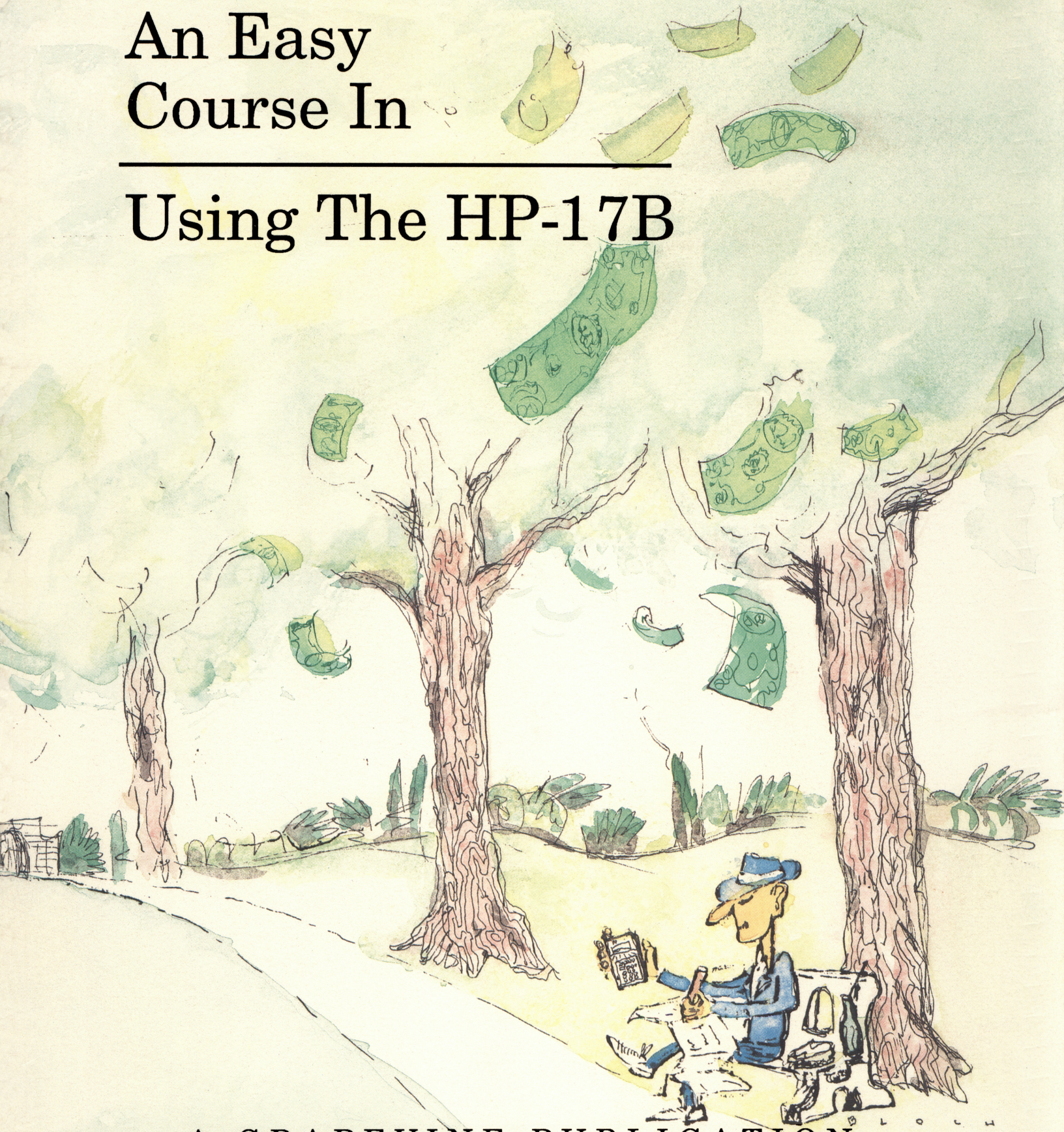
An Easy Course In

Using The HP-17B



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By Chris Coffin and John W. Loux

An Easy Course In Using The HP-17B

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Begin Here

The
Upper
Left-Hand Corner.
It's all downhill from here...

Why? Because the hardest part of learning anything new is simply

Getting Started.

This means you've just finished the toughest part of this Course!

But it doesn't mean you're through yet. You've made an investment simply to buy this Course.

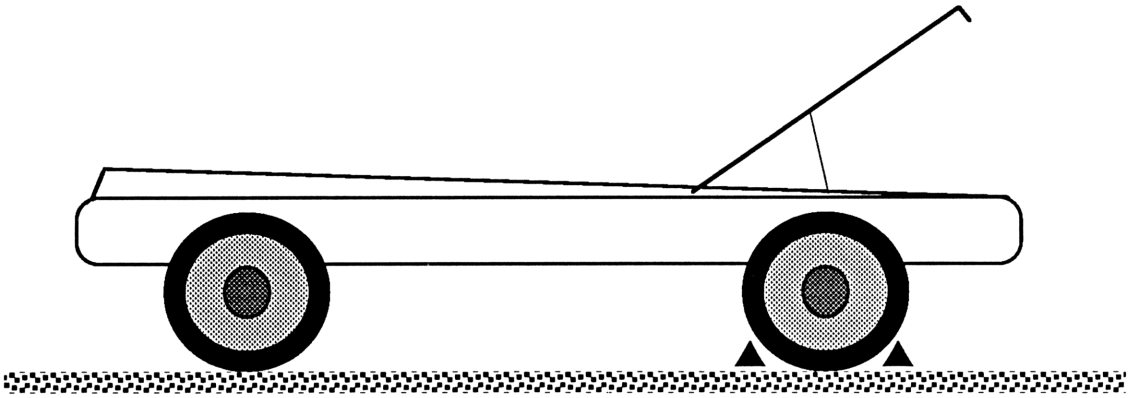
Now complete your venture: *Invest your time in this book.*

You'll find it an even better investment – just a few good hours. But *do* it! The returns will definitely be worth it, for when you finish, you'll know enough to solve problems that haven't even been invented yet!

How's that?

It's like this: The goal here is *not* just to leave you knowing how the buttons work or memorizing a handful of keystrokes and formulas. You'll also get a *fundamental understanding* of financial problem-solving, so that whenever you encounter a new problem, you'll be able to analyze it and solve it confidently.

Now then....



Looking Under The Hood

What's In This Machine?

It's a loyal and friendly calculator engine – congratulations on a great choice!

Your HP-17B is one of 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 just need to learn how to control it – which brings up the next question....

What's *Not* In This Machine?

There's no English-speaking person inside your calculator (one of these days, though...). For now, you still need to "speak" your machine's "language" in order to *translate your everyday calculation problems into forms it can understand.*

That's the whole ball game right there.

Your part of the work is in *defining* the problem correctly for *yourself* and then *restating* it for your calculator. After all, only a human being is truly able to understand our human world (and even then it's tough sometimes)!

This translation skill isn't really very hard to learn. It's a lot like learning to drive a car. Everything seems strange at first, but after some training and practice, you'll be doing things quite automatically – without even thinking much about them!

And that's where this book comes in....

What's In This Book?

This book is a sort of Drivers' School. After learning about your vehicle's controls and buttons, you're going to take it out on the Course for extensive road training.

Along the way, you'll encounter lots of explanations, diagrams, quizzes and answers, and once you successfully negotiate these, you'll be ready to drive anywhere your vehicle can go!

And why is the Course so Easy? Because you choose your own speed and route.

Don't worry about how fast you're moving; it's not a race, and you're allowed to go over the same stretch of road again and again until you're comfortable with it (and you'll even find some rest areas to stop and review where you've been).

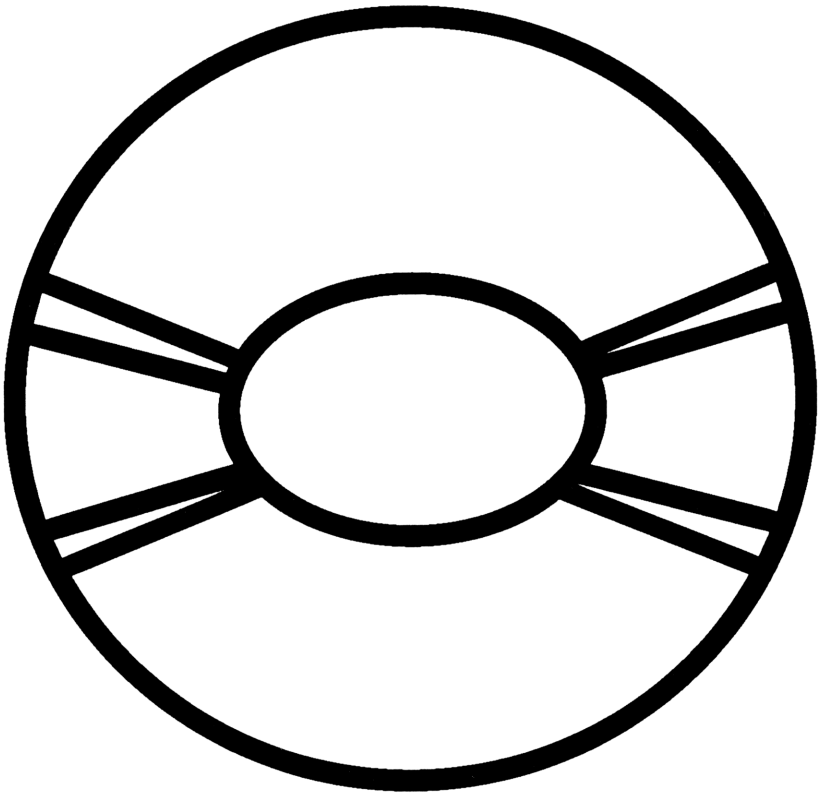
What's *Not* In This Book?

