here are the keys you use to draw a cash-flow diagram for your calculator:

N
IXYR
PV
PMT
FV

Number of Defined Interest Periods (D.I.P.'s) Interest % rate per YeaR Present Value PayMenT Future Value

You're soon going to be very adept with these keys.



5. THE TIME VALUE OF MONEY: TVM

The keys form a picture frame over a cash-flow scenario:



The first thing to look for in this picture is a pattern of steady, regular cash-flows-one per D.I.P.-throughout the time line. If you have uneven or irregular cash-flows along the timeline (except for the ends), you can't use TVM (as shown above, the cash-flows may be \$0.00, but they must be level and regular throughout).

The reason for this restriction is TVM's **PMT** (PayMenT) key. When describing a cash-flow scenario to your calculator, you must put this steady, level cash-flow amount into the PMT register on the TVM Menu.

And here's what the other four TVM keys mean to your picture frame:

N represents the Number of periods (D.I.P.'s) from one side of the picture frame to the other.

PV is the Present Value, which is the net cash-flow (if any) that occurs at the *left* side of the picture frame, *over and above* any PMT cash-flow that may *also* occur there.

FV is the Future Value, which is the net cash-flow (if any) that occurs at the *right* side of the picture frame *over and above* any PMT cash-flow that may *also* occur there.

So, for example, to describe the diagram under your picture frame on the previous page (your \$100 bank account, assuming you wait until after month 6 to withdraw), here's what you would tell your HP 19BII:

$$N = 6$$

 $PMT = 0.00$
 $PV = -100.00$
 $FV = 106.15$

Notice that anytime you have a cash-flow paid *out* (i.e. from you to the other party), you show it on your diagram with a *downward* arrow, and you *tell it to your calculator with a minus sign* (remember the \pm /- key?). By opening your bank account, you *loan* the bank \$100.00, so this is an *out*flow of cash (downward) on your diagram—and a *negative* 100.00 in your calculator.

But what about I%YR—the fifth key on your TVM Menu? The interest is the "glue" that holds the picture frame together.

All you really know is that the D.I.R. is 1% per month, right? But notice that **OTHER** item on your menu. Press it. Here's what you'll see:



This is the second page of the TVM Menu. Here you can vary certain parameters that affect the outcome of TVM calculations.

For example, notice the message: 12 PMTS/YR: Your HP 19BII is telling you its current assumption about the "picture" you're "drawing" for it: 12 payments per year.

Is this correct for your bank account problem? You don't really make any PMT's (withdrawals or deposits), do you? No, but there are 12 PMT's per year, nevertheless—because the number of payments per year is always the number of periods (D.I.P.'s) per year. There's always one PMT per period—even if it's zero; that's what you mean by a PMT that steady, level, once-per-period cash-flow.

Since the D.I.P. is one month, there are 12 payments per year—no need to change that message (which you could do by using the **PAYR** key).

Now EXIT to return to the TVM Menu.

OK, so there are 12 PMT's per year. How does this help you determine the interest rate in your "picture frame?"

It helps a lot: It means that you can *key in the I%YRas an A.P.R.* (recall the discussion on page 101). That is, I%YR is the annualized approximation you use to *conveniently specify* the interest rate. And, just like the bank* with its quoted, *nominal* A.P.R., the calculator knows that it's supposed to divide the I%YR by the number of PMT's per year to get the actual D.I.R. to do its compounding:

Therefore, saying that

... is really saying that

And in this problem, that's

A.P.R. \div D.I.P.'s/Year = D.I.R. I%YR \div PMTS/YR = D.I.R.

 $12\% \div 12 = 1\%$



Seem complicated? The point is, *all you need to key in* is the 12%—the I%YR. Then, as long as the machine knows the right number of PMTS/YR, it knows how to convert the annualized I%YR to the actual D.I.R.

*Just like a U.S. bank, that is. For a Canadian mortgage, you need to perform a quick conversion to arrive at the correct A.P.R. to match the HP 19Bu's U.S. assumptions. See the Appendix.

So now you know all five TVM variables in the picture of your bank account—the scenario where you withdraw after the sixth month:



And here's the completed picture frame around the scenario:



Of course, normally, you need the calculator to *compute* one of these five variables for you—after you tell it the values for the other four. But you can always test your calculator to see if it agrees with these values. Do that now: Give it any four of the five values and see if it comes up with the missing value—the missing piece of the "picture...."

Verify: Try solving for Future Value. That means you need to key in the other four TVM values. From the TVM Menu, press



Things to notice and remember:

- 1. Remember that pressing a menu key can mean either to store or to calculate—depending upon what you did just previously.
- 2. You could have keyed in the N, the I%YR, the PV, and the PMT *in any order*—just so you have them all in there when you ask for the FV. *You may solve for any of the five variables, but you must always specify the other four*. Never ignore a variable or assume that it's zero and therefore irrelevant!
- 3. The machine obeyed its own sign convention: Since your PV was negative (meaning cash out of your pocket), it figured that FV must be the pay-off—when the cash comes back—there-

fore, positive. In fact, the machine *insists* that PV and FV be of opposite sign—to keep this idea of investment and return. If you give it a PV and FV of the same sign (when solving for PMT, for example), it beeps with a NO SOLUTION message, because you *must* have at least one investment and one return in any meaningful TVM problem.

4. Most importantly, now that you have all the parameters in the TVM registers, you can play "What-If" simply by changing the number of months you leave your money in there. For example, by pressing 1 N H FVM, you change the analysis to the case where you withdraw your money after 1 month. By pressing 2 N FVM, you do the 2-month scenario, etc. You use the TVM keys to "slide" a cash-flow (your withdrawal) up and down the timeline—just as you did on paper (page 113).

So, what if you let your account grow for a full 12 months? How about 50 years (600 months)? The answers to each of these are merely variations on the same procedure. You're varying one parameter (N, the number of periods), preserving three others, and checking to see how this affects the fifth parameter (Future Value). And remember: as with all menus, you never need to re-key in any number once it's stored in a TVM Menu register. It's there to be used—or varied—over and over again.



Drawing the Picture for Your Calculator

A Typical Mortgage Problem

Now it's time to put TVM into practice with something more exciting than a bank account. After all, what's life without a good mortgage?

Like This One:	You're buying a \$120,000 property by paying down \$20,000 and financing the rest on a 30-year mort- gage with monthly payments. The quoted A.P.R. is 12.00%. What is the monthly payment?*
Solution:	You can't solve this problem until you fill in some details that aren't specifically spelled out:
	• Is the monthly payment at the beginning or at the end of the month?
	• What is the D.I.P.?
	• What is the D.I.R.?
	• Why do you care about these things?

*If you already know how to solve this, go to page 128. Note: Laws for quoting mortgage rates in Canada differ slightly from the U.S. To use the HP 19B11 under Canadian rules, see the Appendix.

BEGIN or END?

Does it make any difference whether the payment is at the beginning or at the end of a month? After all, isn't the beginning of one month the same as the end of the previous one? Compare the two scenarios:



As you can see, in the first case, a payment is due at the beginning of the loan—right when you sign the papers. This reduces the balance sooner, so there is *less interest* to be paid on the borrowed money. With less interest to be paid, the PMT amount (which covers both principal and interest) will be less; indeed it does matter whether the payment is at the beginning or at the end of the month. So what about your mortgage? Which is it-BEGIN or END?

In a real contract, it would have to be stated, of course, but for this problem, just assume the more common case—the **END** of the month. So, how do you tell your HP 19BII to assume this too?

Like This: From the TVM Menu, press **OTHER** and see this again:



Notice the two keys, there, **BEG** and **END**.

Press them alternately and notice the change in the message in your display (but be sure to leave it in END MODE for this problem).

Don't forget to set this mode to match the specifications of the loan you're computing. And remember to check this for each new TVM problem; except when you first arrive at the TVM Menu, you can't usually tell which of these two modes your calculator is using.

Next detail to clear up:

What's the D.I.P.?

The problem says 12% A.P.R.—and it's compound interest, of course but it doesn't say how *often* this interest compounds. Is it yearly? After all, A.P.R. does stand for <u>Annual</u> Percentage Rate.*

Well, yes and no: Yes—that's what A.P.R. means, but no—the compounding isn't yearly. It's monthly.

How do you know? Because the payments are specified as monthly, and unless told otherwise, you can assume that the payment period is the same as the compounding period (and vice versa).

Thus, the Defined Interest Period (D.I.P.)—the period over which interest *actually* compounds—is a month. And now you need to tell your HP 19BII this detail also....

Clue It In:	From the second "page" of the TVM Menu (use OTHER to
	get there), press 12 PAYR .

(Your display probably already shows 12 PMTS/YR, but do this anyway, just for practice.)

*Remember that Canadian quoted rates must be converted to an equivalent U.S. A.P.R., which will be different than this 12%. For details, see the Appendix.

And so what's the D.I.R.? What's the monthly rate of interest that corresponds to an A.P.R. of 12.00%?

It's "12% divided by 12 months/year," or 1%/month (recall the discussions on pages 101 and 116). You may sleep better tonight knowing this, but you don't need to tell your calculator—it will *assume* it.*

The nominal A.P.R. used to compute a loan payment is exactly what I%YR means to the HP 19B11.

That is, to arrive at the actual interest rate to use in its calculations, a bank would take this *nominal* A.P.R. and divide it by the number of compounding periods in a year.

So whenever you see a nominal A.P.R. specified for the purposes of computing a payment or a balance, just make sure that your P/YR is set properly and then use that A.P.R. as your I%YR.*

*It's this assumption that forces Canadian lenders and borrowers to do a little interest conversion before supplying the HP 19B11 with an "A.P.R." Again, see the Appendix for details.

The Typical Solution

Finally, you're ready to solve this mortgage problem. Here's the scenario in diagrams again. Notice how it takes your perspective—the borrower. The loan amount is shown as positive (you *receive* it), and each PMT amount is negative (you *pay* it).



Simply by looking at the picture, you can read off the values you need for the TVM registers:



Note how the HP 19BII knows that this PMT must be negative (a cash *out*flow). It, too, obeys the sign convention.

Question: How did you know that FV (Future Value) was zero?

Answer: The problem didn't specifically *say* there's anything left to pay at the end of the 30 years, so you can safely assume there isn't. That is, the payments completely *amortize* (literally: "kill") the loan in 360 months.

> If it were otherwise, the problem would have specified an amount then due in a lump-sum payment—called a *balloon* payment—at the end of the 360-month term.

So you know that FV is zero. *But even so, don't ignore it.* Zero is a number just like any other, and your calculator always uses four TVM numbers to solve for the fifth. If you had forgotten to specify your FV for this problem, your machine would *not* have *assumed* zero. It would have used the number it found in the FV register—no matter what that value was or when it was put in there.

Remember! A number in the continuous memory of the HP 19BII is like a budget deficit: It won't melt back to zero just because you ignore it.



The Typical Mortgage Checklist

Review in your mind the checklist of all the little invisible steps you took to actually calculate the payment on that \$100,000 mortgage.

- 1. You got a verbal description of the loan.
- 2. You decided on the *annuity* mode. In other words, do the payments come at the END of the month (also called "annuity in arrears") or at the BEGINning of the month (also called "annuity in advance")?
- 3. You interpreted the terms of the loan in order to arrive at the proper D.I.P. and thus the D.I.R. You set the P/YR accordingly and observed that the A.P.R. given in the problem can be used directly as your I%YR.
- 4. You drew the correct picture of the problem from your perspective as a borrower, thus establishing the directions of the cashflows (up or down on the diagram, + or - in your calculator).
- 5. You observed that since no mention was made of any balloon payment, the mortgage must be completely amortized after the 360th payment. So the Future Value (FV) was zero.
- 6. You plugged in all known values: N = 360 months, I%YR = 12.00, PV = 100,000, FV = 0. Then you solved for PMT.
- 7. You realized that most of the real problem is in defining it; the keystrokes are easy.

Variations on a Theme

So there you have it: a \$1028.61 monthly mortgage payment, assuming that your payment comes due at the **END** of the month.

Question:	What if it were at the BEGINning of the month? What would your payment amount be? From the comparison diagrams on page 121, can you tell whether it's more or less than the END mode payment?		
Solution:	Don't touch any of the values you now have in the five TVM registers. Just go to the OTHER Menu and change the annuity mode from END to BEGIN.		
	Now EXIT) back to the TVM Menu, and solve for PMT. <u>Answer</u> : PMT=-1,018.43		

About ten bucks a month *less*—not a whole lot, you might think. But over 360 months, that works out to be over \$3,600 in interest saved.

And keep in mind how you're saving this interest—it's not from a lower rate: With BEGIN mode, you're still paying the same interest *rate*, but you save money, because you are borrowing for a slightly shorter *time*.

From the diagram on page 121, you can see that you're actually making each payment one month earlier than in the END mode scenario.

Well, in either BEGIN or END mode, that payment's a little steep for your budget. But you do want the house, so now you're going to use the "What-If?" abilities of your HP 19BII to shop for better loan terms....

- **O Joy:** Up jumps a lender who offers you all the same terms—360 months, payment at the end of each month, etc.—*and* it's only a 10.5% A.P.R.(!) What will your payment be?
- Easy: Again, leave all your TVM parameters alone, except for the ones you're now going to vary:

Press **OTHER END**, to set the annuity mode. Then **EXIT**. Now, the only thing you need to change is the I%YR, right?

Prove this by *recalling* each of the five TVM registers (menu variables are just registers you STO) into and RCL from):

RCLN	N=360.00	Don't change this.
	I%YR=12.00	Change this.
RCL PY	PV=100,000.00	Don't change this.
RCL PMT	PMT=-1,018.43	Recalculate this after
		changing I%YR.
RCL FY	FV=0.00	Don't change this.

OK, so change the interest rate: 10.5 INF.... And recalculate PMT : PMT=-914.74

Well... that's better—about \$100 lower on the payment. But what if it's still too high? Suppose your absolute limit for a principal-and-interest payment is \$900.00. That's fine—but it will mean that at the end of the 360th month, you'll have a lump-sum balloon payment to make—to pay off the remaining balance. After all, you *know* there'll be a remaining balance—the machine just told you that it will take \$914.74/month to *completely* amortize this loan in 360 months. If you pay even slightly less per month than that, there'll be some leftover to pay at the end.

So here's how the scenario looks:	m	\$
	0	100,000.00
	1	(900.00)
	2	(900.00)
	3	(900.00)
	:	(900.00)
	:	(900.00)
	360	(900.00)+(FV)



What you want to know is: How much is that final balloon payment?

Find Out: Again, three of the five TVM parameters are already correct (the term, N; the interest rate, I%YR; and the Present Value, PV). What you will do now is *specify* the payment (rather than calculate it), and then find the Future Value that would result.

Press 900+/- PMT (remember why this should be negative?), and solve for the remaining balance:

Answer: FV=-37,089.98

Remember the definition of Future Value! This represents the amount you would have to pay *over and above* your final (360th) payment—and it's negative, as it should be, to indicate who's paying it (yep—it's you). Since this is an END mode problem, your last PMT occurs at the same time as this balloon payment.

As you can see, then, you *could* lump those last two cash-flows together and write just one check if you wanted. Just be sure that you don't forget what each part means. Sometimes, the terms of a contract won't itemize this final combined payment, and if you try to confirm such terms by using that *combined* total as your Future Value ... well, that's not what your HP 19BII means by Future Value. You need to subtract out the amount of the final PMT.

Looking at the T-bar and cash-flow diagram on the previous page here, you can see how clearly and succinctly it shows all this information. *You'll never get confused if you get the picture right*. So, here's what you've decided: You want to borrow \$100,000.00 at 10.5% A.P.R., repaying it in 360 end-of-month installments of \$900.00, plus a final balloon payment of \$37,089.98 ...OK?...

No? Now what's wrong?

Oh—the balloon's a bit much, eh? It's amazing what "a little less" each month adds up to over thirty years, isn't it? All right, but you realize, of course, that a lower balloon will demand a slightly higher monthly payment; you'll be breaking your \$900.00 monthly payment ceiling—by few more bucks a month now—to save thousands over thirty years.

How big a balloon payment could you stand—say, \$20,000? Fine. Now check to see what PMT this will demand.

Not Much More:	As usual, change only the values you need to
	(this is routine by now, no?): Press 20000
	+/- I FI to specify the balloon amount. Then
	press PMT to find the corresponding payment.

```
<u>Answer</u>: PMT=-906.79
```

See how powerful this "What-If?" ability is? And you can review your variables at any time with the RCL key (RCL **EXYR**, etc.):

360	10.50	100,000.00	-906.79	-20,000.00
N	I% YR	PV	PMT	FV

So you can live with those terms. The only problem is, your lender with the 10.5% A.P.R. won't agree to anything less than full amortization—no balloons. In fact, he's encouraging you to consider even *higher* payments, to shorten the term of the loan down to 25, 20, even 15 years.

Of course, you already know you can't afford this much every month, but now that you've got a machine like the HP 19BII, it doesn't hurt to play some more "What-If?" So, *what if* you had the same financing rate and amount, but only, say, a 20-year term? Your scenario would be:

т	\$
0	100,000.00
1	(PMT)
2	(PMT)
3	(PMT)
:	(PMT)
:	(PMT)
240	(PMT)



Play With the Term:	Find the payment amount necessary to fully amortize this loan in 25, 20, and 15 years.
Solution:	Change only what you need to, and leave the rest of the five parameters alone: [25]X[12](ALG) or [25]INPUT 12X(RPN) [N] (a shorter term). Then [0] FV (no balloon), and solve for FMT Answer: PMT=-944.18
	Not much more than the \$914.74—for 5 years' fewer payments! What about 20 years? 20×12(ALG) or 20INPUT 12×(RPN) NE, then PHT Answer: PMT=-998.38
	Try 15 years: 15×12 ALG Note Hen

Answer: PMT=-1,105.40



Did you realize that for less than \$200 more per month, you could cut your mortgage term in *half*? Not bad—if you could scrape together that extra \$200/month. But you can't, so you shake the fellow's hand, thank him for his eye-opening offer, and head on down the road.... Feeling slightly discouraged at this point, you start to wonder if you can really afford this house after all....

- Sigh:You had set your upper monthly payment limit at \$900.00,
but even that was pushing it. What you *really* wanted to get
away with was about \$800.00 or less—and no balloon.
- **Check:** How much house could you finance at 10.5% A.P.R., with 30 years of \$800 end-of-month payments?

Here's how the TVM registers should look right now (and you can verify these with the RCL) key, remember?):

180	10.50	100,000.00	-1,105.40	0.00
N	I% YR	PV	PMT	FV

This time, you're varying the PMT and calculating the Present Value—the amount you can finance over 30 years:

```
      30×12 (ALG) or 30 INPUT 12× (RPN)

      800+/-

      FM

      (the payment you'd like to make)

      find how much you could finance)

      Answer:
      FV=87, 456.61
```

So if you could come up with about \$22,500 for a down-payment on that \$110,000 house, you'd have an \$800.00 monthly payment. But you've only got \$10,000 for a down-payment, and you *do* want the house, so stick to your \$900 limit (with a \$20,000 balloon) and keep looking....

The next bank down the road seems to have a better deal for you. Here's a lender who will loan you \$100,000 in exchange for \$906.79 endof-month payments for 360 months. Period.

Same payments—but no \$20,000 balloon—what a deal!

"Uh... what's the catch?"

This: There's a *loan fee* (also known as "points") due and payable at the moment you sign the papers. This fee is 2% of the amount financed, but it's not an early installment on the loan; you still have to pay 360 full payments of \$906.79 each.

Is this really a better deal than the \$20,000 balloon? Better find out. Start with the T-bar and diagram: $m \mid$



Still, it's hard to tell which is the better deal for you. How can you use your TVM calculations to help?

Think about it: On page 132, you *know* you're paying 10.5% A.P.R. that's what you specified to calculate your PMT. But this lender here just pulled a payment amount out of the air. What's the interest rate he was using to do this?

Hmm... Let your HP 19BII tell you. Here are the current contents of the TVM registers:

360	10.50	87,456.61	-800.00	0.00
Ν	I% YR	PV	PMT	FV

You need to change only PV and PMT. First, press **98000** Since you net together all simultaneous cash-flows, what with the \$2000 fee (2% of \$100,000), you're *not* getting a \$100,000 loan. It's a \$98,000 loan—but you're still paying \$906.79 a month for 30 years.

So press 906.79+/- PMT then IWE to find the real A.P.R... Answer: IYR=10.64

Aha! That loan fee effectively raised the rate *above* 10.5% A.P.R. you're looking for—not so good!

By using just fundamental TVM skills and your HP 19BII's "What-If?" ability, you saved yourself from an expensive mistake (and the calculator probably paid for itself several times over)!

Interest CONVersions

More confident now, you continue your search for the elusive Perfect Mortgage.... Finally, you find a bank that agrees to your payments, balloon, and a 10.35% rate(!)—but this is a rate that compounds *daily*.

That calls for a little thought.... An *effective* yield is higher than a *nominal* (quoted) rate, since interest compounds. For example, your \$100 bank account yields you \$112.68 after one year—because the 12% quoted A.P.R. is actually compounded at 1% per month for 12 months.

But when competing for borrowers, a lender wants to put his rates in the best possible light. So, if he's allowed to quote a 10.35% nominal rate alongside its higher effective yield, he'll probably want to emphasize the nominal rate—the lower number is simply more attractive to the loan shopper.

The point is, the more often you compound, the bigger this difference becomes—between the nominal rate and the effective yield. And you can prove this.



Prove It: Use the HP 19BII to find the *effective* yield on a nominal annual rate of 10.35%, compounded:

(i) annually; (ii) semi-annually; (iii) quarterly;(iv) monthly; (v) semi-monthly; (vi) weekly; (vii) daily

Like So: EXIT from the TVM Menu and notice the **TONN** selection. This is a side-calculations menu for converting between interest rates. So press **TONN**... Then, since you want *periodic* interest conversions (converting from one period to another), press **PER**. Here's what you'll see:

EFF%=NOM% COMPOUNDED P TIMES PER YEAR 10.64 NOME FFF

Just like any other "What-If?" menu, you key in any two variables and solve for the third. Here you know the NOMinal rate (10.35%) and you have some values to try for P (the number of Periods to be compounded) to see what EFFective yields they produce:

10.35 NOME 1 For EFFE EFF = 10.35 10.35% compounded once a year is just 10.35%. But now try 2 For EFFE EFF = 10.62 That's the effective yield for *semi-annual* compounding. And 4 For EFFE EFF = 10.76 (quarterly) Well, you get the idea. Try the rest of the compounding periods (P = 12, 24, 52, and 365) on your own. As you'll see, the effective rate for 10.35% compounded daily is 10.90.

"This lender is charging me 10.90% ??? That's way too high!"

Not so fast. That's the *effective* rate. You're trying to compare that to a 10.5% *nominal* rate—like comparing apples and oranges. Besides, it's a nominal rate that the HP 19BII needs for its I%YR, since it then converts this to a D.I.R. according to its assumptions.

So, what nominal rate—compounded monthly—*is* equivalent to 10.35% compounded daily? Use the ICONV Menu to find out....

Do It: At the (periodic) interest conversion Menu: 10.35 NOME 365 FFE EFFE EFF%=10.90 You've already done this much.

Now just 12 P NOME NOM%=10.39

See? You can use this menu to work in either direction—from nominal to effective or vice versa.

That's the A.P.R. this bank is really quoting you. It's higher than it looked—but it's still less than the A.P.R. you were hoping for! And that means you'll actually have a slightly *smaller* payment or balloon than you were willing to accept.

Go for the smaller payment....

Choose: Leaving the interest conversion (19.39) right where it is, go back into the TVM Menu (EXITEXITETIC). Then, once you're there, the first thing you do is press STO INTER (don't just press INTER, because that would be asking the calculator to *calculate* I%YR, which is not what you want).

> Now you're ready to figure your payment: N=360.00 (don't touch it) IXYR=10.39 (you just stored this—don't touch it) PV=100,000.00 (you'll probably need to key this in) FV=-20,000.00 (key this in, too)

```
Solve for PMT : PMT=-898.64
```

That's less than your \$906.79 for the monthly compounding case, which makes sense: The equivalent A.P.R. here is 10.39, rather than 10.5.

At last—a mortgage with a \$20,000.00 balloon <u>and</u> payments of less than \$900! All your shopping around and "What-Iffing" with your HP 19BII has finally paid off. Congratulations (take a bow).



Interest CONVersion Review

Here's a summary of how to convert an interest rate with differing compound and payment periods, using the ICONV Menu. Remember that the idea is to find the rate to use in TVM (with TVM's assumptions) that produces the same *effective* result as the quoted rate:



And keep in mind that this conversion can go in either direction.
One more conversion example—just to be sure you've got it....

- **Example:** You're making monthly payments on a \$88,500 loan for 25 years. The rate is 12.75%, compounded *daily*. What's the equivalent I%YR you would use in TVM?
- **Solution:** At the ICONV Menu, convert the daily-compounding rate to an equivalent monthly-compounding rate:

12075) NOM2
365 P	
EFF%	(EFF%=13.60)
12 P	l
N0M2	Answer: NOM%=12.82

Notice that each step here matches the step on the opposite page—no magic, no mystery.



By now, you should know how to handle these types of problems:

- A simple, fully-amortized loan with annuity either in arrears (END) or in advance (BEGIN);
- A loan with a balloon payment;
- A loan with prepaid fees (also called "prepaid finance charges" or "points up front");
- Conversion of an interest rate that compounds over a different period of time than the payment period;

If those are the typical kinds of problems you face each day, then you might wish to skip now to the quiz (on page 160).



Or, if you want to explore some other kinds of TVM before you try the quiz, then just continue on right here....



AMoRTization Schedules

The most common questions you'll want to answer after you know the terms of a mortgage are:

"How much interest and principal am I paying every year? And what's my remaining balance?"

Well, the HP 19BII has an additional feature on the TVM Menu to help you answer these very questions.

Try This:From the TVM Menu, select OTHER. Notice an item here
that you haven't used yet: Press MMRT, and see this:



An AMoRTization schedule is an itemized computation of the amounts of principal and interest ("P and I") paid over any given number of periods within the term of a mortgage. You'll want to know at least the amount of interest you've paid each year, because it's usually tax-deductible.

The AMRT Menu is a set of side calculations—much like the ICONV Menu—but AMRT has an added advantage: *It uses the values directly from your TVM registers;* that's why it's located on the TVM Menu. To get a feel for AMRT, look at your original house loan again: It was a 30-year, fully-amortized mortgage for \$100,000 at 10.5% A.P.R., with monthly payments in arrears, and a balloon of \$20,000 at the end (this was before you found that attractive 10.35% loan).

Try This: Use the AMRT Menu to find the principal and interest you would pay in each of the first three years—and the remaining balance still due after the third year.

Solution: First, fill in the usual TVM parameters:

EXIT EXIT to return to the TVM Menu, then 360 N 10.5 IZYR 20000 FV 20000 FV END EXIT PMT Result: PMT=-906.79

This payment ought to look familiar. It was what you had settled on as "acceptable," with a \$20,000 balloon.

Now go to the AMRT Menu, by pressing **OTHER HMRT**. Then just follow the displayed directions:



Since you want to look at 12 payments (one year) at a time, just press 12 #P



There are the remaining balance and the total interest paid in payments 1-12 (the first 12 months of the loan)! To see the principal paid in this same period, just press **PRIN**.... **PRINCIPAL=-400.39**

Notice that your payments show as negative numbers here—because AMRT follows the same sign conventions as the rest of the TVM Menu. That makes sense, right?

But here's the best part: To amortize the NEXT set of 12 payments, just press **NEXT**.... Not bad, eh?

You can go all the way through the life of the loan this way. To start over from the beginning of the loan, just **EXIT** from the AMRT Menu, then re-enter it again with the **AMRT** key.

Play around with the AMRT Menu items on your own a little bit. Notice especially the selection called **THELE**. It lets you *print* any portion of the amortization schedule, if you have a printer.

One other note about AMRT: As you know, your HP 19BII uses 12 digits in its arithmetic, including the TVM calculations. *But AMRT is a rare exception to this rule.*

Look: Recall the current value in the PMT register (from TVM, press RCL FMT). You'll see this: PMT=-906.79

But now SHOW all of its digits (press SHOW).... That's what the payment *really* works out to be (to nine decimal places, at least): PMT=-906.791435594

But nobody writes a check for that much, right? So even though this is the amount you would need to pay every month to *exactly* amortize that 30-year mortgage, you won't be paying that. To be accurate, you need to use the true amount to the nearest penny (here it would be rounded down: 906.790000000).

Sokey it in: 906 • 79+/- PMT . And now recalculate the FY

You get FV=-20,003.61 What does this mean?

This: Since you had to round your payment down slightly (by a fraction of a penny), you've technically (mathematically) *underpaid* your loan by \$3.61. Therefore, your \$20,000 balloon payment at the end of the loan is *increased* slightly.

AMRT uses the TVM values, too, but it doesn't use unrealistic "penny fragments" that those TVM registers may hold. Except for the I%YR variable (which is always used to 12 digits), the AMRT Menu uses TVM values only up to the *displayed* number of digits.

In other words, if you have your display set to FIX 2 digits (for dollars and cents), the AMRT calculations will automatically round its own copies of PV and PMT in the same way—so that you always end up with a realistic and verifiable amortization schedule.

Prove It: Go back and run the AMRT example on pages 146-147 again—but with a DISP ALL setting.... Then try it with a FIX 4 setting.... See how the results differ slightly?

So although you'll normally keep a FIX 2 setting, it's instructive to see and understand this difference—to avoid any unnecessary misunderstandings with the bank.



AMoRTization Schedules

Other Side Calculations

The TVM Menu is designed to handle one basic kind of interest-bearing situation—an amortized installment loan (such as a mortgage). The TVM Menu can handle *only* regular installments over regular periods, with interest compounding each period. So while it's very useful for analyzing investments with cash-flow diagrams, sometimes you need to do other, preliminary calculations simply to construct those diagrams. That's where the "side calculations" menus come in handy.

You've already seen how to use one of these side calculations menus the ICONV Menu—when you need to determine a proper I%YR to use in the TVM Menu. But there are a couple other such side calculations menus that you ought to look at now....

Do This: Go to the MAIN Menu (press MAIN). Press FINE.... There, alongside the TVM selection you've come to know and love, you'll see several other choices:



You've already seen the ICONV Menu. And CFLO is another major cash-flow diagram analysis tool (like TVM) the subject of the next chapter. But the two other choices are indeed side calculations menus: **EONO** and **DEPRE**.

<u>Bonds</u>

A bond is just another kind of loan, but it has different conventions than those of the TVM Menu. A bond is simply a piece of paper that acknowledges an interest-bearing debt from the *issuer* of the bond (the borrower) to the *holder* (the lender). The issuer usually makes *interestonly* payments once or twice a year. The bond specifies the amount of this interest (the *coupon rate*), when it is paid (the *coupon dates*), and when the principal amount is to be repaid (the *maturity date*):



Furthermore, bonds are generally designed to be *negotiable*. That is, they may be freely traded at any time* and for any price.* Thereafter the issuer must pay the interest (and the principal, at maturity) to the *new* holder. This makes for some complications when calculating your yield or the price you should pay, because the dates upon which you buy or sell a bond may not coincide with its coupon dates or maturity date:



This is why you can't put a bond scenario on a TVM-compatible cashflow diagram—because the time periods may be *irregular*.

*within all applicable laws and the terms of the bond's original issuance, of course.

Try One: On July 3, 1990, you buy a municipal bond that matures on August 30, 1994 for \$100. The bond's coupon rate is 6.75%, with semi-annual payments, calculated on a 30/ 360-day basis (30 days/month and 360 days/year). What is your yield to maturity if you paid a price of \$96.50?

Solution: Press the **EOND** selection and see this menu:

TYPE SETT MAT CPN% CALL MORE

Specify the TYPE of bond you have: Press **TYPE SEMI** and **SEO** to select the coupon payment frequency and the calendar basis, respectively.

Now EXIT and key in the SETTlement date (the date when you buy the bond): (7.031990 SETT... ...and the MATurity date: 8.301994 MAT... ...and the CouPoN percentage rate: 6.75 CPN?... ...and the CALL (maturity) value: 100 CALL....

Now MORE, 96.5 PRICE VLCK.... Answer: YLD%=7.75

Easy, no? There's not a lot more to say about calculating with bonds. Just key in all the particulars and grind out the answers. You'll get some more hands-on practice in the upcoming quiz, but here are some reminders and things to consider about the BOND Menu:

- No matter whether the coupon is paid annually or semi-annually, the rate you key in is the *annual* coupon rate.
- Key in dates according to the current date format. This example assumed that your HP 19BII was in MM.DDYYYY date mode.*
- Sometimes a bond may have one or more optional "pay-off" dates—earlier than the maturity date. This is a *call date*, and the HP 19BII allows for it (just key it in as the MATurity date) *as long as it coincides with a coupon date* (a date when interest is paid).
- A call value may be different from \$100, but the maturity value must be \$100, the conventional basis for face value. Thus, all calculated values represent *percentages of the face value* of your bond. The "pay-off" value—whether it's the face value or some other call value—must always go into the CALL register. However, for convenience, the calculator *automatically* puts 100.00 into the CALL register whenever you press CLEAR DATA.
- Unlike some of the other "What-If?" menus you've seen, most of the values on the BOND Menu are for input only; you can't solve for them. Only PRICE or YLD% may be your unknown—and you must key in one to get the other.
- When you buy a bond on any date other than a coupon date, in addition to the price, the seller is also due the as-yet-unpaid interest accrued since the last coupon date. So after calculating either the price or yield (whichever is your unknown), just press **ACCRU**. Result (for this example): **ACCRU=2.31**

*You can change this format: Press MAN TIME SET MAD, then MAN FIN BOND to return to the BOND Menu. Date formats are covered in Chapter 8.

Depreciation

The final topic of this chapter is another "side-calculation" menu you may need when constructing a TVM diagram.

Usually, when you think of the Time Value of Money, it's an investment or account that gains value over time. But depreciation occurs when an asset *loses* value over time. It starts at its cost or other BASIS value, then, over its useful LIFE, depreciates to its SALVage value. The total value lost over the LIFE ime is called the *total depreciable value*.

Example: You're buying a piece of equipment for \$40,000. You estimate it to have a useful life of 5 years and a salvage value of \$10,000. What amounts should you recognize as depreciation in each of those five years?

Answer: First of all, identify the BASIS value. Usually, this is the cost: \$40,000. You know the SALVage value is \$10,000, and so the total depreciable value—the difference—is \$30,000. This is the total capital value you expect the asset to *lose* over its 5-year LIFE.

Now, that doesn't answer the main question: What fraction (percentage) of the depreciable value should you depreciate each year—for tax and accounting purposes—for this asset? There are several standard methods to compute this—different methods for different assets. The HP 19BII gives you four such methods. Consider each, as it would treat your \$40,000 asset:

- SL: Straight Line. This is the easiest method to compute (and to understand). It simply *prorates* the total depreciable value, reducing it evenly over the LIFE of the asset. That is, the same percentage of the original value is taken each year. Your asset has a total depreciable value is \$30,000, so you simply depreciate \$6,000/year for each of the 5 years of its useful life.
- **Do It:** From the MAIN Menu, press **FIN DEFRE**.... This is the "sidecalculations" DEPReCiation Menu.

First, key in the values you know: (40000) STALS 10000 SALV (5) LIFE. Then press MORE to see the menu's next page.

Now just key in each year you're interested in and ask for the SL amount of depreciation for that year:

1 YR# SL	<u>Result</u> : SL=6,000.00
2 YR# SL	<u>Result</u> : SL=6,000.00
3 YR# SL	<u>Result</u> : SL=6,000.00
4 YR# SL	<u>Result</u> : SL=6,000.00
5 YR# SL	<u>Result</u> : SL=6,000.00
6 YR# SL	<u>Result</u> : SL=0.00

As you can see, Straight-Line depreciation is just that—steady and uniform. And notice that it's smart enough to catch your "Year 6" error. The HP 19BII won't let you take depreciation beyond the asset's SALVage value—provided that you don't change depreciation methods in midstream. **DB: Declining Balance.** This method reduces the *total remaining* value of the asset by the same *fraction* each year. That fraction is expressed as a percentage of the fraction necessary for a *Straight-Line* depreciation to *zero* (no salvage value).

> For example, with your five-year asset, a straight-line depreciation to zero Salvage Value would require that you depreciate 20% (of the original value) per year. A Declining Balance factor of, say, "150%" would therefore depreciate 30% (that's 1.5 times—or 150%—as fast as the SL 20%) per year.

> But *unlike SL*, DB is depreciating this 30% off of the *Remaining* Depreciable Value. As that value declines, so does the amount of depreciation in each successive year. Here are the two methods, side by side:

	Straight Line (20% of <i>total BASIS</i> <i>value</i> per year)		Declinin (30% of tota value p	n g Balance a <i>l remaining</i> er year)
Year	\$ deprec.	Remaining Value	\$ deprec.	Remaining Value
0		\$40,000		\$40,000
1	\$8,000	32,000	\$12,000	28,000
2	8,000	24,000	8,400	19,600
3	8,000	16,000	5,880	13,720
•				
•				
	I		I	

And so on.

Do It: From the previous example, you're already within the DEPRC Menu, with your known values already in the BASIS, SALV and LIFE registers.

> So press **MARE**, if necessary, and key in the Declining Balance FACTor, as a percentage: **150 FACTOR**. This is how fast the declining balance rate begins its depreciations, compared to a Straight-Line/no-salvage pace. Then, as usual, key in each year and ask for the amount of depreciation for that year:

1 YR# DB	<u>Result</u> :	RDV=18,000.00 DB=12,000.00
2 YR# DB	<u>Result</u> :	RDV=9,600.00 DB=8,400.00
3 YR# DB	<u>Result</u> :	RDV=3,720.00 DB=5,880.00
4 YR# DB	<u>Result</u> :	RDV=0.00 DB=3,720.00
5 YR# DB	<u>Result</u> :	RDV=0.00 DB=0.00

Notice that the calculator forces the Remaining Depreciable Value (RDV) to finish at the SALVage value:

If the depreciation rate is too fast, there may be one or more years at the end in which the depreciation is *zero*—as in year 5 here—since all RDV has already been used. Or, if the rate is too slow, then there may be a big chunk of depreciable value left for the final year—and it will *all* be taken that year. SOYD: Sum Of the Years' Digits. This method—like the DB method weights the depreciation toward the beginning. But it does so by depreciating a *decreasing* percentage of the total *depreciable* value (whereas DB takes a *constant* percentage of the total *remaining* value). The pattern of SOYD's percentage decreases is determined by the Sum Of the Years' Digits. For example, your \$40,000 asset has a total depreciable value of \$30,000 and a 5-year LIFE. And the *sum* of those five years' *digits* is 1+2+3+4+5 = 15. So:

<u>Year</u>	fraction depreciated	<u>\$ amount of deprec.</u>
1	5/15	\$10,000
2	4/15	8,000
3	3/15	6,000
4	2/15	4,000
5	1/15	2,000
Total	15/15	\$30,000

Go: Using the existing asset data (BASIS, LIFE and SALVage), key in each year and ask for the depreciation for that year:

1 YR# SOYD	<u>Result</u> : RDV=20,000.00
	SOYD=10,000.00
2 YR# SOYD	<u>Result</u> : RDV=12,000.00
	SOYD=8,000.00
3 YR# SOYD	<u>Result</u> : RDV=6,000.00
	SOYD=6,000.00
4 YR# SOYD	<u>Result</u> : RDV=2,000.00
	SOYD=4,000.00
5 YR# SOYD	<u>Result</u> : RDV=0.00
	SOYD=2,000.00

ACRS: Accelerated Cost Recovery System. This method isn't really much of a calculation. ACRS simply assigns percentages of the total depreciable value to be taken in each year in the asset's LIFE. These percentages don't necessarily follow a mathematical formula, but they must add up to 100% of the BASIS value over the asset's LIFE (ACRS ignores the SALVage value). Here's an example of how ACRS depreciation percentages and amounts might look for your 5-year asset:

<u>Year</u>	percentage depreciated	<u>\$ amount of deprec.</u>
1	25	\$10,000
2	15	6,000
3	20	8,000
4	20	8,000
5	20	8,000
Total	100	\$40,000

So: Using the existing asset data (the BASIS value) do this:

<u>Result</u> : ACRS=10,000.00
<u>Result</u> : ACRS=6,000.00
<u>Result</u> : ACRS=8,000.00
<u>Result</u> : ACRS=8,000.00
<u>Result</u> : ACRS=8,000.00

As you can see, these ACRS calculations are little more than simple percentage calculations—where *you* key in the percentages. So beware: The HP 19BII doesn't check these percentages to see if they add up to 100—nor does it check to see if the BASIS or LIFE has been exceeded.