You won't find discussions of *everything,* because some parts of your HP-17B just don't need much explanation at all. Therefore, included here are just those things that most folks tend to use most of the time.

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 examples.

But this book is *not* a reference manual; it's an entirely different approach, with a careful selection of topics that are meant to be taken in order.

So start here at the beginning and stay on the road! Then, if the Course is worth its tuition, you'll seldom – if ever – need it again; thereafter, a reference source should be enough to keep your driving skills fresh and sharp.



In The Driver's Seat

The [ON] Button

If you're looking at your HP-17B for the first time, it's not obvious how powerful and useful it really is.

"But does that mean it's going to be difficult to use?"

No – not after you know all its parts. So go ahead and get started – turn it on....

"How? There's no [ON] button!"

Actually, there is, but it's not labelled "ON" as you might expect. It's the [CLR] key at the extreme lower left.

The [OFF] Button

Is it on? All right, now turn your calculator off once again, by pressing the [OFF] button....

"Isn't the [OFF] button the same [CLR] key?"

Yes and no.

Yes, you do use the [CLR] key, but since the word OFF is written in gold above it, you need to press the blank, gold "shift" key (one row up) *before* pressing [OFF].

(If you're already quite familiar with the keyboard and the display, you can skip ahead now to page 23.)

A Good First Setting

Now, with your calculator turned on, what's in the display? That's hard to say, actually. Since your HP-17B has continuous memory, it will look now just as it looked when the dealers or factory technicians finished with it – or when you last used it.

So as a way to be sure you're starting with a clean slate, here's a procedure for resetting the machine.

Warning: You're only doing this now to be sure that you can follow along on this Course. This procedure completely wipes out all meaningful information that you or someone else may have stored in the machine. This is *not* something you want to do very often. There are plenty of other safer ways to selectively erase parts of its memory. But this Reset is an Equal Opportunity Erasure!

Drum Roll, Please: Press and *hold down* the [CLR] key. While holding it down, press and *hold down* the far-left key in the top row. While holding *both* those keys down, *press and release* the far-right key in that same top row. Now release the top-left key. Now release the [CLR] key.

You'll hear the machine hiccup and you'll see this:

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

The Display

There you see it, a machine with utter amnesia. But notice that even now, in its most empty state, it uses the display to tell you what's going on. So when in doubt, look at that display for clues.

(But if you're in no doubt now about the display, what it's telling you *and* how to adjust it, then skip ahead to page 20).

The Viewing Angle

Can you see and read the display comfortably? That LCD (Liquid Crystal Display) is hard to read if you're not looking at it from a certain angle, but you can adjust that angle!

Try It: With the machine still on, *press and hold down* the [CLR] key. Then press and hold the [+] or the [−] key and watch how the viewing angle varies. Go ahead and play with it until you find a comfortable angle.

Messages and How To Clear Them

That MEMORY LOST is a good example of a message – something spelled out in English – usually telling you of an error or asking you for something.

The thing to realize is that a message just *temporarily covers* part of the display. To get rid of it, all you need to do is press the [CLR] key. Do it now....

...OK?

The Calculator Line

Now your display should look like this:

It has two full lines. For numbers (and messages), it usually uses the upper line.

Try This: Press 1 2 3 . 4 5.

See how the number keys work? When you're doing calculations, that upper line is where the arithmetic is shown, so that upper line is called the *Calculator Line.*

What about the lower line? What's all *that?*

The Menu Line

The lower line is the Menu Line. As you'll soon see, each of the selections on the menu line is associated with one of those ⌓ keys just beneath the display (which is why HP chose the Menu Line to be the lower line of the display rather than the upper).

That Menu Line is one of the best ways to find out "where" your calculator is.

For example, you're seeing this right now:

This particular menu is the *MAIN menu,* sort of the "home base" starting point that you'll come to know and love. That's why, when you reset (entirely erased) the machine, it "woke up" showing you this MAIN menu. Its memory is totally blank, and so it's starting from its "home base."

Makes sense, right?

The Keyboard

Of course, there's a lot more to this calculator than just the display. It's now time to look at all the keys (but if you already know the basics of the keyboard, go ahead and jump to page 23).

The Arithmetic Keys

Look first at the lower five rows of the keyboard. This is where you'll find the keys for your arithmetic and other number-oriented operations. All the digit and arithmetic keys are here, as is the [CLR] key that you've seen already.

The Other Keys

Look now at the top two rows of the keyboard. These keys are mostly for "moving and selecting" the numbers and operations in your HP-17B. And, as you'll soon see, you can also use these keys to spell out words and names, very much like a typewriter!

But you'll notice the different word and symbols printed in gold (like the [OFF] key you've already used). What are they?

The ■ Key

That blank gold key on the lower left is in fact the "shift" key for the calculator – similar to a shift key on a typewriter (but since this book is only black-and-white, the shift key appears here as ■).

This gold ■ key is easy to remember, because any key's "shifted" meaning is generally printed in *gold* right above it. And just like a typewriter, to get the shifted version of any key, you must first press the shift key.

Try This: Press the ■ key. What do you notice? The ⮥ *annunciator* appears (a little signal up there in the *Annunciator Area*), telling you that the next key you press will produce its *gold* operation.

Now press ■ again. The ⮥ disappears, right? You've just discovered a *toggle key* – a key which alternates its meaning between two opposites in an on-again-off-again manner.

Keep these things in mind, also: *Unlike* a typewriter, you don't need to keep holding the ■ key down while pressing the key you're after. Just press and release the ■ key, *then* press the key you want. The ⮥ will always tell you when the "shift" is in effect (and it's cancelled after every use. You need to re-press the ■ for every gold function you want; ■ is *not* a "Caps Lock").

You'll find that the ■ key is more than just a convenient way to cut down on the number of separate keys needed on the calculator. Usually, the gold ("shifted") meaning of any key is closely related to its white ("unshifted") meaning.

For example, the [INPUT] key is for putting numbers into the machine, while its gold function, [CLEAR DATA], is for clearing them out again.

The Cursor

One more thing: You'll notice that flashing black box, the *cursor,* as it waits there at the end of your number, **123.45** that you've begun to key into the Calculator Line.

The cursor is there just to tell you where you'll be putting the next digit or character on the Calculator Line (it's pretty much what you would expect if you've ever worked with a computer display).

But the cursor is also there to tell you that you're not yet finished keying in this number.

Finish It: Press [INPUT] to tell the machine that you've completed this number, **123.45**.

See how the cursor disappears?

Pop Quiz

Yes, things are moving pretty slowly here at first – but never fear, you're going to shift gears as soon as you're ready. The idea here is to 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. And along with those answers you'll find a page number to refer you back for re-reading, just in case. Above all, don't hurry; there's plenty of time, and who cares if you re-read? It's *your* Course!

1. What's a toggle key? Name one such key.

2. Name the two Lines of the display, and give their respective uses.

3. What's an annunciator?

4. What's a message? How do you get rid of it?

5. What does it mean to reset your calculator? When would you do this?

6. What happens when you "shift" a key with nothing written above it in gold?

7. What would happen to your calculator if you forgot to turn it off before leaving for Tibet?

Pop Answers

1. A toggle key is like a light switch: hit it once to turn something on; hit it again to turn that something off. ■ is one such key (see page 21 for review).

2. From the upper line of the display downward, they are the Calculator Line and the Menu Line, respectively. The Calculator Line is for calculating with numbers (and editing letters, as you'll see). The Menu Line tells "where" you are and offers your current choices of operations (pages 18-19).

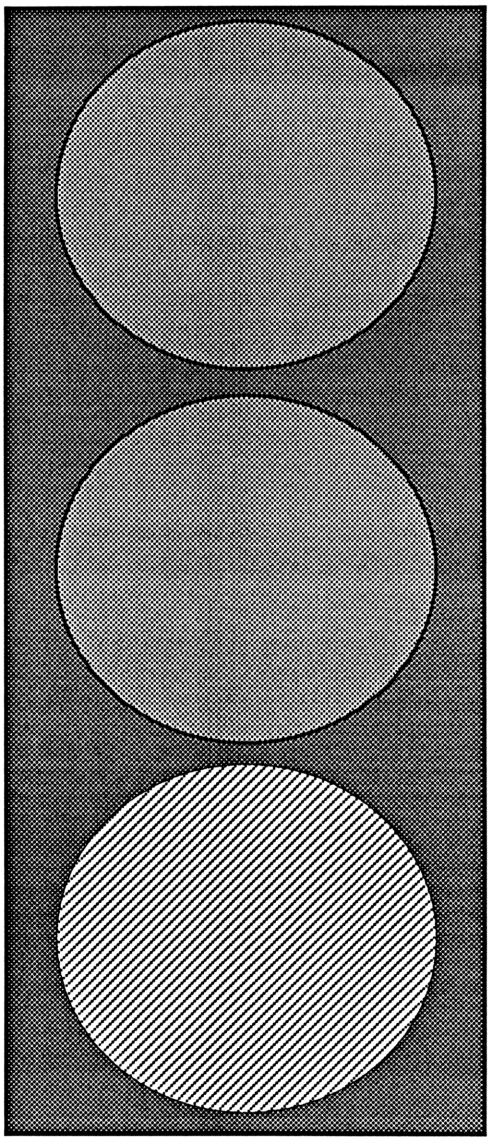
3. An annunciator is a little signal, a status indicator that appears in the Annunciator area, above the Calculator Line. Its usual function is to keep you informed of the current "doings" of the machine. You generally can't and shouldn't do anything about it – just understand what it means. For example, the shift annunciator, ⬏ means that any key with a gold operation written above it will produce that operation if pressed (page 21).

4. A message is a phrase or question that temporarily *covers* what's on the Calculator Line, to notify you of an error or ask you to do something. When you want it to go away, just press [CLR] and see your display undisturbed once again (page 17).

5. By resetting the machine, you effectively erase all numbers, letters, formulas, and appointments that you may have stored in the machine. You could lose entire phone directories, years of statistics, months of appointments, and formulas that took weeks to develop. This is usually not too good an idea. Use reset as seldom as possible (page 16).

6. The calculator will beep, or perform its "non-shifted" job, or do nothing at all. It's very smart and quite forgiving, as machines go.

7. After about 10 minutes, it would turn itself off. Then, if you came back and turned it on, its display (and memory) would be the same as it had been when you left.



Learning To Drive

The Engine: Arithmetic

It's time to get down to basics.

Arithmetic is truly the engine of your calculator, because no matter what other options and accessories come with it, you'll always want a machine that can at least "crunch" numbers.*

As you might guess, most of this "number crunching" happens on the Calculator Line. So turn your machine on (if it's not already) and look at that Calculator Line.

*At this point, if you're already quite comfortable with doing arithmetic on your HP-17B, including percentages, negative numbers, scientific notation and various display settings, then feel free to go on to page 44.

Cleared For Departure

First of all, you'll notice that you're starting with **123.45** on the Calculator Line. Do you need to clear it before beginning a new calculation?

No. For example, press [2] [+] [3] [=] and see the result: **5.00**
That **123.45** didn't mess anything up, did it?

Question: What if you now want to find 64 x 11? Do you need to clear away that **5.00** somehow?

Answer: Nope. Again, just start your new problem, by pressing [6] [4] [×] [1] [1] [=], and get **704.00**. Notice how the **5.00** just moved out of your way.

What's the idea here?

It's this: Anytime you finish a calculation (usually by pressing the [=] key), the machine knows it and will automatically bump that result out of the way when you begin a new calculation. You don't need to clear anything!

Fine.

But: What if you decide to scrap a calculation midway – when it's *not* complete? How do you clear the Calculator Line?

No Problem: Suppose you decide to abort the calculation 789÷5 just before pressing the [5] key. You would press [7][8][9][÷] and then there's the point where you want to cancel the whole thing.

How?

Easy: *To clear the entire Calculator Line,* you press [CLR].

Anytime you truly wish to clear the entire Calculator Line, you just press [CLR].

But remember that this *isn't necessary* if you've just *completed* a calculation.

OK?

One More Thing: What if you simply make a mistake while keying in an arithmetic problem?

Suppose, for example, you want to find 123 + 465.

So you blithely rattle off [1][2][3][+][4][5][6] (oops).

Not To Worry: This is the main reason for that [←] key. It's a simple backspace key, so use it as such....

First, back out your erroneous digits: [←][←].

Now key them in correctly: [6][5]

And finish the problem: [=] (Answer: 588.00)

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

How Many Digits Do You Have?

As you begin your drive, you'll notice right away that the display is showing exactly two digits past the decimal point on every number.

This isn't an accident. Since the HP-17B is a financially-oriented calculator, this simply makes good cents.*

But is this the best precision you can get?

Not at all.

In fact, *every* number has a total of 12 digits, *no matter how many you can see at the moment.*

So that number you're seeing on the Calculator Line right now, 588.00, is really

588.0000000000.

(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.

And Notice This: Key in 210.9876543210 and press INPUT (this is another way to tell the machine you've "finished" – remember?). What do you see on the Calculator Line?

210.99

What gives? Why did the calculator change the number?

It didn't change it. It changed only its *presentation* (to you).

The entire **210.9876543210** is *still in the machine,* but the display has been instructed to show you only the first 2 places past the decimal point.

And it's only this edited version that is rounded like this. After all, if you're going to see only 2 decimal places, those digits ought to represent the *entire* number as accurately as possible, right?

So the display rounds a number like **210.98765**... *up* to **210.99** (but if that **7** had been a **4** or smaller, the number would have been rounded *down* to **210.98**).

Just keep in mind through all this that 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:

Of course, you may want to tell the display to change its editing for you. What if you wanted to see 4 decimal places rather than 2?

Just Say The Word: Press the DSP key (middle of the second row on the keyboard). Here's what you'll see:

When in doubt, follow the display's directions: You want to FIX the number of decimal places to be 4. So press the ⌓ key under the box marked **FIX**.

Then there's another set of directions to follow. OK, choose 4 and press INPUT.

Voila!

Your display now shows this:

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

Solution: Press [DSP], then **ALL**. Here's the result:

To compare, key in [1][2][3][.][4][5] [INPUT] again.

See? For each number, you get ALL the decimal places that aren't just extra zeros. You need to see only two decimal places of the **123.45** to know all of its digits, but the **210.9877** unveiled its full splendor.

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

Simple Arithmetic: Saying It = Doing It

Actually, you've already done a couple of arithmetic problems, just to illustrate other things.

But now's the time to make sure you're totally comfortable with arithmetic on the HP-17B. Here's a good set of examples. Remember that you can back out of a mistake or clear the Calculator Line entirely, right?

Example: Find 342 - 173 + 13

Solution: Press [3][4][2][−][1][7][3][+][1][3][=] Answer: **182.00**

See? You really do press the keys just as you would say the problem to yourself – left to right! As you proceed, you automatically get intermediate results (do this problem again and watch what happens after you press the [+] key). The [=] gives your final result.

Example: Find 101.00 - 47.50 x 2

Solution: Press [1][0][1][−][4][7][•][5][×][2][=] Answer: **107.00**

This left-to-right rule works even when you mix multiplication (or division) with addition (or subtraction)! And notice that you don't need to key in any trailing zeroes (i.e. **101.00** is just **101**).

Example: Find 342 - (173 + 13)

Solution: Press [3][4][2][−][(][1][7][3][+][1][3][)][=] Answer: **156.00**

When you have a problem that calls for parentheses (i.e. whenever it's not correct simply to read and evaluate it from left to right), you use those parentheses in your calculation, too. Notice how the **173+13** changes into **186.00** when you close the parentheses.

Example: Find $\dfrac{101.00 - (47.50 \times 2)}{64 - (25 \times (3/4))}$

Solution: [1][0][1][−][(][4][7][•][5][×][2][)][÷][(][6][4][−][(][2][5][×][(][3][÷][4][=]

Answer: 0.13 (of course, this is just the first 2 decimal places of the answer, with the second digit rounded. Do you remember how to adjust the display to see more digits – with the [DSP] key?)

Notice that the keystroke solution calls for 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, right?

But notice also that sometimes you don't actually need to finish a parenthetical expression with the right parenthesis; your next keystroke (the last [=] in this problem) tells the machine this!

Do this problem again if you want, and watch your display in action. Then set your display to FIX 2 status before you go on.

Changing The Sign of a Number

Try This One: Find 34 x (-19)

Solution: Press [3][4][×][(][−][1][9][=] Answer: **-646.00**

That's the simplest way to key in a negative number: As usual, you just key it in as you would say it ("34 times minus 19 equals..."). And you *could* skip those clarifying parentheses in this problem, if you wished.

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

Like This: Suppose you're not doing any new calculation. You just want to make that **-646.00** into a (positive) **646.00**.

Solution: Press the [+/−] key! That's the "change sign" key, and it's also for changing the sign of whatever you're working on in the Calculator Line. Notice that this [+/−] key is a toggle key – with alternating meanings.

So there are two ways to make a number negative, the [−] key and the [+/−] key.

Playing The Percentages

Do you realize how easy it is to do percentage calculations on this calculator? "Yes, fans, even these – everybody's *least* favorite problems – are a real breeze!"

Watch: What's 25% more than 134?

Solution: 134 + 25 % = Answer: 167.50

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

And how do you simply find a percentage of a number?

Example: What's 40% of $21.95?

Piece of Cake: Press 21.95 × 40 % = Answer: $8.78

To increase or decrease by a certain percentage, you add or subtract; to simply find a percentage of some number, you multiply! And notice in all cases that the machine evaluates the percentage as soon as it can – just like parentheses.

Try a few more problems on your own....What could be easier?

That Weird E

Now that percentages are easy, here's another feature that's good to know – just in case you run across it.

Try This: What's 2,000,000 x 2,000,000 ("two million times two million")?

Solution: Press [2][0][0][0][0][0][0] [×] [2][0][0][0][0][0][0] [=] Answer: **4.00E12**

Good Grief! What's *that?*

It's just a shorthand way of writing very large (or very small numbers, a notation called "scientific notation," since scientists often use such numbers.

You'd read this as "four-point-zero-zero times ten to the twelfth power." That E is a short way of saying " – times ten to the – "

Notice that little gold E above the [+/–] key. It means that you can actually use this notation when you key numbers in, also.

Go For It: Find "2 million times 2 million" once again – but this time, you're not allowed to press the [0] key.