TVM Quiz

It's time to put it all together. On the following pages are quiz problems that combine and reinforce the various TVM concepts and tools you've studied in this chapter.

Don't blur over these problems! This is where you'll do most of your real learning. You don't know how much you really understand until you do some problems where the answers aren't given right away.*

The problems are grouped according to subject matter, so that you can concentrate on one area, if that's your main concern. Most problems will require you to build a cash-flow diagram or T-bar—and you may need to do "side-calculations" to get those values.

You will learn far more if you try them all, rather than concentrating on your immediate interest, because all the problems give you lots of practice with menus, problem-solving, and—in most cases—with the TVM Menu and cash-flow diagrams. Whatever else you do, be sure to use a diagram or a T-bar for any situation where you need any help in visualizing the timing of the cash-flows!

Enjoy these—and take all the time you need to understand them *well*. There's nobody looking over your shoulder here. Λ



* The answers are given here—they're just collected all together, following the problems.

<u>TVM Review</u>

- 1. If Benjamin Franklin saved (and thus earned) one penny, investing it on January 1, 1750, in a tax-free account earning 5% per year (compounded annually), what would that account balance be on January 1, 2000? When would it reach \$1,000? What if the interest compounds *daily*?
- 2. How much will you need to invest every month for 5 years, in a fund that typically earns 12% (compounded monthly), to accumulate a 15% down payment on a \$130,000 home? What if home prices are rising at 6% per year in the meantime?
- 3. If your money can earn 10% interest (compounded daily) in a liquid account, and you win a \$1 million lottery jackpot, would you rather receive it tax-free but paid out at \$50,000/year over 20 years, or in a taxable lump-sum now? Your tax bracket is 33%.
- 4. A fast-food hamburger that went for \$0.89 twenty years ago now costs \$2.59. Using this as a cost-of-living index, what has been the average annual inflation rate over those twenty years?
- 5. How long does it take to pay down a 30-year, \$100,000 mortgage at 10%, (monthly payments in arrears) to 75% of the original balance? How about 50% of the balance? 25%?

- 6. What is the balance after 48 end-of-month payments of \$188 on a loan of \$7,500 at 12.5%, compounded monthly? What if the first payment is due three months from the date of the loan?
- 7. If you can earn 6.5% in an account (compounded daily), and you are selling a truck for \$15,000, would you accept \$500 down and a note for \$15,000 more—due in 1 year?
- 8. How long would it take to double your money in each of these accounts?
 - a. 7.5%, compounded monthly;
 - **b.** 7.5% compounded daily;
 - **c.** 5% compounded annually;
 - **d.** 10% compounded annually;
 - e. 15% compounded annually;

What yearly-compounded rate doubles your money in 10 years?

9. If, on your 25th birthday (happy birthday), you begin to pay \$2000 per year for 7 years into a (tax-deferred) IRA yielding a 10% A.P.R., and then you *stop* paying into that account for 28 subsequent years, how does the resulting year-end balance compare with a similar account that you open on your 32nd birthday, into which you pay \$2000 for *every year* up through your 60th year?

- 10. As a lessor, what should you pay for a 5-year office lease with monthly rent (due in advance) of \$900? Your discount rate is 8%. Then, for a 12% yield, what should you sell the lease for in 3 years?
- 11. A mortgage was written at 9.5% A.P.R. It amortizes totally in 30 years of monthly payments (in arrears). If the payment amount is \$924.94, what was the loan amount?
- 12. If the loan from the previous problem instead had \$850 payments—and annuity in advance—what would the remaining balance be after the 360th month? After the 120th month?
- 13. Compare these interest rates: A \$20,000 car lease with monthly payments of \$440 (in advance) and a buyout of \$5000 in five years; or a credit card charging 16.5% A.P.R., compounded daily.
- 14. A finance company charges 2 points for a \$100,000 loan at 12% A.P.R., compounded daily (on a 360-day year), with quarterly payments (in arrears) that will amortize the loan in 15 years.
 - a. What is the payment amount?
 - **b.** What is the remaining balance after 10 years?
 - c. If the balance is actually paid in a balloon payment at that 10-year point, what is the A.P.R. earned by the finance company? Would that A.P.R. be different if the loan is carried to term (15 years)? Why?

Residential Real Estate

- 15. You're buying a \$103,000 home, putting 10% down and financing the balance at 11% A.P.R., with monthly payments in arrears. Your maximum payment (principal and interest) is \$900.
 - a. Can you totally amortize this loan in 20 years?
 - **b.** If you were to make the payment necessary to amortize the loan in 20 years, how much interest would you save, compared to a 30-year amortization?
- 16. How long will it take to pay off a 30-year, \$100,000 mortgage at 10%, if you make 26 payments/year, each *half* the normal monthly payment? What is this payment amount? Calculate the amortization schedule for each of the first two years.
- 17. A prospective home-buyer wants to accelerate the pay-down of her mortgage by adding an extra \$20 of payment toward principal in each monthly installment. The \$85,000, 9.5% mortgage would normally amortize in 30 years of monthly payments (in arrears), how much sooner will the borrower pay this off? Calculate the amortization schedule for each of the first two years.
- 18. What is the amount of the first payment on a 30-year, \$72,000 loan at 12% (monthly payments, in arrears), with constant payments to principal? How much is the last payment?

 19.
 The rates for a 30-year, \$90,000 Adjustable Rate Mortgage (ARM) are:
 Year 1: 9.0%
 Year 2: 9.5%
 Year 3: 10.0%

 Year 4: 10.5%
 Year 5: 11.0%
 Year 5: 11.0%
 Year 5: 11.0%

Find the payments and year-end balances for the first five years.

20. A couple is buying a \$90,000 home. Their gross monthly income is \$3500. They pay \$200 per month toward other long-term debt. Insurance on the home will be about \$30/month; taxes are \$2,250 annually. With a 30-year mortgage at a fixed rate of 10%, for what amount of financing could they qualify under each of the following four sets of qualifying rules?* Calculate the corresponding principal-and-interest payments, also.

(Note: Applicable qualifying rules may now be different):

<u>Conventional</u> :	Maximum PITI (Principal, Interest, Taxes and	
	Insurance, plus any mortgage insurance/asso-	
	ciation dues) is the <i>lesser</i> of	
	• 28% of Gross Income (\$GI) or	
	• 36% of \$GI, less long-term debt pmt. (\$LTD).	
	Use 25% of \$GI and 33% of \$GI, respectively, if	
	the down-payment is less than 10%.	
<u>FNMA</u> :	Maximum PITI is 28% of \$GI.	
<u>GNMA</u> :	Maximum PITI is 36% of \$GI, less \$LTD.	
<u>FHA</u> :	Maximum PITI is the <i>lesser</i> of	
	• 29% of Gross Income (\$GI) or	
	• 41% of \$GI, less long-term debt pmt. (\$LTD).	

*Assume no mortgage insurance or other association dues in this example.

Commercial Investment

- 21. For a 10% yield-to-maturity, what price (and accrued interest) can you pay on 7/28/90 for a 7% bond (semiannual coupons, actual calendar basis) maturing on 9/9/99? Then what's your yield-to-call if the bond is callable at 88.125 on 3/9/95?
- 22. At the beginning of a tax year, you buy a small office building with improvements valued at \$75,000, a \$10,000 computer, and then landscape the property with \$5000 in shrubs. Estimated salvage values for these new assets: \$15,000, \$500 and \$0, respectively. What depreciation can you take for each in tax years 3 and 4?:

Property examples	<u>Class</u>	Allowed Depr. Method
vehicles, office/lab equip.	5 years	200% DB or SL
roads, shrubbery,	15 years	150% DB or SL
nonresidential real prop.	31.5 years	SL

23. Use the Band of Investment method (weighting current market expectations for mortgage and equity funds by the Loan-to-Value ratio on a property) to compute the NOI, cap rate and value of this property: <u>Office Warehouse</u>

<u>U</u>	me	warenouse
Rent (\$/ft²/year) 7	7.80	4.07
Floor area (ft ²) 2	,277	2,005
Vacancy rate (%)	0.5	1.0
Taxes: \$3,647 Mngmt	: \$3,060	Maint.: \$2,318
Insurance: \$773	Loan-to-Va	alue: 70%
Mortgage rate: 12.75%	Equity ret	urn rate: 14%

24. An investor is considering the purchase of a small office building appraised at \$750,000, of which 70% is improved.

The proposal:

\$250,000 cash down
First mortgage: \$350,000 at 10.5% for 20 years (1.5 points)
Second mortgage: \$150,000 at 12% for 10 years (2 points)
Costs of closing and acquisition: \$2,000

Maximum gross rent potential: \$125,000/yr Projected vacancy/loss rate: 6% Insurance: \$3,000/yr Maintenance and management: \$12,000/yr

Property tax rate: 2.5% Rent, expenses and prop. values to follow inflation: 5%/yr.

In five years, the investor expects to sell the property (through a broker, for a 6% commission), at a cap rate of 11.5% on the Net Operating Income projected for Year 6. The investor's income tax bracket is 33%; capital gains are 100% taxable.

Find the net (after-tax) cash-flow for the initial investment and for each of the five years of operation. For Year 1, find the Gross Rent Multiplier, cap rate, equity return rate, and the after-tax cash return rate.

<u>Personal Finance</u>

- 25. If inflation is 5% per year, and your tax bracket is 27%, what will be the real value (i.e. the buying power in terms of today's dollars) of a \$1000 investment (today) into a taxable account earning 10% per year—for 25 years? 40 years?
- 26. Assuming a 5% annual inflation rate and an income tax rate of 28%, if you invest \$2,000 of *buying power* at the end of each year into a growth-oriented mutual fund that earns 15% per year, what buying power will accumulate in this account over 30 years? What is the equivalent annual growth rate of this buying power? What if the account were tax-deferred—like an IRA?
- 27. Your monthly salary is \$3333.20 per month, with annual cost-ofliving raises (5% a year). If, for 35 years, you invest 5% of each monthly paycheck into a growth-oriented mutual fund IRA (taxdeferred until withdrawal) averaging 15% growth per year, what gross income (today's dollars) could then you draw for 30 years of retirement if you roll the account into a more secure bond fund at 10%? What is the rollover amount? What if, in addition to that 5%, you were also allowed to invest the 7.65% that now goes for Social Security and Medicare? Repeat the problem for a taxable account (28% income tax bracket).

TVM Quiz Solutions

1. From the investor's perspective:



From the TVM Menu, press **MHER** and set your annuity mode (to END MODE) and PMTS/YR (to 1). Then **EXIT** to TVM, and: 250 NM 5 IN 6 1/- PM 0 PMT FV Answer: FV=1,983.01 (in the year 2000)

Then 1000 FUE N. <u>Result</u>: N=235.97 1750+ <u>Result</u>: 1985.97

So the account balance reaches \$1000 toward the end of 1985.

For daily compounding, just change the number of payments per year: Press MHER and set PMTS YR to 365 (ignore leap years). Then EXIT to TVM, and:

250×365 (ALG) or 250 INPUT 365× (RPN)

Then 1000 FV MM.... <u>Result</u>: N=84,050.11 +365+1750=(ALG) or 365+1750+(RPN) <u>Result</u>: 1980.27 The balance reaches \$1000 in early 1980.



From the TVM Menu, press **THER** and set your annuity mode (to BEG MODE) and PMTS / YR (12). Then EXIT to TVM, and: 5×12 (ALGebraic) or 5 INPUT 12× (RPN) **EXIT** 12 **1**2YF 0 **F** 130000×15× (ALGebraic) or 130000×15× (RPN) **F** Then solve: **FMT**.... <u>Answer</u>: PMT=-236.40

But, if the price of houses is increasing at 6% per year, then you must first compute what a 15% down payment will be in 5 years:



From the TVM Menu, press OTHER and set PMTS/YR to 1. Then EXIT and: 5 N 6 IZWE RCL FV +/- FV 0 PMT FV Answer: FV = 26,095.40 Now re-calculate your monthly investment: OTHER 12 FATE EXIT 5 × 12 (ALGebraic) or 5 INPUT 12 × (RPN) N 12 IZWE 0 FV Then solve: PMT Answer: PMT=-316.36 The question is: "Which is greater—a lump sum of \$1 million, less 33%, or the Present Value of this scenario, discounted at 8%?"



The lump-sum: 100000-33% (ALGebraic) or 1000000 (NPUT 33% (RPN) Result: 670,000.00 To analyze the above scenario, first you must find the equivalent yearly discount rate: EXIT from TVM, and press **ICONN FER** (8) NOME 365 **FOURTER**. Result: EFF% =8.33 Then EXITEXIT TWM, STO **IZYR**. Then press **OTHER** and set your annuity mode (to BEG MODE) and PMTS YR (to 1). Then EXIT and: 20 **N** 50000 **PMT** 0 **FV PV** Answer: PV=-519,064.88 So those 20 later payments are equivalent to \$519,064.88 now.

So those 20 later payments are equivalent to \$519,064.88 now. Looks like the lump-sum is the better deal.

4. A simple rate calculation problem—but the TVM sign conventions still need to treat it as an investment/return scenario:



From the TVM Menu, press OTHER and set PMTS/YR to 1. Then EXIT 20 NO. 89+/- PV 0 PMT 2.59 FV Then solve: TXTR.... Answer: I%YR=5.49



First, find the payment amount: At the TVM Menu, press **OTHER** and set END MODE and 12 PMTS/YR. Then **EXIT** and:

30×12 (ALGebraic) or 30 INPUT 12× (RPN)

Now find the number of payments (months) to reach those specified balances (Future Values):

 RCL
 FV

 X75Z=
 (ALGebraic) or 75Z (RPN)

 N

 Result:
 N=209.92

 (about 17.5 years)

 RCL
 FV

 X50Z=
 (ALGebraic) or 50Z (RPN)

 FV

 Result:
 N=282.40

 (about 23.5 years)

 RCL
 FV

 X25Z=
 (ALGebraic) or 25Z (RPN)

 FV

 Result:
 N=327.34

 (a little more than 27 years)

<u>Note</u>: If you do a lot of this sort of calculation, you might want to try the formula on page 364 in Chapter 9.

6. The conventional loan, from the borrower's perspective:



From the TVM Menu, press \overrightarrow{OTHER} and set END MODE and 12 PMTS/YR. Then \overrightarrow{EXIT} and: \cancel{A} (12) (ALGebraic) or \cancel{A} (NPUT 12) (RPN) \overrightarrow{OTHE} 12.5 \overrightarrow{IXIR} 7500 \overrightarrow{PV} 188+/- \overrightarrow{PMT} Then solve: \overrightarrow{FV} Answer: \overrightarrow{FV} =-702.21

The same loan, but with 90 days before the first payment is due:



First you calculate how much \$7500 becomes with 2 months of accrued interest: 2 **N** 0 **FAT Result:** FV=-7,657.06

Now use this result as the "amount loaned" (after a sign change) for a repeat of the above conventional loan calculation:

(+/_) PV	48 N 188+/- PMT
FV	<u>Answer</u> : FV=-960.49

7. You're looking for \$15,000 now, and the buyer is offering \$500 now. So, is the *present* value of \$15,000 *one year from now* equal to the difference (\$14,500)? Or, to put it differently, what rate of interest are you earning if you *assume* this equivalency? Is it better or worse than 6.5% compounded daily? Here's the picture:



From the TVM Menu, press **OTHER** and set PMTS/YR to 365. EXIT to TVM, and:

```
365 N 14500+/- PV 0 PMT 15000 FV
IXVR.... Answer: IXVR=3.39 Better insist on cash now.
```

- 8. Just double a dollar: 1+/- PV 0 PMT 2 FV
 - a. Set 12 PMTS/YR and EXIT 7.5 **IZVE** <u>Result</u>: N=111.25 (111.25 months—about 9.27 years)
 - b. Set 365 PMTS/YR and EXIT N.... Result: N=3, 373.66 (3,373.66 days—about 9.24 years)
 - c. Set 1 PMTS/YR and EXIT 5 IXYR N.... Result: N=14.21
 - d. 10 IXYR N. <u>Result</u>: N=7.27
 - e. 15 IXWR N. <u>Result</u>: N=4.96

In 10 years exactly : 10 N IXYR Result: IXYR=7.18



From TVM, press OTHER 1 PAYS BEG EXIT.

To begin in the first scenario, find the account balance after 7 years of saving: 7 No. 10 ISYR 0 FW 2000+/- PMT FW.... Result: FV=20,871.78

Now let that amount accrue for another 28 years, with no further payments into the account. This FV becomes the PV now (i.e. you are moving the entire TVM "picture frame" forward in time):

The second scenario: 0 FV 2000+/- FMT FV Answer: FV=295, 261.86

Just 7 early years of saving are better than 28 later years. *That's* the Time Value of Money. **10.** The first problem, from your (the new lessor's) perspective:



From the TVM Menu, press **THER** and set your annuity mode (to BEG MODE) and PMTS / YR (to 12). Then EXIT to TVM, and: 5×12 (ALGebraic) or 5 INPUT 12× (RPN) 8 **TXYR** 900 PMT 0 FV Solve: **PVT**.... Answer: PV=-44,682.50 To find its price for sale in 3 years to yield you 12%: 3×12 (ALGebraic) or 3 INPUT 12× (RPN) **N** 12 **TXYR** FV Answer: FV=24,773.44

11. From the lender's perspective:



From the TVM Menu, press **OTHER** and check your annuity mode (should be **END MODE**) and **PMTS**/YR (should be 12). Then EXIT to TVM, and: (a)(12)(ALGebraic) or (a)(INPUT 12)(RPN) (RPN) (B)(5) IXIR (924.94) FMT (a) FU

Then solve: <u>PV</u>.... <u>Answer</u>: PV=-110,000.04

12. A variation on the previous problem:



Change only what you have to from the previous problem: At the TVM Menu, press **MILER SEE** EXIT. Then **850 FAT 675.02** find the balloon payment after 30 years: FV=138,675.02

Yikes! What's *that*? How can a \$110,000 mortgage produce this howling monster \$138,000 balloon?

It can—if the monthly mortgage payment is not enough to cover all of the monthly interest. And \$850 a month just doesn't do it. Instead of covering all interest plus paying a little principal (like a normal mortgage payment), \$850 pays only *part* of the interest and never touches the principal. That astronomical balloon is the result of the unpaid interest compounding for 30 years.*



Indeed, look how far this *negative amortization* gets in just 10 years: 120 FV=112,807.98

*Once, when asked to name the most awesome force in the universe, Albert Einstein is said to have replied, "compound interest."

13. This is just a comparison of two interest rates, but you'll need to do some calculating before you can compare them directly.

Here's the car loan diagram:



At the TVM Menu (set	12	P/\	'R an	d BE(GIN	MODE):
60 N 20000) PI	4	40	+/-)	MT	
5000+/- FV						
IXYR	Ans	<u>wer</u> :	IZY	R=17	' . 22	1

As for the credit card rate, you don't even need a TVM calculation —just a quick trip to the ICONV Menu:

From the TVM Menu, press EXIT ICONW FER, then 365 F 16.5 NOME, and solve:

EFFX <u>Result</u>: EFFX=17.98 Now find the corresponding nominal rate in a 12-period year: [12] **FORMULE**.... Result: NOMX=16.61

That's better than the 17.22% of your car loan.
14. Here's the situation:



Your first problem is to match the interest rate (daily) to the payment schedule (quarterly). That's an Interest CONVersion side calculation: From the TVM Menu, press EXIT ICONN FER

Then 12 NOM: 360 P EFF?	EFF%=12.75
	NOM%=12.18
Now EXIT EXIT TUM and STO IZYR.	

- a. The payment amount: Press OTHER END and (4) FATE, then EXIT to TVM and 60 N 100000 FV 0 FV FMT Answer: PMT=-3,648.16
- b. The remaining balance after 10 years (40 payments):
 40 No FUE.... Answer: FV=-54,050.52
- c. The finance company really loaned \$98,000: 98000 FUT TAY: Answer: I%YR=12.59
- d. Same calculation, but take the loan to term:
 60 N 0 FV 1248 Answer: 1%YR=12.56

The term of the loan *does* affect the A.P.R. The finance charge is the same in either case, but its impact on the yield percentage is "distributed" over more time in the latter case. (Analogy: The same \$3 tip adds 15% to a \$20 dinner tab but only 10% to a \$30 tab.)

15. Here's the scenario:



This is a balloon that you'd need to *pay* (it's negative), so \$900 is *not* enough to amortize the mortgage in 20 years. And how much interest would a true 20-year amortization save? Compare these:



Each amortizing PMT pays all interest accrued on the loan balance in that period, *plus* it pays a little on the principal. The next month, there's a little less interest to pay and so a little more room to pay on principal, etc. Look at this diagram:



Since in both cases, the loan is totally amortized, the principal paid is the same—the amount financed: \$92,700. So the difference in interest paid is simply the difference in totals paid:

Press **Press to specify total amortization of the 20-year case,** then **PATE...** <u>Result</u>: PMT=-956.84 Then **XRCL THE (ALGebraic)** or **RCL XEX** (RPN) and **STO 1** to store this (to read more about storage registers, see Ch. 7).

The 30-year case: 30×12(ALG) or 30[NPUT 12×(RPN) N (Result: PMT=-882.80) And ×RC = N = (ALGebraic) or RC × (RPN), then -RCL 1=(ALGebraic) or RCL 1-(RPN) Answer: -88,168.09

That's the *face value* of the difference in interest paid. But you can't equate amounts of money unless they are transacted at the same time—not true here. You can't say simply that "the 20-year case saves \$88,168.09 in interest." After all, an extra \$882.80/ month for ten years can earn a lot of interest—far more than its face value. You can earn the added value of *time*.

100,000 1% YR = 10.00% 26 P/YR Per 1 2 3 4 (30-yr PMT)/2... ... (30-yr PMT)/2...

Find the normal monthly payment: At the TVM Menu, press **DITER**, then set END MODE and 12 PMTS/YR. EXIT and: **30**×12 (ALGebraic) or **30**[NPUT 12×(RPN) **N 10 I X R E S I O O P O F PKT** Result: PMT=-877.57 Now divide this in half to get the bi-weekly payment amount: \div **2 O** (ALGebraic) or **2** \div (RPN) Answer: -438.79 Press **PMT**, then **DITER** to set 26 PMTS/YR. Now EXIT and solve for **N O E** That's about 545 *bi-weekly* periods. Divide this by 26, to find that it will take just under 21 years to amortize the loan with 26 "halfmonthly-payments" per year.

The amortization schedule: Press OTHER AMAT

26 #P	PAYMENTS:1-26
	BALANCE=98,521.62
	INTEREST=-9,930.16
PRIN	PRINCIPAL=-1,478.38
NEXT	PAYMENTS:27-52
	BALANCE=96,888.06
	INTEREST=-9,774.98
PRIN	PRINCIPAL=-1,633.56

<u>Note</u>: If you do a lot of this sort of calculation, you might want to try the formula on page 360 in Chapter 9.

16.

17.

\$ 85,000



First, find the normal monthly payment amount: At the TVM Menu, press **DITIER**, then set END MODE and 12 PMTS/YR. Then EXIT and:

30×12 (ALGebraic) or 30 INPUT 12× (RPN) 9.5 ISVE 85000 PV 0 FV PMT Result: PMT=-714.73 Now include the extra \$20: -20=(ALGebraic) or 20-(RPN) Result: -734.73 Now use this as the PMT (press FMT), and solve for N.... Result: N=313.92 That's about 314 months. Divide this by 12, to find that it will take a little over 26 years to amortize the loan with this additional \$20 monthly payment toward principal.

The amortization schedule: Press OTHER AMAT

12 #P	PAYMENTS:1-12
	BALANCE=84,225.09
	INTEREST=-8,041.85
PRIN	PRINCIPAL=-774.91
NEXT	PAYMENTS:13-24
	BALANCE=83,373.25
	INTEREST=-7,964.92
PRIN	PRINCIPAL=-851.84

<u>Note</u>: If you do a lot of this sort of calculation, you might want to try the formula on page 360 in Chapter 9.

18. In a conventional mortgage, each monthly payment covers all of that month's interest, plus a little bit of principal. The total payment amount stays constant, but the portions paid to interest and principal shrink and grow, respectively, throughout the term of the loan (recall page 181). But if you specify that the portion paid to principal must remain constant, then the total payment will not—it will shrink as the interest portion shrinks.

To find the steady amount of each monthly payment that goes to principal, divide the starting principal by the number of months: $72000 \div 360$ (ALG) or 72000 (NPUT $360 \div$ (RPN) <u>Result</u>: 200.00 Knowing that, you know this:



At the TVM Menu, press **DTHER**, set END MODE and 12 PMTS/ YR. Then EXIT and: 1 N 12 IXYR 72000 FW and -2009 +/- (ALG) or 200 - +/- (RPN) FW PMT Result: PMT = -920.00 The first payment.

For the last payment, you know that this is the situation:



<u>Note</u>: If you do a lot of this sort of calculation, you might want to try the formula on page 366 in Chapter 9.

19. Each time the rate changes in an ARM, you recompute the payment, using the new rate and the remaining term of the loan to amortize the remaining balance. At the TVM Menu, set END MODE and 12 PMTS/YR. Then EXIT and:

$\underline{\text{Year 1}}: \Im 0 \times 12 (\text{ALGebraic}) \text{ or } \Im 0 \text{ INPUT 12} \times (\text{RPN}) $			
9 IXYR 90000 PY 0 FY PMT	•		
<u>Result</u> : PMT=-724.16	Monthly payment.		
12 N. FYFV=-89,385.12	Year-end balance.		
<u>Year 2</u> : +/-) PV 9. 5 IXYR 0 FV			
29×12(ALGebraic)or 29INPUT 12×(F	RPN) N PMT		
<u>Result</u> : PMT=-756.26	Monthly payment.		
12 N FVFV=-88,775.47	Year-end balance.		
Year 3: +/- PV 10 IXYR 0 FV			
28×12(ALGebraic)or 28 INPUT 12×(F	RPN) n pmt		
<u>Result</u> : PMT=-788.29	Monthly payment.		
12 N. FVFV=-88,166.10	Year-end balance.		
27×12(ALGebraic)or 27 INPUT 12×(F	RPN) n pmt		
<u>Result</u> : PMT=-820.21	Monthly payment.		
12 N FVFV=-87,551.99	Year-end balance.		
Year 5: +/- PY 11 IXYR 0 FY			
26×12(ALGebraic) <i>or</i> 26INPUT 12×(F	RPN) n pmt		
<u>Result</u> : PMT=-851.99	Monthly payment.		
12 N FVFV=-86,927.97	Year-end balance.		

<u>Note</u>: If you do a lot of ARM calculations, you might want to try the formula on page 362 in Chapter 9.

20. For conventional, FNMA and GNMA loans, the comparison is generally between 28% of \$GI and 36% of \$GI less \$LTD—unless the amount of financing is 90% or more of the home value:
3500×28% = (ALGebraic) or 3500 INPUT 28% (RPN) Result: 980.00
and 3500×36% = 200 = (ALGebraic) or 3500 INPUT 36% 200 = (RPN) Result: 1,060.00

For FHA loans, compare 29% of \$GI and 41% of \$GI less \$LTD: 3500×29%=(ALGebraic) or 3500 INPUT 29% (RPN) <u>Result</u>: 1,015.00 and 3500×41%-200=(ALGebraic) or 3500 INPUT 41%200-(RPN) <u>Result</u>: 1,235.00

<u>Conventional</u>: Maximum PITI is \$980—unless the financing is 90% or more. Now find the maximum mortgage payment by subtracting the monthly insurance and taxes:

980-30-(2250÷12= (ALGebraic) or

980INPUT30-2250INPUT12÷-(RPN)

<u>Result</u>: 762.50

At the TVM Menu, press +/- PMT. Then press OTHER, set END MODE and 12 PMTS/YR. Then (EXIT) and:

30×12 (ALGebraic) or 30 INPUT 12× (RPN)

10 IXYR 0 FV PV

Result: PV=86,887.50

But this is over 90% of the value of the \$90,000 home (\$1,000), so test whether the 25%/33% limits can improve upon this 90% limit: $3500\times25\%$ (ALGebraic) or 35000 (NPUT 25% (RPN)

 Result:
 875.00

 and 3500×33×-200= (ALGebraic) or

 3500
 NPUT33×200- (RPN)

 Result:
 955.00

 So maximum PITI is \$875:

 875-30-(2250+12= (ALGebraic) or

 875
 (RPN)

 Result:
 657.50

 At the TVM Menu, press +/ FMT

 Then
 FMT

 Result:
 PV=74,922.66

 So the maximum conventional financing is 90%, or \$81,000.

<u>FNMA</u>: Maximum PITI is \$980, so the maximum financing is \$86.887.50, as you just calculated for the conventional case.

 GNMA: Maximum PITI is \$1,060:

 1060-30-(2250+12= (ALGebraic) or

 1060(NPUT30-2250(NPUT12+- (RPN))

 Result:
 842.50

 At the TVM Menu, press +/- PMT

 Then PU_....
 Result: PV=96,003.57

 FHA:
 Maximum PITI is \$1,015:

 1015-30-(2250+12= (ALGebraic) or

 1015[NPUT30-2250[NPUT12+- (RPN)

 Result:
 797.50

 At the TVM Menu, press +/- FMT.

 Then FWE....
 Result: PV=90, 875.78

<u>Note</u>: If you do a lot of these home loan qualifying calculations, you might want to try the formula on page 352 in Chapter 9.

- 21. Just a quick review problem with bonds: From the Main Menu, press FIN SOND TYPE AND SEMILEXIT. Then 7.281990 SETT 9.091999 MAT 7 CPNZ
 MORE 10 YLCZ FRICE....PRICE=82.31 For a 10% YTM. HCCRU.... ACCRU=2.68
 MORE 3.091995 MAT 88.125 CALL
 MORE WLCZ YLDX=9.75 The yield-to-call. Note: If you often need bond calculations that also account for taxes and commissions, see the formula on page 370 in Ch. 9.
- 22. Take the greater of the two allowed depreciations whenever you have a choice. From the Main Menu, press **FIN DEFR**.

The building: 75000 EASIS 15000 SALV 31.5×12 (ALG) or 31.5 INPUT 12× (RPN) LIFE The HP 19BII won't accept non-integer input, but SL depreciation is uniform; just multiply the monthly depreciation by 12: Pick any period: MORE 1 VR# SLSL=158.73 ×12= (ALG) or 12×.... 1,904.76 The computer: MORE 10000 EASIS 500 SALV 5 LIFE MORE 200 FACTS 3 YR# DEDB=1,140.00 SLSL=1,900.00 4 YR# DEDB=864.00 SLSL=1,900.00* The shrubs: MORE 5000 EASIS 0 SALV 15 LIFE MORE 150 FACTS 3 YR# DEDB=405.00 SLSL=333.33 4 YR# DEDB=364.50 SLSL=333.33

*Caution! The RDV of the computer is only \$1200 in Year 4, if you've been using 200% DB in the previous years. If you do a lot of MACRS calculations, see the formula on page 390 in Chapter 9.

23. The gross rents, less vacancies: 7.8×2277-.5% +((4.07×2005-1%)= (ALG) or 7.8(INPUT 2277×.5%)-4.07(INPUT 2005×1%-+ (RPN) (Result: 25,750.54)

Less operating expenses: -3647-3060-2318-773= (ALG) or 3647-3060-2318-773- (RPN) <u>Result</u>: 15,952.54 The NOI-leave it in the Stack.

Now find the cap rate by weighting each portion of the investment by its expected return rate (this is the Band of Investment method for determining a cap rate):

 $1275 \times 70\% + (14 \times 30\% = (ALG)$ or

(1275) (NPUT) (7) (14) (NPUT) (3) (RPN)

<u>Result</u>: **0.13** The cap rate, as a decimal.

Then divide the NOI by the cap rate: \Rightarrow LAST = 1/x (ALG) or \Rightarrow (RPN) Result: 121,543.19 The property value.

<u>Note</u>: If you do a lot of this sort of calculation, you might want to try the formula on page 378 in Chapter 9.

24. At TVM, press **OTHER**. Set END MODE and 12 PMTS/YR. EXIT and amortize the first mortgage:

20×12)(ALG) or 2011 12X (RPN)	N
10.5 1	2YR 350000 PV 0 FV	
Then solve	: PMT <u>Answer</u> : PMT=-3,49	4.33
The amorti	zation schedule: Press OTHER AMAT	, then:
12 # P	PAYMENTS:1-12	(Year 1)
	BALANCE=344,561.24	
	INTEREST=-36,493.20	
PRIN	PRINCIPAL=-5,438.76	
NEXT	PAYMENTS:13-24	(Year 2)
	BALANCE=338,523.11	
	INTEREST=-35,893.83	
NEXT	PAYMENTS:25-36	(Year 3)
	BALANCE=331,819.56	
	INTEREST=-35,228.41	
NEST	PAYMENTS: 37-48	(Vear 4)
	BALANCE=324-377-23	(1001 1)
	INTEREST=-34.489 63	
	INTEREOT = 04,407.00	
NEXT	PHYMENIS:49-60	(Year 5)
	BHLHNCE=316,114.75	
	INTEREST=-33,669.48	

Now EXIT EXIT and do the second mortgage:

10×12 (ALGebraic) or 10 INPUT 12× (RPN)

The amortization schedule: Press OTHER MMAT, then:		
12 #P	PAYMENTS:1-12 BALANCE=141,730.24 INTEREST=-17,554.96	(Year 1)
PRIN	PRINCIPAL=-8,269.76	
NEXT	PAYMENTS:13-24 BALANCE=132,411.66 INTEREST=-16,506.14	(Year 2)
NEXT	PAYMENTS:25-36 BALANCE=121,911.28 INTEREST=-15,324.34	(Year 3)
NEXT	PAYMENTS:37-48 BALANCE=110,079.16 INTEREST=-13,992.60	(Year 4)
NEXT	PAYMENTS:49-60 BALANCE=96,746.46 INTEREST=-12,492.02	(Year 5)

Annual debt service:

3494 • 33+2152	0 6 \mathbf{X} 12 = (ALG) or
3494 · 33 INPUT 21	52•06+12X (RPN)
<u>Result</u> : 67,756.68	The mortgage payments.

Annual depreciation: (750000×70%÷31•5= (ALG) or (7500001NPUT 70%31•5÷ (RPN) <u>Result</u>: **16,666.67** The 31.5-year SL cost recovery. Annual deduction for points:

350000×2·5%+(150000×2%)+5=(ALG) or 3500000INPUT•015×1500000INPUT

02X+5÷(RPN)

Result: 1,650.00 The annual points deduction.

Initial Cash-Flow ("Year 0"): Down-payment, points and COA:
250000+(350000×1·5%)
$+(150000\times2\%)+20000=+/-(ALG) or$
2500001NPUT3500001NPUT • 015X+
150000 (NPUT $\cdot 02X + 2000 + +/-$ (RPN)
Result: -260,250.00 The initial cash-flow.

<u>Year 1</u>: Each yearly cash-flow is the NOI (rents less operating expenses), less income taxes, plus tax relief for depreciation and interest and prorated points (and, for Year 1, costs of acquisition), less debt service:

125000-6%	(rent)
-3000	(– insurance)
-12000	(- mnt./mgmt.)
$-(750000\times2.5\%)$	(- prop. taxes)
= (= NOI:	83,750.00)
-33%	(-income taxes)
$+(16666 \cdot 67)$	(+ tax relief
$+36493 \cdot 2 + 17554 \cdot 96$	
+2000+1650×33%))
-67756•68	(– debt serv.)
=)(ALG)	

or (RPN): 125000119076%-	(rent)
3000-	(– insurance)
12000-	(– mnt./mgmt.)
750000INPUT • 025X-	(– prop. taxes)
	(= NOI: 83,750.00)
33%-	(-income taxes)
16666667 [INPUT]	(+ tax relief
3649302+1755409	6+
2000+1650+·33×+)
67756•68—	(– debt serv.)

Result: 12,896.21 The Year 1 cash-flow.

Year 2: Each year, the NOI increases by the inflation rate:

83750+5%	(NOI + inflation adj.)
-33%	(-income taxes)
$+(16666 \cdot 67 + 3589$	3.83 (+ tax relief
$+16506 \cdot 14 + 1650$	D X33%)))
-67756•68	(– debt serv.)
=(ALG) or (RPN):	
83750INPUT5%+	(NOI + inflation adj.)
33%-	(-income taxes)
16666.67 [INPUT 3589]	3•83+ (+ tax relief
16506 • 14+1650-	+•33×++)
67756•68-	(– debt serv.)

Result: 14,497.94 The Year 2 cash-flow.

Year 3: Each year, the NOI increases by the inflation rate:

83750+5%+5%	(NOI	+ inflation adj.)
-33%		(-income taxes)
$+(16666 \cdot 67 + 35228 \cdot$	41	(+ tax relief
+15324·34+1650×3	3%))
-67756•68		(– debt serv.)
=(ALG) or (RPN):		
83750 INPUT 5%+5%+	(NOI	+ inflation adj.)
33%-		(-income taxes)
16666.67 INPUT 35228.4	11+	(+ tax relief
15324•34+1650+•3	3×+)
67756•68-		(– debt serv.)

Result: 16,834.26 The Year 3 cash-flow.

Year 4: Each year, the NOI increases by the inflation rate:

83750+5%+5%+5%	(NOI	+ inflation adj.)
-33%		(-income taxes)
$+(16666 \cdot 67 + 34489 \cdot 6$	33	(+ tax relief
+13992•6+1650×331	%)))
-67756•68		(– debt serv.)
=(ALG) or (RPN):		
83750INPUT5%+5%+5%+	(NOI	+ inflation adj.)
33%-		(-income taxes)
16666.67 INPUT 34489.6	3+	(+ tax relief
13992•6+1650+•33	×+)
67756•68-		(– debt serv.)

Result: 19,244.19 The Year 4 cash-flow.

<u>Year 5</u>: When the property sells (at a price based upon a cap rate and projected Year 6 NOI), the lenders are repaid from the net sale proceeds, and capital gains are realized on the difference between the net proceeds and the unrecovered cost:

83750+5%+5%+5%+5%+5% (Year 6 NOI) (net sale proceeds: 873, 697. 97) + 115 - 6% =-316114.75-96746.46 (-mortgage balances) (- tax on capital gains... -(873697)97- $(750000 - (5 \times 16666 - 67)) \times 33\%)$...) +(83750+5%+5%+5%+5%)(+ Year 5 NOI) -33% (-incometaxes) +(16666667+33669+48)(+ tax relief... $+12492\cdot02+1650\times33\%)\dots$ -6775608)(- debt serv.)