Solution: Press [2] [E] [6] [×] [2] [E] [6] [=]

Saves a few [0]'s, doesn't it? Anyway, whether you like to use this shortcut or not, just be sure to recognize the E when your calculator needs to use it.

The History Stack and the ■ LAST Key

By now, you've probably wondered what happens to all your previous calculations after you've finished with them: Whenever you start your next problem, those previous results simply bump out of the way.

What's *really* going on here, anyway?

Do This: Press 1 INPUT 2 INPUT 3 INPUT 4 INPUT.

You are "pretending" that you've just finished four problems, one after another (remember that INPUT key? It's another way – besides the = key – to tell the machine that you're finished with the number on the Calculator Line).

Now notice the arrow keys, ▲ and ▼.

If you press them, you'll find that the four most recent results you've completed will "roll around," so that you can make any one of them the "most recent" again!

Try it! (With much research, your four most recent results were carefully planned so that you can watch the rolling more easily.)

Roll them back to the way they started and then press 5 INPUT. Can you now roll 5 results around? Give it a shot.

Nope. This *History Stack* is good only for the last four. So now it has **5.00**, **4.00**, **3.00**, and **2.00**, from "bottom" to "top."

It is indeed a "Stack" of your recent calculations History, isn't it? And notice that it doesn't matter whether or not you can see all levels of that Stack. They're still there – all four of them.

But what good are they?

Glad You Asked: Your gross incomes and total taxes for the last three years were as follows (not really, just pretend):

Gross Income	Total Taxes
$ 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: You'll need 3 separate calculations, one for each year....

First, press [2][8][5][2][5] [÷] [8][1][5][0][0] [=] (0.35) This is the fraction of your income paid in taxes three years ago;

Next, press [3][9][7][0][8][•][5] [÷] [9][6][8][5][0] [=] (0.41) This is for two years ago;

Finally, press [3][8][8][8][7][•][5] [÷] [1][0][3][7][0][0] [=] (0.38) This is last year's fraction.

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

Not Only That: Suppose you now want to find out the *difference* between the fractions in your best year and your worst year. How can you use your history stack to do this?

How About This: Starting with your History Stack back in its original position (with 0.38 on the Calculator Line), press the ▼ key to roll it down one notch. Now your display should look something like this:

You now have your "worst year" right where you want it – with your "best year" right above it (use ▼ and ▲ if you want to verify this). So press − to prepare to subtract...

Now press ■ LAST (bottom row, second from right).

Presto! That ■ LAST key brings a *copy* of the second level of the History Stack back to the Calculator Line. See how that works?

Now finish the subtraction (press =) to find the difference in tax bite: 0.06

So there you have it – a four-level History Stack that you can roll around, look at, and even recall (from the second level to the first) with the ■ LAST key!

A Pause For the Cause

That's about it for this section on arithmetic. Look at all the stuff you know:

- 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 (with FIX and ALL) to see however many decimal places you want (up to 11).
- You know that to do most arithmetic problems on this machine, you simply press the buttons as you would say the problem out loud;
- You know two different ways to work with negative numbers;
- You know how ridiculously easy it is to do percentage problems now;
- You know what 4.00E12 means (and how to key it in, too);
- You know about the History Stack and the ■ LAST key;
- You know that you'll probably have an arithmetic quiz now....

Arithmetic Quiz

Solve these on your HP-17B – as efficiently and joyfully as you now know how. As usual, the solutions are on the next pages, with page references for review items (but you might also see some new variations, too):

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

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

2. Which is greater: $4 \div 7$ or $6.281 \div 11$?

   What's the difference?

3. **4.00E12** is "4 trillion" (a very large number).

   How much is **4.00E-12**? How would you key this in?

4. 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 $25,000.00, what will next year's be?

5. Find (-19) x (-19). Find it 3 different ways, two of which *don't* use the ⊠ key.

6. Find $\sqrt{4096}$ two different ways.

   Then find $\sqrt[12]{4096}$.

7. Find $((1 - (1.1^{-10}) \div .1) + 100) \times (1.1^{10})$

Arithmetic Solutions

1. Press [1][0][0] [÷] [7][5] [÷] [(][(][2][5] [×] [6][4][)] [+] [(][3][4] [×] [−][1][9][)] [=]
   Answer (to 8 decimal places): **0.00139762**

   The easiest way to solve the second part is to notice that it's the "flip" of the first, which you can find by using the [■][1/X] key (the shifted version of the [÷] key), which takes the reciprocal of the number on the Calculator Line.
   Answer (to 2 decimal places): **715.50**

   Of course, the other way is to start all over from scratch: Press [2][5] [×] [6][4] [+] [(][3][4] [×] [−][1][9][)] [÷] [(][1][0][0] [÷] [7][5] [=] (if you want to review your basic arithmetic, flip back and re-read pages 35-36).

2. To compare the two, you need to find both answers: Press [4] [÷] [7] [=] and [6][·][2][8][1] [÷] [1][1] [=]. Now use [▼] and [▲] to compare the two answers as they sit at the first and second levels of your History Stack.

   If you're looking only at the first two decimal places, they look identical (**0.57**). But ask the display to show you (FIX) more of the relevant digits (say, 7), and you'll see the difference (see pages 31-34 to brush up on FIX).

   To compute this difference, just subtract: [−] [■][LAST] [=] (remember how that [■][LAST] key works? See pages 40-42 if you don't).
   Answer (to 7 decimal places): **-0.0004286**

3. This is "four times ten to the minus twelfth power," or "four trillionths." Written out fully, it would be 0.000000000004. To key this in, you would press [4][■][E][−][1][2] (see page 39 for a re-read of E, if you want).

4. Say to yourself: "25,000 plus 35%, times 85%." Now press keys as you say it:
   [2][5][0][0][0] [+] [3][5][%] [×] [8][5][%] [=]
   Answer: $28,687.50 (see page 38 to review percentage calculations)

5. First way: [1][9][+/−] [×] [−][1][9] [=]

   Second way: [1][9][+/−] [■][x²] . That [■][x²] key squares the number you're currently working on in the Calculator Line – similar to the [■][1/x] key.

   Third way: [1][9][+/−] [■][yˣ][2] [=]. The [■][yˣ] key is for raising a number to a power (it puts the ^ in the display, which you read as "...raised to the..."). After all, $(-19)^2$ is actually "nineteen raised to the second power," right?

   (In any case, you ought to get the same result: 361.00)

6. First way: [4][0][9][6] [■][√x]. Again, here's another key that operates on the last number in the Calculator Line; it takes its square root.

   Second way: [4][0][9][6] [■][yˣ][.][5] [=]. Taking the square root is the same as raising to the one-half (.5) power! (Result either way: 64.00)

   Similarly, $\sqrt[12]{4096}$ is $4096^{1/12}$. So press: [4][0][9][6] [■][yˣ][1][2] [■][1/x] [=]
   Answer: 2.00

7. Press [1] [−] [(][1][.][1] [■][yˣ] [−][1][0][)] [÷] [.][1] [+] [1][0][0] [×] [(][1][.][1] [■][yˣ][1][0] [=]
   Answer (to 2 decimal places): 275.31

Road Signs: Menus and Their Keys

So much for arithmetic.

The best news about all this "number crunching" is that there's a whole lot of it you don't actually need to do "manually" (on the Calculator Line), because there are so many built-in formulas and tools.

(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 55.)

Up to now, you've been "driving around the block," so to speak. No matter what arithmetic you were doing, the Menu Line in your display seldom showed anything else but this:

That's "home," the "MAIN menu" – as you know already. But it's time to leave home and drive off on that road tour you've been waiting for. Your machine's tools and formulas are destinations you can choose for the trip.

It may seem strange to be talking about maps, driving, road trips and then menus, all in the same breath, but it actually makes some sense.

Think about it: You're on the freeway and up ahead you see one of those big green signs, showing which lanes are for which exits. That truly *is* a menu – just like the kind with spareribs and banana flambé – because you have *different selections which are mutually exclusive.*