= (ALGebraic)

or (RPN):

 $[8]_3]_7[5]_0[NPUT]_5]_7[+[5]_7]+[5$ (115+6)(net sale proceeds: 873, 697.97) 316114.75-96746.46- (-mortgage balances) (- tax on capital gains... 873697 • 97 INPUT 5[NPUT 166666.67X+/-750000+-.33X-...) 83750INPUT5%+5%+5%+5%+ (NOI+infl.adj.) 33%-(-incometaxes) (+ tax relief... 16666667[INPUT3366948+ $(12492 \cdot 02 + 1650 + 33 \times + ...)$ $67756 \cdot 68 -$ (- debt serv.)

(+)

Result: 414,242.63 The Year 5 cash-flow.

The GRM (Gross Rent Multiplier) is $Price+Rents_{max}$: 750000+125000=(ALG) or 750000(NPUT 125000+(RPN) <u>Result</u>: 6.00 The GRM.

The cap rate is NOI_1 +Price: **8**3750+750000×100= (ALG) or **8**3750 INPUT 750000+100× (RPN) <u>Result</u>: **11.17** The cap rate, as a percentage.

The equity return rate is the ratio of the net cash-flow, mortgage principal payments and appreciation, to the down-payment: $\begin{array}{c} 1 & 2 & 8 & 5 & 4 & 1 & + & 5 & 4 & 3 & 8 & & 7 & 6 & + & 8 & 2 & 6 & 9 & & 7 & 6 & + \\ \hline (7500000 \times 5\%) + & 2500000 \times 1000 = (ALG) \ or \\ 1 & 2 & 8 & 8 & 5 & & 4 & 1 & \text{INPUT} \\ 5 & 0 & 0 & 0 & 0 & \text{INPUT} \\ \hline 7500000 & \text{INPUT} & 0 & 5 & \text{X} + & 2 & 5 & 0 & 0 & 0 & \\ \hline Result: & 25.64 & \text{The equity return rate, as a percentage.} \end{array}$

The after-tax cash return rate is the Year 1 cash-flow divided by the initial cash-flow:

<u>Note</u>: If you do many of these lengthy income property analyses, you should consider using the formula on page 384 in Chapter 9.

But that doesn't take taxes into account. If interest is taxable at 27%, then 27% of the \$0.10 interest earned by your dollar goes you-know-where. So:

1-27½+1÷1·05-1×100= (ALG) or
1 [NPUT27½-1+1·05÷1-100× (RPN)
This is the *after-tax* growth rate of your real buying power—as a percentage: 2.19. This is what you should use as your interest rate in the TVM Menu to grow your \$1000 investment:



<u>Note</u>: If you do a lot of after-tax-and-inflation TVM calculations, see the formula on page 398 in Chapter 9.

Now use this as your interest rate in the TVM Menu:

STO IXYR OTHER 1 PAYR END EXIT

2000+/- PMT 0 PV

30 N FUE.... <u>Answer</u>: FV=145, 472.28

This is the *buying power* (in terms of today's dollars) in your taxable account after 30 years. The actual *face-value* amount of dollars will be higher, but those dollars don't buy as much then.

Repeat this calculation for the IRA—a tax-deferred account (no tax on interest while it's growing):

 $1 \cdot 15 \div 1 \cdot 05 - 1 \times 100 = (ALG)$ or

 $1 \cdot 15$ [INPUT $1 \cdot 05 \div 1 - 100X$ (RPN)

<u>Answer</u>: 9.52

Now use this as your interest rate in the TVM Menu:

STO IXYR FY Answer: FV=300,718.13 What a difference an IRA makes!

But keep in mind that the level \$2,000 PMT amount you're using here is also in terms of buying power ("today's dollars"). To hold that *buying power* investment amount steady, its *face value* must increase every year by 5%. Inflation is a hard taskmaster.



27. Since you're saving a level *percentage* of your inflation-adjusted income, you're investing a level amount of buying power (today's dollars) each month. So you can just use today's income numbers—if you adjust the growth rate of the account to reflect the true growth rate of its buying power instead of its face value:*

•15+12+1+(•05+12+1)
-1×1200=(ALG) or
•15/INPUT12+1+•05/INPUT12+1++
1-1200X (RPN)
(<u>Result</u> : 9.96) Use this as the interest rate in TVM:
STO IXYR OTHER (12) PAYR END EXIT
3333•2×5%= (ALG) or 3333•2INPUT 5% (RPN)
+/ PMT 0 PV
35×12 (ALGebraic) or 351NPUT 12× (RPN)
EVE <u>Answer</u> : FV=626,011.09 The rollover amount.
Use this as a Present Value to amortize over 30 years of retire-
ment in an account paying 10%: +/-) FV 0 FV
30×12 (ALGebraic) or 30 (INPUT 12× (RPN)
(1+12+1+()05+12+1)
-1×1200=(ALG) or
•1)[NPUT 12+1+•05[NPUT 12+1++
1-1200X (RPN)
(Result: 4, 98) FWR FWT Answer: PMT=3, 352, 63

Your monthly retirement income—in today's dollars.

*For simplicity here, you may assume that all rates are *nominal* rates that compound monthly (otherwise—if they were *effective* annual rates—you'd need to use the ICONV Menu to find the corresponding nominal rates to use in the TVM Menu).

Repeat for the taxable scenario:*

(-15-28%+12+1+(-05+12+1)) $-1\times1200=(ALG) or$ (15)[INPUT] 28 % - 12 ÷ 1+ 05 [INPUT] 12 ÷ 1+ ÷ 1 - 1200X (RPN)(Result: 5.78) $[3]3]3] \cdot [2]x[5]% = (ALG) or [3]3]3] \cdot [2]INPUT[5]% (RPN)$ (+/-) PMT (0) PV 35 X 12 (ALGebraic) or 35 INPUT 12X (RPN) Answer: FV=225, 536, 96 The rollover amount. Then: (+/-) **P!** (0) **F!** 30 × 12 (ALGebraic) or 30 (INPUT) 12 × (RPN) (1-28)(+12+1+(-05+12+1)) $-1\times1200=(ALG) or$ (1) [INPUT] 2 8 % - 1 2 \div 1 + (0) 5 [INPUT] 1 2 \div 1 + (\div) 1 - 1200X (RPN)(Result: 2.19) TXVR PMT Answer: PMT=855.32

And what if you could also invest the 7.65% of your income that now goes toward Social Security and Medicare (a total of 12.65% of your income)? Your answers would be *proportionately* higher. So just multiply each answer above by (12.65+5):

	IRA (tax-deferred) acct.	<u>Taxable acct.</u>
Rollover:	1,583,808.06	570,608.52
Ret. income:	8,482.15	2,163.96

<u>Note</u>: If you do a lot of retirement planning calculations, see the formulas on pages 400 and 402 in Chapter 9.

*Again, for simplicity here, you may assume that you pay monthly taxes on your interest—not generally true, but note that this leads to a slightly more conservative (lower) growth rate, which, if you're going to go wrong with assumptions in retirement planning, is the side on which to err.





Problems with Uneven Payments

So far, all the various finance problems you've been solving have had one thing in common: that smooth, level PMT cash-flow happening once every period. Well, the world isn't always so neat and tidy. Often, you'll run into situations where the periodic cash-flow amounts vary sometimes quite often—like this:

	m	\$
20,000	0	(25,000.00)
	1	400.00
	2	400.00
750 400 400 4	3	400.00
	4	400.00
Month 2 3 4 5 6 7 8 9 10 11 12	5	750.00
1	6	0.00
	7	0.00
	8	0.00
	9	0.00
▼ 25,000	10	0.00
	11	0.00
	12	20,000.00

Notice that there's a cash-flow for every period (zero *is* a cash-flow). But if cash-flows occur at irregular *time* intervals, you're out of luck; the HP 19BII cannot analyze such a situation for you. The HP 19BII can analyze scenarios where the cash-flow *amounts* are uneven, but their *occurrences* must still be regular—once per period.

The above picture does indeed fall within those limitations, but how do you analyze it? Not with the TVM keys—there's no level PMT. You must use the CFLO Menu instead....

Go Find It: From the MAIN Menu, press FIN, but instead of TWM, hit CFLO. You'll see something like this:



This is a CFLO list. The pointer () shows you where you are in the list, and any value you key in will go into the list at that point. To move up and down the list, you use the () and () keys. And you can use () and () to jump all the way to top or bottom of the list.

This kind of list is just a specially reserved kind for representing cash-flow diagrams.

You've already seen how the variables in the TVM Menu "draw the picture" for your calculator. But now you're working under a different set of circumstances, because there's no level PMT value.

Instead, to draw a picture of an *uneven* cash-flow situation, you use the concept of cash-flow *groups*.

Cash-Flow Groups

Here's that uneven cash-flow scenario again:



Notice that you could describe it quite succinctly like this:

"The initial cash-flow is -25,000.00.

"The amount of the first cash-flow group is 400.00. The number of times this occurs in a row is 4.

"The amount of the next cash-flow group is 750.00.

The number of times it occurs in a row is 1.

"The amount of the next cash-flow group is 0.00. The number of times it occurs in a row is 6.

"The amount of the next cash-flow group is 20,000.00. The number of time it occurs in a row is 1." That's the whole idea right there. Notice, however, that you treat the very first cash-flow (the INITIAL FLOW) separately; it usually represents the investment (a negative) cash-flow in the scenario.

But other than that, just read off the groups from your T-bar (top to bottom) or diagram (left to right), note how many times each cash-flow amount occurs in a row, and key this information into your CFLO list.

- **Do It:** Key in the cash-flow scenario from the previous page.
- Like So: First, of course, go to the CFLO Menu so that your display looks like that shown on page 204. Now, watch your display as you press CLEAR DATA TEST and then:



Did you notice your display as you were doing this? The \blacktriangleright shows you which item you're currently working on, and the FLOW()= and #TIMES= tells you what that item is.

Keep in mind that the initial flow is really "FLOW(\emptyset)," and it always occurs just "1 time in a row." It's the first cash-flow group *after* that which is called FLOW(1).

Also, notice that every time you key in a cash-flow amount, the machine starts out by assuming that this flow occurs only once. That is, it puts a 1 in there for the **#TIMES=**, so that if this *is* the case, you don't need to key in (1); you just press [NPUT]—very handy.

Change Values:	Go to the top of the to check it. Then (not the number of	ne list and step down through it a change the cash-flow <i>amounts</i> of times each occurs) as follows:
	INIT=-22, FLOW(1): FLOW(2):	000 250.00 400.00
	FLOW(2):	400.00 25,000
Solution:	Press (to jum), and check the Then () once a	p to the top), then () () () () () () () () () () () () ()
	22000+/- 250(INPUT) +400(INPUT) +++250)(INPUT)) 0]0)(INPUT)
	(You can change t	the numbers in any order, but it

just means more moving around with (+) and (+).)

	m	\$
	0	(22,000.00)
25,000	1	250.00
	2	250.00
400	3	250.00
250 250 4	4	250.00
	5	400.00
Month 2 3 4 5 6 7 8 9 10 11 12 1	6	0.00
	7	0.00
	8	0.00
	9	0.00
22,000	10	0.00
	11	0.00
	12	25,000.00

With the changed numbers, your situation now looks like this:

Now, before you do any calculations, you should NAME your list so that the machine will save it: Press **NAME FRED**(NPUT). Then **CALC**....

Look: You'll see this menu:



This is the CALCulations Menu, where you "crunch" your answers after drawing the correct picture. Notice the message, telling you that you must key in an interest rate, I%, before you can calculate NPV, NUS, and NFV. Why? What are those calculations anyway?

What Is NPV?

Suppose this cash-flow scenario ("FRED") is a real-life situation—an investment opportunity you're being offered to help your friend, Fred, to get a business started over the course of the next year.

The budding entrepreneur figures that he needs \$22,000 up front. He offers to demonstrate his good faith and ability to manage cash by paying a little something back over the first five months (\$250 for four months and then one month of \$400). Then, if you'll give him until the end of the year with no further payments, he'll pay you off with an even \$25,000 at that time.

The pitch: Over the year-long scenario, he claims that you'll be earning an A.P.R. of about 19.175%.

Would you do it? How can you verify his claim?

Go back to the basics: The Time Value of Money is *the interest value that time adds to money*. Alittle bit now is entirely equivalent to more later, and the equalizer is the interest rate that acts over that time.

Now apply this to the question at hand: Your friend is claiming that your \$22,000 given to him now is *entirely equivalent* to his giving you \$250/month for 4 months, \$400 for 1 month, \$0/month for 6 months, and then \$25,000, *assuming an interest rate* of 19.175% A.P.R.

Can you prove this equivalence? Yes—with NPV....

Recall (from pages 109-110) that you can slide cash-flows across a cashflow diagram (or up and down a T-bar*)—as long as you increase or discount them according to the prevailing interest rate.

What if you were to take each of the cash-flows of this proposal and slide them back to the beginning of the timeline, *discounting* each one of them according to the assumed 19.175% A.P.R.?

Here's the starting situation:



Here it is after you've slid that first \$250 back. See how it's reduced? It has been discounted, according to the assumed 19.175% A.P.R.:



And here it is after the second \$250 slides back. It amounts to even less, of course, because it had a longer time to be discounted:



*This particular explanation will use cash-flow diagrams, but you can do it with T-bars, too.

And so on, until the picture looked like this:



All the cash-flows have been discounted back and stacked up (the zero cash flows would still be zero, right?).

Then, of course, you can add together any simultaneous cash-flows. So one big simplification would be to lump together (sum) all those positive cash-flows:



They *balance* the negative cash-flow—to within a nickel! Coincidence? No, this is what your entrepreneur friend, Fred, has said all along: Your \$22,000 investment in him *was* equivalent to all his various future repayments, if you discount everything back at 19.175% A.P.R.

That's what NPV is: A discounting-back-and-summing-up of all cash flows at the beginning of the timeline.

Of course, the idea here is that your calculator can compute this NPV —do all the discounting and summing—very quickly. And since you've already keyed in the whole picture, you're ready to "crunch," right?

Wrong. Look again at the reminder in your display. You need to tell it what interest rate (I%) to use as the discount rate.

- **Tell It:** Tell your HP 19BII to use a 19.175% A.P.R. as the prevailing discount rate in this cash-flow scenario.
- Ahem: Do you just key in 19.175 and press 2. Nope.

The CFLO Menu is not like the TVM Menu, where you don't need to worry about converting the A.P.R. to a D.I.R.—the machine does it for you, once you tell it the P/YR. Here in the CFLO Menu, you must *manually* convert any A.P.R. to its correct form (monthly in this case).

```
So you must press 19.175÷12=(ALGebraic) or
19.175[NPUT12+(RPN),
```

and then

Now you're ready. If your paper analysis has been correct, then the NPV should be about zero, because it nets together everything at the beginning of the timeline, adding your initial -22,000 to that stack of positive cash-flows that were discounted back from the future. Since these amounts are equal and opposite, they *ought* to net out to be zero—within a nickel or so. So press **NPW** to see: NPW=-0.05

Now, notice the other items on this CALC Menu. Each of them analyzes your CFLO list. For example, press **TOTAL**. You'll get the simple sum of all cash-flows in your list: **TOTAL=4,400.00**

Silly Question:	If you compute an NPV with a discount rate (I%) of zero, what would you get for an answer?
Silly Answer:	A zero discount rate means that you're not dis- counting at all. You're just moving each cash-flow, as is, back to the beginning of the timeline and summing all of them.
	So, what should you get? It's the same as taking the TOTAL, which you just did, above: 4,400.00
Make Sure:	Do it. Press () 12 , then NPV <u>Answer</u> : NPV=4,400.00

But what does this 4,400.00 mean? And what was the meaning of that leftover nickel (-0.05) from the analysis of Fred's proposal? What *is* the meaning of NPV?

To answer that, look at this simple demonstration....

Problem:	If you use a discount rate of 19.175% A.P.R. then the Net Present Value (NPV) of Fred's deal is about zero. That is, after all the discounting-and-summing, <i>your investments balance your returns</i> .
	But what would be the NPV of Fred's proposal if you were to use a discount rate of 20% A.P.R. instead?
Solution:	Press 20÷12= (ALG) or 2011PUT 12÷ (RPN), IX NEV Answer: NPV=-170.01
Question:	What does this number mean?
Answer:	It means that <i>if</i> the value of your money (i.e. what you could yield with it in some other, similar investment) is really 20% A.P.R., then you would <i>lose</i> \$170.01 by choosing this deal over that other, similar investment.
	That's what you were being told in the 19.175% A.P.R. case also: Under that discount rate, the deal had an NPV of -\$0.05, meaning that by helping Fred with his start- up, you were losing just a nickel compared to any other investment that would yield you 19.175% A.P.R
So NPV is an advisory number that compares the cash-flow scenario you're analyzing with a hypothetical investment that yields exactly the discount rate, I%, that you specify:

- If the resulting NPV is *positive*, this means the cash-flow scenario is earning you *more* than the specified discount rate.
- If the NPV is *negative*, the cash-flow scenario is yielding *less* than the specified discount rate;
- If the NPV is zero, then there's no difference—a perfect balance.



Therefore, it's usually wise to use as a discount rate that which you really *could* yield in another investment of similar risk and liquidity. Then the NPV is a very good indicator of any investment's value to you *relative to what else you could reasonably expect to do with that money.*

For another good illustration of the advisory message offered by NPV consider the 4,400.00 NPV value you calculated with a discount rate of 0% (page 213).

\$4,400—a *positive* NPV—tells you this: "If the yield on your money in other investments of similar risk and liquidity is *really* 0%, then you come out \$4,400 *ahead* by putting your money into Fred's scenario rather than into any of your 0%-yield alternatives."

What Is IRR%?

The other "big" item on your CFLO CALC Menu is IRR%, and now it's time to take a look at what Internal Rate of Return is all about. What exactly does it mean?

In 25 words or less:

"Internal Rate of Return (IRR%) is the discount rate that produces a Net Present Value (NPV) of *zero* for the given cash-flow situation."

Remember your friend Fred's claim about your 19.175% A.P.R. "yield" on his business startup plan (page 209)? You proved he was right by proving that your returns *balance* your investment if you discount those returns back at a 19.175% discount rate.

This balancing is what IRR% does. It actually performs a set of trialand-error NPV calculations, varying the discount rate until it finds a rate that gives an NPV of zero.

Indeed, where do you suppose Fred *got* that 19.175 he quoted to you? Lucky guess, maybe? No, he probably did an IRR calculation.

Prove It: Find the IRR% of Fred's proposal (shown again here):



Solution: This scenario is the list you named FRED, so from the CFLO Menu, GET that list now, by pressing GET FRED. Then—without any further ado—just go to the CALC Menu and calculate the IRR%: CALC MENU Answer: IRR%=1.60

Uh... that's not the 19.175 you were expecting, is it? No—remember that all discount rates in the CFLO Menu are *periodic*, not annualized (not true of the I%YR of the TVM Menu). The periods in your friend's scenario are months, so the IRR% is also monthly.

So annualize it: $\times 12 = (ALG) \text{ or } 12 \times (RPN)$ <u>Result</u>: **19.17** That's better. And if you see ALL its decimal places (press DISP **FILL**), you'll see that it *was* just about 19.175—but not exactly, which explains why, when you used *exactly* 19.175, you had a nickel or so of difference. Thus, in many cash-flow scenarios, IRR% is a very convenient way to compute the discount rate that "balances" the situation—the rate that equates the present value of all your investments with the present value of all your returns. In this respect, you can often think of the IRR% as the "yield" on your investment, and many people do rely heavily upon IRR% to tell them their "yields."

But be careful! There are two traps you can fall into with IRR%:

Trap #1: It's entirely possible to have a cash-flow situation where there is no discount rate that will give a zero NPV. And (even worse), it's also possible to have more than one rate that zeros out the NPV—multiple IRR%'s.

> You can often spot such multiple situations because they tend to flip-flop their cash-flows a lot, maybe with some investments first, then some returns, then some more investments, etc., like this:



Fortunately, a conventional, one-time investment situation—like FRED—generally has one IRR% at most.

Trap #2: Even when you can find an IRR% that seems reasonable, it's easy to talk yourself right into the land of unreality.



For example, look at this investment:



At the beginning, you invested \$100,000, and over the next ten years you received steady, even returns on that investment. The IRR% ("yield") for this situation is 10%. So you yielded 10% per year on \$100,000 for ten years, right?

Wrong! You actually yielded:

10% for *one* year on \$14,795.04, then pocketed \$16,274.54 10% for *two* years on \$13, 450.03, then pocketed \$16,274.54 10% for *three* years on \$12,227.30, then pocketed \$16, 274.54 ...etc. (use TVM to confirm these numbers, if you wish). In other words, this is the real picture:



Every multiple cash-flow situation is really made up of investment/return pairs like this. And—as you've seen this is exactly how NPV looks at it too: It identifies and transforms each cash-flow into its discounted counterpart back at the beginning of the timeline. The discount rate is used as the *rate of return* on each of these little "internal" investment/return pairs.

The point is, IRR% makes no assumptions about what you do with your "pocketed" returns once you get them. It only claims that the growth rate of each of these little investments was 10% per year *while it was invested*. The minute you get your money back, *the growth stops on that money* who's to say what you do with it after that?



6. ROUGHER ROADS: THE CFLO MENU

So you actually yield 10% for *ten years* on only \$6,274.54. That's a whole lot different than yielding 10% on \$100,000 for ten years.

An easy way to illustrate this is to add up all the pocketed returns of your investment: it comes to \$162,745.39. This is what you'd have after the entire ten-year term of your cash-flow scenario—assuming that you did nothing but keep those returns in your pocket.

Now compare that with a simple \$100,000 note, invested for 10 years at 10% per year. Its maturity value is \$259,374.25.

Those are vastly different numbers. But in both cases your yield is 10% per year. The difference arises in the amount of time you let this yield act. Only in the case of the 10-year note can you say that you yielded 10% on your entire \$100,000 for the *entire* term.

Never confuse the term of an investment *analysis* with the term(s) of the actual investment(s) *within* that analysis.



CFLO Quiz

(Draw those T-bars or cash-flow diagrams!)

CFLO Review

- 1. A loan is written at 12% A.P.R., with \$450 monthly payments (in arrears), for 30 years. What is the loan amount? As an exercise, find it with an NPV calculation (don't cheat by using the TVM keys!). Do the same for annuity in advance.
- 2. How much should you deposit now in a bank account that earns 8% A.P.R. (tax deferred), compounded monthly, so that you can withdraw \$10,000 at the beginning of every quarter for 20 years, starting 20 years from now? What about \$15,000 withdrawals?
- Suppose that, for one initial \$10,000 investment, you could choose between either of these schedules of income: (i) \$1000 after Years 1 and 2, \$2000 after Year 3, \$3000 after Year 4, \$5000 after Year 5, \$8000 after Year 6; or (ii) \$2800 after each of the six years. Which is better? Comparable investments yield you 16%.
- 4. What even income stream is *equivalent* to the uneven stream in the previous problem? What would be the first year's income in an equivalent stream that increases annually by 4%?

Residential Real Estate

5. You're transferred to a new city for 4 years. You have \$10,000 for a down-payment and are considering a \$100,000 home. Property values are growing at 8% annually. The 30-year mortgage rate is 10%, and inflation is 5%. A liquid cash fund earns 8%, but a stock mutual fund could earn 15% annually over 4 years.

To buy the home, closing costs are \$400; the loan fee is 1%. Insurance starts at \$30/month, with \$180/month in utilities and maintenance. Property taxes are 1.25% per year. Your tax bracket is 28%; capital gains are 100% taxable. You'll pay a 6% commission to resell the home.

On the other hand, if you rent the home, your security deposit would be \$300. Your rent would start at \$750, with monthly insurance at \$15 and maintenance/utilities at \$100.

"To buy or not to buy-that is the question."

6. You have just made the 84th monthly payment (in arrears) on your 30-year mortgage, whose rate is 11.875%. The balance now stands at \$64,750, and current rates are at 10.5%. The refinancing fee is 2.5%. Should you refinance? You may pay off the mortgage on time, or in a balloon after 180th month.

Commercial Investment

- 7. You're considering the purchase of a double mortgage. The first mortgage was written for \$90,000 for 30 years, with end-of-the-month payments at 12% A.P.R. After 15 years, a second mortgage for \$30,000 was added, at 13.0% for 20 years, again with monthly payments in arrears. The bank now holding both mortgages is willing to discount them to you so that you can earn 16% on your investment. How much should you pay the bank for the right to "inherit" these contracts (begin to receive their payments) at the end of the third year of the second mortgage (i.e. at the end of the 18th year of the first mortgage)? What if you settle instead on a price that yields you 17.5%?
- 8. What is the monthly payment amount for a 5-year lease with skipped payments (annual schedule shown below) on a \$40,000 computer with a 10% residual buy-out? The lessor is asking for 4 advance payments (other than the first normal payment) and wants an 18% yield.

<u>Month</u>	Payment?	<u>Month</u>	Payment?
1	yes	7	no
2	yes	8	no
3	yes	9	no
4	no	10	yes
5	no	11	yes
6	yes	12	yes

9. A manufacturer is relocating and needs a warehouse until its own facilities are completed (2 years). One suitable building is for sale for \$100,000, of which 75% is depreciable. The firm has \$30,000 in ready cash. The 20-year mortgage rate is 10%, and inflation is 5%. Cash funds earn 7%; stock funds earn 15%. To buy the building, closing costs are \$400; the loan fee is 2%. Insurance starts at \$60/month, with \$250/month in utilities/maintenance. Property taxes are 1.25% per year. The company's tax bracket is 33%, with capital gains 100% taxable. A broker will charge 6% commission to resell the building. Estimated price: \$115,000.

Alternatively, to lease the building from the current owner, rent would start at \$750/mo. (including property taxes), with 2 payments (in addition to the first regular payment) due immediately, and with annual adjustments for inflation. Insurance would be \$85; maintenance/utilities would be \$220.

Should the company buy the building or lease it?

10. A home currently has two mortgages: \$100,000 at 10% for 30 years (no balloon); and \$50,000 at 11.5% for 10 years, with a \$10,000 balloon. The second mortgage began after the 15th year of the first. Now, after the 20th year, the owner wishes to consolidate loans and get financing for more remodelling. You offer to "wrap" his current mortgages (cover all their obligations) and loan him \$50,000 in new money, in exchange for 120 monthly payments of \$2,200 and a \$25,000 balloon. What is your yield? And what is the borrower's overall A.P.R.? He paid 1 point up front on the first mortgage, 2 points up front on the second.

11. You are considering an investment in low-income housing. Your cash-flows will look like this:

<u>Year (end)</u>	<u>Cash-Flow</u>
0 (initial flow)	\$ -50,000
1	25,000
2	50,000
3	-25,000
4	50,000
5	-25,000
6	-10,000
7	-10,000

What would be your yield on this investment scenario?

12. Find the FMRR for the following cash-flow scenario, assuming that all cash is taken from, and returned to, an account earning 6%. Compare this FMRR with the IRR% for the same situation.

<u>Year</u>	<u>Cash-</u>	<u>Flow</u>
0	\$ (7:	5,000)
1	1:	5,000
2	1:	5,000
3	(6	0,000)
4	7:	5,000
5	(3	5,000)
6	200),000

13. Using a safe rate of 6% and a risk rate of 15%, find the FMRR, \$MIN and \$MAX of the scenario in Chapter 5, problem 24 (pages 167 and 190-196).

<u>Personal Finance</u>

- 14. Recall the comparison of IRA's in Chapter 5 (prob. 9, pages 162 and 175). The idea was that 7 early years of investment were more valuable after 28 years than similar investments made in each of those later 28 years. Prove this again with a CFLO list.
- 15. After having invested in three no-load mutual funds as shown in the schedule below, you had a sudden, violent attack of prudence on August 31, 1987, and sold everything—for these net amounts:

A:	\$34,319
B:	\$13,526
C:	\$22,410

Fund	Date	Amount Invested
А	9-30-82	\$ 3000
В	3-15-83	1000
С	5-31-83	2500
Α	6-30-83	2500
В	11-15-83	1000
С	4-15-84	2500
Α	5-31-84	3500
В	8-15-84	1000
С	10-15-84	3000
Α	12-31-84	3000
В	4-15-85	1500
С	6-30-85	4000

What was your overall annualized yield?

CFLO Quiz Solutions





Your unknown is the cash-flow at the beginning of the timeline. Therefore, if you take the NPV of the rest of your list—using the actual rate as the discount rate, the result must exactly balance this unknown flow—equal and opposite (recall Fred's scenario). This makes sense: If the quoted 12% A.P.R. truly represents the interest rate in this mortgage, it *must* be the discount rate for which the entire scenario's NPV is zero. If it produces an NPV either more or less than zero, then the mortgage's yield is either more or less (respectively) than the 12% A.P.R. You use this "incomplete" NPV to deduce what other cash-flow must have happened at the beginning of the timeline to produce a *zero* NPV.

So just key in the cash-flow scenario, ignoring the initial flow: Press **GET KNEW** at the CFLO Menu. Then: (no initial cash-flow except the unknown you ignore)
(a) (INPUT)
(

Now redraw the picture for the case of annuity in advance:



Again, find the unknown flow at the beginning by ignoring it. EXIT to the CFLO Menu to modify your list now:

+450 INPUT	(in BEGIN Mode, there's a PMT right away)
•	(change only the frequency of $FLOW(1)$)
359INPUT	
0 INPUT INPUT	(the end of month 360 has no cash-flow)
CALC NPV	<u>Answer</u> : NPV=44,185.73
The initial cash-flow	w(from the lender's viewpoint) was -\$44,185.73.

Verify these values with the TVM Menu, if you wish.

q	\$
0	(?.??)
1	0.00
:	0.00
79	0.00
80	10,000.00
:	10,000.00
159	10,000.00

Discount = 8.00% (compounded monthly)



Again, the problem is to find the unknown initial cash-flow. But you have *quarterly* cash-flows with *monthly* interest compounding of interest ("...sounds like a job for... ICONV!").

First, draw the picture: At the CFLO Menu: CLEAR DATA YES

 0(INPUT)
 (nothing happens initially, except for the unknown flow, which you ignore for now.)

 0(INPUT)
 (79 quarters of no cash-flows)

 10000(INPUT)
 (80 quarters of withdrawals)

 Now convert the interest rate:
 EXIT FCONNETION

 8 NOME 12
 FILE

 9 INPUT
 (ALG) or 4+ (RPN), then EXIT EXIT CFLOR EALCH, then +4 = (ALG) or 4+ (RPN), then ISON NEW

 Answer:
 NPY=81,967.88

NEW Answer: NPV=122,951.83

3. The alternatives:



From the CFLO Menu, clear or name the current list, then begin a new list: 10000 +/- (NPUT 2800 (NPUT 6) (NPUT CALC 16 IN NEW Answer: NPV=317.26

That's the simple, even cash-flow option. Now EXIT to CFLO, and name this list: NHME EVEN (INPUT), and GET ENEW.

Now for the other case:



NPV tells you that the EVEN case is worth slightly more to you.

4. This is a question to answer with a NUS ("Net Uniform Series") calculation. NUS takes the NPV of a given set of cash-flows and then computes what uniform series would give that same NPV:



Notice that the initial -\$10,000 is not in question; it's assumed in either case. You're analyzing only the positive cash-flows to see what uniform yearly amount could replace each of them.

So just omit the initial investment in your UNEVEN scenario (this should be the current CFLO list if you've just come from the previous problem): EXIT (10 (INPUT) CALC and then NUS).... Answer: NUS=2,770.22

So (at a discount rate of 16%), your uneven payment scenario has exactly the same value to you as six level payments of \$2,770.22. This seems plausible: it's only slightly less than the \$2800 EVEN case of problem **3**, and—as the results of that problem showed there was only a slight difference between those two NPV's.

Prove the equivalency of your NUS, by using it as the cash-flow amount in the EVEN case; the NPV should then be exactly that of the UNEVEN case: EXIT and GET EVEN. Then () and simply INPUT to replace the \$2800 with the NUS (which is still on the Calculator Line). Then CALC and NPV Answer: NPV=207.52 Sure enough. The other part of this problem is similar, but it asks you to find a certain *uneven* scenario that satisfies the equivalency:



Each cash-flow in the unknown scenario is 4% more than the previous, *and* its NPV must match that of the UNEVEN scenario. First, find that NPV: EXIT **GET UNEVE**. Then **CALC NEV**.... Answer: NPV=10, 207.52

Now, a 4%-increasing scenario that starts with one dollar has an NPV that is x times less than that of a 4%-increasing scenario that starts with \$x. In other words: $NPV_{s_1} = x(NPV_{s_1})$. But you've just calculated that NPV_s is 10,207.52. So the x in the unknown $x = 10,207.52 \div NPV_{s1}$ scenario above is given by: So: EXIT) and GET ENEW. Then: () [INPUT] (1)INPUT)INPUT) +4% (ALG) or 4%+ (RPN) [INPUT]INPUT] + + RCL]INPUT + + (+]4% (ALG) or [4%]+ (RPN) [INPUT]INPUT] + [+ [RCL]INPUT] + [+] +4% (ALG) or 4%+ (RPN) [INPUT]INPUT + + RCL[INPUT + + + +4% (ALG) or 4%+ (RPN) [INPUT]INPUT] + [+ RCL[INPUT] + [+] +4% (ALG) or 4%+ (RPN) [INPUT]INPUT] CALC NPV (Result: NPV=4.01) Then 1/x and $x_10207.52=(ALG) or (10207.52)(RPN)$ Answer: 2,548.38

(If you do a lot of calculations with increasing annuities like this, you may find it useful to use the formula on page 368 in Ch. 9.)





BUY assumptions: The mortgage payment, utilities and maintenance are due at the END of the month. You pay yearly insurance (in advance) and property taxes (in arrears), and tax relief from deductions comes at the end of the year. When you sell the home and pay off the mortgage, you will owe capital gains tax on your net gain—after any commission to a broker. The property value (and thus its tax) increases annually at the given growth rate.

The RENT assumptions: You owe first and last month's rent, plus a fully-refundable security deposit immediately. Rent is paid at the beginning of each month, maintenance/utilities at the end. Your renter's insurance premium is paid annually, in advance. Also, you pay yearly income tax on the interest accruing on your investment of the down-payment money.

In both cases, insurance, utilities / maintenance (and your rent in the RENT case) increase yearly by the inflation rate. $_{+dep.}$



proceeds of resale

closing ins. The <u>ending balance</u> of the down-payment money invested:

EXITEXIT TWM OTHER 1 PAWR EXIT, and

4 N 10000+/- PV 0 PMT

15-28%= (ALG) or 15INPUT28%- (RPN)

```
<u>Answer</u>: FV=15,071.59
```

<u>Monthly rent</u> : 7 <u>50+/-</u>	-750.00	(Year 1)
+5%= (ALG) or INPUT 5%+ (RPN)	-787.50	(Year 2)
+5%= (ALG) or 5%+ (RPN)	-826.88	(Year 3)
[+[5]%]=) (ALG) or [5]%]+) (RPN)	-868.22	(Year 4)

Yearly insurance (RENT): 15+/-X12= (ALG) or

15+/-INPUT12X(RPN)	-180.00 (Year 1)
+5%= (ALG) or 5%+ (RPN)	-189.00 (Year 2)
+5%= (ALG) or 5%+ (RPN)	-198.45 (Year 3)
+5%= (ALG) or 5%+ (RPN)	-208.37 (Year 3)

Monthly util./mnt. (RENT): 100+/-	-100.00	(Year 1)
+5%= (ALG) or INPUT 5%+ (RPN)	-105.00	(Year 2)
+5%= (ALG) or 5%+ (RPN)	-110.25	(Year 3)
+5%=(ALG) or 5%+(RPN)	-115.76	(Year 4)

Yearly insurance (BUY): 30+/-X12=(ALG) or

- 30+/-INPUT 12X (RPN) -360.00 (Year 1)
- +5% = (ALG) or 5% + (RPN) -378.00 (Year 2)

 +5% = (ALG) or 5% + (RPN) -396.90 (Year 3)

 -396.90 (Year 3)
- +5% (ALG) or 5% (RPN) -416.75 (Year 4)
- Monthly util./mnt. (BUY): 180+/--180.00 (Year 1)+5% = (ALG) or (NPUT5% + (RPN))-189.00 (Year 2)+5% = (ALG) or 5% + (RPN)-198.45 (Year 3)+5% = (ALG) or 5% + (RPN)-208.37 (Year 4)

The <u>net (after-tax) yearly property taxes</u>:

 $100000+8\%\times1\cdot25+/-\%-28\%=(ALG) or$

100000INPUT8%+1•25+/-%28%-(RPN)

-972.00 (Year 1)

+8% = (ALG) or 8% + (RPN) -1,049.76 (Year 2)

+8% = (ALG) or 8% + (RPN) -1,133.74 (Year 3)

+[8]% = (ALG) or (8)% + (RPN) -1,224.44 (Year 4)

Monthly mortgage pmt: (At TVM—set P/YR to 12) 360 N 10 IXWR 90000 PV 0 FV PMT PMT=-789.81

The mortgage balance after 4 years: **48 No. FV**.... FV=-87,662.00

The mortgage interest yearly tax relief: OTHER AMAT,

12 #P	+/-×28%= or +/-28%	2,513.70	(Year 1)
NEXT	+/-X28%=or+/-28%	2,499.03	(Year 2)
NEXT	+/-X28%=or+/-28%	2,482.83	(Year 3)
NEXT	$+/-\times28\%=0r+/-28\%$	2,464.93	(Year 4)

The mortgage points tax relief:

900×28%= or 900INPUT28% 252.00 (Year 1)

The <u>proceeds of re-sale</u>:

10000+8%+8%+8%-6%(ALG)*or*

100000INPUT8%+8%+8%+6%-(RPN)

(result: 127,885.96). So the gain on the sale is \$27,885.96

 The net (after-tax) proceeds at resale:
 -87662

 -(27885.96)
 -(27885.96)

 27885.96)
 -(28X-)

 (RPN)
 32,415.89

The completed RENT diagram:



900.00 400.00 360.00

Now find the NPV of each scenario, using your 8% cash fund interest (less taxes) as the discount rate: MAIN FIN CFLO, etc. (you should now know how to key in the above diagrams). For each scenario, CflC and:

As you can see, either case is a net *expense* to you—your cost of housing—but it will be less if you buy the house.

<u>Note</u>: If you do a lot of these rent/buy analyses, see the formula on page 356 of chapter 9.

6. Just find the NPV of the refinanced scenario, *using the original mortgage rate* as your discount rate:



7. As the investor, you're the new lender:



See page 380 in Ch. 9 for a SOLVE formula for such calculations.

8. Here is the proposed scenario:



First, find the NPV which the lease payments must "balance:" At the CFLO Menu: CLEAR DATA TES 40000[NPUT] 0[NPUT]59[NPUT]40000+/-[NPUT][NPUT]CALC and 18+12=(ALG) or 18[NPUT]12+(RPN) 12 NPU NPV=38,362.82 The payments must "balance" this. Now, as in problem 4, when you don't know the amount of a given cash-flow—but you do know its NPV—use a \$1 cash-flow. That NPV is proportionally less than that of the unknown cash-flow, so the *ratio* of the NPV's is the amount of the unknown cash-flow: EXIT CLEAR DATA YES 5+/-[NPUT] (4 in advance, plus the first)

1 + - [INPUT] $2 $ [INPUT]	0 [INPUT] 2 [INPUT] 1 +/- [INPUT] INPUT]
0 INPUT 3 INPUT	1+/
1 +/- (INPUT) INPUT)	0 INPUT 3 INPUT 1+/- INPUT 6 INPUT
0 (INPUT) 2 (INPUT)	1 +/- INPUT INPUT 0 INPUT 3 INPUT
1+/-INPUT 6 INPUT	0 INPUT 2 INPUT 1+/- INPUT INPUT
OINPUT 3 INPUT	11+/-INPUT 6 INPUT

(Remember that the final 4 payments were paid in advance) **CALC NEW**.... NPV=-25.64 Then 1/x and 38362.82=(ALG) or $38362.82\times(RPN)$ <u>Result</u>: -1,496.36 The monthly lease payment amount. <u>Note</u>: If you do a lot of leasing calculations, see the formula on page 372 in Chapter 9. **9.** This is like **#5** (page 234), but all expenses are tax-deductible. Also, there is depreciation (31.5 years, Straight Line); the capital gain is the difference between the re-sale and *depreciated* values.

Ending balance of the down-payment money invested: EXIT EXIT THM OTHER 1 PAYR EXIT, and 2) N 30000+/- PV 0 PMT 15-33%=(ALG) or 15(INPUT33%)-(RPN)Answer: FV=36,333.01 F.U. -750.00 (Year 1) Monthly lease payment: 750+/--787.50 (Year 2) +5% = (ALG) or [INPUT] 5 % + (RPN) Yearly insurance (LEASE): [8]5]+/-]X[1]2]=](ALG) or [8]5]+/-[INPUT]1]2]X](RPN) -1,020.00 (Year 1) -1,071.00 (Year 2) +5% = (ALG) or 5% + (RPN)<u>Monthly util./mnt.</u> (LEASE): 220.00 (Year 1) -231.00 (Year 2) +5%=(ALG) or [INPUT 5%+(RPN)Expenses yearly tax relief (LEASE): 750×14+1020+ (12X220)X33% = (ALG) or (750)(NPUT14X) $1020+1210 \times 4,672.80$ (Year 1) $787 \cdot 5 \times 10 + 1071 + (12 \times 231) \times 33\% = or$ 787.5 [INPUT] 10 × 1071+12 [INPUT] 231×+33% 3,866.94 (Year 2) <u>Yearly insurance</u> (BUY): 60+/-X12= (ALG) -720.00 (Year 1) or 60+/-(INPUT 12X) (RPN) -756.00 (Year 2) +5% = (ALG) or 5% + (RPN)

 Monthly util./mnt. (BUY):
 250+/ -250.00 (Year 1)

 (+5)%=) (ALG) or [NPUT[5]%+) (RPN)
 -262.50 (Year 2)

 Net yearly property taxes:
 100000×1.15

 1.25+/-%
 -33%= (ALG) or 100000

 II.25+/-%
 -898.12 (Year 1)

 II.15
 II.15

 II.15
 II.15

 II.15
 II.15

 II.15
 II.15

 II.15
 II.15

Monthly mortgage payment: (At TVM) OTHER 12 PAYR END EXIT 240 N 10 IXYR 70000 PV 0 FV PMT PMT=-675.52

Mortgage balance: 24 NEW FV=-67, 562.08

Mortgage interest yearly tax relief: OTHER AMET,

 12 #P
 +/-X33%=or+/-33% 2,292.80 (Year 1)

 NEXT
 +/-X33%=or+/-33% 2,252.77 (Year 2)

<u>Mortgage points yearly tax relief</u>: 70000×2%×33%÷ 2=(ALG) or 70000(INPUT 2%2+33%(RPN) 231.00

<u>Depreciation yearly tax relief</u>: 75000÷31•5×33%= (ALG) or 750000[INPUT31•5÷33% (RPN) 785.71

Expenses yearly tax relief (BUY): 400+720+ (12×250)×33%=(ALG) or 400[NPUT720+ 12[NPUT250×+33% (RPN) 1,359.60 (Year 1) 12×262.5+756×33%=(ALG) or 12[NPUT 262.5×756+33% (RPN) 1,288.98 (Year 2)

 Proceeds at resale:
 115000-6%=(ALG) or 115000

 INPUT6%-(RPN)
 108,100.00
 (Gross proceeds)

 -(100000-(2×75000÷31•5=(ALG) or
 100000(INPUT750000(INPUT31•5÷2×---) (RPN)

 12,861.90
 (Gain)



The company would be slightly better off leasing the building. <u>Note</u>: If you do many such lease/buy analyses, see the formula on page 374 of Chapter 9.





...and from the borrower's point of view:



At the CFLO Menu, key in each of these scenarios and calculate their IRR%'s (you should know the keystrokes by now).

<u>Result</u> (your scenario):	IRR%=1.41
Annualize: $X12=(ALG)$ or $12X(RPN)$	16.97
Result (borrower's scenario):	IRR%=0.88
Annualize: $X12=(ALG)$ or $12X(RPN)$	10.51

Note: If you do a lot of these calculations, see the formula on page 380 of Chapter 9.

 11. Nothing to it—just GET a new CFLO list and key in the numbers:

 50000+/-_(INPUT)

 25000(INPUT)(INPUT)

 50000(INPUT)(INPUT)

 25000+/-_(INPUT)(INPUT)

 25000+/-_(INPUT)(INPUT)

 25000+/-_(INPUT)(INPUT)

 10000+/-_(INPUT)(INPUT)

 10000+/-_(INPUT)(INPUT)

 CHLC

MANY OR NO SOLUTIONS

TOTAL | IRRX



What's a good starting guess? Something modest—say, 12%? So press 12 STO IRE Result: IRR = 17.77 Not bad.

But you've just been told that there is at least one other solution, so try to find another—just for comparison. Try a much more pessimistic guess: 050 IRE Result: IRR = 9.49

Which IRR% is right? Will you be losing or making money on this housing deal?

It's not easy to tell—neither percentage is necessarily "right." Remember that IRR% is simply a number that, when used as the discount rate, happens to make the NPV balance at 0. It *doesn't* always mean that your dollars are actually accruing that much interest—as this example demonstrates.

So this is one of those times when you cannot simply look to IRR% to tell you your "yield." But, fortunately, there's another very logical way to calculate your "yield," the Financial Management Rate of Return (FMRR). Here's how it works:

When you invest money in any one place, you're choosing *not* to invest it somewhere else. Presumably, you do so because this investment best suits your needs—acceptable levels of risk and liquidity and, within those constraints, a good rate of return. But picture how you would actually make the investment(s) in the required schedule....

- **Question:** Where will you get the money at each of the required dates of the investments?
- **Answer:** From a bank account or another *readily liquid* account that is yielding you at least a little interest in the meantime—say, a money market account.
- **Question:** As you receive returns on these housing investments, what will you do with that money?
- Answer: If you have more investments (outflows) left on the schedule, you'll certainly use this money to supply those cash-flows. As for any excess, since you're clearly willing to risk that money to the degree of risk of the housing project, you'll probably put these excess returns into some other equally risky investment—a "risk-rate" account—until the end of the housing venture.

To summarize this strategy:

- You start with a certain amount of cash in a liquid account, earning interest at some "safe rate" until you invest it in the housing project.
- You also use interim returns to supply any subsequent investments in the schedule.
- You let all excess returns "ride" in a higher-yielding ("riskrate") account until the end of whole investment venture.

Keep in mind that this isn't any big secret formula. It's what any competent financial manager does—just common sense, really—which is exactly why it's used for the FMRR.

Question:	Under this strategy, what's the very minimum amount of money (\$MIN) you'll actually need to commit at the beginning of the housing deal to get the ball rolling?
Answer:	<i>Just enough</i> so that it—plus any interim returns— will grow sufficiently in that account to supply all your necessary <i>investments</i> (outflows).

- **Question:** What's the maximum amount of money (\$MAX) you can expect to hold in your hands at the very end of this whole venture?
- **Answer:** It's the ending balance of your risk-rate account, where you have put all excess returns (those not needed for further investments).

What you're doing, then, is reducing your entire investment scenario to this single-investment/single-return model:



∳ \$MIN

So the only question, really, is how to calculate \$MIN and \$MAX. The complication is the sharing of returns (positive cash-flows). That is, what portion of these returns must you hold in your saferate account to cover investments (outflows) yet to be disbursed; and what portion can you salt away in your risk-rate account? To figure this out, you work *backward* in time—from the last cashflow to the first—*clearing each flow as you go, by discounting it back or sending it forward*:

- If a cash-flow is *negative*, you discount it back in time—using the *safe rate* as your discount rate—to add to the *previous cash-flow*. Why not just discount this negative flow all the way back to \$MIN, just like an NPV calculation? Because it might be covered by a previous positive cash-flow, in which case you don't need to commit any funds for it as part of your minimum up-front commitment, \$MIN. Thus, you work back one flow at a time, looking for positive flows to offset negative flows.
- Of course, if a cash-flow is *positive*, you can send it all the way forward—added to \$MAX at the end of the scenario—using the *risk rate* as the discount rate. You can salt this flow away, because you don't need any of it to cover future negative cash-flows (working backward, you've already cleared them all).

Watch as you work backward through each of the cash-flows in the housing scenario. Assume a 6% safe rate and a 15% risk rate:

"Discount -\$10,000 back 1 period at 6%:"









"Send \$50,000-\$23,584.91 forward 5 periods at 15%:"






Notice that in this case, \$MIN is simply the initial -\$50,000. Now here are the keystrokes for the entire solution—all done at the TVM Menu: MAIN FINE TWE OTHER 1 PAYR EXIT. Then:

10000 FW 0 PMT 1 N 6 IXYR PV PV=-9,433.96

-10000=+/- (ALG) or 10000-+/- (RPN) FU

-25000=+/- (ALG) or 25000-+/- (RPN) FW

25000 FV 1 N 6 IXYR FV PV=-23,584.91

25000=+/- (ALG) or 25000+/- (RPN) PU 6 N FU FUFV=57, 826.52

Now find the growth rate that transforms \$MIN into \$MAX: 7 50000+/- FW, then 13868.76+53130.19+57826.52= or 13868.76[NPUT53130.19+57826.52+ (Result: 124,825.47 This is \$MAX)

Now **FUE TRUE**....<u>Answer</u>: IXYR=13.96 Your FMRR a good estimate of your rate of return in this housing scenario.

Note: See also the FMRR formula on page 388 in Chapter 9.

12. At the TVM Menu, press OTHER 1 PAYR EXIT. Then:

35000 FV 0 PMT 1 N 6 IXYR PV PV=-33,018.87

+75000=+/- (ALG) or 75000++/- (RPN)

60000 FV 1 N PV PV=-56,603.77

+15000=+/- (ALG) or 15000++/- (RPN)

+15000=+/-(ALG) or 15000++/-(RPN) **FV**

-75000= (ALG) or 75000- (RPN) <u>Result</u>: -97,876.27 This is \$MIN.

Now PY 6 N, then

(Result: 247,170=) or (2000) (INPUT) (71) (70) (Result: 247,170.00) This is \$MAX)

To compare this to the IRR%, key in the scenario as a CFLO list (you know the keystrokes by now, right?), then **CALC MARK**.... <u>Result</u>: IRR%=20.69

Which is more accurate? Look at it this way: IRR% is the rate at which your money appears to grow *only while it is invested*, and it doesn't account at all for what happens to the returns—the positive flows—after you receive them (recall pages 219-221). On the other hand, your FMRR assumes that you reinvest excess returns at a rate of 6%. Which is closer to reality?

13. Here's the T-bar of the situation:

у	\$
0	(260,250.00)
1	12,896.21
2	14,497.94
3	16,834.26
4	19,244.19
5	414,242.63

Now, you *could* just grind out the FMRR at the TVM Menu, as in problems **11** and **12**. Or, you could observe that all the cash-flows except the initial flow are positive. So \$MIN *is* the initial flow.

And notice therefore, that, to find \$MAX, you'll just be sending all the positive values forward, using the risk rate, summing the results. That's an NFV (Net *Future* Value) calculation—and it's available on the CFLO Menu. Similar to NPV, NFV sends all cashflows *forward* (rather than back), summing the results at the *end* of the timeline (instead of the beginning).

So use NFV to find \$MAX: At the CFLO Menu, GET a new list (or
clear the current one). Then: OINPUT (just the <i>positive</i> flows)
12896 21 INPUT INPUT 14497 94 INPUT INPUT
16834 · 26 INPUT INPUT 1924 4 · 19 INPUT INPUT
414242•63INPUTINPUT CALC 15 I? NFV
<u>Result</u> : NFV=503, 241.86 This is \$MAX.
Now go to the TVM Menu for the final calculation:

EXITEXIT TWM STOL FY OTHER 1 PAYR EXIT 260250+/- PV 5 N IXVR Answer: IXYR=14.10 The FMRR.

14. The two alternatives:	у	\$
	0	(2,000.00)
	1	(2,000.00)
10.00% A B B	:	(2,000.00)
10.00% A.P.H 4FV = ?		(2,000.00)
Year 1 2 3 7 8 9 Year 35	7	0.00
		0.00
2,000.00 ea.	34	0.00
	35	?
	у	\$
	0	0.00
	1	0.00
10.00% A.P.R	:	0.00
۲۷ = ۲ Vor. 1.0.0	6	0.00
	7	(2,000.00)
(0.00) * * * * * * * * * * * * * * * * * *	:	(2,000.00)
		(2,000.00)
	35	?
Your strategy: Find the Net Future Value (NFV)	ofea	ch scenario.

The save-early plan: At the CFLO Menu, clear the current list (CLEAR DATA) or NAME it and GET a *NEW list. Then:

20001NPUT

2000INPUT 6INPUT

0 INPUT 2 9 INPUT

CALC 10 12 NEW Answer: NEV=300,991.75

The save-later plan: EXIT to the CFLO Menu, . then:

0 INPUT

0 INPUT

+2000 INPUT 28 INPUT

0 INPUT INPUT

CALC NEW Answer: NEV=295,261.86

15. To find an overall rate of return, ignore the fund names (A-B-C). Notice, however, that the time periods between cash-flows are uneven (the machine can't handle this). Stymied? Not totally. Look at the dates of those investments. Why not designate the period in the analysis to be a half-month (24 per year)? It's a little imprecise, but the error is only a day or two in any given case, and the analysis spans about 5 years, so it's a decent approximation:



At the CFLO Menu, clear the current list or get a new one. Then:



Rest Area

Need a break? It's probably time to stop, stretch your legs, and look at your map.

• In Chapter 5, you saw several variations on amortized loans, including balloon payments, negative amortization, loan fees, differing annuity modes, etc. TVM is the menu to use on such "smooth-road" problems—they all involve a steady PMT amount.

You also used the ICONV Menu to convert interest rates for these problems, and you also explored depreciation and bonds.

• Here in Chapter 6, you saw how to represent and then build *uneven* cash-flow solutions—the "rougher roads"—with the CFLO Menu. You then learned what NPV does and what it means. Next came IRR%. You saw how IRR% *can* represent your yield in an investment scenario—but not necessarily! So you learned when and how to obtain an alternative investment measure: FMRR.

Next Destination?

Time to check the map again, because here's another junction. Check the signs now and choose your route....





7. THE DATA YOU COLLECT: SUM LISTS

Saving Numbers

Of course, the whole point of "navigating" through the menus of your HP 19BII is to get to places where you can do calculations.

But what about afterwards? What do you do with the results of these calculations? What if you need to use the results from one menu in some other menu—"way across town?"



How do you store your answers for later use? And how do you retrieve this information, edit it, erase it, view it, use it, etc.?

With its continuous memory, the HP 19BII doesn't forget numbers, and you should know how to take advantage of this. Up to this point in the Course, although you kept a few results in the Stack while changing menus, that's about the only place you've really stored anything. It's time to learn about other places (the best places) to save numbers—in *registers* and in *lists*.

The Numbered Registers

The simplest way to save the result of any calculation is in a *numbered* storage register, so called because that's how you refer to it—by number—when you want to store into it or recall from it.

Try This:	This: Store the result of 789÷5 into register 4.	
Solution:	Press 789÷5=(ALG), or 789ENTER 5÷ (RPN), to get 157.80, then press STO(4 Simple, right?	
Now Do Th	is: Clear the Stack (by pressing CLEAR). Then <i>recall</i> the number you just stored.	
Nothing To	It: Press RCL 4.	

See how these numbered registers can act as convenient holding bins? And there are ten such registers, numbered 0-9.

Notice that the STO and RCL keys both copy values. That is, after you pressed STO(4), the value 157.80 was still in the Stack, too; a copy was sent to register 4.

Likewise, when you pressed [RCL] 4 to bring that value back, you were bringing back a *copy* of the contents of register 4. Right now, there's still a 157.80 in register 4 (clear the Stack and do another [RCL] 4), if you want to prove this to yourself).

Lists of Numbers

So the ten numbered storage registers give you one option for saving results—the quickest, simplest way. But there's another, far more sophisticated way you may need, too.

For example, what if you have a set of numbers that represent, say, your income levels for the past 11 years? You can't store these in the numbered registers because there are only ten registers. Besides, it would be very handy to keep all of these figures in one list, so you can compare them and analyze them, right?

Well, you *can* do this—and here's how: Suppose that you're an income property owner, and that the numbers below show the gross annual rental incomes for 11 different buildings:



<u>Building</u>	<u>Gross Rental Income</u>
1	17,000.00
2	22,000.00
3	21,500.00
4	24,000.00
5	14,500.00
6	19,000.00
7	23,000.00
8	24,000.00
9	24,500.00
10	18,000.00
11	27,000.00

Starting from the MAIN Menu, press the **SUM** key. You'll see something like this:



The SUM Menu is for *lists*—and you're about to start building one.

Question: How do you start a new list?

Answer: First you GET a *NEW (blank) list—so press GET.

The machine then asks you which list you want to get, and it gives you a choice of list names on the Menu Line. If you had already saved some lists of your own, their names would now appear alongside **ENER**.

But right now, **EXER** is probably the only game in town, so choose it (actually, therefore, you didn't need to GET it at all, since a *NEW list was already in your display, above. But now you know how to GET any list, new or named).

That takes you back to the SUM Menu display (above) and you're ready to enter numbers. What you see there on Line 2 is the list *pointer* (\clubsuit). It tells you which item in the list you're dealing with at the moment.

And down below it, you'll see the running total of all the numbers in your list (of course, it's 0.00 right now—because you haven't put any numbers in yet).

Fill in the Numbers:	Put all eleven items of your rental income data into this list.
Solution:	(Watch your display as you do these key- strokes. That will tell you a lot about how lists work in the HP 19BII.):
	17000 INPUT 22000 INPUT 21500 INPUT 24000 INPUT 14500 INPUT 19000 INPUT 23000 INPUT 24000 INPUT 24500 INPUT 18000 INPUT 27000 INPUT

Not too tough, right?

But here are some important things to notice:

- 1. Items in a list are *numbered*. In this particular list, each *building* is identified by its number, 1-11.
- 2. You tell to the calculator to "accept" a number by pressing [INPUT].
- **3.** Each time you press [NPUT], the machine accepts the number *and* recomputes the **TOTAL** of all items.
- 4. After you've keyed in all eleven of your numbers, the machine still sits there and waits for the twelfth item....

Now what? How do you say, "I'm finished!" ?



(Read on)

7. THE DATA YOU COLLECT: SUM LISTS

Editing Your List

First of all, just ignore your machine's prompting for another item. It's *always* going to allow you to add one more to the bottom of your list.

But are you sure all your numbers are keyed in correctly? How about a quick review?

- **Do It:** Jump to the beginning of your list and step down through it to check each entry.
- How? First, you must move the pointer back up to the top. Remember the two keys, (*) and (*) that roll your Stack around? Those two keys are good for *all sorts* of lists and stacks—including this kind of storage list.

So you could press $\textcircled{\bullet}$ eleven times to move the pointer back to item 1. Or you could press $\textcircled{\bullet}$. That's a quick way to *jump* to the beginning of the list, all in one motion (and no prizes for guessing how to jump to the *end* of the list again).

So "go first class"—use the **m** + method. Then use **+** to "walk" down the list and check your numbers.... If you find a mistake, simply position the pointer to the erroneous number, key in the correct value and press **(NPUT)**.

A good indicator that your numbers are all right is that your TOTAL is 234, 500.00.

- **Problem:** Suppose that you've numbered your income properties according to the time you have owned them—oldest to newest. But now you sell building 1, which you've held longer than any of the others—and buy a new building, which produces \$34,000 in rental income. How do you change the list?
- **Solution:** You delete the first building's income and then tack on the new building's income at the end of the list:

First, press to jump to the top of the list, if you're not there now. Then press the **DELET** selection from the SUM Menu. This deletes the item the pointer is currently indicating—17,000.00—the first value in the list. Remember: the pointer determines which item is affected when you do anything to a single item in your list.

So now the *new* first item in your list is 22,000.00, and there should be *ten* items altogether. Jump to the end of the list (press ••), to check thisSure enough— ITEM (11) is now blank, and the pointer is pointing to it. So key in 34000 and press INPUT to store it there. Voilá! You've just updated your 11-building income list. And notice that your running TOTAL=251,500.00 is now up-to-date, too.

Notice that this same method works for any fixed-length list intended to keep a chronological record (for moving averages, etc.): Delete the oldest value (at the top) and add the newest value to the bottom.

Analyzing Your List

Of course, you can do much more analysis on your list data than simply to sum the TOTAL. Notice the **CALC** item on the menu. Press **CALC** now and experiment with some of the calculations available:

INTEL...(you've already seen this).... TOTAL=251, 500.00 MERN...the average data item value.... MEAN=22, 863.64 MEON...the median value, the value that is less than half the values but greater than the other half.... MEDIAN=23,000.00 STORY...the standard deviation is a measure of how consistent (closely grouped around the mean) your data is.... STDEV=5,074.89 SANS...the difference between the greatest item value and the least... RANGE=19,500.00

(press MURE)

MIN ... the least value in your data set... MIN=14, 500.00 MEX ... the greatest value in your data set... MAX=34,000.00 (Don't press SORT or FREE right now; you'll see them a little later.)

But now press **HIST**....

Pretty slick, eh? This is a *histogram* of your data's distribution—a bar graph of the data's frequencies, divided into ten sub-ranges, or *cells*.

Use the \rightarrow and \rightarrow keys to move the little cell pointer to any given cell. Then you can press (INPUT) to get more specific information on that cell. And EXIT returns you to the CALC Menu.

Naming Your List

Before you go any farther into analyzing the data in your rental income list, you should EXIT back to the SUM Menu and *name* it—so that you can build other lists and do other calculations and yet be able to GET this list back again whenever you need it.

Problem: Name your list INCOME.

Solution: Press Nime; then type [] NCOME (INPUT), as you're told to do by the display. Your list is now named, and you can EXIT to the MAIN Menu.

Later: First, GET a *NEW list (press SUM GET ENEW)—to pretend that you've been working with other lists.

Now go GET your INCOme list (**GET INCO**).... As you see, all *named* lists appear on the GET Menu, too. But notice that not all the letters of INCOME will fit into a menu box. There's room only for four or five letters, so choose short names.



7. THE DATA YOU COLLECT: SUM LISTS

FoReCaSTing with Your List

One of the most common kinds of analysis you'll probably want to do with a list of data is to use it to forecast—to *predict*—something.

Example:	Suppose you're considering the construction of another income property—a twelfth building in your list—simi- lar to the other eleven in quality and location. How can you predict the annual rental income it might generate?			
Answer:	Use the pattern of rents from the existing buildings to help you forecast this.			
Problem:	Your existing buildings all have different rents because they are of different sizes (floor square footage). So a simple average of those rents won't tell you very much— especially for your new building, which will have quite a bit more space (5000 ft ²).			
Solution:	Create a second list, composed of each building's rental floor area, to <i>correlate</i> with its rental income. Use that correlation (rental income per square foot), to predict the rental income for your new building.			

Take it step-by-step....



Here are the rental floor areas of your current 11 buildings, alongside their annual rents (which you've already built into your INCOme list):

<u>Building</u>	<u>Rental Floor Area (ft²)</u>	<u>Gross Rental Income</u>
1	2,650	\$ 22,000.00
2	2,500	21,500.00
3	2,700	24,000.00
4	1,500	14,500.00
5	2,100	19,000.00
6	2,600	23,000.00
7	2,650	24,000.00
8	2,700	24,500.00
9	2,000	18,000.00
10	2,900	27,000.00
11	3,750	34,000.00

So: GET and NAME a new list: GET **XNEW NAME** AREAS (INPUT)

Then fill in the data:

2650(INPUT)	2500(INPUT)	2700 (INPUT)
1500(INPUT)	2100[INPUT]	2600 (INPUT)
2650 (INPUT)	2700 [INPUT]	2000 (INPUT)
2900 (INPUT)	3750 [NPUT]	

(Quick accuracy check: Your TOTAL should be 28,050.00)

Now you can use this list of floor areas to forecast the *income* of your new building. To do so, you must GET the list of the *income* data.

Do It: Press GET INCO, then CALC MORE, then FROST

Question: What does SELECT X VARIABLE mean?

Answer: To forecast, you need to decide "what to graph against what." So the question your machine is really asking you is, "Which list is your X-variable data—your *area* list (AREAS) or your *income* list (INCOme)?"

> Think about it like this: You're looking for a trend that shows that the income level *depends* on the floor area. So your income must be the *dependent* variable (along the Y-axis), and therefore area must be the *independent* variable (along the X-axis) on your graph:



So, answer your calculator's question by pressing HHEHE.

Question: What does SELECT A MODEL mean?

- Answer: Your machine is asking: "What mathematical model what shape curve—do you want to fit to your data?" Your choices are LINear, LOGarithmic, EXPonential or POWer. You're looking for the linear relationship between floor area and rent per square foot. So press **LIN** to see the FoReCaSTing Menu itself.
- Watch: Press MORE and PLOTE.... See your data points—and the straight line your HP 19BII has tried to fit to them? And notice that you can use the arrow keys to move those little crosshairs around, to see approximate coordinates of any point (the coordinates show in the display).

The plot is all well and good for a general picture, but what you want is a number. You want to be able to key in any X-value (a floor area) and have the machine tell you the Y-value of that point on the curve.

Easy: Key in your X-value—that's the area of your new building: EXIT 50000, then MORE MORE XLIST. Now press WIIST to find the corresponding income: YLIST=44, 433.47

> And now you can play "What-If?" all day like this—with any building size you wish: Just enter the floor space, and press **HIST**, then **HIST**. What could be simpler?

Quiz

- 1. Fill up the Stack with 1.00,2.00,3.00, and 4.00. Now use the numbered storage registers to reverse their order.
- 2. GET your INCOME list. Make a copy of it, called 11RNTS. Make another copy, TMP. Now *erase* TMP—data first, then the name.
- 3. Still in your INCOME list, label each list item as a BLDG (instead of ITEM). Then change only BLDG(4) back to ITEM(4).
- 4. Use the menu items **START** and **SURT** (SUBTotal) keys to compute the total income generated by buildings 6 through 10.
- 5. Is there a strong *non*-linear correlation between your building rents and floor areas? Is it stronger than the linear correlation?
- 6. Use the following values of your current 11 properties to estimate the value of your 5000 ft² building now under construction:

1. \$160,000	2. \$ 162,500	3. \$180,000
4. \$105,000	5. \$144,000	6. \$175,000
7. \$175,000	8. \$ 190,000	9. \$140,000
10. \$ 210,000	11. \$ 250,000	

Quiz Solutions

1. (First, EXIT) from the SUM Menu, to see more of the Stack.) Fill up the History Stack: press 1(INPUT), 2(INPUT), 3(INPUT), 4.

Then extract its four values, storing the numbers into four corresponding storage registers: STO 1+STO 2+STO 3+STO 4

Now recall them back to the Stack: RCL1RCL2RCL3RCL4....

Voilá! And notice that you don't need to clear the previous Stack before beginning your recall process. Those previous values simply get "popped off the top" as you recall more values to the Stack.

2. Press SUM GET INCO, if necessary, then MORE COPY. Then follow the display's instructions and type 11RNTS (INPUT).

You've now made a copy of the INCOME list, and the copy's name is 11RNTS. But now that you've made the copy, you're still working in the original—the INCOME list.

So make another copy: **COPY** TMP(INPUT)....and then go GET this TMP list: **MORE** GET TMP.

Now erase it: Press CLEAR DATA and answer YES to both of the questions it asks you. This is how to clear both the data and the name—in that order (to clear the data but save the name, you would answer NO to the second question).

On the second page of the SUM Menu, notice the item called
 Press that now.... This feature allows you to give your own customized label to any or all items in the list.

To change *all* item labels at once (that is, make a *global* change), simply type in the new label (BLDG) and then **ELUSE**. You'll see the results immediately in your list....

Now change BLDG(4) back to ITEM(4): Press (if you're not already at the top of the list), then <math>(++) to move the b to BLDG(4). Then press (+), type (+) (+), and choose (+), which changes only the *current* item's label.

4. Here's the idea: Move the pointer to the *first* item to be included in your subtotal and press **START**. Then move to the *last* item in the subtotal and press **SURT**.

So, assuming you're at ITEM(4) from the previous problem, press (+) to get to BLDG(6). Then press **START**. Next, press (+) (+) to move the pointer down to the last item in your subtotal, BLDG(10), and press **SURT**....

Answer: SUBTOTAL=116,500.00

SURT tells you the SUBTotal of all items from the STARTing item to the pointer's position. 5. When you use the FoReCaSTing feature in the SUM Menu, it asks you to SELECT A MODEL. To estimate the income likely from your new building, you selected LIN to find the best *straight*-*line* correlation between floor space and rent. But what about the other three types of correlations the HP 19BII can compute—LOGarithmic, EXPonential and POWer curves?

How do you know which curve will best fit your data? You don't —not without trying each type. You could get a *general* feel by plotting each type, to see which curve stays closest to the points. But often it's hard to tell by looking at plots, so on the FoReCaSTing Menu, there's an item called **CORR**, that finds the *CORRelation coefficient* (r) for the current curve type. This r is a measure of the "goodness" of the fit of the curve to the data points. The better the fit, the closer r approaches 1 or -1. A poorer fit gives an r nearer to 0. So to find the best-fitting curve, **EXIT** the plotter and simply compute r for each type of curve:

EXIT LIN CORR	Result: CORR=0.99	(.987475213604)
EXIT LOG CORR	Result: CORR=0.96	(.959580918724)
EXIT) EXP CORR	Result: CORR=0.99	(.988251144624)
EXIT PWR CORR	Result: CORR=0.99	(.986513832084)

All the fits are quite good (close to 1), but the EXPonential fit is the best of the four. So, what does it predict for the income of your 5000 ft² building? Find out: EXIT EXP 5000 HIST HIST....

<u>Result</u>: YLIST=57, 517.50. That's quite a bit higher than the LINear estimate, so the more conservative amount to figure on as income from your new building is still the linear estimate —about \$44,500. 6. This is just another practice problem in forecasting.
First, GET and NAME a new list: GET XNEW NAME VALS (INPUT). Then fill in the data:

160000(INPUT)	162500 (INPUT)	180000(INPUT)
105000(INPUT)	144000 (INPUT)	175000(INPUT)
175000 (INPUT)	190000(INPUT)	140000 (INPUT)
210000(INPUT)	250000 (INPUT)	

(Accuracy check: Your TOTAL should be 1,891,500.00)

Press CALC MORE, then FROST. To forecast the value of your new building based upon its floor area, use MREAS as your X-variable list. Try a linear correlation: Press LIN 5000 HISH, then WISH to find the predicted value: YLIST=331, 563.73

But is linear the best type of correlation? Find out:*

CORR	Result: CORR=0.97	(.974993369088)
EXIT LOG CORR	Result: CORR=0.96	(.956276883471)
EXIT EXP CORR	Result: CORR=0.97	(.970082365602)
EXIT PWR CORR	Result: CORR=0.98	3 (.97768675078)

All the fits are quite good (close to 1), but the POWer fit is the best of the four. And what does it predict for the income of your 5000 ft² building? Find out: 5000 **ELEST FLIST**....

<u>Result</u>: YLIST=325,030.20. That's a bit lower than the LINear estimate, and since the fit *is* slightly better, maybe this is the better—more conservative—value to assume for your new building: about \$325,000.

^{*}If you find yourself needing to do a lot of these comparisons—trying to find the best correlation coefficient (r)—you might study the SOLVE equation on pages 392-393.



Which Way Now?

Here's another fork in the road.

As you've heard, the best choice is probably to keep going straight on through the book. Each topic will teach you a lot about the calculator. But if you want to, you can "skip around."

So read the sign now, and make another choice....





8. TIME TRAVELLING

Using the Clock

Hold your place here and flip back for a minute to page 62.... Remember that big diagram of the TIME Menu "highway and suburbs?" You didn't get to explore those "routes" then, so now here's your chance.

Basics First: What time is it? What's today's date? Is it Friday yet?

One Key: To find out *all* of this from your HP 19BII, go to the MAIN Menu (MAIN) and press **TIME**. You'll see a display similar to this (but of course, yours will probably show a different date and time):



One key tells you all that; anytime you want to check the clock or the calendar, press **MAN TIME**.

But what if your HP 19B11 clock/calendar is wrong? How do you set it or *adjust* it?*

*You've had one quiz problem (Chapter 4, problem 2, page 76) that showed you briefly how to set the time and date, but there's a lot more to that story.

<u>SETting the TIME</u>

Suppose that today is actually March 29, 1990, and that it's about 1:30:36 in the afternoon. To set your HP 19BII to show this, from the TIME Menu, press **SET**. You'll see a display similar to this:



The idea is to key in a number that represents the date or the time, then press **DATE** or **TIME**.

Like So: Press 3.291990 DHTE ; 1.3036 TIME

See how this works? You mimic the order of the time and date numbers as you see them in the display, using the \odot to separate months/days and hours/minutes.

If you ever forget how this works, you can press **HELP** for a reminder (do it now, just to see)....

The other selections on this menu (**MPM**, **MPO** and **12724**) are all *format* options for the time and date. Try them now and observe how your display changes....

And simply press them again to undo the changes.

<u>ADJuSTing the TIME</u>

When the time and date are just plain wrong—"way off"—as they were on the previous page, the easiest thing to do is to use **SET**, as you did.

But what if the time is only slightly off—and you want to improve the accuracy? Use **MUST**....

- Ah, Spring: On the first Sunday in April, most parts of the U.S. go to Daylight Savings Time, setting all clocks ahead by an hour. So before you step out to get the Sunday paper, you open your HP 19BII and...
- **Do This:** EXIT the SET Menu (if you're still there), then press **COUST**. Now, with *one keystroke*, you can advance or delay the clock by exactly one hour, one minute, or one second. Sojust press **CHE**, and voilá!—you've Saved some Daylight.



Anytime you want, you can adjust the clock for more accuracy. As another example, suppose you notice that your HP 19BII is, say, 4 seconds fast, according to The Official Time. No big problem: Just press **SEC SEC SEC SEC**, and that's all there is to it.

CALCulating with Dates

How do you calculate the number of days between two given dates? For example, how would you calculate how many days in 1990 will be on Daylight Savings Time, which runs from April 1 to October 28 (the first Sunday in April to the last Sunday in October)?

Easy: EXIT the ADJuST Menu, if necessary, and press CALC. Now, the idea here is to key in any two dates (using the current date format, as the display reminds you now), then press CAYS to calculate the actual number of calendar days between those two dates. Try it:

And you can go the other way, too—knowing the number of days and one of the dates, then calculating the other date.

Like So: What date was 45 days after March 22, 1988? How about 45 days before March 22, 1988?

3.22	2 1 9 8 8 DATE1 4 5 DAYS	DATE2
<u>Result</u> :	DATE2=05/06/1988	FRI

(45+/-) DAYS DATES Result: DATE2=02/06/1988 SAT As you can see, a *negative* number of DAYS means simply that you go backward into the past—instead of ahead into the future. And *notice* that the calculator assumes that DATE1 is earlier than DATE2: if you give a DATE1 *later* than a DATE2, the number of DAYS will be *negative*.

Now, what about those other three items on the CALC Menu: **3500**, **3550** and **TODAY**? What do they do?

Well **MORY** is easy—it's just a convenient way to see and/or key in the current date. Try it.... As for the other two items,...

Find Out: How many days are there from February 1st to March 1st, in the year 1992?

2.011992011193.011992011119 01115.... <u>Result</u>: ACTUAL DAYS=29.00

Ah, but what if you ignore leap-year considerations and simply assume that every year has 365 days? Press **IEED**.... Result: 365 DAYS=28.00

And what if you assume that every month has 30 days making for a nice, tidy 360-day year? Press **SECO** <u>Result</u>: **360** DAYS=**30.00**

These *alternative calendar assumptions* help you calculate days between dates on the "simplified calendars" commonly used for interest calculations with bonds and other financial instruments.

Making **APPoinTments**

Probably the best thing about the TIME Menu in your HP 19BII is that it can store appointments for you (up to six of them, in fact)—and then beep to remind you at the right times.

EXIT from the CALC Menu, if you're still there now. Then press **HPPT**. You'll probably see the following messages in the display:

PENDING: NONE	(currently, you have no appointments set for any time in the future.)*
PAST DUE: NONE	(currently, there are no appointments that have come due <i>that you haven't already</i> <i>acknowledged</i> .)*

Fine. Now, to set up a demonstration appointment, choose one of the appointments from the menu (say, **MPPTU**). Then press **CLEAR DATA** to clear everything so that you're ready to begin.

To set an appointment, the idea is to key in (in any order):

- the **date** and **time** you want to be reminded of the appointment;
- the **message** you want to see at that time;
- the **repeat** interval (if any), so that the machine will automatically reset itself to go off again after that interval (handy for daily or weekly schedules.

*Don't worry if your machine has one or more appointments showing as pending or past due. These won't interfere.
OK, suppose you want to set an appointment that repeats every 2 minutes, starting about 2 minutes from now, with a message that says, THIS IS ONLY A TEST.

Easy: Press MSG, then follow the display's instructions, typing a message and pressing INPUT when you finish:

THIS SPACE IS SPACE ONLY SPACE A SPACE TEST. INPUT.... The display will come back to the APPT Menu and echo the information you've given it so far.

Now set the repeat interval: Press **MPT**, then key in 2 and press **MIN**....Again, the display returns to the APPT Menu, echoing all the known information.

Next, key in a time that reflects *your* current time, plus about two minutes, then press **TIME** (the date should automatically default to your current date). Be sure that the am/pm setting is correct (adjust it with **MPM** if necessary).

Now EXIT the APPT Menu. You should see:

PENDING: 1 (appointment #1 is now pending.) PAST DUE: NONE

So, press MAN, then turn the page and wait for your appointment to come due....

When Your Appointment Comes Due

Even if your calculator is off, an appointment that comes due will cause it to turn on, beep at you, and show the message for about 20 seconds. Here are your options:

- If you press any key (ON is a good one) *during* that time, this automatically acknowledges the appointment, and allows the machine to reset it for the next repeat interval, if there is one.
- If you don't press any key until after the beeping stops, the (•) annunciator will stay on, to tell you—no matter where you are in the machine's menu system—that you have a past due appointment. To acknowledge it, you must simply go into that appointment's menu (press APPTI or APPTE, etc.—whichever one it was). Only after you acknowledge it will it reset itself for any repeat.