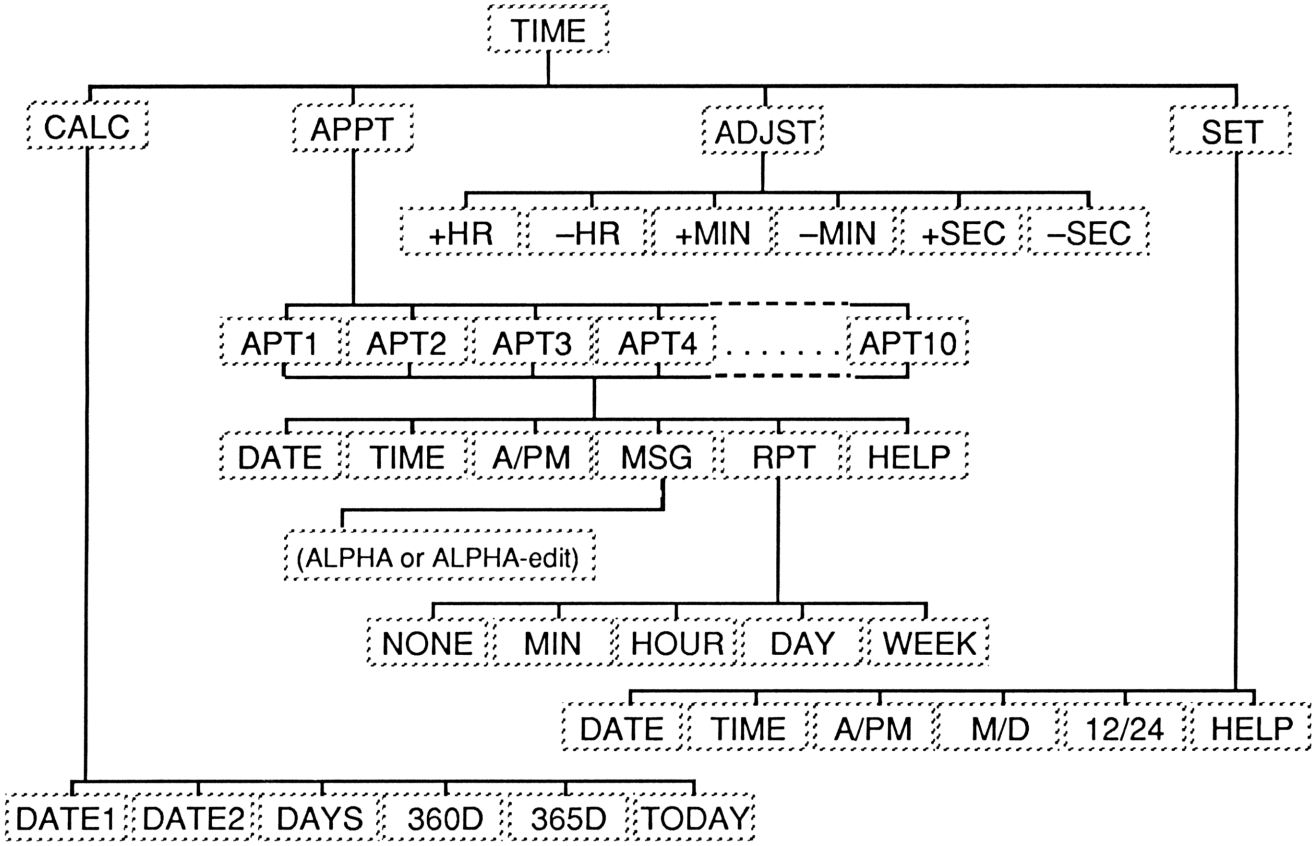
And how do you get on and off freeways? You choose the proper lane and the proper exit – and you remember them for your return trip, right?

So if you want to think about it this way, "home" (the MAIN menu) is really the MAIN freeway, from which you could exit, say, to the FIN or TIME highways. Then from those routes, you could exit onto still smaller thoroughfares, etc.

All this means is this:

Your "destinations" are the calculating tools of your HP-17B. Therefore, finding and using those tools is just a matter of properly reading the road signs in your display!

A Menu Map



Try This: Look at the map above. Of course, this isn't a complete map of all the places you can take your machine, but it is one "major route" (TIME) – 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** **TODAY**.

Do you see what happens? **TODAY** is a *calculation* that gives you today's date and the day of the week (don't worry whether it's right or not; you can fix that later).

This is the idea: Some menu selections are merely exits to get you onto a different "road." And some selections (usually those at the end of the road) are your destinations – where the machine actually does some calculating for you.

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

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

To retrace your route, you need to use the [EXIT] key. Every time you press this key, you retrace your route one level back to the previous EXIT.

Thus, you would press [EXIT] once to go from

here ⇒

to here ⇒

and then [EXIT] once more to arrive "home" at the MAIN menu!

To see how you can "fly" home, first travel out to TODAY once again.... Now press ■[MAIN].

■[MAIN] is the "When-All-Else-Fails-And-You-Can't-Figure-Out-Where-You-Are" key (so never fear – you can always get home in time for dinner)!

Pages of the Menu

One thing you need to notice about these "road signs" in your display: Sometimes there's just not enough room on the sign for all your possible choices.

What do you do (traffic engineers just write a little smaller, but your HP-17B can't do that, can it)?

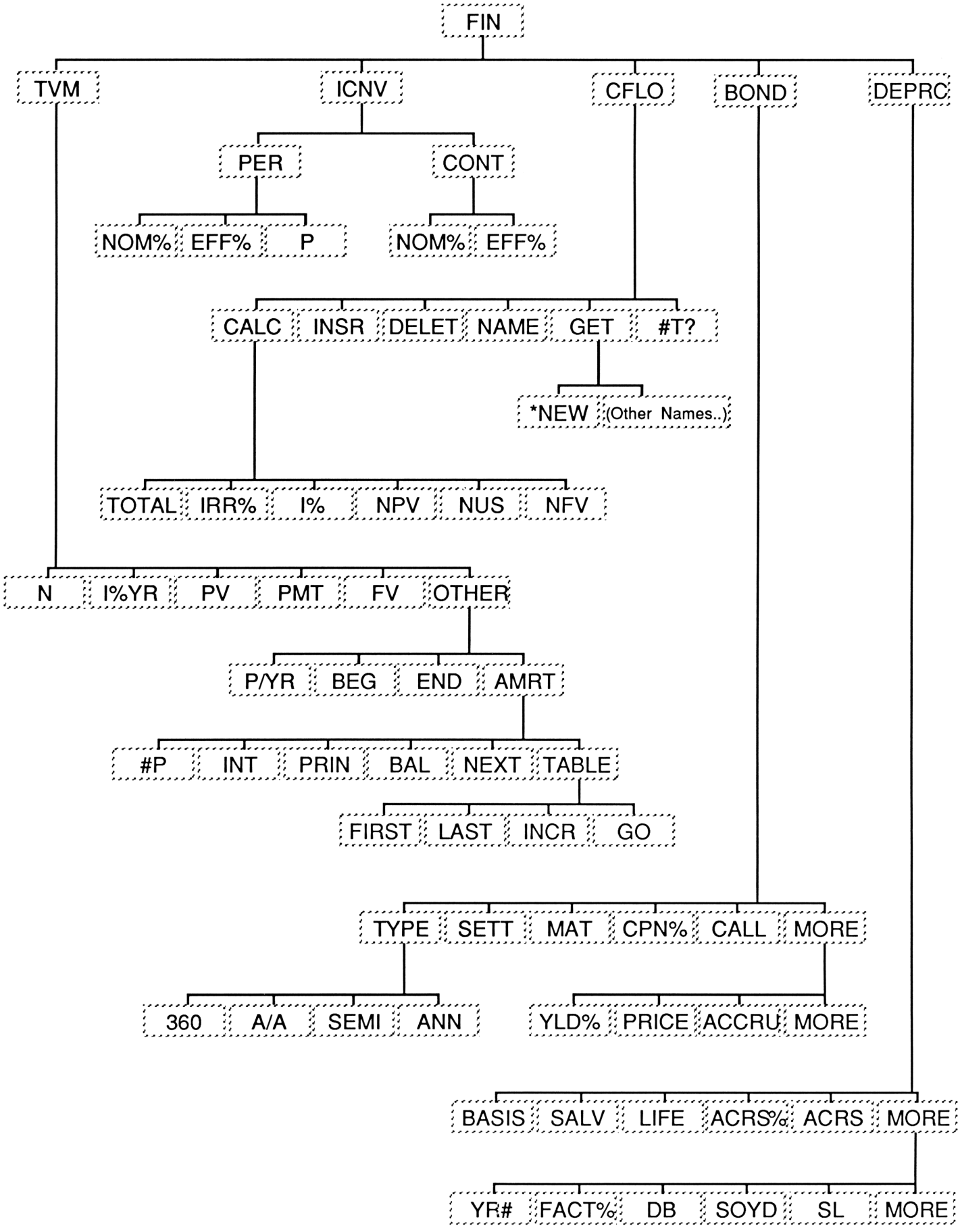
When this happens, you can temporarily think of the menu as being more the restaurant kind, because then it has more than one *page*.

Look at the menu map on the opposite page (again, this is only a partial map of your calculator).

Now Try This: Starting from your MAIN menu, "move" through the map until your Menu Line looks like this:

Solution: Press **FIN**, **DEPRC**, then **MORE**.

That **MORE** is an additional item that appears on any menu with more than one page. As you can see from the map (and your current display), the **MORE** will appear on every page of a multiple-page menu. OK?


FIN
TVM
ICNV
CFLO
BOND
DEPRC
PER
CONT
NOM%
EFF%
P
NOM%
EFF%
CALC
INSR
DELET
NAME
GET
#T?
*NEW
(Other Names..)
TOTAL
IRR%
I%
NPV
NUS
NFV
N
I%YR
PV
PMT
FV
OTHER
P/YR
BEG
END
AMRT
#P
INT
PRIN
BAL
NEXT
TABLE
FIRST
LAST
INCR
GO
TYPE
SETT
MAT
CPN%
CALL
MORE
360
A/A
SEMI
ANN
YLD%
PRICE
ACCRU
MORE
BASIS
SALV
LIFE
ACRS%
ACRS
MORE
YR#
FACT%
DB
SOYD
SL
MORE

That's all you need to know about menus and "moving around" in your HP-17B. Just keep in mind these few important things:

- When in doubt, look at your display! It will always orient you, showing you your current menu choices, error messages, instructions, etc.

- You can always get "Home" to the MAIN menu quickly, by pressing ■ MAIN.

- You can always retrace your steps "backward" (toward Home) with EXIT.

- Whenever there are more choices than places for them, you'll find a second "page" for that menu, by choosing the MORE choice on the first "page."

- Even short quizzes can be helpful....

Menu Quiz

1. There's a calculation called **PRICE** in the **BOND** menu. Your mission: Starting from the MAIN menu, find it (but 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 (on the Calculator Line) and you suddenly decide to change menus ("move") for some reason, what happens to your calculation?