Quiz TIME

- 1. When it's 2:00 p.m. in Arch Cape, Oregon, it's 7:00 a.m. *the following day* in Okinawa. How do you cure your calculator's "jet lag" when travelling back and forth across the International Date Line like this?
- 2. According to your HP 19BII, how many (actual) days are in the years 2000 and 2100?
- 3. Set the following appointments in your HP 19BII:

APPT1:	Today, 15 minutes from now TAKE A BREAK (repeat: 2 hours)
APPT2:	September 9, 1999 9:09 a.m. CATCH PLANE (repeat: 10 days)
APPT3:	February 29, 2040 10:30 a.m. SEE DENTIST (no repeat)

- 4. How do you stop an appointment from repeating? How do you clear any given appointment? How about *all* appointments?
- 5. Can an appointment come due without beeping at you?

Answers TIME

1. Okinawa is 17 hours *ahead* of Oregon. Or, you can think about this as being 7 hours *less* than one *day* ahead. So, when going west (to Okinawa), and assuming your HP 19BII is set to Oregon time, you could do one of the following:

Starting from the MAIN Menu (MAIN), press **TIME MUST**, then press **WHE** seventeen times (just don't lose count);

Or, starting from the MAIN Menu (MAIN), press **TIME HULST**. Then press **THE** seven times, then **EXIT** and set the date to tomorrow (whatever your current date happens to be, just key in the date for the next day).

Of course, when going east (to Oregon), you'd do the reverse of one of those two procedures: Use **-HE** seventeen times; or use **-HE** seven times and SET the date to yesterday.

2. From the MAIN Menu (press MAIN), press TIME CALC. Then 1.012000 CATEL 1.012001 CATEL CAYS Answer: ACTUAL DAYS=366.00

The year 2000 is a leap year, but the year 2100 is not (you might want to read up on the rules of leap years to find out why this is the case). Starting from the MAIN Menu (MAIN), press TIME AFFT, then select AFFTI. Now key in some time about 15 minutes from now (using the format HH. MM), then press TIME (the current date will automatically be entered at this point).
Then: MSG (TAKE) SPACE (A) SPACE (B) REAK (INPUT); then RFT (2) HR and EXIT.

Next: Press HFFTE, and 9.091999 UHTE, 9.09 TIME; then MSG CATCH SPACEPLANE (INPUT); then RFT 10 UHY and EXIT.

Next: MPPTE, then 2.292040 DATE * 10.3 TIME; then MSG SEESPACEDENTISTINPUT, then RPT NONE, and EXIT.

4. To stop an appointment from repeating, from the MAIN Menu (MAIN) press TIKE APPT, then select the appointment you're interested in—say, APPT1 (press APPT1), for example. Then select APT NONE, to specify no repeat.

To clear an appointment altogether, from the MAIN Menu (MAIN) press **MAIN** press **MAIN**, then select the appointment you want to clear —say, APPT1 (press **MPPT1**). Then **CLEAR DATA**.

To clear all appointments at once, from the MAIN Menu (MAIN) press **MAIN** (MAIN), then **CLEAR DATA** and respond with **MEST** to the machine's request for confirmation of this "sweeping purge."

*"Whoops—say! That's a Wednesday! Guess we'll have to reschedule! How about...next year...?"

5. Well, the machine will always try to beep when an appointment comes due, but you won't hear it if the beeper is turned off. Press
MODES and notice the messages in the display. One of those messages probably says: BEEPER: ON

This means, of course, that when the beeper is "beeped," you'll hear it. But notice the menu item called **STEP**. Press it once.... The beeper message changes: **BEEPER: APPTS ONLY**

This is just like having the beeper turned off—i.e. anytime the beeper would normally sound, it will be silenced—*except* for appointments, so that you won't miss them.

Now press **BEEP** once more.... **BEEPER**: **OFF** In this mode, you *never* hear a beep—not even for appointments.

Now press **BEEP** again to set the beeper to **ON** again.... As you can see, **BEEP** is a *three*-way switch that controls the beeper.

Whither Now?

Time to check the map again, because here's another junction.

As usual, it's best to simply keep on going, straight through the book. But check the signs now and choose your route....





9. Building Your Own Roads: The SOLVE Menu

Memory Space: The Final Frontier

So much for civilization. Now you're on your own.

Now you need to learn how to solve problems for which there are no calculations already built into your HP 19BII. That is, you need to learn how to go to places that just aren't on the map.

"How?"

You literally add to your calculator's "map"—invent your own solutions. And once you've invented these formulas, you can *store* them in a list in the machine, where they'll reside until you need them again. Of course, you can erase them, too, when you don't need them anymore.



But since your customized formulas will take up space in the memory of your HP 19BI, you need to know a little more about that memory before you start building your formulas.... First of all, recall (from Chapter 7) what the numbered registers are all about: There are ten of them, called 0-9, and each stores just one number at a time—usually some value you want to keep "on the side" for awhile.

But you've discovered some other registers, too: As you recall (from Chapter 4), the names that appear on a calculations menu are really names of *built-in registers* used by that menu. And because you vary their values when playing "What-If," these are called "variable registers," or just "variables."

The point is, every variable uses space in your calculator's memory. Sometimes, the same variable is used in more than one formula. For example, you saw how the variables COST and PRICE are actually shared between the MU%C and MU%P formulas. When you stored a value into the variable PRICE at the MU%C Menu, *that value was still there* when you moved over to the MU%P Menu and pressed RCL PRICE.

A Picture of Memory

The variable registers used by the built-in formulas are indeed built into the machine. You can reset their values to zero, but you can't erase their formulas. But that's not the case for your "user memory." There you can create (and delete) new lists, formulas and registers of your own.

For example, here's a picture of how your HP 19BII's memory probably looks right now:



Of course, you'll notice that you haven't created any formulas or formula variables yet—which is what this chapter is all about:

Full Speed Ahead: From the MAIN Menu, press the **EXEN** key, and enter the world of HP SOLVE:



This is the SOLVE Menu, where you go to create or use a formula of your own.

Notice the little α ("alpha") annunciator up in the Annunciator Area (you may have seen this before, when naming lists). It means that the machine is now expecting you to type in alphabetical characters from the left-hand keyboard.

So here you are, ready to type in an equation—a useful formula that creates its own menu for you....



...

Creating Formulas

For openers, since you're "driving" through this Easy Course, how about a simple little formula to help you figure your gas mileage?

Do It: Create an equation for gas mileage. Then compute your mileage for a trip of 350 miles, which used 12 gallons of gasoline. If the car has a 15 gallon tank, how far could you have gone before the last "fumes" ran out?

Solution: From the SOLVE Menu, MPG=MILE+GAL.

Then press **CHLC**....The machine verifies your formula, to make sure that it understands everything you typed.

And then you know what to do:

350 MILE 12 GAL MFG <u>Answer</u>: MPG=29.17

Now for that old familiar "What-Iffing:" Change the number of gallons to the maximum: 15 Gil.

And calculate how many miles you could have gone: <u>Answer</u>: MILE=437.50 All right, you're happy with the way your formula works, but suppose you'd like to rename the variables in it. What do you do?

Edit It: Instead of MILE, you want MILS; and instead of GilL, you want GilS.

Solution: EXIT to the SOLVE Menu. Notice that the a comes on again and that the pointer is pointing to your formula. Now press EDIT and see the blinking cursor return.

Next, look on the left-hand keyboard down at the bottom, and find these keys: NSDEL . Try one—press Now press . See? The key does the same for the cursor as it does for the list pointer. And now, since you're there, type S to change GAL to GALS.

Next, press ++++++ and S again. Not much to this editing business, is there? Notice how the cursor simply replaces the character currently under it.

Finally, press **CALC** to let the machine verify the formula again, and then you'll see your modified variable names come up in the menu.

- **Problem:** Some service stations sell gasoline by the liter. Write yourself an equation to help you convert between liters and gallons so that you can still use your mileage formula (there are about 3.785 liters in a U.S. gallon).
- **Solution:** From the SOLVE Menu, type this equation into your list of equations (notice that when you begin typing, your mileage formula "bumps up" a notch and the pointer now indicates the new formulas you're now starting):

$LTRS = GALS \times 3.785$

Now **CALC** ... and there it is—a conversion formula.

Try It: On another trip, you used 40.7 liters to cover 306 miles. What was your mileage?
Solution: Press 40.7 LIES, then GALS. Answer: GALS=10.75
Now EXIT to the SOLVE Menu, move the pointer up to the mileage equation (press 1), and press CALC.
Then press ACL GALS, and notice that GALS is already set to 10.75. Simply by spelling its name the same in each equation, you have created a *shared variable*.
Now key in what you need to finish the calculation: 306 GALS and GEES.... Answer: MPG=28.46



Take a look at the memory diagram of your machine now:

How much more room do you have? If you're curious, just press MEM to see the percentage of the total memory still available.... Now try another problem, to become more familiar with the rules of SOLVE....

A contractor often quotes the square-footage area of the rectangular concrete slabs he lays and then figures the cubic yards of mixed concrete necessary for the job. He knows the length and width (in feet) of the slab, and its depth in inches—and he orders ready-to-pour concrete only in whole cubic yards (no extra fractions of yards).

First:	Devise a SOLVE formula to help him compute the area of slab, in square feet.	
Easy:	You get area by multiplying length by width. So an area formula isn't too much of a problem:	

AREA=LONG×WIDE

Next:	Devise a SOLVE formula to help the contractor find the
	volume of concrete required for a given slab.

OK: You get volume when you multiply length by width by depth—or, multiply *area* by depth. So here's a formula:

VOL=AREA×DEEP

That's about all there is to the logic of the formulas—but you must take care to keep your units consistent! You can't expect to get a volume in cubic yards by multiplying a length and width in feet and a depth in inches. After all, what kind of unit is a "foot foot inch?" It's neither a cubic foot, nor a cubic inch, nor a cubic yard. To use your formulas meaningfully, therefore, you must key in all your dimensions *in the same unit*. Things work fine as is for your area formula, but—as you just observed—your *input* units aren't consistent with one another, nor do they match the *output* units you need in your volume formula. To get the right result, you would have to *convert* the inputs to other units at the time you key them in—not too convenient.

Suggestion: Let the calculator do these conversions for you. That is, build the conversion into the formulas, thus allowing the inputs to be keyed in in the conventional-but-inconsistent units that the contractor would be likely to use—depth in inches; length and width in feet.

- How? How do you modify your formulas to do this?
- **Hmm:** The area formula doesn't need to change at all; multiplying feet × feet gives area in square feet:

FTAR=FTLG×FTWD

The *names* of the variables should probably be improved like this, though, to tell you which units they assume. This is a good habit—making the name of a variable tell you as much as possible about it.

The volume formula needs some work: First, you convert the depth in inches to depth in feet by dividing the number of inches by 12: $VOL=FTLG \times FTWD \times (INDP \div 12)$

But that's cubic *feet*, so now divide by 27 (because 27 cu. ft = 1 cu. yd.): VLYD=(FTLG×FTWD×(INDP÷12))÷27

About those parentheses: You don't really need them here. They're included simply to remind you of the reasons for the 12 and the 27. If you omit them, the result will be the same, because \times and \div have the same *priority of evaluation* in a formula.

The HP 19BII doesn't evaluate a SOLVE formula in quite the same way as it evaluates an ALGebraic* arithmetic problem. For instance, to compute $2+(3\times5)$ via ALGebraic arithmetic, you press $2+(3\times5)$ ($3\times5=$, because the machine just works left-to-right if you don't use parentheses. But the SOLVE formula $\mathbf{h}=2+3\times5$ will produce the same result *without* parentheses, because the \times has a higher priority of evaluation than does the $\mathbf{+}$. So keep in mind that the HP 19BII does not simply proceed left-to-right when evaluating a SOLVE formula; it evaluates according to the following list of different operations:

- First are the *functions*, such as SQRT(A+B), which is "the square root of A+B."
- Next comes *exponentiation*, such as **A^5**, i.e. **"A** raised to the fifth power."
- Next in line are multiplication (X) and division (\div) .
- Last of all come addition (+) and subtraction (-).

Note, however, that whenever there are two or more operations of the *same* priority, then the calculator does indeed work left-to-right.

^{*}With SOLVE formulas, you don't have the choice of arithmetic methods: The syntax for SOLVE formulas is only algebraic—parentheses and all—no RPN.

Those are the rules that tell you if you need parentheses in your formulas. Of course, if it's too much to remember, you can just go ahead and use parentheses anyway—to be on the safe side.

Back to the problem of those concrete slabs. Here are the two formulas you've developed—without unnecessary parentheses:

FTAR=FTLG×FTWD

VLYD=FTLG×FTWD×INDP÷12÷27

Notice: Dividing by 12 and then by 27 is really dividing by 324:

FTAR=FTLG×FTWD

VLYD=FTLG×FTWD×INDP÷324

And notice that you could share the variable $\ensuremath{\mathsf{FTAR}}$ between the two formulas:

FTAR=FTLG×FTWD

VLYD=FTAR×INDP÷324

Now you can use the first equation to compute the area of a slab, then use the second equation to compute the yards of concrete necessary—simply by keying in the inches of depth—since the area (FTAR) will already be calculated and sitting there! So that's it then....except...the problem stated that the contractor could order concrete loads only in whole cubic yards.

- **Oh:** You need to round your volume calculation *up* to the next whole cubic yard. How do you adjust the equation for this?
- Ah: Suppose you take your actual cubic yards requirement, add 1 yard, and then keep just the whole-yards portion of the result. Thus, if your real concrete needs were 3.4 yards, you'd calculate it to be IP(3.4+1), where IP stands for the *Integer Portion*. The IP of (3.4+1) is just 4. So the formula would correctly recommend an order of 4 cubic yards when a slab needs 3.4.

```
How about 1.9 yards? IP(1.9+1) = 2. That checks, too.
How about 2.0 yards? IP(2.0+1) = 3.
```

Hmmm... if a slab needs exactly 2 yards, then you *don't* want to order and waste an entire extra yard—the formula isn't perfect yet. To fix it, just use some common sense: If the real needs were 2.01 yards, would you order 3? Probably not. But if the requirement were 2.1 yards? Probably so.

So change your formula to reflect this judgement—adding a tenth less than a whole yard, like this: IP(2.0+.9). Therefore:

FTAR=FTLG×FTWD

VLYD=IP(FTAR×INDP÷324+.9)

Ready: Key in those versions of the formulas and test them.

Solution: From the SOLVE Menu, press ■ to position the b to the bottom of your growing list of formulas. Then:

FTAR=FTLGXFTWD CALC Looks OK on the menu.

Try it: 40 FTLG 30 FTLD FTAR Answer: FTAR=1,200.00 OK.

Now EXIT and \rightarrow and do the other one: VLYD=IP(FTARXINDP/324 $\rightarrow 9)$, and EALC to verify it and create its menu.

Now press RCL FIAR, to see if your shared FTAR variable works correctly: FTAR=1,200.00 Yep.

So this slab is $30 \text{ feet} \times 40 \text{ feet}$. If it's 6 inches deep, how many cubic yards of concrete should you order?

Press 6 INOF and VLYD Answer: VLYD=23.00 Right on!



Combining Formulas

So there you have it— a set of equations to help the contractor. What could be more convenient?

Well...actually, it *would* be more convenient to have just a single equation—one menu—offer both calculations, no? *Could you* put both of these calculations into the same formula?

Stop and think for a minute: Isn't every formula an *equation* (i.e. "something *equals* something else")? Right now, for example, you've developed these two separate equations:

FTAR=FTLG×FTWD

VLYD=IP(FTAR×INDP÷324+.9)

And when you CALCulate with either of these, it builds its own separate menu, of course. But, more importantly, notice that you always solve for one of the variables by using the given values of *all* the others.

It seems, therefore, that you can have only one "unknown;" the rest must all be "knowns." So it seems that you can't have a single formula for both FTAR or VLYD— because that would be two unknowns in the same equation.

But this is where the HP 19BII "cheats" a bit—to make such things possible. There *is* a way to write two separate, unrelated formulas into one, so that all the variables of both formulas appear on one menu....

To use this method, first you must hearken back to those happy, golden days of algebra class, and *rewrite* both formulas so that everything is on one side of the = and a $\overline{\mathbf{0}}$ is on the other (you "add the negative to both sides of the equation"—remember?):

FTAR-FTLG×FTWD=0

VLYD-IP(FTAR×INDP÷324+.9)=0

Now, notice that if you keep FTAR as a shared variable, it would be the *unknown* in the first equation but a *known* in the second one. There's nothing wrong with this, but it would mean that you would always have to solve for the FTAR before solving for the VLYD, which would defeat your purpose here—to use a single menu to solve for either unknown, *in any order you want*.

Therefore, you should probably use **FTLG**×**FTWD** in the VLYD formula, since FTLG and FTWD are always *knowns* that you key in anyway.*

Thus, here is your set of equations, properly written in $\dots = 0$ form, so that they're ready to be combined:

FTAR-FTLG×FTWD=0

VLYD-IP(FTLG×FTWD×INDP÷324+.9)=0

*This is a good point in general: If a set of equations uses a shared variable that is treated as the *unknown* in one equation but as a known in another, then combining them will limit the order of your calculation.

Now to do the combining itself, you need to use the proper "phrase" in the SOLVE language, which is IF(S)....* Here's how:

```
IF(S(FTAR)

:FTAR-FTLG×FTWD

:VLYD-IP(FTLG×FTWD×INDP÷324+.9))=0
```

(The line breaks and indentations appear for clarity only. When you key this in—don't do it yet—simply ignore this formatting. The result will appear in your display as follows:)



Here's what that formula says:

"IF you're Solving for FTAR then [the first : means "then"] solve FTAR-FTLG×FTWD=0 otherwise [the second : means "otherwise," i.e., IF you're Solving for something other than FTAR], solve VLYD-IP(FTLG×FTWD×INDP÷324+.9)=0"

You rewrote the two separate equations set equal to Θ so that you could also implicitly equate them with the Θ at the end of the IF(S... combined-equation structure.

*In fact, for the rest of this chapter, keep your Owner's Manual opened to Table 12-1, to get an idea of the various handy "phrases" in your HP 19Bii's SOLVE "vocabulary."

- **Test It:** Key in and use this combined, two-in-one formula.
- Solution: First delete your FTAR equation: At the SOLVE Menu, use the they to move the to your FTAR formula. Then press **DELET**. You then have the option to delete both the formula and its variables or just the variables. If you delete just the variables, the formula will remain in your list, but none of its variables will exist in the machine's memory until the next time you CALCulate with it (an option to save memory). But you want to delete both the formula and its variables, so press **EDTH**.

Now, since your new combined formula is rather long, why not create it by EDITing VLYD? Press **EDIT**, and use **INS** to insert space in your formula for the new part (26 **INS**'s should do it). Then type: IF(S(FTAR)): FTAR-FTLGX(FTWD):

Now move four places: ++++ and replace = with - (press -). Then replace the FTAR with FTLG×FTWD: +++++ (NS(NS(NS(NS(NS(LG×FTWD). Then finish the formula: -+)=0.

Now CALC, and check this with your 30×40 slab: 30 FTMD 40 FTLG 6 INOP and WLYO Answer: VLYD=23.00

Now find the **FTHR**....<u>Answer</u>: **FTAR=1,200.00** Voilá! Take a moment now to review the steps you take to use the IF(S... syntax to combine separate formulas onto a single menu:

 Rewrite the separate formulas so that nothing but Ø appears to the right of the =. For example, you would rewrite

 $25\times(A+B)=11+C+D$ as $(25\times(A+B)-D)\times C-11=0$ and $E=M\times C^{2}$ as $E-M\times C^{2}=0$

- 2. To avoid being forced to solve in a certain order for the unknowns in the combined formula, be sure that any variable shared between the equations will always be a *known* value. Thus, the above formulas will best combine as long as the shared variable C is always a known. If C is an unknown in one formula, you'll always be forced to solve for C before you can use it in the other part of the combined formula.
- 3. Use the IF (S... syntax to tell the HP 19BII when to use each part* of the combined formula:

IF(S(E) ("IF you're Solving for E :E-M×C^2 ...then solve this :(25×(A+B)-D)×C-11)=0 ...otherwise solve this")

*You're not limited to just two parts. You can combine many formulas with a *nested* arrangement of IF(S...:

("IF you're Solving for A
then solve this
otherwise, IF you're Solving for B
then solve this
otherwise, IF you're Solving for C
then solve this"), etc.

To see if you're getting the hang of IF(S), try one more...

For the Road:	Remember your gas mileage and your liters-gal- lons conversion formulas (pages 299-301)? Com- bine them now into a single formula that will allow you to compute your mileage (in miles per gallon) no matter whether you buy fuel in liters or gallons.
A Good Route:	Here are the two formulas as they exist now in your HP 19Bu's memory:
	MPG=MILS÷GALS
	LTRS=GALS×3.785
	Of course, you could re-write the latter as
	GALS=LTRS÷3.785
	And so your two formulas for mileage would be:
	MPG=MILS÷GALS
	MPGL=MILS÷(LTRS÷3.785)
	Now you have two formulas with two separate unknowns. So you're ready to rearrange them to get zero on the right sides and then scoop them

both into a single formula with IF(S....

Rearranging to isolate Θ on the right:

MPG-MILS+GALS=0

MPGL-MILS+LTRS×3.785=0

Now combine these, using the **IF**(**S**... structure:

IF(S(MPG) :MPG-MILS+GALS :MPGL-MILS+LTRS×3.785)=0

Or, in the format you'll see it when editing:

>IF(S(MPG):MPG-MILS+GAL S:MPGL-MILS+LTRS×3.785) =0

Key this in: At the SOLVE Menu, press **I** to begin a new formula (and delete the two separate formulas shown on page 302, also).* Then type the above formula and press **CALC** and test it—try that first mileage problem you did on page 299:

350 MILS 12 GALS MPG Answer: MPG=29.17

And if you went the same distance on 50 liters? **50 LTRS MEEL** Answer: MPGL=26.50

*To delete a formula, position the b to it and select **DELET**. You will then be asked whether you want to delete just the variables (**WARS**) for that formula or **EXTH** the formula and its variables. Select **EXTH** (you'll soon see the reason for the **WARS** option).

Naming Formulas

Question: As you begin to build your list of SOLVE formulas, what with the IF (S...and all that), how will you remember which formula does what, as you move the b up and down the list, looking for the proper one to select?

Answer: Just put a *name* in front of any formula whose purpose you might otherwise forget. A name is separated from the start of the formula itself by a colon (*).

Thus, you could give your combined gas mileage formula the name $\mbox{GRS},$ like this:*

GAS: IF(S(MPG): MPG-MILS+GALS: MPGL -MILS+LTRS×3.785)=0

Or, give your combined concrete slab formula the name SLAB, like this:

SLAB:IF(S(FTAR):FTAR-FTLG×FTWD :VLYD-IP(FTLG×FTWD×INDP÷324 +.9))=0

Exercise: Do it—name your two formulas as shown: Just **EDIT** each and insert the name and a colon at the beginning of each formula. Now they're stored in your HP 19BII.

^{*}Again, remember that the line breaks and indents are shown here simply to emphasize the parts of the formula under discussion. Such formatting will never appear in your calculator's display.

Question: How many formulas can you store in your HP 19BII?

- Answer: That depends on how long or complex they are and how many variables they use. Of course, it takes memory to store the typed formula itself, but each *variable* created by the formula needs space when you use the formula.
- **Prove It:** Select your **GAS** formula and press **CALC** as if you were going to use it.... Now **EXIT** (as if you've finished using it) and check the available free memory (press **MEM**). Make a note of the result.

Now press **DELET** and then **WHESE**, to delete the *variables* of the **GAS** formula—without deleting the formula itself. Since you're through using **GAS** for the moment, why take up memory space for its variables (MPG,MILS, GALS, MPGL and LTRS)? After all, you'll just create them again anyway, whenever you next **CALC** with **GAS**.

Press MEM again.... <u>Result</u>: There's more memory available, now that you've deleted the **GRS** variables.

<u>Moral of the Story</u>: To maximize the amount of memory available to you, delete the variables of SOLVE formulas that you're *not currently using*.

Of course, you can do a lot more with SOLVE than just gas mileage . As Table 12-1 of the HP Owner's Manual shows, you have many "formulabuilding-blocks," including sophisticated financial calculations....

Problem:	How would you devise a SOLVE formula to compute the	
	true A.P.R. of a loan with loan fees ("points up front"), as	
	you computed manually back on pages 136-137?	
Solution:	You would build a <i>simulated TVM</i> solution, using the	
	I VM equation shown in Appendix B (page 297) of your	
	HP Owner's Manual.	

In Appendix B, HP lists most of the mathematical formulas it has used for the built-in menus, including these two TVM formulas:

$$i\% = \frac{I\% YR}{P/YR}$$

and

$$0 = PV + \left(1 + \frac{i\% \times S}{100}\right) \times PMT \times \text{USPV}(i\%:n) + FV \times \text{SPPV}(i\%:n)$$

Now, if you substitute the smaller, top expression for *i*% into the longer, main formula, here's how that main formula would look:

$$0 = PV + \left(1 + \frac{\frac{I\% YR}{P/YR} \times S}{100}\right) \times PMT \times \text{USPV}\left(\frac{I\% YR}{P/YR}:n\right) + FV \times \text{SPPV}\left(\frac{I\% YR}{P/YR}:n\right)$$

Or, in SOLVE notation, it would look like this:

0=PV+(1+I%YR+P/YR×S+100)×PMT ×USPV(I%YR+P/YR:N)+FV×SPPV(I%YR+P/YR:N)

This is the one equation that correctly relates all seven TVM variables.

"But aren't there just five TVM variables?"

No! Don't forget about the OTHER Menu, where you establish the values of two other variables: the number of payments per year (P/YR) and the annuity mode (BEGIN or END—represented in the formula by the value of the variable, S). Even if you don't usually vary these when playing "What-If?", they are still used—and essential—for TVM computations. And there's no OTHER Menu for SOLVE formulas, so you must include all relevant values in one equation like this.

Question:	What are those two SOLVE functions, USPV and SPPV?
Answer:	They are "Uniform-Stream Present Value" and "Single- Payment Present Value."
	USPV($i \times : n$) is the Present Value of a Uniform Stream of <i>n</i> periodic \$1 cash-flows, discounted at <i>i</i> % per period. SPPV($i \times : n$) is the Present Value of a <i>single</i> \$1 cash- flow discounted <i>n</i> periods at <i>i</i> % per period.
	These are useful for all sorts of TVM calculations; in- deed, HP even used them in their built-in formulas.

Here again is the "TVM-mimicking" formula you've developed so far:

0=PV+(1+I%YR+P/YR×S+100)×PMT ×USPV(I%YR+P/YR:N)+FV×SPPV(I%YR+P/YR:N)

- **Question:** If they're named the same, are SOLVE variables then *shared* with those of the built-in TVM Menu?
- Answer: No! A SOLVE variable may be shared only with another SOLVE variable. And variables for the *built-in* menus are shared only with those of other *built-in* menus. So you can give your SOLVE variables names such as the PV, PMT, FV, etc., as above, and *they will have absolutely no connection* to the built-in TVM variables of the same names. The SOLVE variable names may *mean* similar things to you (that's why you use similar names*). But the actual, built-in TVM Menus (and BUS Menus, etc.) are in a separate world from your SOLVE formulas.



*After all, you could use other, less meaningful names in your formula, like this:

0=A+(1+B+C×D+100)×E×USPV(B+C:F)+G×SPPV(B+C:N)

But then, how would you remember that \mathbf{R} is the variable name for your Present Value, and \mathbf{F} is the name for the number of periods, etc.? A SOLVE formula without meaningful variable names is almost worse than useless.

Now, back to the problem: to develop a formula that mimics TVM and accounts for a loan's prepaid finance charge ("points up front"). Right now you have just a simple TVM simulator: If you were to **CRLC** with it now, you'd key the number of payments into **CRLC**, the amount financed (using the sign convention) into **CRLC**, the amount feel much like the built-in TVM—but it wouldn't be any more convenient for handling a finance charge—so what would be the point?

Problem: Modify your formula to account for "points up front."

Solution: Looking back at your keystroked solution for a mortgage with loan fees (pages 136-137), you'll see that there's no difference in the way you treated any TVM quantity except PV. So there's no need to change the way you're using the N, PMT, FV, P/YR and S variables in your formula here. But in calculating the true A.P.R. on page 137, the idea was to *reduce* the actual amount financed (i.e. the original PV) by the amount of the finance charges, then put *that* into the PV register and recompute I%YR. So use FV+FC** instead of FV (thus FC becomes another variable on the menu):

0=PV+FC+(1+I%YR+P/YR*S+100)*PMT *USPV(I%YR+P/YR:N)+FV *SPPV(I%YR+P/YR:N)

*For the second variable, you would key in a 1 for BEGIN mode or a 0 for END mode. **You might think this would increase PV, but remember that the TVM equation you're mimicking assumes the cash-flow sign conventions: FC will always be of the *opposite sign* from PV. Test It:Try a 30-year, 10.3935% mortgage for \$100,000, monthly
payments (in arrears) of \$906.79 and a 2% loan fee.

 Solution:
 At the SOLVE Menu, press . and 0=PV+FC+

 (1+1%YR+P/YRS+100)XPMT

 ×USPV(1%YR+P/YR:N)

 +FVX SPPV(1%YR+P/YR:N)

 +FVX SPPV(1%YR+P/YR:N)

 INPUT.

 Then CALC and test: 100000

 2000+/

 FC

 (for END mode)

 MURE 906.79+/

 MURE 12478....

 Result:

 1%YR=10.64

Question: Wouldn't it be more convenient to key in the loan fee as percentage points rather than as a dollar amount?

Answer: Probably. So instead of PV+FC, you could use

PV×(1-PTS÷100)

Your formula would then become:

0=PV×(1-PTS÷100)+(1+I%YR÷P/YR×S÷ 100)×PMT×USPV(I%YR÷P/YR:N)+FV× SPPV(I%YR÷P/YR:N)

So **EXIT** and **EOIT** your formula, then **CALC** to test it: 100000 FV 2 FTS 12 FYR 0 S MORE $906 \cdot 79 + -$ FMT 360 N 0 FV MORE TXYR Result: IXYR=10.64 Still OK.
Getting the Menu Right

- Hm: The order of menu items in your formula doesn't really match the order on the built-in TVM Menu—disconcerting if you're used to finding things in certain places. Can you somehow adjust your formula to get its menu to more closely match the built-in TVM Menu?
- Yes: The order of menu items is the order in which each variable first appears in the formula. To rig this order, just use a phony set of "first appearances"—in the order you want—*multiplying them by zero so as not to affect the math*:

0×(N+I%YR+PV+PMT+FV+P/YR+S+PTS) +PV×(1-PTS÷100) +(1+I%YR÷P/YR×S÷100)×PMT ×USPV(I%YR÷P/YR:N) +FV×SPPV(I%YR÷P/YR:N)=0

This is a good, simple trick to remember. Re-edit your formula into the above version and **CALC** to test this as before:

360 N. 100000 FV 906.79+/- PMT 0 FV MORE 12 FYYR 0 SM2 FTS MORE 12YR <u>Result</u>: IXYR=10.64

That's an easier menu to use, don't you think?

- **Problem:** Your formula now computes the true A.P.R. of a mortgage with "points up front"—as long as you've already used the real, built-in TVM Menu to compute the PMT and/or FV and then copied all values to the corresponding variables on the formula's menu. But wouldn't it be nice to be able to do all the computation in one place?
- You Can: Use your formula to perform the other calculations *first*, using the original mortgage rate as your I%YR *and ignoring the finance charge*. Watch:

360 N 10•3935 IXYR
100000 PV 0 FV
MORE 12 P/YR O S O PTS
MORE PMT <u>Result</u> : PMT=-906.79
Then MORE 2 PTS
and MORE TAWE Result: IXYR=10.64

- **Comment:** This can still be confusing: Sometimes **THYR** will contain the mortgage rate; sometimes the true A.P.R. Isn't there some way to further simplify things?
- Idea: Create two formulas and combine them with IF (S...: In one formula, use the loan amount less points to allow you to solve for the true A.P.R. In the other formula, use the nominal mortgage rate and the real loan amount in a true "TVM-mimicking" manner to allow you to solve for (and play "What-If?" with) *any* of the TVM parameters.

Do It: First—to solve for the true A.P.R. (this should look familiar, except for the name of the interest rate, **APR**)—this formula:

PV×(1-PTS÷100)+(1+APR÷P/YR×S÷100)×PMT ×USPV(APR÷P/YR:N)+FV×SPPV(APR÷P/YR:N) =0

And the second formula—the simple "TVM-mimicker"—is this:

PV+(1+I%YR+P/YR×S+100)×PMT×USPV
(I%YR+P/YR:N)+FV×SPPV(I%YR+P/YR:N)=0

Notice that both are already conveniently arranged into the proper "=0" format required by IF(S.... So, combine them:

IF(S(APR)
PV×(1-PTS÷100)+(1+APR÷P/YR×S÷100)×PMT
×USPV(APR÷P/YR:N)+FV×SPPV(APR÷P/YR:N)
PV+(1+I*YR÷P/YR×S÷100)×PMT×USPV
(I*YR÷P/YR:N)+FV×SPPV(I*YR÷P/YR:N))=0

Add "opening appearances"—for the menu order—and a name:

POINTS:0×(N+I%YR+PV+PMT+FV+P/YR+S+PTS)
+IF(S(APR)
*PV×(1-PTS÷100)+(1+APR÷P/YR×S÷100)×PMT
×USPV(APR÷P/YR:N)+FV×SPPV(APR÷P/YR:N)
*PV+(1+I%YR÷P/YR×S÷100)×PMT×USPV
(I%YR÷P/YR:N)+FV×SPPV(I%YR÷P/YR:N))=0

Now key in and test this.... The menu will behave like the built-in TVM Menu except for the last items, **PTS** and **MPR**.

Question: Can you imitate the built-in TVM Menu's **BEC** and **END** items on your menu—instead of using **BEC**?

Answer: Yes, to a great extent, you can.

Consider how the **BEG** and **END** items operate on the built-in TVM Menu: They are always *knowns* (you never solve for the annuity mode as your unknown). But you don't key in any values before pressing them, either; they're just "yes-or-no" *mode* items. You simply select one item or the other and that selects the annuity mode.

But in a SOLVE formula, whenever you press a variable's menu key without first keying in a value, the HP 19B11 will solve for that variable. You can't stop it from doing this solving, but you can tell it to do something else—set another value—in the process.

Look: These simple formulas will always give you the same result for the variable BEG: 1=BEG or 1+0=BEG So will this: 1+L(END:0)=BEG You are still saying "BEG=0+1," but at the same time ("in passing," so to speak) you are also saying "Let END be set to: 0."

Does this give you any ideas on the **SEG** and **END** problem?

- ??: Write three formulas that, respectively: set BEG to 1 and END to 0; set BEG to 0 and END to 1; and use BEG as the annuity mode variable in a "TVM-mimicking" formula. Then use IF(S... to combine the three formulas into one.
- I: To set BEG to 1 and END to 0: 1+L(END:0)=BEG To set BEG to 0 and END to 1: 1+L(BEG:0)=END To use BEG as the annuity mode in a "TVM-mimicker": PV+(1+IXYR÷P/YR×BEG÷100)×PMT×USPV (IXYR÷P/YR:N)+FV×SPPV(IXYR÷P/YR:N)=0

Now two of them need to be rearranged into $\dots = \overline{O}$ format:

1+L(END:0)-BEG=0 1+L(BEG:0)-BEG=0

Then combine them all:*

```
IF(S(BEG)

:1+L(END:0)-BEG

:IF(S(END)

:1+L(BEG:0)-END

:PV+(1+I%YR÷P/YR×BEG÷100)×PMT×USPV

(I%YR÷P/YR:N)+FV×SPPV(I%YR÷P/YR:N)

))=0
```

*This is an example of a combination of *more* than two formulas—as in the footnote on page 313. The parentheses that end the two *nested* IF(S... statements are isolated here for clarity (as always, line breaks and indents are for clarity only; the calculator doesn't display this way).

Note: Don't confuse the S in the SOLVE-phrase $IF \langle S ... with the variable name S$ for the annuity mode here. You could have chosen any name for that variable (you were simply using the names shown in HP-s equation in Appendix B of their Owner's Manual).

- **OK**: Using what you've just learned, see if you can modify the formula from page 325 to include BEG and END items that behave a little more like their TVM counterparts.
- Go: It's going to be a nested set of IF(S...'s, for sure. Your existing formula already has one IF(S..., and now you're going to add a couple more.... Here goes nothing:

```
POINTS:
                                  (The formula's name)
0×(N+I%YR+PV+PMT+FV)
                                       (Set up
   +P/YR+BEG+END+PTS+APR)+ the menu order)
IF(S(BEG)
                           ("IF you're Solving for BEG
 :1+L(END:0)-BEG
                           ...then solve this formula
 : IF(S(END) ...otherwise, IF you're Solving for END
: 1+L(BEG:0)-END ...then solve this formula
    : IF(S(APR) ...otherwise, IF you're Solving for APR
      :PV×(1-PTS÷100)+(1+APR÷P/YR×BEG
        ÷100)×PMT×USPV(APR+P/YR:N)+FV×
        SPPV(APR+P/YR:N) ... then solve this formula
      :PV+(1+I%YR+P/YR×BEG+100)×PMT
        ×USPV(I%YR+P/YR=N)+FV×
        SPPV(IXYR+P/YR:N) ...otherwise solve this")
)))=Ø
```

Notice how you work through each *specific* case first—where you tell the machine what to do when solving for one specific variable. That leaves the final *"otherwise"* formula to include all the other possible variables you might solve for. **Exercise:** Key in and test this formula (EDIT the previous version).

 Solution:
 Press EDIT and modify the formula. Then CALC to test

 it:
 360
 N
 1003935
 1278

 100000
 PV
 0
 FV
 MORE
 12
 PVVR

 END
 (the display will show END=1.00)
 MORE
 PMT

 Result:
 PMT=-906.79

 Then
 MORE
 PMT
 APR
 Result:
 APR=10.64

Question:	The formula uses $I \stackrel{\checkmark}{} YR \stackrel{\diamond}{} P \stackrel{\checkmark}{} YR$ and $APR \stackrel{\diamond}{} P \stackrel{\checkmark}{} YR$ three times each. Could you avoid this repetition?		
Answer:	Yes. For example, use $L(I:I%YR+P/YR)$ the first time you need $I%YR+P/YR$ —to also assign that value to another variable I. Then, to use that value again, just use $G(I)$, which means: "Get the value of I without showing I on the menu." Thus:		
(definir (using (definir (usin;	<pre>>POINTS:0×(N+I%YR+PV+PM T+FV+P/YR+BEG+END+PTS+A PR)+IF(S(BEG):1+L(END:0))-BEG:IF(S(END):1+L(BEG :0)-END:IF(S(APR):PV×(1) .0)-END:IF(S(APR):P</pre>		

- Question: Using L(:) and G(), you saved yourself some typing—but did you save the machine any memory space?
- **Find Out:** A formula uses more memory when you use it (when its menu is in the display). So, with your current version of **POINTS**, run the test calculations on page 329. Then press **MEM** to see how much memory is available.... Note this number.

Now edit your formula back to the "longer" form shown below (i.e. as it was on page 328) and repeat the above calculations and memory test....

This "longer" formula uses about 28 *fewer* bytes during calculation—*because it uses fewer variables*. Recall (from page 296) that each variable uses memory space. With the additional variables A and I, you bought some typing convenience by using a little more memory.

One other comment: Notice that in your **POINTS** formula, you must always solve for PMT first—so that the APR portion of the formula has that value to use when solving for APR. In the **POINTS** formula, that assumption isn't a big problem; you're probably in the habit of solving for the PMT first, anyway. But you *can* make these unknowns entirely independent—just as you did with your **SLAB** formula (page 311). As usual, you trade memory for convenience. Here's the modification:*

> POINTS:0×(N+I%YR+PV+PM T+FV+IF(P/YR=0:L(P/YR:1 2):0)+BEG+END+PTS)+IF(S (BEG):1+L(END:0)-BEG:IF (S(END):1+L(BEG:0)-END: IF(S(APR):PV×(1-PTS+100))+(1+APR+P/YR*BEG+100)× (-PV-FV*SPPV(I%YR+P/YR:N)+(1+APR+P/YR*N)+FV*SPPV(I%YR+P/YR:N)+USPV(I%YR+P/YR:N)+FV*SPPV(I%YR+P/YR*N)+FV*SPPV(APR+P/YR*N)+FV*SPPV(APR+P/YR*N)+FV*SPPV(I%YR+P/YR*N)+FV*SPPV(I%P/YR*P/YR*N)+FV*SPPV(I%P/YR*P/YR*N)+FV*SPPV(I%P/YR*P/YR*N)+FV*SPPV(I%P/YR*P/YR*N)+FV*SPPV(I%P/YR*P/YR*N)+FV*SPPV(I%P/YR*N)+FV*N)+FV*SPPV(I%P/YR*N)+FV*NP/YR*N)+FV*N)+FV*NPV+FV*NP/YR*N)

Is this capability worth the extra typing and/or memory, just to be able to solve for APR first, if you wish? Maybe not. But you'll see formulas where such *unknown independence* is indeed advisable—where, instead of just two unknowns, you may have nine or ten. Then it's *really* inconvenient to dictate the order in which you must solve for them.

*Notice some other modification in this version, too: It sets the value of P/YR to 12, as a *default*, if you neglect to give it a value (i.e. leave it at \emptyset). Also, in the menu-ordering portion ($\emptyset \times \langle ... \rangle$), there's really no need to include APR, since it's the last variable in the menu anyway. Finally, notice that there's no = \emptyset at the end. Anytime a formula ends in = \emptyset , you may omit it.

SOLVE Review

"Set the brake and idle" for a moment, and review all the things you now know about the SOLVE Menu of your HP 19BII:

- You know how to use the SOLVE Menu to select or type a formula, and how to EDIT a formula—use (NS), DEL), ←, (+), (+) and (+)—to create space, delete characters and move the cursor;
- You know that MEM shows the memory remaining, and you can maximize this by deleting the *variables* of formulas not in use;
- You know that a SOLVE formula is basically just an algebraic equation—variables and numbers equated by an = and evaluated according to *operator priorities* (not just right-to-left).
- You know how the machine creates the menu of variables that appear in a formula—in the order of the first appearance of each variable. So you choose a short but *meaningful* name for each variable, to describe it and its units or other assumptions;
- You know that SOLVE formulas may share variables (i.e. use the same variable name and value) with other SOLVE formulas, and built-in menus may share with other built-in menus—but a SOLVE variable is never shared with a built-in variable;
- You've worked through the logic of some practical calculations, including unit conversions and rounding (recall the IP function); you've worked quite a lot with the IF(S... notation, which allows you to combine two or more separate formulas (so long as each formula has been written into the form "something = @");
- You've seen how to use L(:) to assign a value to a variable "in passing;" and you've seen how to use G() to get the *value* of a variable without causing its name appear on the menu.

Formulas For Practical Use (and More Study)

Of course, there are many more SOLVE functions to discover—and much more practicing to do. So the rest of this chapter is simply an extensive and useful collection of formulas—listed in EDIT format, for easy entry.

Note: These formulas will *not* all fit into your HP 19BII at once. With some of the longer ones, you may be able to fit only one or two. Designed for real-world situations, they use a lot of memory (recall the memory/convenience trade-off); some may take 20-25 minutes to key in. Although not handy for the odd occasion, each can easily pay for itself (and this book), saving you hours of time, if you need such a calculation regularly.

> Browse the formula descriptions on the next few pages (they are grouped by category). For any that interest you, study their solutions, sample problem(s) and memory requirements. If you wish to have several large formulas in the machine at once, note that it takes a lot more memory to *verify* a formula than to *use* it (the extra amount needed is unpredictable). So leave at least 25% of memory free at all times, for verification space, and (after deleting the variables of all other formulas), key in the formulas *by size*—largest to smallest.

Although you needn't understand the logic of the formulas to employ them fruitfully in your work, they are posed as problems, so you can treat them as a quiz, if you wish. They use the techniques you've seen here, plus many others. Polish your SOLVE skills by studying them. <u>Very Helpful Study Tip</u>: To learn about the design of a formula, a good first step is to *rewrite it in expanded, indented, commented format* like that used on page 328—to help identify each part and its function.

SOLVE Problems

Misc. SOLVE Functions

- 1. Your company does a lot of direct-mail advertising. The response on mailings varies, depending on the list you rent and the time of year. Develop a formula to calculate the net profit from a mailing. (The solution is on page 342.)
- 2. An obstetrician friend has a new HP 19BII, and she has asked you to write a combination of two formulas for her work: One formula uses the estimated starting date for a woman's pregnancy and calculates her delivery date (280 days later). The other formula uses today's date and the starting date to calculate the number of weeks and days in the pregnancy progress. (Page 343)
- 3. You are a lineman for the county, and you drive the main road, but the county reimburses you monthly for using your own car and gas on the job. Write a SOLVE formula to do the monthly mileage and reimbursement calculations. (Page 344)
- 4. Write a set of formulas to compute, from an employee's weekly time card, the gross pay (hourly wage plus overtime), the proper amounts to withhold for FICA and Medicare, federal and state income taxes, and then the net paycheck amount. (Page 346)

5. Suppose that all payroll deduction taxes were combined into one tax on *gross* income. Although tax rates would still be progressively structured (higher earners would still be paying a higher percentage of gross income as tax), nobody would be allowed to take any deductions before computing his/her tax.

Suppose further that this tax structure had *no discrete brackets*. That is, the percentage of gross income paid by each taxpayer would be given by a *continuous function*, like this:



The formula for the tax itself might be something like this:

 $TAX = .01 \times GRO$ $\times LOG(GRO$)

(the LOGarithm function produces a curve of the above shape).

Of course, a payroll clerk would still need a SOLVE formula to process an employee's weekly timecard into a paycheck. Write the formula to do so, and compare this solution with that for the previous problem. (Page 350)

<u>Residential Real Estate</u>

- 6. Write one formula to compute the maximum home price and principal-and-interest payment for which a borrower could qualify for financing under these rules:
 - a. Conventional
 - b. FNMA
 - c. GNMA
 - d. FHA
 - **e.** VA (Page 352)
- 7. Write a formula to help a prospective home buyer determine whether it is more advantageous to rent or buy a home during a given period of time. Include considerations for taxes, inflation, and alternative investments over this time period. (Page 356)
- 8. A mortgage borrower can significantly reduce the term of the mortgage by paying *a portion* of the normal monthly payment *more often* than once a month (e.g. 24 or 26 "half-payments" per year). Write a TVM formula, including AMRT, for this. (Page 360)
- **9.** Write a kind of TVM formula for an Adjustable Rate Mortgage (ARM). (Page 362)

10. In a conventional amortizing loan (i.e. with a shrinking balance), the periodic payment usually pays that period's entire interest, plus some principal: Payment = Interest + Principal

As the unpaid balance shrinks, so the interest amount in each payment shrinks. But in a conventional mortgage, the *total* payment amount is nevertheless held constant, so as the interest portion of each payment shrinks, the principal portion grows. Thus, over the life of the loan, the pay-down rate accelerates (see the diagram on page 181). Write a TVM-like formula (including AMRT) that calculates when a conventional mortgage balance will reach a given percentage of the original loan. (Page 364)

- 11. Occasionally, an amortizing loan is written to specify a *constant* payment to principal, so that the payoff rate is indeed steady over the entire term of the loan. But a constant principal amount requires a *non-constant payment* amount. Write a kind of TVM formula, including AMRT, for this situation. (Page 366)
- 12. Write a TVM-like formula (excluding AMRT) to compute present and future values of a cash-flow stream that periodically changes by either a set *percentage* (%CH) or by a set *amount* (\$CH). Such terms are often built into contracts to adjust for inflation. (Page 368)

Commercial Investment

- 13. Write a combined formula to compute price and yield on a bond, after income taxes, capital gains taxes and broker commissions, otherwise mimicking the HP 19Bu's built-in BOND Menu as much as possible. (Page 370)
- 14. Write a TVM-like formula to compute a lease's value, payment amount, residual (as a percentage of the value), or rate. Allow for an annual pattern of skipped payments and/or advanced payments. (Page 372)
- **15.** Write a formula to help analyze the relative merits of steady leasing or outright buying a commercial asset, including the cost of money, property, depreciation, capital gains and income tax rates, and resale value. (Page 374).
- 16. Write a formula to estimate an income property's value to an investor, based upon its operating income and expenses, current market rates for mortgage and equity performance, investment risk, etc. (Page 378)
- 17. Write a kind of TVM formula to compute wraparound mortgages and second mortgages, either from the borrower's or the lender's point of view. (Page 380)

- 18. Write a formula to compute these values for an income property:
 - the initial after-tax cash-flow at purchase;
 - the after-tax cash-flow for any operating year;
 - the after-tax cash-flow at sale (after any operating year);
 - the ratio of the purchase price to the potential gross income (often called the Gross Rent Multiplier);
 - the Capitalization rate (ratio of the first year's Net Operating Income to the purchase price), in percentage form;
 - the rate of return on *equity* in year 1 (in percentage form);
 - the rate of return on *cash* in year 1 (in percentage form) both before and after taxes.

(Page 384)

- **19.** Write a formula to compute the following values for a single CFLO list, under the assumptions of a risk rate and a safe rate for alternative investments:
 - the IRR;
 - the Financial Management Rate of Return (FMRR);
 - the minimum initial investment required under FMRR assumptions;
 - the final net lump-sum return expected under FMRR assumptions (also called the Future Wealth).

(Page 388)

<u>Business Management</u>

- 20. Write a formula for the maximum depreciation allowed and the remaining depreciable value under 1990 rules for regular MACRS depreciation of an asset, given its class life (3, 5, 7, 10, 15, 20, 27.5 or 31.5 years) and the current year in that life. (Page 390)
- 21. Often an inventory item's unit cost depends on the volume of the order. Write a combination formula to help an inventory manager estimate the unit cost of any order size, and the *best* order size for an inventory item, given the following values:
 - a. An estimate of the total number of this item that will be used—at a steady rate—over a given period
 - **b.** The unit cost of holding the item in inventory over that period (warehousing, financing, insurance, etc.).
 - **c.** A set of quotes from the manufacturer—aggregate prices for orders of various sizes.

(Page 392)

22. Write a formula to evaluate the return on investment and the minimum cash commitment for a manufacturer to develop a new product. Include time and cost-of-money considerations, and assume a linearly increasing sales pattern. (Page 396)

<u>Personal Finance</u>

- 23. Write a TVM-like formula to do compound interest calculations in terms of *buying power* (i.e. "today's dollars")—after inflation and taxes. (Page 398)
- 24. Assume that at the beginning of your career, you begin to invest a set percentage of your gross monthly paycheck in a taxable, interest-bearing account. Assume steady employment—with yearly salary raises to keep pace with inflation—and the same tax bracket for all your working years. Write a combined formula to compute how much (in terms of today's dollars or "purchasing power") would be in the account at the time you retire, *and* the monthly annuity you could draw from this (earning a different interest rate, if desired) for a given number of years thereafter. (Page 400)
- 25. Write a combined formula that will project retirement income in terms of today's dollars—for a married couple, in a given tax bracket, who may have IRA's and Social Security incomes to draw upon, in addition to a taxable savings account. (Page 402)



SOLVE Solutions

1. This is a straightforward problem, but it's a good reminder of how useful a simple SOLVE formula can make the "What-If" game:

DIRMAIL: -TOTL×\$CST+\$PR F×TOTL×RET%÷100=\$NET

<u>Approximate Memory Required</u>: 5% to use, 1% to store. <u>Required Knowns</u>: None (i.e. any value may be the unknown).

- Example: If you send out 130,000 flyers, costing \$0.30 apiece, and the average profit per response is \$19.00, what is the break-even response percentage? How much will a 4% response net you?
- Solution:
 Key in the above formula and press
 CALC
 ...

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 •3 3051
 19 3486

 0
 ENET
 RET2

 Answer:
 RET2=1.58

 4
 RET2
 SNET
 Answer:
 \$NET=59,800.00

Notice:

- The variables are named with **\$** or ***** wherever possible, to remind you of the assumptions of the formula;
- The order of the formula's arithmetic is a little "unnatural," but this makes the menu more convenient, left-to-right.

2. This uses some of the calendar functions in the HP 19BII's SOLVE vocabulary (DATE, DDAYS and CDATE):

>BABY:0×L(D:DATE(START: 280))+IF(S(DUE):DUE-G(D):IDIV(L(P:280-DDAYS(CD) ATE:G(D):1)):7)+MOD(G(P)):7)+10-WW.D)

<u>Approximate Memory Required</u>: 7% to use, 2% to store. <u>Required Knowns</u>: The starting date (START) of the pregnancy.

- Example: If today is 9/9/91, and a pregnancy began on 2/27/91, what is its due date and progress as of today?
- Solution:First, set the clock to the "correct" date (of course, the
date is usually correct already):MAIN TIMEDISP ALL 9.091991DATENext, go to the
SOLVE Menu, enter the formula and CALC.
Then give the starting date:2.271991DIEAnswer:DUE=12.041991(12/4/91)WH.DAnswer:WW.D=27.5(27 weeks, 5 days)

Notice:

- The formula uses one number, WW.D, to give two pieces of information—just as the calculator uses a single number of the form MM.DDYYY to show all three parts of a date.
- Thanks to the formula's hidden variable, D, you need not solve for **DUE** before solving for **DUE**.
- There's no = 0 at the end of the formula. Anytime a formula would normally end with = 0, you may omit it.

 A SOLVE formula can use (but not alter) any value in a SUM list. Also, the SOLVE language has a summation tool: Σ(). So if you record your starting and ending odometer readings (one pair after another) in a SUM list named TRIPS, here's the formula:

> ▶MILE\$REIMB:0×L(M:∑(N:2 :SIZES(TRIPS):2:ITEM(TR IPS:N)-ITEM(TRIPS:N-1)))+IF(S(MILS):MILS-G(M): \$/MI×G(M)-\$RMB)

Approximate Memory Required:7% to use, 2% to store, not
including the TRIPS list.Required Knowns:A list named TRIPS, containing sequen-
tial pairs of odometer readings.

Example: Below are odometer readings for last month's trips. Find your mileage and reimbursement @ \$.21/mile.

<u>Trip</u>	Start Reading	<u>End Reading</u>
1	45,678.9	46,111.0
2	47,142.8	47,376.5
3	48,123.4	48,571.4
4	49,012.3	50,987.6

<u>Solution</u>: First, build your TRIPS list (in actual use, of course, you would do this during the month, as you record the odometer readings for each trip):

MAIN SUM GET XNEW NAME TRIPSINPU	Т
45678•9(INPUT) 46111(INPUT)	
47142•8 INPUT 47376•5 INPUT	
48123•4 INPUT 48571•4 INPUT	
49012·3(INPUT) 50987·6(INPUT)	

Next, press DISP FIX 2 INPUT.

Then MAN SOLVE, key in the formula, press CALCE, MILS (maybe twice) <u>Answer</u>: MILS=3,089.10 (21) STATE STATE.... <u>Answer</u>: \$RMB=648.71

Notice:

- The SIZES() and ITEM(:) functions are defined "phrases" in the SOLVE language. In the formula, the term SIZES(TRIPS) means "the SIZE of the SUM list named TRIPS." And ITEM(TRIPS:N) means "the value of ITEM number N in the SUM list named TRIPS."
- The meaning of the summation formula, $\Sigma($), is this:

The Σ (: : :) function is yet another defined "phrase" in the SOLVE language.



4. The only hard part is to compute the withholding amounts from the formulas provided by the various tax agencies. This solution assumes actual 1991 formulas for withholding Social Security, Medicare and Federal income tax, and (as an example) a hypothetical state income tax structure, all summarized as follows:

Social Security:6.20% of first \$53,400 of annual gross incomeMedicare:1.45% of first \$125,000 of annual gross income

Federal tax (weekly payroll):

The portion of (Gross Pay – 39.42×W4 Allowances) for single or married falling between ______ is taxed at

ter single <u>er</u> married, rannig setween			is tanea at
0	and	23 <u>or</u> 65	0%
23 <u>or</u> 65	and	397 <u>or</u> 689	15%
397 <u>or</u> 689	and	928 <u>or</u> 1,573	28%
928 <u>or</u> 1,573	and	2,121 <u>or</u> 3,858	33%
2,121 <u>or</u> 3,858	and	~	28%

State tax (weekly payroll):

The portion of (Gross Pay – Federal Tax – $33 \times W4$ Allowances) for single <u>or</u> married, falling between ______ is taxed at

0	and	21 <u>or</u> 55	0%
21 <u>or</u> 55	and	131 <u>or</u> 250	5.0%
131 <u>or</u> 250	and	∞	7.5%

▶PAY:0×(W4+L(F1:SNGL×23 +MARR×65)+L(F2:SNGL×397 +MARR×689)+L(F3:SNGL×92 8+MARR×1573)+L(F4:SNGL× 2121+MARR×3858)+L(S1:SN GL×21+MARR×55)+L(S2:SNG L×131+MARR×250)+L(H:∑(I :2:SIZES(TCARD):2:MOD(2 4+HRS(ITEM(TCARD:I))-HR S(ITEM(TCARD:I-1)):24)))+L(G:\$/HR×(MIN(40:G(H))+OTXMAX(0:G(H)-40)))+L (A:G(G)-39.42×W4)+L(SS: .062xIF(\$YTD(53400:MIN(G(G):53400-\$YTD):0))+L(M:.0145×IF(\$YTD(125000: MIN(G(G):125000-\$YTD):0))+L(F:.15×MIN(MAX(G(A) :G(F1))-G(F1):G(F2)-G(F 1))+.28×MIN(MAX(G(A):G(F2))-G(F2):G(F3)-G(F2)) +.33×MIN(MAX(G(A):G(F3))-G(F3):G(F4)-G(F3))+.2 8×(MAX(G(A):G(F4))-G(F4)))+L(B:G(G)-G(F)-W4X33)+L(S:.05×MIN(MAX(G(B): G(S1))-G(S1):G(S2)-G(S1 >>+.075×(MAX(G(B):G(S2))-G(S2))))+IF(S(SNGL):L (MARR:0)+1-SNGL:IF(S(MA RR):L(SNGL:0)+1-MARR:TE (S(HOURS):HOURS-G(H):IF (S(\$GR):\$GR-G(G):IF(S(\$ SS):\$SS-G(SS):IF(S(\$MC) :\$MC-G(M):IF(S(\$FED):\$F ED-G(F): IF(S(\$ST): \$ST-G (S):IF(S(\$NET):G(G)-G(S) S)-G(M)-G(F)-G(S)-\$NET: \$NYG-G(G)-\$YTD)))))))

Approximate Memory Required:

54% to use, 14% to store, not including the TCARD list.

<u>Required Knowns</u>: The employee's W4 withholding allowances; marital status (SNGL or MARR); hourly wage (\$/HR); overtime factor (OT); Year-To-Date gross pay (\$YTD) before this paycheck; a SUM list, TCARD, containing his work-time log for the week.

 Example: Shown below is an employee's work log for last week. Calculate his hours, gross pay, tax, net pay and new year-to-date gross. He is single, with 3 withholding allowances claimed on form W4. His previous yearto-date gross was \$10,000; his wage is \$10/hour, and his overtime factor (for hours over 40 per week) is 1.5.

<u>Period</u>	In	\underline{Out}
1	6:00 a.m.	12:45 p.m.
2	11:00 p.m.	1:00 a.m.
3	8:00 a.m.	4:00 p.m.
4	9:00 a.m.	5:15 p.m.
5	9:00 a.m.	5:00 p.m.
6	8:00 a.m.	5:00 p.m.

Solution: First, build the TCARD list (in actual use, of course, you would do this during the week, as the employee "clocks in and out" of work each day):

MAIN SUM GET XNEW NAME (TCARD INPUT
6)[INPUT] 1] 2 • 4 5) [INPUT] 2 3) [INPUT] 1) [INPUT]
8)[INPUT] 1] 6) [INPUT] 9) [INPUT] 1] 7] •] 1] 5) [INPUT]
9)(INPUT)(1)(7)(INPUT)(8)(INPUT)(1)(7)(INPUT)

	🖬, key in	the formula and CALC .		
Now 3 AH SNEL (result: SNGL=1.00).				
Then 10 E/HR	1•5 0	MORE 10000 34TD		
HOURS	Answer:	HOURS=42.00		
36R	Answer:	\$GR=430.00		
B SS	Answer:	\$SS=26.66		
\$MC	Answer:	\$MC=6.24		
MORE SFED	Answer:	\$FED=43.31		
35T	Answer:	\$ST=17.25		
SNET	Answer:	\$NET=336.54		
SNYG	Answer:	\$NYG=10,430.00		

Notice:

- In the formula, the use of a hidden variable to actually calculate each of the unknowns—and then the extensive set of nested IF(S... statements—allows you to solve for those unknowns in any order.
- The expression MOD(24+HRS(ITEM(TCARD:I)) -HRS(ITEM(TCARD:I-1))
 :24)

in the TCARD summation is just a simple subtraction (i.e. "time out minus time in"), but with the necessary conversions to decimal hours and a mathematical adjustment to allow for the case where the employee works past midnight.

• The **SNEL** and **MARE** items on this formula's menu have been constructed to allow you to use them as mode keys (no numerical input necessary)—similar to the way you devised **SEE** and **END** in your modified-TVM formula (**POINTS**) on pages 326-328. 5. After the previous problem, this should seem quite simple:

<u>Approximate Memory Required</u> :		19% to use, 5% to store, not	
		including the TCARD list.	
<u>Required Knowns</u> :	The employee's Year-To-Date gross (\$YTD)		
	before this paycheck; hourly wage (\$/HR)		
	and overtime factor (OT); and the SUM		
	list, TCARD (see previous solution)		

Example: Shown below is an employee's work log for last week.

<u>Period</u>	<u>In</u>	\underline{Out}
1	6:00 a.m.	12:45 p.m.
2	11:00 p.m.	1:00 a.m.
3	8:00 a.m.	4:00 p.m.
4	9:00 a.m.	5:15 p.m.
5	9:00 a.m.	5:00 p.m.
6	8:00 a.m.	5:00 p.m.

Calculate his hours, gross pay, tax, net pay and new year-to-date gross. His previous year-to-date gross was \$10,000; his wage is \$10/hour, and his overtime factor (for hours over 40 per week) is 1.5.

<u>Solution</u>: First, build the TCARD list (if it doesn't exist already —in actual use, you'd do this during the week, as the employee "clocks in and out" of work each day):

MAIN SUM G	ET XNEW	NAME TCARD)(INPUT)					
6 [INPUT] 1 2 • (45)INPUT	3 (INPUT) 1 (INPU	T					
8 [INPUT] 16 [INPUT] 9 [INPUT] 17 • 15 [INPUT]								
9 (INPUT) 1 7 (INP	UT) 8) INPUT	17 (INPUT)						
	🖪, key in t	he formula and	CALC .					
Then 10000 \$710 10 \$788 1.5 01								
HOURS	Answer:	HOURS=42.0	0					
\$GR	Answer: 3	\$GR=430.00						
MORE STAX	Answer: 3	\$TAX=19.11						
SNET	Answer:	\$NET=410.8	9					
SNYG	Answer: 3	\$NYG=10,43	0.00					

Notice:

- A hidden variable calculates each of the unknowns—to let you solve for them in any order.
- The expression MOD(24+HRS(ITEM(TCARD:I)) -HRS(ITEM(TCARD:I-1))
 :24)

in the TCARD summation is just a simple subtraction (i.e. "time out minus time in"), but with conversions to decimal hours and adjustments to allow for an employee working through midnight. 6. This solution assumes the following rules for the five qualifying methods (*note:* your applicable rules may now be different):

<u>Conventional</u> :	Maximum PITI (Principal, Interest, Property									
	Taxes and Insurance, plus mortgage insurance/									
	association dues, if any) is the <i>lesser</i> of									
	• 28% of Gross Income (\$GI) or									
	• 36% of \$GI, less long-term debt pmt. (\$LTD).									
	Use 25% of \$GI and 33% of \$GI, respectively, if									
	the down-payment is less than 10%.									
<u>FNMA</u> :	Maximum PITI is 28% of \$GI.									
<u>GNMA</u> :	Maximum PITI is 36% of \$GI, less \$LTD.									
<u>FHA</u> :	Maximum PITI is the <i>lesser</i> of • 29% of Gross Income (\$GI) or • 41% of \$GI, less long-term debt pmt. (\$LTD).									
<u>VA</u> :	 Maximum PITI is <i>lesser</i> of 41% of \$GI, less long-term debt pmt. (\$LTD). \$GI less \$FED, \$ST, Social Security, \$LTD, less family support, maintenance/utilities, from this table: 									
	Fl. Area Total Family Members									
	(Sq. Ft)	1	2	3	4	5	6	7		
	< 1101	457	704	834	930	968	1044	1122		
	1100-1500	472	720	851	948	988	1065	1143		
	> 1500	407	00	105	120	1007	1080	122		
	puus. 55 66 105 120 122 127 152 if the loan amount > \$69999, <i>plus</i> \$6 for a house older									
	than 20 years, <i>plus</i> \$40 if it's not heated by gas.									

The formula:

▶QUAL:0×(L(S:.062×MIN(\$ GI:4450)+.0145×MIN(\$GI: 10416.67))+\$LTD+L(T:T%Y R+1200)+\$INS+\$DUS+L(Z:U SPV(I2YR÷12:#YRSx12)))+ IE(S(CV):(-DN+CV)+G(Z)-MIN(\$GIXIF(CV)DNx10:.25 : 28):\$GI×IF(CV>DN×10:. 33:.36)-\$LTD)+\$INS+\$DUS +G(T)XCV:IF(S(\$C):\$C-(C V-DN)+G(Z):IF(S(FMV):(F MV-DN)+G(Z)-\$GI×.28+\$IN S+\$DUS+G(T)×FMV:IF(S(\$F M):\$FM-(FMV-DN)÷G(Z):IF (S(GMV):(GMV-DN)+G(Z)-\$ $GI \times .36+$ \$INS+\$DUS+G(T)×G MV+\$LTD:IF(S(\$GM):\$GM-(GMV-DN)+G(Z): IF(S(FHAV) :(FHAV-DN)+G(Z)-MIN(\$GI ×.29:\$GI×.41-\$LTD)+\$INS +\$DUS+G(T)×FHAV:IF(S(\$F HA):\$FHA-(FHAV-DN)÷G(Z) :IF(S(GAS?):GAS?-ABS(G(GAS?)-1):IF(S(VAV):MIN(\$GIX.41:\$GI-IF(AGE)20:6 :0×SQFT)-40×(1-GAS?)-RN D(ITEM(VA:L(N:MIN(#FAM: 7)))+(14+1.1×MIN(G(N):6 >>>XIF(SQFT(1101:0:IF(SQ FT(1500:1:2)):0)-IF(G(V AV)-DN>69999:ITEM(VA:G(N)+7):0)-\$FED-\$ST-G(S)) -\$LTD-\$INS-\$DUS-G(T)XVA V-(VAV-DN)÷G(Z):\$VA-(VA V-DN)+G(Z))))))))))))

Also, you'll need this SUM list, named $\forall \mathbf{A}$:

ITEM(1)=456.50 ITEM(2)=703.50 ITEM(3)=833.50 ITEM(4)=929.50 ITEM(5)=968.00 ITEM(6)=1,044.40 ITEM(7)=1,122.00 ITEM(8)=53.00 ITEM(9)=88.00 ITEM(10)=105.00 ITEM(11)=120.00 ITEM(12)=122.00 ITEM(13)=127.00 ITEM(14)=132.00

<u>Approximate Memory Required</u>: 53% to use, 14% to store including the VA list.

<u>Required Knowns</u>: <u>All</u>: \$GI,\$LTD,T%YR,\$INS,\$DUS,I%YR, #YRS, \$DN.

VA: GAS?, AGE, SQFT, #FAM, \$FED, \$ST.

Example: A couple with four children and \$10,000 for a downpayment finds a 25-year-old, 3000-ft² home (gas heat).



Their gross monthly income is \$3500, less \$319 and \$209 for federal and state taxes, respectively. In addition, they pay \$200 per month toward other long-term debt. Insurance on the home will be about \$30/month; taxes are 1.25% annually.

With a 30-year mortgage at a fixed rate of 10%, what price could they offer and still qualify for financing? Use each of the five sets of qualifying rules.* Find the corresponding principal-and-interest payments, also.

*Assume no mortgage insurance or other association dues in this example.

Solution: Key in the VA list, then the formula, then CALC.

Then 3500 351 200 3LTD 1.25 TXVR 30 SINS 0 SOUS, then MORE 10 IXYR 30 #YRS 10000 30N Answer: CV=100,000.00 GV Answer: \$C=789.81 ÆC MORE FMW ... Answer: FMV=105, 706.10 Answer: \$FM=839.89 ΈFΜ Answer: GMV=113,854.91 GMV Answer: \$GM=911.40 3.GM Answer: FHAY=109,271.20 FHAV.... MORE SEFHA .. Answer: \$FHA=871.18 Then **GAS?** ...(toggle until **GAS?=1.00**) And 2 5 HGE 3000 SOFT 6 #FHM MORE 319 EFED 209 EST Answer: VAV=131,680.43 VAV Answer: \$VA=1,067.83 ΈFHA

Notice:

- The formula requires that, for each qualifying method, you solve for the maximum home value *before* calculating the corresponding monthly payment.
- The menu has been ordered so that you can work left-toright and reach an unknown item immediately after having keyed in all its required knowns.
- The **EASY** item on the menu is a mode *toggle*: Press it once for "yes" (1.00); again for "no" (0.00).

Which scenario has a greater Net Present Value? 7. closing costs tax relief int. tax relief РМТ РМТ PMT DMT DMT мацімаці IMALLIMAL n taxes down D. taxes pts

closing ins.

BUY assumptions: You own the home for a whole number of years. The mortgage payment (amortized over a whole number of years) and utilities/maintenance are paid at the END of each month. Insurance premiums (in advance) and property taxes (in arrears) are paid yearly. Tax relief from interest deductions is realized at the end of the year. When you sell the home and repay the mortgage, you'll owe capital gains tax on your gain—after any commission to a broker. The property value and taxes are increased annually by the property growth rate.

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RENT assumptions: You owe first and last month's rent, plus a fully-refundable security deposit immediately. Rent is paid at the beginning of each month; maintenance/utilities at the end. Your renter's insurance premium is paid annually, in advance. Also, you pay yearly income tax on the interest accruing on your investment of the down-payment money. In both scenarios, insurance, utilities and maintenance (and your rent in the RENT case) increase yearly by the inflation rate. All percentage rates are annual but are compounded monthly.

48 M&U M&U The formula:

▶B~RNT:Ø×(L(P:(\$PR-\$DN+)) 0xNY)+USPV(IzYR+12:NYx1 2))+PTS+\$CL_B+PTX2+B\$IN +B\$UM+G2.IT+\$DEP+\$RNT+R \$IN+R\$UM+INF%+YRS+INV%) +(\$PR+100×IP(G%,IT)×L(T FP(G% IT))+\$PR×SPFV(PG R%+12:YRS×12)×(1-FP(\$CL .B))x(1-IP(G2.IT)÷100xG (T)))xL(Z:SPPV(L(C:((()))) 1+DSC%+1200)^12-1)×(1-G (T))+1)^(1÷12)-1)×100): YRS×12))-Σ(K:12:YRS×12: 12:SPPV(G(C):K)X((1-G(T))xPTX2÷100x\$PRxSPFV(PG R%+12:K)-G(T)×(12×G(P)-((\$PR-\$DN-G(P)×USPV(I/Y $R \div 12$: K - 12) $) \div SPPV(12YR \div 1)$ 2:K-12)-(\$PR-\$DN-G(P)XU SPV(I/YR+12:K))+SPPV(I/ YR÷12:K))))-G(P)×USPV(G(C):YRSx12)-G(Z)x(\$PR-\$DN-G(P)xHSPV(T2YR+12:Y RS×12))+SPPV(I/YR+12:YR Sx12)-PTS÷100x(\$PR-\$DN) $\times(1-G(T)\times SPPV(G(C):12))$ - IP(\$CL.B)-(((B\$UM-R\$UM -\$RNT×(1+G(C)÷100))×USP V(G(C):12)+12×(B\$IN-R\$I N))XUSEV((((1+TNEZ+1200)+(1+G(C)+100))^12-1)x1 00:YRS)+\$RNT×(1+INF/+12 00)^(12×(YRS-1))÷(1+G(C)+100)^(YRS×12-1)+G(Z)×

(\$DEP+\$DN×SPFV((SPFV(IN V%+12:12)-1)×100×(1-G(T)):YRS))-\$DEP-\$RNT)=B~R

Approximate Memory Required:50% to use, 13% to store.Required Knowns:NY (the mortgage term); I%YR (mortgage rate); \$CL.B (composite value: the costs of closing at purchase and the sales commission % upon resale); G%.IT (a composite value: the capital gains taxability and the normal income tax bracket).

Example: You're transferred to a new city for 4 years (YRS). You have \$10,000 for a down-payment and are considering a \$100,000 home. Property values are growing at 8% annually (PGR%), and the mortgage rate (I%YR) is 10%. Inflation (INF%) is 5%, and a liquid taxable fund earns 8% (DSC%), but a taxable stock mutual fund earns 15% (INV%). To buy the home, closing costs are \$400; the loan fee is 1%. Insurance start at \$30/month, with \$180/month in utilities and maintenance. Property taxes are 1.25% per year. Your tax bracket is 28%, and capital gains are 100% taxable. You'll pay a 6% commission to resell the home.

On the other hand, if you rent the home, your security deposit would be \$300. Your rent would start at \$750, with monthly insurance and maintenance/utilities at \$15 and \$100, respectively. So, should you buy the home or rent it (investing the down payment in the stock mutual fund) instead?


- B~R represents the *difference* between the Net Present Value of the BUY scenario and that of the RENT. If B~R is positive, it's better to buy than to rent.
- The analysis is *after-taxes*; both the discount (DSC%) and alternative investment rates (INV%) are assumed taxable.
- The property growth rate is assumed to include wear-andtear depreciation in the value of the house.
- The menu has been ordered so that the five variables you might be most likely to play "What-If?" with are all located on the last "page" of the menu.

8. P.% specifies any principal (P) paid *in addition to* a P&I payment that is a percentage (%) of the conventional monthly payment:

TVM~ACCPYDN:0×(M+I/YR+ PV+PMT+FV+L(I:I%YR+IF(P /YR=0:L(P/YR:12):P/YR)) +L(P:L(F:IF(FP(G(P.%))= 0:1:FP(G(P.2))))X(-PV-F VxSPPV(L(R:I%YR÷12):M)) ÷USPV(G(R):M)÷(1+G(BEG) ×G(R)÷100)-L(D:IP(G(P.%))xSGN(PV))))+IF(S(BEG) :ABS(G(BEG)-1)-BEG+0×P. %:IF(S(Y):PV+(1+BEG×G(I)÷100)×G(P)×USPV(G(I):Y XP/YR)+FVxSPPV(G(I):YXP /YR):IE(S(AMRT):L(Z:BEG)XL(BAL:RND(PV:2))XL(NE XT:L(INT:L(PRIN:0)))-AM RT: IF(S(NEXT): 1E3+#P+10 01E3×FP(G(NEXT)÷1E3)-NE XT+0×L(B:BAL): IF(S(BAL) :RND((RND(PMT:2)×USPV(G (I):#P-G(Z))+G(B)+G(Z)× RND(PMT:2))+SPPV(G(I):# P-G(Z)):2)-BAL:IF(S(PRI N):PRIN+G(B)-BAL:IF(S(I NT):#PXRND(PMT:2)-PRIN-INT+L(Z:0):PV+(1+BEG×G(R)÷100)×(2×PMT-G(P)+G(D))+G(F)×USPV(G(R):M)+FV xSPPV(I/YR÷12:M)))))))

<u>Approximate Memory Required</u>: 39% to use, 10% to store. <u>Required Knowns</u>: **#**P.

- Example: In how many years can you pay off a 30-year, \$100,000 mortgage at 10%, with 26 payments/ year, each *half* the conventional monthly amount, plus \$20? What is this payment? Amortize the first 2 years' payments.
- $30\times12=(ALG) or 30(INPUT) 12\times(RPN)$ Solution: 10 IXYR 100000 PV 0 FV , MORE (2)6) PAWR BEG (toggle this until BEG=0.00) 20.5 P.2 <u>Result</u>: Y=18.26 MORE MORE PMT Result: PMT=-458.79 Next, MORE AMAT (display: AMRT=0.00), to begin the amortization, then MORE and [2]6] #P to amortize 26 payments at once. Now, in this order, press: **NEXT** to identify the payments in the group: NEXT=1,026.00 (that is, payments 1-26) BAL=97,975.82 BAL ■377 PRIN=-2,024.18 INT INT=-9,904.36 NEXT=27,052.00 (pmts 27-52)NEXT ■m BAL=95,739.19 PRIN=-2,236.63 INT=-9,691.91

- P/YR defaults to 12 if you forget and leave it as zero.
- PMT and YRS are entirely independent as unknowns; you may calculate them in any order. M is the loan's conventional term (in Months); Y is "Years until actual pay-down."
- As with the built-in AMRT, you may change #P between groups or use **MART** to start over completely.

In this formula, the interest rate may change yearly until Year
 After specifying those rates, you solve for payment, balance, and APR% as of any month. Payments are monthly, in arrears.

DARM:0×(NT+L(A:I1%+12)+ L(Q:(PV+P1×USPV(G(A):12))÷-SPPV(G(A):12))+FV+P TS+L(B:I2%+12)+L(C:I3%+ 12)+L(D:I4%+12)+L(E:I5% +12)+N+PMT+BAL+APR%+*** **+L(R:(Q-EVxSPPV(B:NT-12))+USPV(B:NT-12))+L(S :(Q-RXUSPV(B:12))+SPPV(B:12))+L(T:(S-FV×SPPV(C :NT-24))+USPV(C:NT-24)) +L(U:(S-TxUSPV(C:12))+S PPV(C:12))+L(V:(U-FV×SP PV(D:NT-36))+USPV(D:NT-36))+L(W:(U-VXUSPV(D:12))+SPPV(D:12))+L(Y:(W-F VxSPPV(E:NT-48))+USPV(E :NT-48))+L(F:IF(N(13:(P V+L(P:P1)×USPV(A:N))÷-S PPV(A:N):IF(N(25:(Q-L(P :R)×USPV(B:N-12))+SPPV(B:N-12): IF(N(37:(S-L(P: T)×USPV(C:N-24))+SPPV(C :N-24):IF(N(49:(U-L(P:V) \times USPV(D:N-36)) \div SPPV(D: N-36):(W-L(P:Y)×USPV(E: N-48))+SPPV(E:N-48)))))))+IF(S(PMT):PMT-G(P):I F(S(BAL):BAL-F:IF(S(APR %):PV×(1-PTS÷100)+F×SPP V(L(Z:APR%÷12):N)+P1×US PV(Z:MIN(12:N))+R×USPV(Z:MIN(12:MAX(0:N-12)))× SPPV(Z:12)+T×USPV(Z:MIN (12:MAX(0:N-24)))×SPPV(Z:24)+V×USPV(Z:MIN(12:M AX(0:N-36)))×SPPV(Z:36) +Y×USPV(Z:MAX(0:N-48))× SPPV(Z:48):PV+P1×USPV(A :NT)+FV×SPPV(A:NT)))

Approximate Memory Required: 56% to use, 14% to store. Required Knowns: PTS, I2%, I3%, I4%, I5% and N.