4. In general, what happens to your Calculator Line when you change menus? How about your History Stack?

Menu Answers

1. From the MAIN menu, press **FIN** **BOND** **MORE**, and there on the second page of the **BOND** menu, you'll see the choice called **PRICE**.

   Notice that, as usual, if you press **MORE** at this point, you'll flip-flop between the pages on the **BOND** menu (see page 52 if you don't remember this). Then press ■ MAIN to "fly home" again.

2. From the Main Menu, press **TIME** (obviously), then **SET** (because you want to set the time and date). That brings you to another menu.

   Of course, if you just press **DATE** or **TIME** on that menu, you probably won't see the correct time or date appear in the display. What do you do? You ask for **HELP**!

   See? It shows you how to key in the number to represent the correct time and date. For example, if today is September 28, 1987, and it's 2:25 p.m., you would press 9 . 2 8 1 9 8 7 **DATE**, then 2.25 (then **A↕PM** if necessary) and **TIME** to get 2:25 in the afternoon. Now set your *correct* date and time, noticing how the information in the display changes as you do so. Play around with the other choices on this menu and see what you find!

3. Absolutely nothing happens to your calculation-in-progress. Try it: Press 2 + 3, change menus (EXIT or something), then =, to finish your addition.

4. In general, when you change menus, your Calculator Line *and* History Stack are undisturbed.

Another Pause To Get Your Bearings

Stop and think for a moment about what you've seen on your road tour so far:

- You know how to adjust the display for easy viewing and for an appropriate number of decimal places;

- You know how to use that display as a source of information, error messages, instructions, and menu choices;

- You know generally what most of the keys are used for, and you know how the shift key lets some of them do "double duty;"

- You know how to do basic arithmetic, including negative numbers, percentages, and scientific notation;

- You know how the History Stack works – and the ■ LAST key;

- You know it's time to figure out what else you can do with numbers besides simple arithmetic....

Mementos: Saving Numbers

Of course, the whole idea of these excursions through the menus is to arrive at places where you can do calculations.

But what do you do when you finish calculating? And what happens if you want to use the results from one menu in some other menu – "'way across town?"

The question is: How can you *save* your answers for later use?

After all, the HP-17B has continuous memory; it won't forget any number that you've properly saved in it.

There are two ways to save numbers: in *registers* and in *lists.**

*and if you already know how to use both these methods, then go right ahead to page 67.

The Numbered Registers

The simplest way to save the result of any calculation is in a *numbered storage register.*

It's called a numbered storage register because that's how you refer to it when you want to store into it or recall from it.

Try This: Store the result of 789÷5 into register 4.

Solution: Press [7][8][9][÷][5][=] to get **157.80**, then [STO][4].

What could be simpler? Just as with arithmetic, you do what you say.

Now Try This: Clear your Calculator Line (by pressing [CLR]). Then recall that result you just stored in register 4.

Nothing To It: Press [RCL][4].

See how these numbered registers can act as your holding bins? And there are ten such registers, numbered 0 – 9, so you have room for quite a few results.

So that's one option you have for saving results – and it's the quickest, simplest way to do that. But there's another way....

Lists of Numbers

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 you'd run out of registers (there are only 10 of them).

Besides, it would surely be handy to keep all of these figures in one list, so you can compare them, sum them, etc.

Good news – you can do this! Suppose that the numbers below are your annual incomes for the past 11 years:

Year	Gross Income
1977	17,000.00
1978	22,000.00
1979	21,500.00
1980	24,000.00
1981	14,500.00
1982	19,000.00
1983	23,000.00
1984	24,000.00
1985	24,500.00
1986	18,000.00
1987	27,000.00

Your Goal: Figure out where in your HP-17B you need to "go" to build a list in which you can save these numbers.

Solution: Starting from the MAIN menu, press the **Σ+** key. You'll see something similar to this:

This menu is for lists – and you're about to build one.

Next Question: How do you start a new list?

Next Answer: By GETting a *NEW (blank) list to fill. From the above menu, you press **GET** . The machine then asks you which list you want to get, and it gives you a choice on the Menu Line. If you had already saved some lists of your own, their names would now appear alongside **NEW**.

But right now, **NEW** is the only game in town, so you 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 **Σ+** menu and the above display. You're all ready to begin keying in numbers.

Time To Fill In The Numbers: Put all 11 years' worth of income data in this list.

Solution: (Be sure to watch your display as you do these keystrokes. That will tell you a lot about how to work with a list.)

Press

[1][7][0][0][0] [INPUT]
[2][2][0][0][0] [INPUT]
[2][1][5][0][0] [INPUT]
[2][4][0][0][0] [INPUT]
[1][4][5][0][0] [INPUT]
[1][9][0][0][0] [INPUT]
[2][3][0][0][0] [INPUT]
[2][4][0][0][0] [INPUT]
[2][4][5][0][0] [INPUT]
[1][8][0][0][0] [INPUT]
[2][7][0][0][0] [INPUT]

Not too tough, right?

And notice that below the Calculator Line, you'll begin to see the running total of all the numbers in your list.

But here are some important things to notice:

1. Items in a list are numbered, so you made each calendar year correspond (chronologically) to a number from 1 to 11.

2. You always signal to your calculator to "accept" your number by pressing [INPUT].

3. Each time you press [INPUT], the machine accepts the number *and* recomputes its running total of all items.

4. After you've keyed in all your eleven numbers, the machine still sits there and waits for the twelfth item. What do you do now?

(Read on)

Editing and Using Your List

First of all, don't worry about your machine's insistence on a twelfth item. It's always going to allow you to add another item to the bottom of your list, but just because there's this unfilled item down there doesn't mean you can't work with your 11-item list anyway.

Secondly, are you sure all your items are keyed in correctly? How about a quick review?

Go For It: Jump to the beginning of your list and step down through it to check each entry.

How? First, you move the pointer back up to the top. Remember the two keys, ▲ and ▼ that roll your History Stack around? Well, they're really good for all sorts of lists and stacks – including this kind of storage list.

So you *could* press ▲ ten times to get the pointer back to item 1.

Or you could press ■▲. That's a quick way to *jump* to the beginning of the list, all in one motion (no prizes for guessing how to jump to the end of the list again).

So you might as well go first class – use the ■▲ method. Then use ▼ to walk down the list and check your numbers.

A good clue is that your TOTAL should be 234,500.00

Next Problem: Suppose you want this 11-item list to keep a *moving* record (i.e. always for the most *recent* eleven years). What would you do to change the list at the end of 1988, when you had another year's income to record?

Next Solution: You would delete the first item (1977's income) and then tack on the 1988 income (say, 34,000) at the end of the list.

First, you would press ■▲ to jump to the top of the list, if you're not there now. Next, to get back to that SUM menu, press EXIT.

Then press the DELET selection from that SUM menu. *This deletes whatever item you're now looking at on the Calculator Line* (and that's always what determines which item is affected when you edit your list on an item-by-item basis).

So the first item in your list will now be your 1978 income (22,000.00), and there should be only ten items altogether, right?

Now jump to the end (press ■▼), to check that theory...

...sure enough, Item(11) is now blank.

So key in 34,000 and press INPUT to store it there.

Voila! You've just updated your 11-year income statement! And notice that your running TOTAL (251,500.00) is always up to date, too.

Naming and Saving Your List

So, now that you're through with your income statement for another year, can you [EXIT] the **SUM** menu and do other calculations? Not quite yet. You haven't NAMEd your list. After all, how else could you go **GET** this list again?

Name It: Name your list INCOME.

Solution: First, press [EXIT] (to get back to the SUM menu again), then **NAME**. Aha! – the secret to typing alphabetical characters on the HP-17B! Since there aren't enough keys for all of them, they're in *menus!* For example, to type INCOME, you'd press menu keys as follows:

FGHI **I** **NOPQ** **N** **ABCDE** **C** **NOPQ** **O** **JKLM** **M** **ABCDE** **E**.

Get the idea? It's not the most convenient way ever invented for typing, but it gets the job done on those few occasions when you need it, so grin and bear it. Then, when you finish, press [INPUT], to finalize the name. Your list is now named INCOME, and you can now [EXIT] to the MAIN menu (go ahead).

Verify: First, GET a *NEW list (press **SUM** **GET** ***NEW**), just for the sake of comparison. It's all blank, just as you would expect, right? But notice that when you press **GET**, your named list is right there on the menu, too! So go GET it now: **GET** **INCO**.... Voilá!

Notice that the display can't fit all the letters of INCOME into its menu box. Usually it can fit four or five, so it's wise to choose short names that are unique somewhere in their first 4 or 5 letters.

A Quiz On Saving Numbers

A few things to review...and a few new twists to discover....

1. Fill up your History Stack with the numbers `1.00`, `2.00`, `3.00`, and `4.00` (reading top to bottom). Now, using the numbered storage registers as temporary holding bins, see if you can create a new History Stack that is in reverse order to the current one – without keying in any more numbers.

2. Find your average, minimum, maximum, and median yearly income over the 11 years of your current INCOME list.

3. What was your average yearly salary increase (dollar amount – not percentage) over this 11-year period? (Reminder: This is the yearly average of the net increase from the first year to the last – *not* from the minimum year to the maximum year!)