Example: The interest rates for a 30-year ARM of \$100,000 are: Year 1=9.0%; Year 2=9.5%; Year 3=10.0%; Year 4=10.5%; Year 5 (and beyond) =11.0%. Find the starting payment, and for Year 5, the payment amount and the year-end balance and APR. The loan fee is 1.5%.

Solution: Key in the formula, and CALC. Then:

360 NT 9) II: 100000 PV 0 FV
PI	<u>Result</u> : P1=-804.62
MORE 105	PTS 905 12% 10 13%
10.5 142	11 IS? MORE
60 N PM	II <u>Result</u> : PMT=-946.66
BAL	<u>Result</u> : BAL=-96,586.63
APR2	<u>Result</u> : APR%=10.28

- You must solve for P1 (the starting monthly payment) first.
- Memory doesn't permit concealment of intermediate variables, but the variable ***** pushes them onto later pages.

10. You specify a *percentage* of the principal as a remaining balance (RB%) and then find the number of years (YRS) it will take to amortize the loan down to that point:

TVM~RBZ:0×(N+IZYR+PV+P) MT+FV+L(I:I/YR+IF(P/YR= 0:L(P/YR:12):P/YR)))+IF (S(BEG?): ABS(G(BEG?)-1) -BEG?: IF(S(YRS): PV+(FV-(PV+EV)XRB2÷100)XSPPV(G (I):YRS×P/YR)+(1+BEG?×G (I)÷100)×L(PMT:(-PV-FV× SPPV(G(I):N))+USPV(G(I) :N)+(1+BEG?×G(I)+100))× USPV(G(I):YRS×P/YR):IF(S(AMRT):L(Z:BEG?)×L(BAL :RND(PV:2))×L(NEXT:L(IN T:L(PRIN:0)))-AMRT:IF(S (NEXT):1E3+#P+1001E3×FP (G(NEXT)÷1E3)-NEXT+0×L(B:BAL):IF(S(BAL):RND((R ND(PMT:2)×USPV(G(I):#P-G(Z))+G(B)+G(Z)×RND(PMT) :2))+SPPV(G(I):#P-G(Z)) :2)-BAL:IF(S(PRIN):PRIN +G(B)-BAL: IF(S(INT): #P× RND(PMT:2)-PRIN-INT+L(Z :0):PV+(1+BEG?×G(I)÷100)XPMTXUSPV(G(I):N)+FVXS PPV(G(I):N)))))))

<u>Approximate Memory Required</u>: 35% to use, 9% to store. <u>Required Knowns</u>: RB%, #P.

- Example: How long will it take to pay down a 30-year, \$100,000 mortgage at 10%, (monthly payments, *in advance*) to 75% of the original balance? How about 50%? 25%? Also, find the payment amount and run an amortization on the first year of payments.
- Solution:
 30×12=(ALG) or 30 [NPUT 12×(RPN)
 N

 10
 12/12
 100000
 PV
 0
 FV
 MORE

 12
 P/YR
 BEG?
 (toggle this until BEG?=1.00)

75 RB2 YRS	<u>Result</u> :	YRS=17.49
50 RB2 YRS	<u>Result</u> :	YRS=23.53
25 RB2 YRS	<u>Result</u> :	YRS=27.28
MORE MORE PMT	<u>Result</u> :	PMT=-870.32

Next, MORE FINIAL (display: AMRT=0.00), to begin the amortization, then MORE and 12 HERE to amortize 12 payments at once. Now, *in this order*, press: NEXT to identify the payments in the group: NEXT=1,012.00 (that is, payments 1-12) EXT BAL=98,622.26 FRIN PRIN=-1,377.74 INT INT=-9,066.10

- PMT and YRS are independent as unknowns. Also, the value of P/YR defaults to 12 if you forget and leave it as $\bar{0}$.
- With any of these TVM formulas with AMRT capabilities, you can shorten them a lot by omitting those five IF(S... statements (AMRT, NEXT, BAL, INT and PRIN).

11. This formula works a lot like TVM except that I%YR must be a known value. Then you can find the constant principal amount (PRN) in each payment and, for any given period (PER), the total payment amount (PMT) :

TVM~CNSTPRN: 0×(N+I%YR+ PV+PRN+FV+L(I:I%YR÷100÷ IF(P/YR=0:L(P/YR:12):P/ YR)))+IF(S(BEG?):ABS(G(BEG?)-1)-BEG?: IF(S(PER) OR S(PMT): IF(PER=0:0:(PV+PRN×(PER-1))×IF(PER= BEG2:0:G(I))-PRN)+PMT:I F(S(AMRT):L(BAL:RND(PV: 2))×L(NEXT:L(INT:L(PRIN :0)))-AMRT:IF(S(NEXT):1 E3+#P+1001E3×FP(G(NEXT) ÷1E3)-NEXT-0xL(B:B6L):I F(S(BAL):BAL-G(B)-RND(P RN:2)×#P:IF(S(PRIN):#P× RND(PRN:2)-PRIN:IF(S(IN T):Σ(T:0:#P-1:1:RND((G(B)+RND(PRN:2)×T)×G(I):2 >>-IF(NEXT(2E3 AND BEG? ×SGN(#P)=1:RND(G(B)×G(I):2):0)+INT:(PV+N×PRN)× (1+BEG?×G(I))+FV))))))

<u>Approximate Memory Required</u>: 31% to use, 8% to store. <u>Required Knowns</u>: I%YR, P/YR, #P.

- Example: What is the amount of the first payment on a 30-year, \$72,000 loan at 12% (monthly payments, in arrears), with constant payments to principal? How much is the last payment? Run an amortization on the first year of payments.
- Solution: $30\times12=(ALG) or 30(INPUT) 12\times(RPN)$ 12 IXYR 72000 PV 0 FV , MORE (1)2) PATR SEG? (toggle this until BEG?=0.00) MORE MORE PRN Result: PRN=-200.00 (the constant principal portion of the payment) MORE 1 PER PMT Result: PMT=-920.00 360 PER PMT Result: PMT=-202,00 **EMET** (display: AMRT=0.00), to begin the amortization. And then MURE and 12 #P to amortize 12 payments at once. Now, in this order, press: **NEXT** to identify the payments in the group: NEXT=1,012.00 (that is, payments 1-12) Result: BAL=69,600.00 Result: PRIN=-2,400.00 INT Result: INT=-8,508.00

- I%YR is a *required known* in this formula. Also, you must calculate PRN before calculating PMT.
- BEG? is a *toggle* mode key: press it once to change to BEG mode; again to switch back to END.
- P/YR and BEG? values default to 12 (monthly payments) and 0 (END mode), respectively—like the real TVM Menu.

12. This formula behaves like TVM, except that you can also specify a percentage change (%CH) or an amount change (\$CH) in the beginning PMT. This change occurs periodically after a specified number of payments (GRUP):

> ▶PMT\$CH%:0×(N+I%YR+PV+P MT+FV+IF(P/YR=0:L(P/YR: 12):0))+IF(S(BEG?):ABS(G(BEG?)-1)-BEG?:PV+FV%S PPV(L(I:I%YR÷P/YR):N)+(1+G(I)÷100×BEG?)×USPV(G (I):GRUP)×(PMT×USFV(((1 +CH%÷100)÷(1+G(I)÷100)^ GRUP-1)×100:N÷GRUP)+\$CH ×∑(G:0:N÷GRUP-1:1:G×SPP V(G(I):G×GRUP)))

<u>Approximate Memory Required</u>: 16% to use, 4% to store. <u>Required Knowns</u>: None.

- Example: What should you pay now to take over as lessor on a five-year office lease whose current monthly rent (due in advance) is \$900, increased yearly by 5%, plus \$50? Assume a discount rate of 8%. Then, for a yield of 12%, what should you sell the lease for in 3 years?
- Solution:
 5×12= (ALG) or 5 [NPUT 12× (RPN)

 8 I2YR 900 PMT 0
 FV, MORE

 12 FAYR SEGN (toggle this until BEG?=1.00)

 12 GRUP 5 CH2 50 SCH

 MORE
 FV

 MORE
 FV

 S6
 N 12 I2YR

 FV

 Result:
 FV=33,652.04

- The formula uses only a whole number of groups (i.e. it uses the *integer portion* of N+GRUP).
- As usual, I%YR compounds once per period (P/YR times per year); but %CH compounds once every GRUP periods.
- This formula obeys normal TVM sign conventions, *including the dollar amount specified in \$CH.* Thus, if PMT is negative in the perspective you adopt, then to indicate an *increase* in the amount of the PMT, \$CH must be negative also. That's *not* true for CH%, where a positive value always increases the PMT amount, and a negative percentage decreases it.



13. On this BOND Menu, you specify a TYPe value: 1 or 2 (annual or semiannual coupons)—positive for an actual calendar, negative for a 30/360 basis. Also, you specify capital gains and income tax rates and the sales commission (as a percentage of the PRICE). Interest is treated as taxable income, and any difference between price+commission and par or call is taken as capital gain (loss).

BND~T&C:0×(IF(TYP=0:L(TYP:2):0)+L(E:.01×(FP(1 00×SETT)+IP(100×MAT)))+ L(Z:SGN(DDAYS(G(E):SETT :1)))+IF(G(Z)=0:L(Z:1): 0)+L(F:IF(L(T:ABS(TYP)) =1:G(E)+1E-6×G(Z):G(E)- $G(Z) \times (6-1E-6)) + IF(G(F))$ >=13:L(F:G(F)-12+1E-6): IF(G(F)(1:L(F:G(F)+12-1 E-6):0))+IF(G(Z))0:L(D: G(E))+L(E:G(F)):L(D:G(F >>>+L(P:IF(TYP(0:DDAYS(SETT:G(D):3)+360×TYP:DD AYS(G(D):SETT:1)+DDAYS(G(D):G(E):1)))+L(N:1E4× (FP(100×MAT)-FP(100×G(D >>>>C(T)-IF(G(Z)(0 AND) G(T)=2:1:0))+L(A:G(P)×C PN%+G(T))+IF(CALL=0:L(C ALL:100):0)+L(I:CPNZ+G(T (1-FP(G.I))+CM/+L(Y :YLD2÷100÷G(T))+L(C:C8L L+IP(G.I)÷100×FP(G.I)×(PRICE-CALL+CM%÷100)))+I F(S(ACCRU):ACCRU-G(A):I F(G(N)<2:(G(C)+G(I))+(1

+(1-G(P))×G(Y)):G(C)÷(1 +G(Y))^(G(N)-G(P))+Σ(K: 1:G(N):1:G(I)÷(1+G(Y))^ (K-G(P))))-G(P)×G(I)-PR ICE×(1+CM%÷100)+0×YLD%)

<u>Approximate Memory Required</u>: 44% to use, 11% to store. <u>Required Knowns</u>: All *except* YLD%, PRICE and ACCRU.

Example: With all capital gains taxable at a tax bracket of 33%, for a 10% after-tax yield-to-maturity, what price (and accrued interest) can you pay on 7/28/90 for a 7% bond (semiannual coupons, 30/360 basis) maturing on 9/9/99? The commission is .15%. What's your yield-to-call if the bond is callable at 88.125 on 3/9/95?

<u>Solution</u> :	2+/-) TYP	
	7•281990 SE	TT 9•091999 MAT
	7 CPN2	
	MURE 100-33	G.I •15 CMX
	10 YLD? PRICE	Result: PRICE=65.72
	ACCRU	Result: ACCRU=2.70
	MORE 88 • 125 (ALL 30091995 MAT
	MORE YLD?	<u>Result</u> : YLD%=11.02

- TYPE defaults to a value of 2; CALL defaults to 100.
- The formula uses the bond equations in Appendix B of the Owner's Manual, but it works only for MM.DDYYYY date format and doesn't use "end-of-month" conventions. So, for an actual-basis bond maturing on the last day of the month (or on 8/29 or 8/30), move all dates forward by one day.

14. This formula works like TVM, except:

You enter the future value as a residual percentage, RES%, of the lease's Present Value (PV). *BEGIN mode is assumed*. Also, you can specify a number of *extra* payments, #ADV, to be made in advance (#ADV does *not* include the normal first payment, made at the same time). Use the SKP? toggle to indicate if the annual payment pattern includes skipped payments. If so, use a CFLO list named LP, to show that pattern (a year of \$1 payments)—and in that case, N must be a whole number of years.

LEASE~TVM~SKP~ADV:0×(N) +I%YR+PV+PMT+RES%+IF(P/ YR=0:L(P/YR:12):0))+IF(S(SKP?):ABS(G(SKP?)-1)-SKP? PV-ABS(RES%)+100×P V×SPPV(L(I:I/YR+P/YR):N)+(#ADV+IF(SKP?=0:(1+G(I)+100)×USPV(G(I):N-#AD V):0x(L(A:#ADV)+L(C:1)+ L(S:0)+ $\Sigma(G:SIZEC(LP):0$:-1:Σ(F:#T(LP:G):1:-1:L (D:SGN(ABS(FLOW(LP:G))) XSPFV(G(I):G(C)))+0×IF(G(D)>0 AND G(A)>0:L(S:G (S)+G(D))+L(A:G(A)-1):0)+0×L(C:G(C)+1)))×USPV(((1+G(I)+100)^P/YR-1)×1 00:IP(N+P/YR))-G(S)×SPP V(G(I):N)))XPMT)

Approximate Memory Required:

24% to use, 7% to store, not including the list, LP.

Required Knowns: N, #ADV.

Example: Find the monthly payment for a 5-year lease with irregular payments (annual schedule shown below) on a \$40,000 computer with a 10% residual buy-out. The lessor wants 4 advance payments and an 18% yield. What's the residual percentage for a \$1400 payment?

<u>Month</u>	Payment?	<u>Month</u>	Payment?
1	yes	7	no
2	yes	8	no
3	yes	9	no
4	no	10	yes
5	no	11	yes
6	yes	12	yes

Solution: First, build the LP list:

MAIN CFLO GET XNEW NAME LP INPUT
() INPUT) () INPUT) () INPUT) () INPUT)
1 INPUT INPUT 0 INPUT 3 INPUT 1 INPUT 3 INPUT
Now MAIN SOLVE, key in the formula and CALCE.
Then $5 \times 12 = (ALG) or 5 INPUT 12 \times (RPN)$
18 IXYR 40000 PV 10 RESX, MORE
SKP? (toggle this until SKP?=1.00)
(4) #ADV
MORE PMT Result: PMT=-1,496.36
1400+/-) PMT
<u>Result</u> : RES%=25.09

- The LP list is necessary only with skipped payments.
- P/YR defaults to 12, and the formula obeys the normal TVM sign conventions—except for RES%, which needs no sign.



BUY assumptions: You own the asset for a whole number of years, depreciate it via straight-line, then sell it, taking a capital gain or loss on the difference between the sales price and the depreciated basis. Both the loan payment and maintenance are paid in arrears each month. Insurance premiums (in advance) and taxes (in arrears) are paid yearly.



LEASE assumptions: Payments are due at the beginning of each month; the lessor may demand some more payments in advance. You may also pay property taxes. You do pay yearly income tax on the interest on your down-payment investment. In both scenarios, insurance and maintenance (and your payment in the LEASE case) increase yearly by the inflation rate. Property assessments increase yearly, in a compound growth pattern. All rates are annual but compound monthly.

36.333.01

B~LS:0×(L(P:(\$PR+0×(NY))) +I%YR)-L(D:IP(\$D.PT)))+ USPV(L(I:I%YR÷12):NY×12))+\$C.B+\$SV.L+L(T:FP(G% .IT))+B\$IN+B\$HM+PTX2+\$E P+L(A:IP(AD.IF))+L\$IN+L \$UM)+IF(S(LTX?):ABS(G(L TX?)-1)-LTX?:L(Z:SPPV(L (C:((((1+DSC%+1200)^12+ 1)x(1-G(T))+1)^(1+12)-1)x100):YRSx12))x(\$SLx(1 -FP(\$C.B))-IP(G%.IT)÷10 $0 \times G(T) \times (\$SL \times (1 - FP(\$C.B))$)-\$PR+L(S:(\$PR-IP(\$SV.L))+FP(\$SV.L)+100)xYRS)-(\$PR-G(D)-G(P)×USPV(G(I):YRS×12))+SPPV(G(I):YR Sx12))-X(K:12:YRSx12:12 :SPPV(G(C):K)X(IF(LTX?= 0:(1-С(Т))×РТХ2÷100×≴РВ X(\$SL+\$PR)^(K+12+YRS):0)-G(T)×(12×G(P)-((\$PR-G (D)-G(P)×USPV(G(I):K-12))+SPPV(G(I):K-12)-(\$PR-G(D)-G(P)XUSPV(G(I):K))+SPPV(G(I):K))+G(S)+L(F:FP(\$D.PT)×(\$PR-G(D))) ÷YRS+(12x(B\$TN-L\$TN+B\$H) M-L\$UM)-\$LPX(12+IF(K=12):G(A):IF(K=YRS×12:-G(A) :0))))×SPFV(FP(AD.IF)×1 00÷12:K-12))))-G(P)×USP $V(G(C):YRS\times 12)-G(F)-IP($ $\pm C_{\rm B} \times (1 - G(T) \times SPPV(G(C))$:12))-(((B\$UM-L\$UM-\$LPX (1+G(C)+100))×USPV(G(C) :12)+12×(B\$IN-L\$IN))×US FV((((1+FP(AD.IF)+12)+(1+G(C)+100))^12-1)×100: YRS)+G(Z)×(\$LP×(1+FP(AD .IF)+12)^(12×(YRS-1))×(1+G(C)+100)×USFV(G(C):G (A))+G(D)×SPFV((SPFV(IN V%+12:12)-1)×100×(1-G(T)):YRS))-G(A)×\$LP)-B~L)

<u>Approximate Memory Required</u>: 59% to use, 16% to store. <u>Required Knowns</u>: NY, I%YR, \$C.B, G%.IT, \$D.PT, AD.IF, \$SV.L

Example: A manufacturing firm needs an extra warehouse for 2 years. A suitable building is available for \$100,000, of which 75% is depreciable. The company has \$30,000 in ready cash. The 20-year mortgage rate is 10%, and inflation is 5%; cash funds earn 7%; stock funds earn 15%. To buy the building, closing costs are \$400, and the loan fee is 2%. Insurance will be \$60/mo.; utilities/ maintenance, \$250/mo. Property taxes are 1.25% per year. The income tax bracket is 33%; capital gains are 100% taxable. A broker will charge 6% to resell the building. Estimated re-sale price: \$115,000.

> Alternatively, to lease the building from the current owner, rent would start at \$750/mo. (including property taxes), with 2 payments (in addition to the first regular payment) due immediately, and with annual adjustments for inflation. Insurance would be \$85; maintenance/utilities would be \$220.

Should the company buy the building or lease it?

<u>Solution</u>: Key in the formula, and **CALC**. Then:

100000 3PR 20 NY

10 IXYR 30000.02 20.PT (down. points)

400.06 EC.B (closing costs. broker's com%)

MORE

25000.315 **ESV.L** (salvage. depr. life)

100.33 GX.II (CG taxability%. tax bracket)

60 BEIN 250 BEUM 1 • 25 PTXX

MORE 750 &LP

2.05 HD.IF (advance payments. inflation)

85 I HIN 220 I HUM

(toggle this until LTX?=0.00; lessee does not pay property taxes in addition to lease payment)

MORE	7	DSCX	2	YRS
------	---	------	---	-----

115000 ±5L 15 INV?

<u>Answer</u>: B~L=-1,225.12

Under the assumptions of the problem, the company would do slightly better by *leasing* the warehouse.

- B~L is the *difference* between the Net Present Value of the BUY scenario and that of the LEASE. Only if B~L is positive is it better to buy than to lease.
- The menu has been ordered so that the five variables you might be most likely to play "What-If?" with are all located on the last "page" of the menu.

16. This formula computes the value of an income property, using up to two different rental rates, floor areas and vacancy rates. For the capitalization rate, the formula averages the Summation Method (a Safe rate for liquid funds, plus increments for Risk, Illiquidity and Management) and the Band of Investment method (weighting current market expectations for mortgage and equity funds by the Loan-to-Value ratio on the property's mortgage).

▶IPVAL:0×(L(N:\$RT1×SFT1 ×(1-VAC%1÷100)+\$RT2×SFT 2×(1-VAC%2÷100)-\$PTX-\$M GT-\$MNT-\$INS)+L(C:(SAF% +RSK%+ILQ%+MGT%+LTV%÷10 0×MRT%+EQR%×(1-LTV%÷100))÷2))+IF(S(\$NOI):\$NOI-G(N):IF(S(CAP%):CAP%-G(C):\$VAL-G(N)÷G(C)×100))

<u>Approximate Memory Required</u>: 20% to use, 3% to store. <u>Required Knowns</u>: All *except* \$NOI, CAP% and \$VAL.

Example: Find the NOI, cap rate and value of this property:

	<u>Office</u>	<u>Warehouse</u>
Rent (\$/ft²/year)	7.80	4.07
Floor area (ft ²)	2,277	2,005
Vacancy rate (%)	0.5	1.0

Taxes: \$3,647 Mngmt	: \$3,060 Maint.: \$2,318
Insurance: \$773	Loan-to-Value: 70%
Safe rate: 10.5%	Risk factor: 2.0%
Illiquidity factor: 0.5%	Management factor: 0.4%
Mortgage rate: 12.75%	Equity return rate: 14%

 Solution:
 7.8 SATI 2277 SFTL 5 WACAI

 4.07 SATE 2005 SFTE MORE 1 WACAE

 3647 SFTH 3060 SMET

 2318 SMNT 773 SSINS MORE

 10.5 SAFE 2 RSK2 .5 ILC22 .4 META

 70 LTV2 MORE

 12.75 MATE 14 ECRE

 SNOT

 Result: \$NOI=15,952.54

 GAPX=120,283.08

- All rates are yearly but are compounded monthly. All dollar amounts are yearly.
- Besides being a property valuation tool, this formula is also handy for calculations of Net Operating Income (\$NOI).



17. This formula allows up to two mortgages and a "wrap" loan. You specify when the second mortgage and the wraparound loan begin, via the variables M and W, respectively:



The formula can compute the payments (or any of the other usual loan parameters) on the first two mortgages, then the borrower's overall APR (including any points paid on the first two mortgages), and also any of the loan parameters on the wraparound mortgage.

Of course, the formula can also wrap a single mortgage, or find the APR on one or two conventional mortgages (no wraparound at all). But if there is a wraparound mortgage, it may start no earlier than the last mortgage.

2 F <u>Approximat</u> <u>Required Kr</u> SOLVE Solutions

WRAP~2ND:0×(N1+T21+PV1) +PMT1+EV1+N2+T22+PV2+PM T2+EV2+PTS1+PTS2+L(W:IE (M>=W:MAX(N1:M+N2):W))+ APR%+NW+Y%W+PVW+PMTW+FV W)+IF(S(APR%):-(USPV(L(A: APR2+12):NW)×PMTW+FVW xSPPV(G(A):NW)+PVW)xSPP $V(G(A):W)+PV1\times(1-PTS1+1)$ 00)+PMT1×USPV(G(A):MIN(N1:W))+IF(N1<=W:FV1×SPP V(G(A):N1):0)+SPPV(G(A) :M)x(PV2x(1-PTS2÷100)+P MT2xUSPV(G(A):MIN(W-M:N 2))+IF(N2+M<=W:FV2×SPPV</pre> (G(A):N2):0)):IF(S(N1) OR S(1%1) OR S(PV1) OR S(PMT1) OR S(EV1): PV1+P MT1×USPV(T21÷12:N1)+EV1 ×SPPV(I%1÷12:N1):IF(S(Y 2W) OR S(PVW) OR S(PMTW) OR S(FVW):Y%W÷12-L(Y: Y%W÷12)+PVW+PMTW×USPV(G (Y):NW)+EVWxSPPV(G(Y):N W)+IF(N1>W:FV1×SPPV(G(Y):N1-W)+PMT1×USPV(G(Y): N1-W):0)+IF(N2+M>W:FV2× SPPV(G(Y):N2+M-W)+PMT2x USPV(G(Y):N2+M-W):0):PV2+PMT2×USPV(1/2+12:N2)+ FV2×SPPV(I/2÷12:N2))))

Approximate Memory Required: 34% to use, 9% to store. Required Knowns: M, W, NW. Example: A home currently has two mortgages: \$100,000 at 10% for 30 years (no balloon); and \$50,000 at 11.5% for 10 years, with a \$10,000 balloon. The second mortgage began after the 15th year of the first. Now, after the 20th year, the owner wishes to consolidate loans and get financing for more remodelling. You offer to wrap his current mortgages, loaning \$50,000 in new money, for 120 monthly payments and then a \$25,000 balloon. What should the payment amount be to get you a 17% yield? What then is the borrower's overallAPR%? He paid 1 point up front on the first mortgage, 2 points up front on the second.

<u>Solution</u> :	360 NI (1	
	100000	PVI () FVI
	PMTI	<u>Result</u> : PMT1=-877.57
	MORE 120	N2 11.5 I%2
	50000 PL	2 10000+/-) FV2
	PMT2	<u>Result</u> : PMT2=-658.22
	MORE 180	M 240 W
	MORE 120	NM 17 YZM
	50000+/-) PVW 25000 FVW
	РМТЫ	<u>Result</u> : PMTW=2,201.26
	MORE MORE M	IORE 1 PTSI 2 PTS2
	APR2	<u>Result</u> : APR%=10.51
	- • •	
ى	A Car	
20 20	<u> CON</u>	

- *Important:* For cash-flow signs (+ or -), take the viewpoint of the *borrower* on the first two mortgages; take the *lender's* perspective on the wraparound loan.
- All payments are assumed to be monthly, in arrears.
- You must solve for the payments (and all other parameters) on the first two loans before computing the APR% or any parameters on the wraparound mortgage.
- The formula doesn't allow points for the wraparound mortgage; for PVW, use the *net* new money loaned.
- The formula can also be handy for determining whether it makes sense simply to refinance a single mortgage:
 - First, compute the APR% of the original mortgage (including any points and other fees charged), if you pay it off over its normal term.
 - Next, calculate its current balance. Use this number as the "balloon" on the "first" mortgage *and* as the "starting balance" on a "second," which starts now (at the same time you pay off the first). Be careful of the cash-flow signs!
 - If the overall APR% of this "back-to-back" pair of mortgages (including the lower interest rate and the refinance points/fees for the "second"), is *lower* than the first APR%, you save by refinancing.



18. This formula will analyze an income property for net cash-flows at purchase, annually during operation, and upon re-sale. It also computes investment measures for the first year of operations: GRM, cap rate, equity return rate, and cash return rates before and after taxes. It allows for two mortgages on the property, and can handle inflationary increases of rent, property assessment, insurance and maintenance. The investor holds the property for a whole number of years and sells at a price based upon a given cap rate and Net Operating Income in the year after the re-sale.

▶IPA:0×(L(D:\$PR+0×\$C0A-\$M1+0×(N1+I1%+PTS1)-\$M2)+L(C:G(D)+(\$M1×PTS1+0× (N2+I2%)+\$M2×PTS2)÷100+ \$COA)+L(N:(IP(\$R.V)×(1-FP(\$R.V))-\$INS-\$MNT+0×I MP%-\$PR×FP(F%_PT))×L(I 1+IP(F%,PT)+100)^(G(Y)-1))+L(Z:IF(TYRS+0×(G% I T+B% CP><Y OR Y<1:0:1>> L+(P:\$M1+USPV(L(J:I1%+1 2):12×N1))+L(Q:\$M2+MAX(1E-99:USPV(L(K:I2%+12): 12×N2)))+0×(\$NCF+GRM+CA P%+EQ%+CC%+ATCC%)+L(E:(\$M1-PXUSPV(J:12X(Y-1))) ÷SPPV(J:12×(Y-1)))+L(F: (\$M1-P×USPV(J:12×Y))+SP PV(J:12×Y))+L(G:(\$M2-Q× USPV(K:12×(Y-1)))+SPPV(K:12×(Y-1)))+L(H:(\$M2-Q ×USPV(K:12×Y))+SPPV(K:1 2×Y))+L(A:N-12×(P+Q)-FP $(G'_{X}, IT) \times (N+E+G-F-H-12 \times (C))$

P+Q)-\$PR×IMP%+3150-(C-D -\$COA)+TYRS-IF(Y=1:\$COA :0)))+IF(S(\$NCF):A×Z-I F(Y=0:C:0)+IF(Y=TYRS:(1 -IP(B%.CP)+100)×N×I+FP(B%.CP)×(1-L(T:IP(G%.IT))+100×FP(G%.IT)))-F-H-T× \$PR×(Y×IMP%+3150-1):0)-\$NCF:IF(S(GRM):GRM-Z×\$P R+IP(\$R.V):IF(S(CAP%):C AP%+100-Z×N+\$PR:IF(S(EQ %):EQ%+100-Z×(\$PR×(I-1))+A+E-F+G-H)+D:IF(S(CC%))+C CC%+100-Z×(N-12×(P+Q))+C:ATCC%+100-Z×A+C))))

<u>Approximate Memory Required</u>: 60% to use, 14% to store. <u>Required Knowns</u>: All variables *except* \$NCF, GRM, CAP%, EQ%, BTC%, and ATCC%.

Example: A certain office building is appraised at \$750,000, of which 70% is improved). The proposal: Put \$250,000 down and secure two mortgages: \$350,000 at 10.5% (20 years, 1.5 pts.); and \$150,000 at 12% (10 years, 2 pts.). Costs of closing/acquisition will be \$2,000. Maximum gross rents are \$125,000 annually, with 6% vacancy/ loss. Insurance will be \$3,000; maintenance/management will be \$12,000. Property taxes are 2.5%. Rents, expenses and property value will follow inflation: 5%. The income tax is 33%; capital gains are completely taxable. In 5 years, the property will sell (through a broker, for a 6% commission), at a cap rate of 11.5% on the Net Operating Income expected for the 6th year. Find the net after-tax cash-flows for the initial investment and for each year of operation. Also, for Year 1, find the GRM, cap rate, equity return rate, and cash return rates before and after taxes.

Solution: Key in the formula and CALC. Then 750000 ±PR 2000 ±C0H 350000 ±MI 20 NI 10.5 IIZ MORE 1.5 PTSI 150000 ±M2 10 N2 12 I2X 2 PTS2 MORE 125000.06 ER. 3000 EINS 12000 **EMNT** 70 IMP? 5 • 0 2 5 FX.PT MORE 5 TYRS 100-33 GZ.IT 6-115 BZ.CP (1) Y SINCE \$NCF=12,896.17 (2) **Y SINCE** \$NCF=14,497.89 3 \$NCF.... \$NCF=16,834.20 (4) Y SINCE \$NCF=19,244.15 5 SNOT \$NCF=414,242.86 1 Y MORE GRM GRM=6.00 CAP%=11.17 CAP2 EQ%=25.64 EQ2 CC%=6.15 ATCC%=4.96 ATCC2

Notice:

- The formula will calculate values for the investment test values (GRM, CAP%, etc.) for any year within the scenario (and give zero values for years outside the scenario), but the investment tests are generally applied *only to Year 1*. So be sure that Y=1 when computing these test values.
- Tax relief from costs of acquisition is taken in Year 1. Tax relief from loan fees ("points") is prorated evenly over the term of the analysis.
- Mortgage terms may be for whole numbers of years only.
- Projected property appreciation in Year 1 (at the assumed rate of inflation) is included in the equity return rate.
- If an investment scenario has uneven income (expense) projections, you can account for such odd or special cashflows with a simple extra calculation for any given year: Take the resulting \$NCF and add (subtract) the *after-tax* portion of the extra income (expense). For example, if, in Year 3 in the example scenario, an extra expense of \$1000 is projected, the true \$NCF for that year would be:

\$16,289.70 - 1000×(1-.33) or \$15,619.00

- To conserve memory, the formula does not use G () to keep intermediate variables off of the menu. These single-letter variables therefore appear in the last pages of the menu; they may be ignored.
- This formula and the next one (FMRR) can both fit into the machine at one time. Together they form a potent combination for analyzing commercial real estate investments.

19. This formula will analyze a CFLO list named \$:

```
FMRR2~IRR2:0x(IF(G(P/Y)))
R)=0:L(P/YR:1):0)+L(Z:Σ
(G:1:SIZEC($):1:#T($:G)
))+L(N:L(F:L(M:L(W:0)))
)+Σ(G:SIZEC($):0:-1:Σ(T
:#T($:G):1:-1:L(M:G(M)+
FLOW($:G))+IF(G(M)<0:L(
M:G(M)×SPPV(SAFE%+G(P/Y
R):MIN(G(Z)-G(N):1))):L
(W:G(W)+G(M)×SPFV(RSK%+
G(P/YR):G(N))+L(M:0)))+
L(F:G(F)+IF(G=0:0:FLOW(
$:G))×SPFV(G(IRR%)÷G(P/
YR):G(N)))+L(N:G(N)+1))
))+IF(S(FMR%) OR S(SAFE
// OR S(RSK/):0×(SAFE/+
RSK/)+G(M)×SPFV(FMR/+G(
P/YR):G(Z))+G(W):IF(S($
MIN):$MIN-G(M):IF(S($FW
) OR S(P/YR):$FW-G(W)+0
xP/YR:FLOW($:0)xSPFV(IR
RZ + PZYR : G(Z)) + G(E))))
```

<u>Approximate Memory Required</u>: 28% to use, 8% to store, not including the \$ list.

<u>Required Knowns</u>: The number of cash-flow periods per year (P/YR), and a CFLO list named \$.

<u>Example</u>: Find the FMRR for the following cash-flow scenario, assuming that all cash is taken from—and returned to—an account earning 6%. Compare the FMRR with the IRR for the same situation.

<u>Year</u>	<u>Ca</u>	<u>Cash-Flow</u>	
0	\$	(75,000)	
1		15,000	
2		15,000	
3		(60,000)	
4		75,000	
5		(35,000)	
6		200,000	

Solution: First, build the \$ list (if it doesn't exist already):

MAIN FIN CF	LO GET	XNEW NAME	\$)[INPUT]
75000+/-	NPUT) 15		2 INPUT
60000+/-)[NPUT)INPUT	75000	NPUT (INPUT)
35000+/-	NPUT)INPUT	200000)(INPUT)(INPUT)
	🖪, key in	the formula a	ind CALC.
Then 6 SHFE? 6	RSK2		
FMRX	Answer:	FMR%=16.	70
EMIN	Answer:	\$MIN=-97	,876.27
Ֆ ғы	Answer:	\$FW=247,	170.00
MORE IRR?	Answer:	IRR%=20.	69

Notice:

- The P/YR defaults to a value of 1 (i.e. yearly cash-flows) if you neglect to give it a value.
- The IF(S(FMR%) OR S(SAFE %) OR S(RSK%)...

lets you use the same portion of the $IF \langle S \rangle$ structure to solve for each of several variables. Normally, you do this by leaving that portion for *last* in the structure, but you get a better menu by placing this "multiple" option earlier.

20. From an asset's basis and salvage values, class life and current year, this formula computes that year's best depreciation and Remaining Depreciable Value (RDV),* with these MACRS rules:

Property examples	<u>Class</u>	Allowed Depr. Method
tractors, racehorses	3 years	200% DB or SL
vehicles, office/lab equip.	5 years	200% DB or SL
furniture, fixtures, misc.	7 years	200% DB or SL
fruit/nut trees/vines	10 years	200% DB or SL
roads, shrubbery,	15 years	150% DB or SL
farm buildings,	20 years	150% DB or SL
residential rental prop.	27.5 years	SL
nonresidential real prop.	31.5 years	SL

▶\$MACRS:0×(L(B:(BASIS-S)) ALV)+CLASS)+L(F:IF(CLAS S<11:2:IF(CLASS<21:1.5: 0))+L(C:1-G(F)+CLASS)+ L(A:BASIS×G(F)+CLASS)+L (Y: IF(CLASS) > 20:0: IP(1+L)N((BASIS-SALV)+BASIS+G(F))+LN(G(C))))+L(R:MAX (BASIS-SALV-∑(N:1:MIN(Y)) R#-1:G(Y)):1:G(A)XG(C)^ (N-1))-MAX(0:YR#-1-G(Y))×G(B):0)))+IF(S(MACR): MIN(G(R):MAX(G(A)×G(C)^ (YR#-1):G(B)))-MACR:RDV -G(R)+MIN(G(R):MAX(G(A) XG(C)^(YR#-1):G(B))))

Approximate Memory Required: 21% to use, 6% to store.

*Assume for this formula that an asset is placed into service at the beginning of the tax year.

<u>Required Knowns</u>: The asset's BASIS and SALVage values, and its CLASS life.

Example: You buy a small office building with an improvements value of \$75,000. You also buy a \$10,000 computer for the office, and you landscape the property with \$5000 in shrubs. Estimate salvage values for these new assets: \$15,000, \$500 and \$0, respectively. What depreciation can you take for each in tax years 3 and 4?

Solution: Key in the formula and press **CALC**. Then take the assets one-by-one, starting with the building:

75000 BHSIS	15000 SALV 31•5 CLASS	
3 YR# MACR	<u>Answer</u> : MACR=1,904.76	
	RDV=54,285.71	
4 YR# MACR	Answer: MACR=1,904.76	
	RDV=52,380.95	
10000885IS	500 SALV (5) CLASS	
3 YR# MACR	<u>Answer</u> : MACR=1,900.00	
	RDV=1,200.00	
4 YR# MACR	<u>Answer</u> : MACR=1,200.00	
	80V RDV=0.00	
5000 BHSISO SHLV 15 CLASS		
3 YR# MACR	<u>Answer</u> : MACR=405.00	
	RDV=3,645.00	
4 YR# MACR	Answer: MACR=364.50	
	RDV=3,280.50	

<u>Notice</u>: This is a modification of a built-in formula, so those equations (for Depreciation) in your Owner's Manual (Appendix B) are the starting point of this formula. 21. The strategy for a short formula is to create two SUM lists (V and C) containing the volumes and costs as bid by the manufacturer. Then you use the built-in forecasting tools (in the SUM Menu) to find the best-fitting curve type and its parameters (M and B), which you then key in as known values in the formula (for CTYPE, use these values: LIN=1; LOG=2; EXP=3; PWR=4):

<u>Approximate Memory Required</u>: 16% to use, 4% to store, not including the lists, V and C.

This version does the curve-fitting, too, from one SUM list, Q:

▶INV:0×(TOTAL+HOLD%+BVO L+VOL+\$EA.+T+M+B)+IF(S(BVOL):0×(L(N:SIZES(Q))+ L(X:Σ(I:1:N-1:2:ITEM(Q: I))+N×2)+L(W:Σ(I:1:N-1: 2:LN(ITEM(Q:I)))+N×2)+L (Y:Σ(I:2:N:2:ITEM(Q:I)) +N×2)+L(Z:Σ(I:2:N:2:LN(ITEM(Q:I)))+N×2)+L(S:Σ(

I:1:N-1:2:(ITEM(Q:I)-X) ^2))+L(L:Σ(I:1:N-1:2:(L N(ITEM(Q:I))-W)^2))+L(U :Σ(I:2:N:2:(ITEM(Q:I)-Y)^2))+L(V:∑(I:2:N:2:(LN (ITEM(Q:I))-Z)^2))+L(C: Σ(I:1:N-1:2:(ITEM(Q:I)-X)×(ITEM(Q:I+1)-Y)))+L(D:Σ(I:1:N-1:2:(LN(ITEM(Q:I))-W)×(ITEM(Q:I+1)-Y)))+L(E:∑(I:1:N-1:2:(IT FM(Q:T)-X)X(|N(TTFM(Q:T +1))-Z)))+L(F: Σ(I:1:N-1 :2:(LN(ITEM(Q:I))-W)X(L N(ITEM(Q:I+1))-Z))+L(G:C^2+S+U)+L(H:D^2+L+U)+ $L(J:E^2+S+V)+L(K:E^2+L+$ V)+L(T:IF(G)H AND G)J A ND G>K:1+0×(L(M:C÷S)+L(B:Y-M×X)):IF(H>J AND H> K:2+0×(L(M:D+L)+L(B:Y-M \times W)):IF(J)K:3+0 \times (L(M:E+ S)+L(B:EXP(Z-M×X))):4+0 $\times(L(M:F+L)+L(B:EXP(Z-M\times$ W)))))))+(MxBVOLxHOLD% +200+TOTAL+IF(T>2:M:0)) XIF(MOD(T:2)=0:1:BVOL)-IF(T)3:1:B-IF(T=2:M×(1-LN(BVOL)):0)):VOLX\$EA.-B×IF(T<3:1:IF(T=3:EXP(M</pre> XVOL):VOL^M))-M×IF(T)2: 0:IF(T=1:VOL:LN(VOL)))

<u>Approximate Memory Required:</u>

56% to use, 14% to store, not including the list, Q.

Required Knowns:The TOTAL sales volume estimated for an
item over a period of time; the added cost
(as a %) of holding it in inventory over that
time (HOLD%); SUM list(s), V and C or Q,
of order Volumes and their corresponding
Cost quotes (Q contains successive pairs
of values: volume, bid, volume, bid, etc.).

Example: A certain book will sell 75,000 copies over its life. It will cost the publisher an additional 60% to sit in inventory over that time. To manufacture the book, a printer bids as follows. Use the short formula to find the publisher's optimum order volume, that unit cost, and the unit cost of an order of 15,000 copies.

<u>Order volume</u>	<u>Manufacturer's bid</u>
2,500	\$ 8,500
5,000	\$ 14,000
10,000	\$ 25,500
20,000	\$ 44,000
40,000	\$ 82,000

Solution: First, build the V and C (Volume and Cost) lists: MAIN SUM GET ENEW NAME V INPUT 2500 INPUT 5000 INPUT 10000 INPUT 20000 INPUT 40000 INPUT GET ENEW NAME C INPUT 6500 INPUT 14000 INPUT 25500 INPUT 44000 INPUT 82000 INPUT Find the best-fitting curve: DISP FIX 6 INPUT (to see small differences in "fit"), CALC MORE FROM
LIN CORR	(<u>result</u> : CORR=.999499)
EXIT LOG CORR	(<u>result</u> : CORR=.942971)
EXIT EXP CORR	(<u>result</u> : CORR=.942620)
EXIT) PWR CORR	(<u>result</u> : CORR=.999398)

Thus, LIN is the best-fitting curve type. So EXIT LIN and MMM (M=1.945430) STO(0); (B=4,645.833333) STO(1).

 Now, to use the short formula, DISP
 FIX
 2[NPUT], then

 MAIN SOLVE, key in the formula, and CALC
 Next,

 MORE
 1 CTUPE (1=LIN), RCL
 MM

 Now
 MORE
 75000
 MM

 STO
 MOL
 SEA
 Answer: \$EA.=2.14

 15000
 VOL
 SEA
 Answer: \$EA.=2.26

Notice:

- The longer formula would require only the last four lines of this solution—no curve fitting. That formula uses the same Forecasting equations as SUM (in Appendix B of the HP Owner's Manual). You could use it for any such SOLVE-formula curve-fitting solution. Note that for speed here, you must compute BVOL before doing VOL/\$EA. calculations. And, because of memory limits, variables normally hidden by G() appear harmlessly (later) on the menu.
- The formulas compute the order volume, v, that minimizes

this total cost, T:
$$T(v) = \frac{TOTAL}{v}C(v) + \frac{C(v)}{2} \left(\frac{HOLD\%}{100}\right)$$

where C(v) is the function (one of the four CTYPE's) that best describes the manufacturer's set of quotes.

22. You key in parameters for a scenario that looks like this:



The formula:

▶MANE.ROIX:0×(I/YR+P/YR +D\$IN+D\$FX+D\$SV+M\$IN+M\$ FX+MD.SD+M\$SV+\$VAR+\$PRC +L(P:L(F:M\$SV))+L(N:TD-IP(100xFP(MD.SD))+1)+($V:G(\#SLD) \div (G(N) \div 2 \times (G(N)))$ +1)))+Σ(T:TD:1:-1:L(P:G (P)+IF(T=IP(MD.SD):D\$SV -M\$IN:0)-IF(T(=IP(MD.SD))):D\$FX:M\$FX)+IF(T(TD+1-G(N):0:(\$PRC-\$VAR)×G(V) \times (G(N)-TD+T)))+IF(G(P)) 0:L(F:G(F)+G(P)×SPFV(12 YR÷P/YR:TD-T)+L(P:0)):L $(P:G(P) \div (1+I/YR \div P/YR)))$))+IF(S(R%YR) OR S(\$PRC) OR S(#SLD) OR S(TD):(1+R/YR+P/YR+100)^TD×(G(P)-D\$IN)+G(F)+0×\$PRC+#S LD-#SLD:\$MIN+G(P)-D\$IN)

 Approximate Memory Required:
 29% to use, 7% to store.

 Required Knowns:
 All except \$PRC, TDAT, R%YR, #SLD and \$MIN.

Example: The capital equipment to develop a new product will cost \$10,000, of which \$2500 is salvageable afterwards. Development overhead is \$25,000/mo. over 3 months. Then manufacturing will begin, requiring a capital expenditure of \$150,000 (of which \$30,000 is salvageable) and fixed monthly costs of \$15,000 (continuing throughout the sales life). Sales will begin a month after manufacturing. If each unit costs \$20 to make and sells for \$99, how many must be sold within 2 years of first investment to break even (i.e. to return the cost of money, 11%)? What minimum cash must the company commit up front to fund this project?

<u>Solution</u> :	11 IXYR 12 P	4YR 10000 DEIN
	25000 DSFX	25000554
	MORE 15000	0 M3IN 1 5 0 0 0 M3FX
	3•04 MD.50 3	0000M35V20 3VAR
	MORE 99 \$PRC (2 4 TD
	11 RZYR #SLD.	<u>Result</u> : #SLD=2618.79
	STATISTICS.	Result: \$MIN=56,381.72

Notice:

- The assumed sales pattern is *linear growth*—where the number of units sold each month increases by a set number.
- Each project checkpoint (Manufacturing Date, Sales Date, Target Date) is measured as the number of periods *since the start of the project*. Two of these points are formatted in one number, MD.SD ("Manufacturing Date. Sales Date").
- \$MIN is an unknown entirely independent of R%YR.

23. This formula behaves like TVM, except that you also specify the yearly inflation rate (INF%) and income tax rate (TAX%):

TAXES~INFL:0×(N+I%YR+P) V+PMT+FV+IF(P/YR=0:L(P/ YR:12):0))+IF(S(BEG?):A BS(G(BEG?)-1)-BEG?-0X(T AX2+INE2): IF(S(R2YR): (((1+(SPFV(I%YR+P/YR*P/YR >-1)×(1-TAX/+100))+SPFV (INF%+P/YR:P/YR))^INV(P /YR>-1>×100-R%YR+P/YR*P V+FV×SPPV(L(I:(((1+(SPF V(I/YR+P/YR:P/YR)-1)×(1 -TAXX÷100))+SPFV(INFX+P /YR:P/YR))^INV(P/YR)-1) ×100):N)+(1+G(I)÷100×BE G?)×USPV(G(I):N)×PMT))

<u>Approximate Memory Required</u>: 19% to use, 5% to store. <u>Required Knowns</u>: None.

Example: Assuming a 5% annual inflation rate and an income tax rate of 28%, if you invest \$166.66 of *buying power* each month (at the end of the month) into a mutual fund that earns 15% per year, what buying power will accumulate in this account over 30 years? What is the equivalent annual growth rate of this buying power? What if the account were tax-deferred —like an IRA?



9. BUILDING YOUR OWN ROADS: THE SOLVE MENU

<u>Solution</u> :	30×12=(ALG 15 IXYR 0 PV 12 P/YR BEG? (1) or 30 [INPUT 12X (RPN) N 166.666+/- PMT, MORE toggle this until BEG?=0.00)
	28 THX: 5 INF:	3
	82Y8	<u>Result</u> : R×YR=5.98
	MORE FV	<u>Result</u> : FV=166,687.52
	MORE	
	0 TAXX RXYR	<u>Result</u> : R%YR=9.96
	MORE FV	Result: FV=373,414.62

Notice:

- The formula assumes that interest is taxable once per year, but that the inflation, interest and growth rates compound once per period (that is, P/YR times per year). Keep in mind that the level, periodic PMT amount is in terms of *buying power* ("today's dollars"). In order for that buying power investment amount to remain steady, its *face value* would be increased every period—to keep pace with inflation.
- The money accruing in a tax-deferred account—such as an IRA—may be taxable upon withdrawal.
- The equivalent interest calculation (I) in the formula is done twice—in the IF(S(R*YR)... and the general TVM formula—to allow for independent unknowns. You could, of course, useG(I) for all but the firstL(I:... definition, but this would destroy the total independence of the unknowns. Alternatively, you could move theL(I:... definition to the menu-ordering section, and useG(I) thereafter. But then I%YR, TAX% and INF% would be *required* knowns; you could never solve for them.

24. This formula is extremely useful and versatile for all sorts of retirement scenarios:

```
▶RETIRE:0×(WYRS+$GI+TBR)
YRS+R%YR+$RGI)+IF(S($RE
T):$RET×SPPV(L(I:(((1+()))))
SPFV(1/YR+12:12)-1)×(1-
TBR/+100))+(1+INF/+100)
>^INV(12)-1)×100):WYRS×
12)-USPV(G(I):WYRS×12)×
$GIX2INV+100:USPV((((1+
(SPFV(R/YR+12:12)-1)×(1
-TBR%÷100))÷(1+INF%÷100
))^INV(12)-1)×100:RYRS×
12)x$RGI-USPV(L(I:(((1+
(SPFV(1%YR+12:12)-1)×(1)
-TBR2÷100))÷(1+INE2÷100
))^INV(12)-1)x100):WYRS
x12)x$GIx%INV+100+SPPV(
G(I):WYRS×12))
```

<u>Approximate Memory Required</u>: 23% to use, 6% to store. <u>Required Knowns</u>: None.

Example: Your monthly salary is \$3333.20/month, with annual cost-of-living raises (5% a year). If, for 35 years, you invest 5% of each monthly paycheck into a growth-oriented mutual fund IRA (tax-deferred until with-drawal) averaging 15% growth per year, what gross income (today's dollars) could you draw for 30 years of retirement if you roll the account into a more secure bond fund at 10%? What is the rollover amount?

Repeat the problem for a taxable account (28% income tax bracket). What if, in addition to the 5% of income that you're putting away in that (taxable) account, you were also allowed to invest the 7.65% that now goes for Social Security and Medicare?

 Solution:
 35 MWRS 3333.2 Staff

 0 TER2 (the IRA incurs no taxes until withdrawal)

 5 INF2 15 I2YR, MORE

 5 ZINU 30 RYRS 10 R2YR

 5 ZINU 30 R2YR

 5 ZINU 30 R2YR

 6 ZINU 30 R2YR

 6 ZINU 30 R2YR

 6 ZINU 20 TERZ

 MORE 20 TERZ

 M

SRGI

<u>Result</u>: \$RET=613, 120.85 <u>Result</u>: \$RGI=2, 388.29

Notice:

- The formula assumes that interest is taxable once per year, that the inflation rate compounds annually, that interest rates compound monthly, and that salary and investment cash-flows occur at the end of the month.
- Since there are no required knowns, you can solve for any parameter by specifying all the others.
- The money accruing in a tax-deferred account—such as an IRA—may be taxable upon withdrawal.

25. This formula estimates the remaining balances of two IRA's and three other accounts after being drawn upon by a retired couple.

From the retirement date onward, the retiree(s) draw(s) a steady *after-tax* annual income, adjusted for inflation. No more contributions are made to any account; rather, they are drawn upon to provide the portion of income *not* covered by the Social Security benefits that each retiree receives, starting at a given age. These benefits are assumed to have yearly Cost-of-Living Adjustments to match inflation. Half of the benefits are assumed to be taxable.

The elder spouse is designated as spouse A. The three non-IRA accounts are depleted first (in direct proportion to their starting balances—so that they all exhaust at once), then IRA_A , then IRA_B . All withdrawals on the IRA accounts are assumed taxable (and a 10% penalty is applied to withdrawals from an IRA account of a spouse not yet 60 years old). Non-IRA accounts #1 and #2 earn taxable interest; account #3 earns tax-free interest.

The retirement ages given must be no later than when the first Social Security benefits are drawn, and both spouses must live at least until they are both drawing Social Security benefits. Upon the death of spouse A, the formula assumes that spouse B will then maintain the income level and tax bracket; inherit all accounts unencumbered; and draw the *greater* of the two Social Security benefits for the rest of his/her life.

> PRET~IRA~SS:0x(L(A:RND(AGEA-IF(AGEB=0:L(AGEB:A GEA):AGEB):0))+L(I:IP(I %.T%)÷100)+L(T:1-FP(I%. T%))+\$SA+SAGA+\$SB+SAGB+ L(E:IP(\$1.%)+IP(\$2.%)+I

P(\$3.%))+L(F:IP(\$8.%))+ L(Q:(1+FP(\$A.%))÷(1+G(I)))+L(G:IP(\$B.%))+L(R:(1+FP(\$B.%))+(1+G(I)))+L (J: IP(\$1.%)+G(E))+L(K: I P(\$2.%)+G(E))+L(P:(1+(I P(\$1.%)×FP(\$1.%)×G(T)+I P(\$2.%)×FP(\$2.%)×G(T)+I P(\$3.%)×FP(\$3.%))+G(E)) ÷(1+G(I)))+L(L:RND(100× FP(AGB.L):0))+L(N:IP(AG B.L)+ $\$NYI+\Sigma(M:RND(AGEB)$:0)+1:MIN(G(L):G(N)):1: $L(Y: \pm NYI - (1 + G(T)) + 2 \times (IF)$ (M+G(A)>=RND(SAGA:0) AN D_M+G(A)<=MIN(G(N)+G(A)</pre> :G(L)):\$SA:0)+IF(M>=RND (SAGB:0):\$SB:0)+IF(M+G(A)>G(L):MAX(\$SA-\$SB:0): (0))+L(E:G(E)XG(P)-G(Y))+L(F:G(F)XG(Q)+MIN(G(E):0)÷L(Z:IF(M+G(A)<60:G (T)-.1:G(T))))+L(G:G(G) $XG(R) + MIN(G(E); 0) \times G(Z) +$ IF(M<60:G(T)-.1:G(T)))+ L(E:MAX(G(E):0))+L(F:MA X(G(F):0)))+0x\$NYI+1(\$B1:G(E)×G(J))+L(\$B2:G(E)×G(K))+L(\$B3:G(E)×(1-G (J)-G(K)))+L(\$BA:G(F))+ $L(\$BB:G(G))=\$TRB+0\times(\$B1)$ +\$B2+\$B3+\$BA+\$BB)

<u>Approximate Memory Required</u>: 52% to use, 13% to store. <u>Required Knowns</u>: *All* except \$NYI, \$TRB, and \$B1-\$BB

- Example: The husband is 55; his wife is 46. Their income tax bracket is 33.4% (including state and local taxes) and inflation averages 5%. Both will begin to draw Social Security benefits at age 65. His yearly benefit will be \$22,800; hers, \$17,700. The couple has \$60,000 in a bank account earning 6.5%; a taxable mutual fund of \$34,330, earning 15%; and a tax-free fund of \$57,000, earning 8.0%. The husband's IRA of \$495,600 earns 7%. The wife's IRA of \$200,000 earns 11.0%. Both expect to live to be 89. What after-tax income (today's dollars) can they expect for the rest of their lives? If they draw that amount for 3 years, how much buying power is left in each account? 10 years? 30 years?
- Solution: 55 HGEH 46 HGEB 5 334 IZ.TZ 22800 \$SH 65 SHGH MORE 17700 \$58 65 SAGE 600000065 512 34330115 52.2 57000.08 33.2 MORE 495600007 34.2 $200000 \cdot 11 \pm 8.2$ 89•89 HGB.L 0 3188 31WI....Answer: \$NYI=46,754.98 49089 mmsu smas \$TRB=777.921.92 \$B1=6,810.36 MORE (RCL) 3-BI \$B2=3,896.66 RCL) 582 \$B3=6,469.84 RCL) 383 \$BA=524,462.85 RCL) SEA \$BB=236,282.22 RCL 388

MORE MORE MORE	
56•89 AGB.L ±TRB	\$TRB=475,998.27
MORE RCL SEI	\$B1=0.00
RCL 182	\$B2=0.00
RCL 183	\$B3=0.00
RCL SEA	\$BA=127,366.64
RCL SEB	\$BB=348,631.64
MORE MORE MORE	
76•89 HGB.L ±TRB	\$TRB=298,050.79
MORE ROL SEI	\$B1=0.00
RCL) SE2	\$B2=0.00
RCL SB3	\$B3=0.00
RCL SEA	\$BA=0.00
RCL SEE	\$BB=298,050.79

Notice:

- The couple retires at the same time, at the ages given. All rate compounding, incomes and taxes occur annually; all dollar amounts are buying power *at the time of retirement*.
- To save space, many variables in the formula represent two values—formatted on each side of the decimal point.
- You specify the term of the analysis by projecting that age for spouse B—the integer portion of the variable AGB.L.
- The calculation of \$NYI is slow. To speed things up, key two "ballpark" values (one after another) into \$NYI, and then *compute* \$NYI. The machine will take these as suggested guesses and home in faster on the correct solution faster.
- To see the values of the individual remaining balances, you don't *solve* for them; you RCL) them—*after* computing \$TRB.



Where To Now?

Time to come down to Earth and check the road map again. Read the sign and choose your next destination....





10. The Notes You Make: TEXT Lists

Saving TEXT

With all that memory space in your calculator, you can certainly store a lot of solutions, as you've just seen.

But you can also store plain *text*—just simple notes to yourself, or lists of names and addresses, or to-do lists, etc. In fact, the HP 19BII is one of very few financial calculators that allows you to do this.

So try it...

Take a Memo:	Make a note in a To Do list to "Remind Martha (x 8092) about Thursday conference."	
Here's How:	From the MAIN Menu, press TEXT .	
	Notice the little α (the "alphabetic annunciator") at the top of the display, indicating that the cal- culator will now be expecting you to enter alpha- betic characters. So, use the left-hand keyboard to type in the note—including the parentheses and numerals. Here's how it should look:	



Now press INPUT to finish the memo.

Notice that you've begun a new list. Once you type the first entry into a list, it then shows the characteristic dotted line—the TOP of the list:

αTOP.... REMIND MARTHA (X8092)… ARK EDIT DELETINAMEI GET IMORE

- Add Another: Remind yourself about your lunch appointment with George on Friday at 1:00.
- Just Type: LUNCH WITH GEORGE (FRI. AT 1:00) And press (INPUT).

Notice that once it's input, each note's display is abbreviated to one line (indicated by the ellipsis...). And the list pointer always points to the *current* entry. As usual, press (+) to move up the list; (+) to move down.

Uh-Oh:	Just now, you remember that tomorrow is your mother's birthday. How do you <i>insert</i> a note to remind yourself—in the middle of the list?
Easy:	Move the pointer to the entry before the intended entry (So in this case, you move the pointer to REMIND MARTHA). Then just type: FLOWERS FOR MOM and (INPUT).

And you can insert entries even at the very top of the list: **I** will move you immediately to the **TOP** marker, where you can then type.

- Question: As you've seen, each entry gets one line in the display, and ... indicates if there's more than what's visible. So how do you get to see a whole message? What if you can't remember what you're supposed to remind Martha?
- **Do This:** Move the pointer to **REMIND MARTHA**. Press **EDIT**. There's the whole message. And if a message needs more than *three* lines, use **+** to see the others. When you're finished, just press **EXIT** to return to the list view.

And, now that you've created a "To Do" list, how about giving it a name so that you can retrieve it later?

Do It: Press **NHME** TO DO (INPUT). It's just like naming any other kind of list. Now you can create other text lists without erasing your TO DO list....



Multiple-Entry Records

Your **TO DO** list is a *simple* list. That is, although some entries occupy more than one line, each note that you made was truly a separate entry. But you can also group entries together into *records*....

Example: Create a text list of these important clients:

Edward J. Davis 9032 SW 96th Pl. Roisterburg, ID 88670 206-187-3492

Abraham L. President 16000 Pennsylvania Dr. Gettysburg, PA 21199 717-TOP-HAT1 AN CONTRACT

Lizbeth Regina 10 Buckingham Circle Piccadilly, WA 98660 206-RED-HEAD

Solution: First, get and name a new list: **GET XNEW NAME** CLIENT (NPUT). Now just start typing:

> EDWARD J. DAVIS (NPUT) 9032 SW 96TH PL. (NPUT) ROISTERBURG, ID 88670 (NPUT) 208-187-3492 (NPUT) [MINAS

Each (INPUT) creates an *entry*. Then MHR groups into a *record* all entries since the previous mark (or since the TOP). Notice the dotted line marking the end-of-record.

Now enter the other two records similarly:

ABRAHAM L. PRESIDENT (NPUT) 16000 PENNSYLVANIA DR. (NPUT) GETTYSBURG, PA 21199 (NPUT) 717-TOP-HAT1 (NPUT) MINIS LIZBETH REGINA (NPUT) 10 BUCKINGHAM CIRCLE (NPUT) PICCADILLY, WA 98660 (NPUT) 206-RED-HEAD (NPUT)

Of course, just as with your TO DO list, you can move through your **CLIENT** list entry-by-entry with (\bullet) and (\bullet) . But when entries are grouped into records, you can also move *record-by-record*....

Try It:Use MORE to get the second page of the TEXT Menu. Thenuse PREV and NEXT to jump between consecutive records.

Notice how the HP 19B11 treats the TOP marker as its own record.

Question: Can you insert a new client record between Ed and Abe?

Answer: Sure: Move the pointer to the record marker (the dotted line) between the Ed Davis and Abe President records. Then just type in the new record:

> GEORGE WILLIAMS (NPUT) 2643 LONGVIEW LANE (NPUT) FEASEL, WA 98702 (NPUT) 206-138-4990 (NPUT)

Now press MORE MARK to insert the record marker.

Problem: Delete Lizbeth's record from your CLIENT list.

Quickie:Press MURE NEXT to move to Ms. Regina's record. Then
press MURE DELET to delete the first entry in the record.
Notice that you delete only one entry at a time—not a
whole record. So finish off the whole record by pressing
DELET three more times. As you delete the last entry,
you'll see the record marker go away, too.



Sorting TEXT Lists

The HP 19BII has just one kind of built-in sorting-alphabetizing.

Try It: Alphabetize your TO DO list (though you don't usually).

Like So: Get the TO DO list: **DEET TO CO**. Then press **MORE SORT MES**. Move down the resulting list and notice how the entries are now alphabetized by their first characters.*

Easy, right? But how does this alphabetical sort work when the list is divided into records?

Find Out:	Sort your CLIENT list.
Like This:	Get the CLIENT list: Press MORE GET CLIEN. Then press MORE SORT YES.
	Now move through the records using NEXT . Notice that the records are alphabetized by the first characters of their <i>first entries</i> .

*Page 197 of your Owner's Manual lists the exact sorting order of all characters—especially useful when you have entries beginning with symbols ($\star, \&, \ddagger$) or foreign characters (A, C, N)

Editing a Record

By now, it's probably bothering you:

Ahem:	If the TEXT sorter alphabetizes only by the first character in a record, then how are you going to get your CLIENT list ordered by <i>last</i> name—as you'd normally use it?

Oh: You put the last name first in each record. Whatever you want to sort by *must* come first in the record.

Looks like you'll have to edit your records...

Edit: With the at ABRAHAM L. PRESIDENT, press EDIT and re-type: PRESIDENT, ABRAHAM L. (NPUT) Now repeat this for the other records:

NEXT EDIT DAVIS, EDWARD J. (NPUT) NEXT EDIT WILLIAMS, GEORGE (NPUT)

Re-Sort: Press **SORT WES** Now you've organized the records by the last names.

Moral Of The Story: You should carefully plan any lists you'll want to alphabetize *before* you enter the data. It will save a lot of editing.

Finding an Entry

Of course, making lists probably wouldn't be worthwhile in the first place if there weren't a quick way to search the list for a particular entry—the one you need *right now*.

Keeping the list alphabetized is one way to enhance its usefulness, but, the HP 19BII also has a searching tool to help you find items quickly.

Example:	Use FIND to locate clients who live in Pennsylvania.
Hmmm	With the \blacktriangleright at the TOP marker, press FIND .
	You'll then be prompted to enter a sequence of charac- ters—and you can request any sequence up to eight characters long—to locate in the list. So type $\mathbf{P}\mathbf{H}$ [NPUT].
	The pointer now points to the third entry in Abe's record. Sure enough, Abe lives in Pennsylvania.
	Are there any other clients who live in PA? To find out, just press FIND (INPUT)
	Ah—the pointer returns to the TOP marker, meaning that the HP 19B11 didn't find any other matches. So Abe

was the only client who lives in Pennsylvania.

Another: Now find all clients in the state of Washington.

Solution: Press **FIND** once again.... You'll see the PA still sitting there, waiting to be used again. So change this search sequence to WA, and press (INPUT)....

What's this? The stops at EDWARD J. DAVIS, who lives in Idaho, not Washington! What gives?

Nothing's wrong, actually. Your HP 19BII is being very reliable: Notice that EDWARD does indeed contain the sequence WA. So FIND found it.

OK, But:You really want to find the state abbreviation and not a
part of some larger word, so change the search sequence
so that it has a space before and after the WA. And re-
member to return to the TOP of the list before you try
the FIND again....

Better: This time you get good results. George Williams is your Washingtonian client.

Moral Of This Story: Your HP 19BII will take you quite literally, so when searching for information in a list, make your search sequence as precise as you can (within the eight-character limit).

TEXT Quiz

A few things to review... and a few new twists to discover....

- 1. How would you delete an entire list?
- 2. What's the crucial difference between the 🕂 and i keys and the PREV and NEXT menu tools?
- 3. Suppose you wanted to organize your TO DO list by days of the week. How might you do this?
- 4. Suppose that you keep two name-address-telephone lists—one for CLIENTS and one for CONTACTS. How do you move a record from the CONTACTS to the CLIENTS list?
- 5. What happens if you perform a **FIND** without starting from the top of the list?

TEXT Quiz Solutions

- 1. To delete an entire list, you must first make it the current list, using **EET**. Then you press **CLEAR DATA** and confirm that you want to clear the list by pressing **VES**. Finally, you confirm that you want to clear the list name (if it has one) by pressing **VES** once again.
- 2. The f and keys move through a list entry by entry—regardless whether the entries are grouped into records. The menu tools,
 INEX and NEXT move through a list record by record. They aren't very useful in lists of single entries—such as the TO DO list—where all entries are essentially in one big record.
- 3. One very straightforward approach is to divide the TO DO list into seven records whose first entry is numbered and contains the name of that day of the week. Watch:

each entry into its own record by adding record markers: Move the pointer to each entry and press

Next, add the properly numbered day-of-the-week label to each record (assume that Martha's reminder comes on Wednesday, Mom's birthday on Thursday and lunch with George on Friday). To do this, move the pointer to the TOP of the list and type:

4.	THURSDAY	(INPUT + +
5.	FRIDAY	(INPUT + +
з.	WEDNESDAY	(INPUT)

The numbers allow you to sort your day-records chronologically. Press MORE SORT YES to see this.

Of course, you can add records for other days of the week and insert "To-Do" notes wherever appropriate, giving each task the priority it deserves within that day's record. Then, as you finish a task, you would delete its entry, thus "clearing your calendar."

- 4. Unfortunately, the HP 19BII has no "cut-and-paste" feature. You cannot move a record from one list to another; you must delete it from one list and retype it into the other.
- 5. **FIND** searches the current TEXT list starting from the entry *below* the current entry (the one with the **b**) and stopping at the bottom of the list (at which time the **b** returns to the TOP). Thus, if you begin a search from anywhere except the TOP marker, **FIND** will have skipped one or more entries and so may not find what you're looking for—even though it is indeed in the list.

Therefore, *make it a habit* to move to the **TOP** marker (via **T**) before using **FIND**.



What's Next?

This is the last chapter in the Course. Now you can go back and read or review any chapter you wish.....





A. APPENDIX

Here are some Solver formulas and related explanations to help your calculations with Canadian mortgages. Be sure to read and digest Chapter 9, to familiarize yourself with the Solver, before trying to use these formulas:

Canadian Mortgage Interest Conversions

Use the following formula to compute the equivalent U.S. A.P.R. (that's the I%YR) for Canadian mortgages with *monthly* payments and *semi-annual* compounding interest (most Canadian mortgages carry these terms).

Formula:	▶C%~US%:((1+CI%YR÷200)^ (1÷6)-1)×1200=I%YR	
	<u>Approx. Memory Required</u> : 3% to use, 1% to store. <u>Required Knowns</u> : None.	
Example:	A Canadian mortgage with monthly payments is writ- ten at 12% A.P.R., compounded semi-annually. What is the equivalent U.S. A.P.R.?	
Solution:	Key in the above Solver formula (the b will appear when you type the formula or review it via EDIT).	
	Then press CALC (12)CIXYR IXYR	
	<u>Result</u> : I%YR=11.71	

Use the following formula for Canadian mortgages with *monthly* payments and *annual* compounding of interest (not common).*

Formula:	▶C%~US%:((1+CI%YR÷100)^ (1÷12)-1)×1200=I%YR	
	<u>Approx. Memory Required</u> : 3% to use, 1% to store. <u>Required Knowns</u> : None.	
Example:	A Canadian mortgage with monthly payments is writ- ten at 12% A.P.R., compounded annually. What is the equivalent U.S. A.P.R.?	
Solution:	Key in the above Solver formula (the will appear when you type the formula or review it via EOIT).	
	Then press CALC 12 CLEAR LARB	

Result: IXYR=11.39



*The rate specified on a Canadian mortgage document may compound no more than twice per year. Most such mortgages use semi-annual compounding (in which case you should use the formulas on pages 425 or 427); the only alternative is annual compounding, given here for completeness. Use the following formula for Canadian mortgages *in general* (you specify the payment and compounding periods during calculation). Canadian rules allow no more than 2 compounding periods per year.

Formula:	▶C%~US%:(((1+CI%YR÷C/YR ÷100)^(C/YR÷P/YR))-1)×P /YR×100=I%YR
	<u>Approx. Memory Required</u> : 5% to use, 1% to store. <u>Required Knowns</u> : None.
Example:	A Canadian mortgage is written at 12% A.P.R Find the equivalent U.S. A.P.R. if:
	 a. compounding is semi-annual, payments monthly; b. compounding is annual, payments monthly; c. compounding is semi-annual, payments quarterly; d. compounding is annual, payments annual;
Solution:	Key in the above Solver formula. Then:
	a. 12 CIXYR 2 CAYR 12 PAYR IXYR <u>Result</u> : IXYR=11.71
	b. () CATE 1278 Result: 1%YR=11.39
	c. 2 CAYR 4 PAYR 12YR Result: IXYR=11.83
	d. (1) CAYE (1) PAYE 12YE Result: IXYR=12.00

Canadian TVM

Use the following formula to do any general TVM calculation (except AMRT) for Canadian mortgages.

Formula: ▶CTVM:0×(N+CI%YR+PV+PMT +FV+IF(P/YR=0:L(P/YR:12):0))+IF(S(BEG):1+L(END :0)-BEG:IF(S(END):1+L(B EG:0)-END:PV+(1+BEG÷100 ×L(I:((1+CI%YR÷100÷IF(C /YR=0:L(C/YR:2):C/YR))^ (C/YR÷P/YR)-1)×100))×PM T×USPV(G(I):N)+FV×SPPV(G(I):N)))

<u>Approx. Memory Required</u>: 15% to use, 3% to store. <u>Required Knowns</u>: None.

Example: A 30-year, \$150,000 Canadian mortgage is written at 10.5%, compounded semi-annually.

a. Find the monthly payment (in arrears).

b. Find the balloon due in 10 years.

c. Repeat a and b for a 20-year amortization.

Solution: Key in the above Solver formula. Then:

- a. 30×12- (for ALGebraic arithmetic); or 30 (NPUT 12×) (for RPN arithmetic) N 10.5 (12413 150000 FW.0 FW. MORE 2 CAWR 12 FAWR END (END=1.00). MORE PMT Result: PMT=-1,347.21
- b. Continuing from the previous solution:
 10×12= (for ALGebraic arithmetic); or
 10 INPUT 12× (for RPN arithmetic)
 N. Then FV.....
 Result: FV=-136,984.93
- c. Continuing from the previous solution:
 20×12= (for ALGebraic arithmetic); or
 20INPUT 12× (for RPN arithmetic)
 Then 0 Fill and FINT
 Result: PMT=-1,475.21
- d. Continuing from the previous solution:
 10×12= (for ALGebraic arithmetic); or
 10 INPUT 12× (for RPN arithmetic)
 INT. Then IFVE....
 Result: FV=-110,344.15

As you can see, this substitute TVM formula can allow you to do the same sorts of "What-If?" calculations as you could do with the built-in TVM—but this one uses the compounding assumptions required for Canadian mortgages.

Use the following formula to do any general TVM calculation *including* AMRT for Canadian mortgages. This works the same in all respects to the previous formula, plus it offers an AMRT capability similar to that built into the HP 19BII. However, there are some keystroke differences to this version of AMRT, as illustrated here.

CTVM~AMRT:0×(N+CI%YR+P) Formula: V+PMT+FV+IF(P/YR=0:L(P/ YR:12):0)+BEG+END+IF(C/ YR=0:L(C/YR:2):0)+AMRT+ #P)+IF(S(BEG):1+L(END:0 >-BEG:IF(S(END):1+L(BEG :0)-END:IF(S(AMRT):L(Z: BEG)×L(BAL:RND(PV:2))×L (NEXT:L(INT:L(PRIN:0))) -AMRT: IF(S(NEXT):NEXT-1 E3-#P-1001E3×FP(G(NEXT) +1E3)+0×L(B:BAL):IF(S(B AL):RND((RND(PMT:2)×USP V(G(I):#P-G(Z))+G(B)+G(Z)xRND(PMT:2))+SPPV(G(T):#P-G(Z)):2)-BAL:IF(S(PRIN):PRIN+G(B)-BAL:IF(S(INT):#P×RND(PMT:2)-PR IN-INT+L(Z:0):PV+(1+BEG +100×L(I:((1+CI/YR+100+ C/YR)^(C/YR÷P/YR)-1)×10 0))xPMTxUSPV(G(I):N)+FV XSPPV(G(I):N))))))) Memory Required: 32% to use, 8% to store. Required Knowns: As with the built-in AMRT, you

A. APPENDIX

must solve for the PMT first.
- **Example:** A 30-year, \$150,000 Canadian mortgage is written at 10.5%, compounded semi-annually. Find the balance, interest and principal paid in each of the first two years.
- Solution: Key in the above Solver formula (the will appear when you review the formula via **EDIT**).

First, find the payment: 30×12= (ALG) or 30[NPUT12× (RPN) N 10.5 CIXWE150000 FW 0 FV , MORE 2 CYVE 12 FYYE END (END=1.00) MORE MORE FWT Result: PMT=-1,347.21

Press MORE AMAT (display: AMRT=0.00) to start the amortization. Then MORE to go to the next menu page. Press 12 ##P to amortize 12 payments at once.

Now, in this order, press:

NEXT to identify the payments in the group. You'll see: NEXT=1,012.00 (that is, payments 1-12)
EXT to see the new balance: BAL=149,213.23
FRIN to see the principal paid: PRIN=-786.77
TNUE to see the interest paid: INT=-15,379.75

NEXT NEXT=13,024.00 (payments 13-24) EXT BAL=148,341.68 PRIN=-871.55 TXT INT=-15,294.97

As with the built-in AMRT, you may change #P between groups or use **MMRT** to start over completely.

Discussion

Here's a little more detail about the calculations in these formulas.

A mortgage rate, as used in the U.S., is the nominal annualized rate that you must divide by the number of payments per year (PMTS/YR) to get the actual Defined Interest Rate (D.I.R.). Thus, a U.S. mortgage rate and the HP 19BII'S I%YR are directly equivalent.

Not so for Canada. On most* Canadian mortgages, the rate *actually used* (the D.I.R.) is the rate which, when compounded over a year's worth of payment periods (D.I.P.'s), produces the same *effective* yield as the rate appearing on the mortgage document would produce when compounded *not more than twice per year*.

That calls for a little thought....

As you saw in the interest conversion (ICONV) discussion on pages 138-139, an effective yield is higher than a nominal annualized rate whenever the interest compounds more often than once per year. And the more often it compounds, the bigger this difference becomes.

But when competing for borrowers, a lender wants to put his rates in the best possible light. So, for example, if he's allowed to quote a 10.5% nominal rate alongside the effective yield of 11.02%, he'll probably want to emphasize the nominal rate. The lower number is simply more attractive to the loan shopper.

^{*}If the mortgage payments are for interest only or if the mortgage is placed outside of Canadian territory, a Canadian lender may not be required to use the Canadian convention.

Well, the Canadian law simply puts a limit on how "approximate" the quoted nominal rate can be. The rule says that the quoted rate may not be converted into an effective yield by compounding any more than twice a year. Thus, for a 10.5% quoted nominal rate, the *effective* rate may not be any higher than 10.78%—no matter how often the actual D.I.R. is compounded. 10.78% is the limit on the effective yield.

But the HP 19BII needs a *nominal* rate (I%YR) to work with, since it then converts this to a D.I.R. according to U.S. assumptions. So the idea is to translate the known effective yield limit of the Canadian mortgage back into its nominal-rate equivalent under the U.S. convention. That's what these formulas do with the value of CI%YR—and you can do it "manually" with the ICONV Menu:

Canadian rate = NOMX

Key in 1 or $2^* \longrightarrow$

Solve for EFF

Key in payments/year in actual loan —>

NOME = U.S. rate (I%YR for TVM)

And remember that this works both ways: You can also start at the bottom—with a known U.S. mortgage rate (I%YR)—and work back up to the top to find the comparable rate for Canada.

*Most Canadian mortgage documents will specify semi-annual compounding for computing the effective yield, in which case the value to use here is 2. But if a Canadian mortgage happens to use annual compounding, you would use 1 for this value.

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