4. Rename your INCOME list. Call it $/YR instead.

Answers To A Quiz On Saving Numbers

1. First, to fill up the History Stack, press [1][INPUT], [2][INPUT], [3][INPUT], [4][INPUT] (just as you did back on page 40). Next, break it down into four pieces and store the pieces in storage registers: [STO][1][▼][STO][2][▼][STO][3][▼][STO][4]

   Now recall them back in opposite order: [RCL][1] [RCL][2] [RCL][3] [RCL][4]. Bingo! Notice that you didn't need to worry about the old Stack. Those numbers were "popped off the top" when you began to recall other numbers.

2. From the SUM menu, GET your INCOME list (if you're not there already), by pressing **GET** **INCO**. Now, notice that first item in the SUM menu: Press **CALC** and see all the different ways to analyze your data.

   Press **MEAN** to get the average: MEAN=22,863.64
   Press **MORE** **MIN** to get the minimum: MIN=14,500.00
   Press **MAX** to get the maximum: MAX=34,000.00
   Press **MORE** **MEDN** to get the median: MEDIAN=23,000.00

3. This average increase is going to be the *difference* between the first year's income and the 11th year's income – divided by 11 – right? OK, from the SUM menu, GET your INCOME list (if you're not there already), by pressing **GET** **INCO**. Now move to the 11th year, [■][▼] [▲], and put a copy of this onto the Calculator Line: [RCL] [INPUT] (this is a handy thing to know!).

   What you're doing here is building yourself a simple subtraction problem by extracting from your list data the two numbers to be subtracted. Since you now have the first number on the Calculator Line, put in the minus now: [−] Then [■][▲] [RCL] [INPUT] to get the second number. Finally, press [÷][1][1][=], and there it is: **1,090.91** – your average yearly income rise over 11 years!

4. From the SUM menu, GET your INCOME list (if you're not there already), by pressing GET INCO. Now, even though the list has a name already, press NAME so you can change it. See how the cursor appears over the current name? And play with the menu selections that show arrows. See how they move that cursor around for you?

   Now type in your new name right over the existing one: Press ALPHA to get to the character sets.... Hmm...now, how do you get a $??

   No problem: Just choose any character set, WXYZ, then OTHER. Here's where all the non-letter characters live – and you'll notice there are several pages to this menu, so press MORE and there, on the second page, is the $ character. Type it and notice that you're instantly back to the ALPHA menu once again.

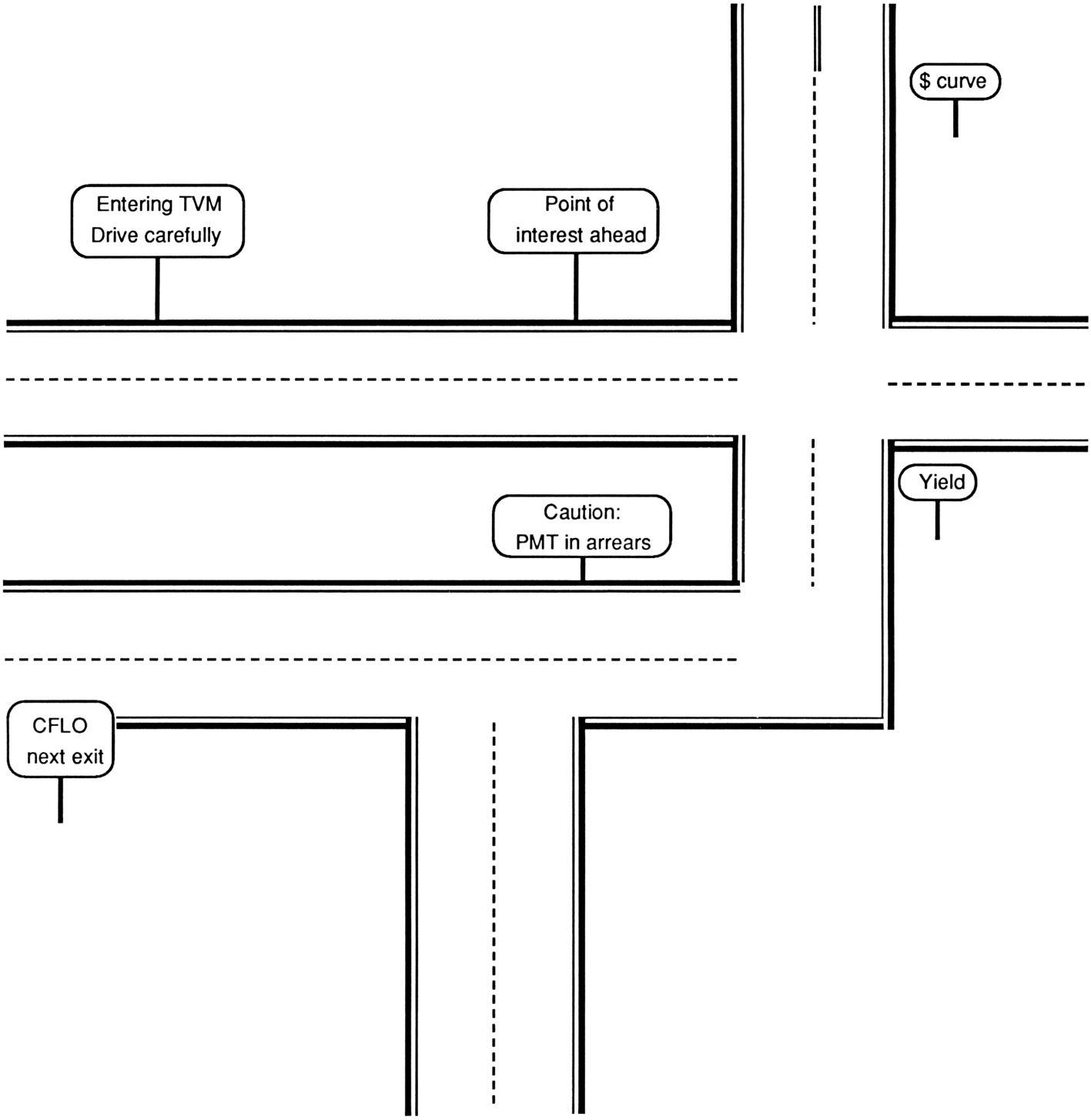
   Did you notice where the / character was? Same place as the $, right? So go find it and type it in: WXYZ OTHER MORE / . Now complete the new name: WXYZ Y ABCDV A .

   Next, to get rid of the rest of the old name: press EXIT to get to the editing menu. Then, since the cursor is already just where you want it, press DEL and watch the I disappear! Keep pressing DEL (six times in all) until INCOME disappears altogether.

   Now, to accept this new name and "make it official," just press INPUT.

   Poof! You're back at the SUM menu. Did the new name "take?" Press GET to find out. Sure 'nuf – it's right there on the menu!

(Now EXIT to the MAIN menu.)



SMOOTH ROADS:
The TVM Menu And "What-If?"

Playing "What-If?" With Menu Keys

By now, you've probably had about enough of "driving around the block."

Getting to know the keyboard and display, arithmetic and storage methods – that's all pretty tame, no? Oh, sure, you've been out to a few places on the map, but not for any particular reason, really. After all, you didn't really calculate anything when you got there; you just turned around and came "Home."

Now you're going to drive somewhere *with a purpose.* You're going to start doing "real, live financial calculations" with the menu keys of your HP-17B....

As you know, menu keys are not just "traveling keys." They're also keys that give you answers – hard numbers (remember when you used the TODAY key and it gave you the date and day of the week?).

The real beauty of the calculations menus is that they're based on equations or formulas that may have several different variables (parameters you can change) in them. And each of these variables has its own key in the menu! You can *vary* each one to see how it affects the others!

Thus, you can ask questions like "*what if* the rent goes up by $200?" And *"what if* that interest rate were 2 points higher?"

And your calculator will show you the answers! You can play the "What-If" game that is so useful in making decisions and evaluating financial scenarios!

Want to see it work?

Watch This: From the Main Menu, press BUS and then %CHG and see this:

And here's the problem you want to solve:

Today's pork belly trading closed at 75. But last week, it closed at 64. By what percentage did the price of pork bellies increase in a week?

If you're going to sell at the point when they've gone up by 20%, what should the price be? (There's your "What-Iffing!")

Solution: 64 OLD 75 NEW %CH

Answer: %CHANGE=17.19

Now specify the percentage you want: 20 %CH

And ask for what the NEW price should be: NEW

Answer: NEW=76.80

See the basic pattern?

And did you notice that you're pressing the same key both to *specify* a variable's value and to *calculate* it?

With the first calculation, you specified the values of the variables OLD and NEW. Then you calculated the variable %CH.

Next, you turned around and specified your desired %CH, you left OLD just as it was before, and calculated NEW.

How does the machine know when you want to specify a value and when you want it to calculate it for you?

The General Idea in 59 Words or Less

Whenever you *key in a number* and then press a variable's key, you will be *specifying* that value for that variable.

Whenever you press a variable's key *without having keyed in a number just previously,* you will be asking the HP-17B to *calculate that variable's value – based upon the values of all the other variables in the menu.*

Just remember: When you use only the menu keys to store values into variables, *you're just using a shortcut to store values into registers.* That is,

is exactly the same as

You can STO and RCL to and from variable registers just as you can from the ten numbered registers.

(But you're going to become so proficient at menus and variables that you'll want to use the shortcut method all the time; therefore, this book will show the upper keystroke pattern only.)

Try This: Review the values in each of the variables.

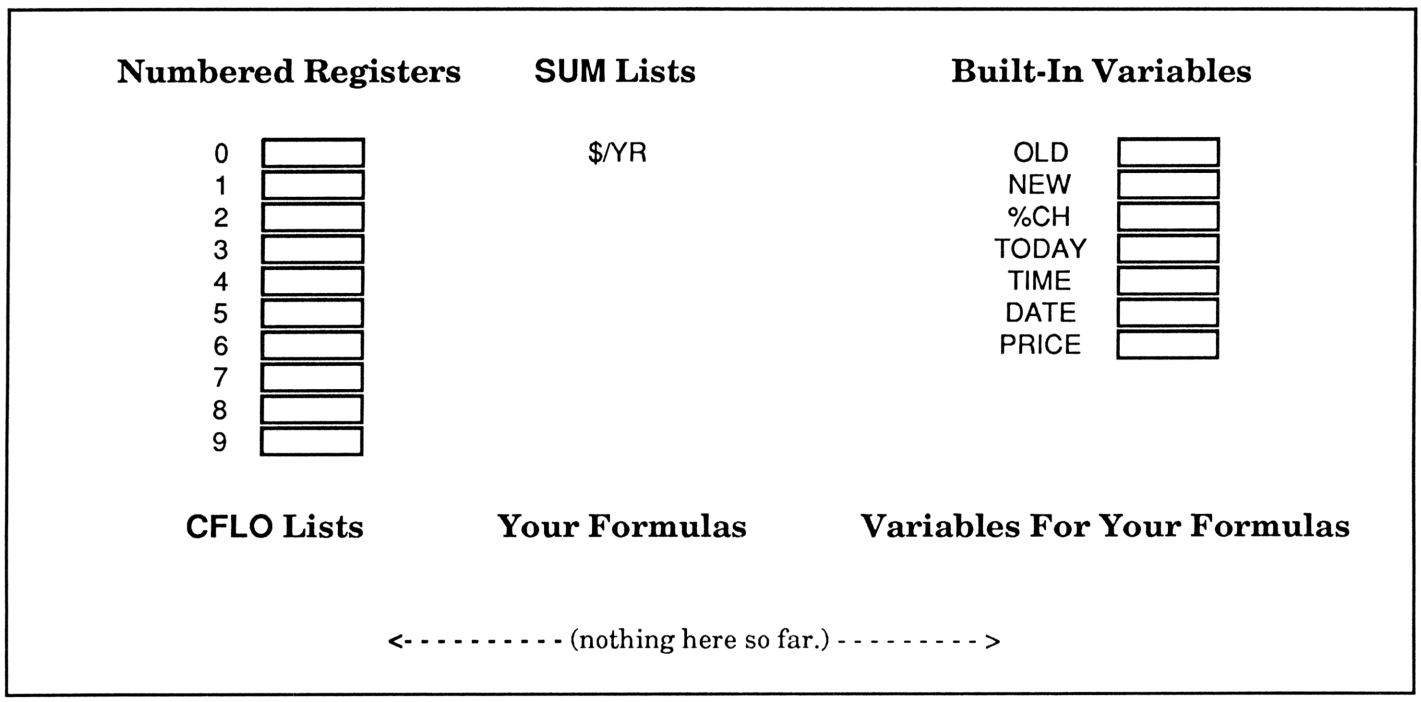
Solution: Press [RCL] [OLD] and see: OLD=64.00

Press [RCL] [NEW] and see: NEW=76.80

Press [RCL] [%CH] and see: %CHANGE=20.00

Remember that [RCL] key? It's the one you use to recall values from numbered storage registers. Is that what it's doing here, too?

Yep – except that these registers aren't named with numbers but with the variables they represent. That is, there are actually three storage registers *built into the machine,* named OLD, NEW, and %CH. To get a better idea, here's a "picture" of the machine's memory, as you've discovered it so far:



That's the heart of it, then: You store values in all menu variables except one, then calculate that one. You can play "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 barrel of oil costs $12 to produce and ship, and at the refinery it fetches a selling price of $15, what is the markup as a percentage of cost?

What is the markup as a percentage of price?

Solution(s): From BUSiness menu, press **MU%C**. This is the "MarkUp as a % of Cost" menu.

So use it: Press [1][2] **COST** and [1][5] **PRICE**.
Then calculate: **M%C**

Answer: MARKUP%C=25.00

To find the markup as a percentage of price, go back to the BUSiness menu ([EXIT]) and press **MU%P**.

Then press **M%P**.

Answer: MARKUP%P=20.00

Hmmm...

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

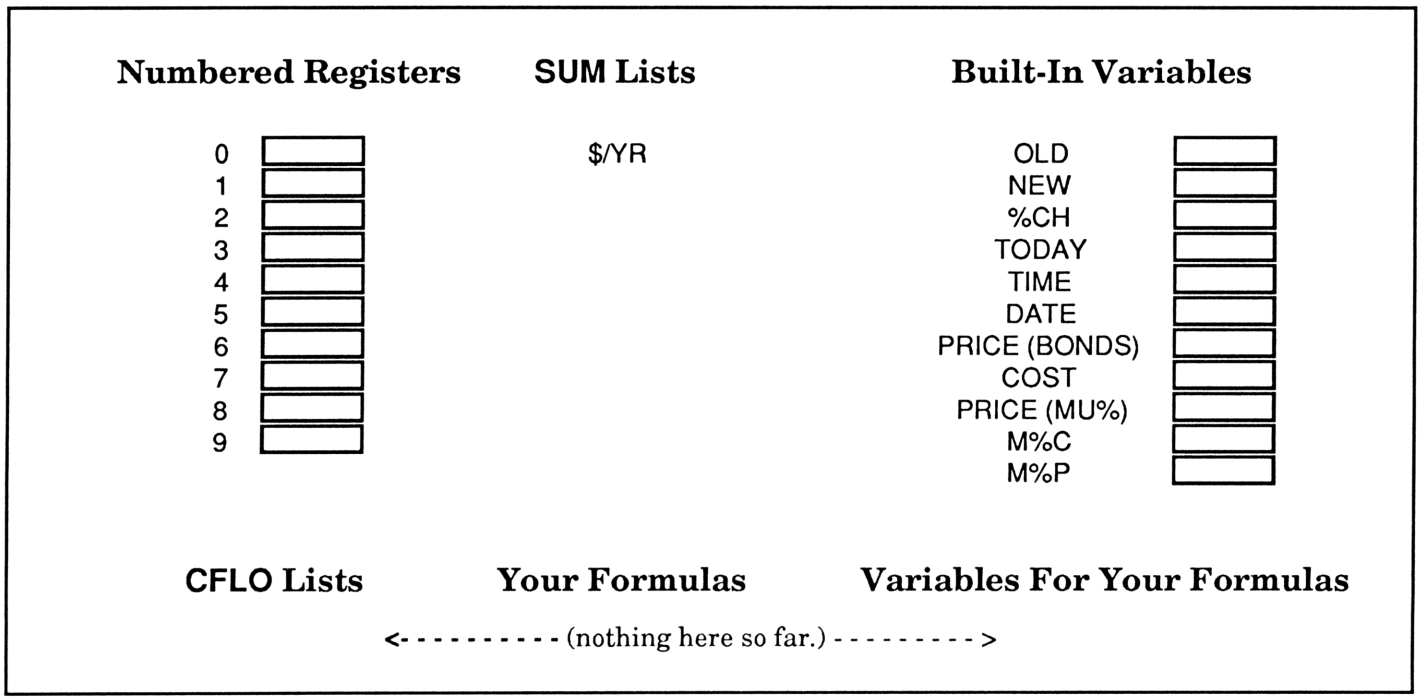
Answer: Because the COST and PRICE in the MU%P menu are *the same variables* as in the MU%C menu! These are *shared variables,* and since you had already stored the 12 and the 15 in the COST and PRICE registers, respectively, those values are still there, ready to be used to calculate either M%C or M%P.

And you can prove this by recalling those values:

Press RCL COST and see COST=12.00

Press RCL PRICE and PRICE=15.00

So the register diagram you can draw now looks something like this:



One More: If the ozone layer over Antarctica has decreased by 36% this year and 25% last year, what was its total percentage decrease over these two years?

Solution: From the BUS menu, choose the **%CHG** option. You'll see there the %CHG menu you used with the pork-belly calculations.

Now, although you don't have any real ozone numbers to work with, you can start with a convenient number, 100, to represent the ozone level two years ago: Press 1 0 0 **OLD**

Now, the level one year later was 36% less than that. In other words, the %CH was -36. So press 3 6 +/– **%CH**.

Now solve for the NEW level by pressing **NEW**: NEW=64.00
So if the ozone level was 100 two years ago, then it was just 64 one year later (you could have done this one in your head, right?).

Now for the second year: The NEW level from the first year is the OLD level for the second year, right? So: RCL **NEW** STO **OLD**

Now give the decrease for the second year: 2 5 +/– **%CH**

And solve for the NEW level by pressing **NEW**: NEW=48.00

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

Press 1 0 0 **OLD**, then **%CH** Answer: %CHANGE=-52.00

Quiz: Playing the Percentages

Ready to drive solo with percentage problems and this "What-Iffing" business? Try these (the answers are on the next page, as usual):

1. A publisher offers its book dealers a 40% discount off of its Suggested Retail Price (SRP). Knowing this, one dealer priced his books by adding 40% to the cost. Did this dealer sell the books for the SRP?

2. 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, what would the bottom level be?

3. A standard football field is 100 yards long (never mind the end zones). If it's 45 yards wide, and you add 9% to both its width and its length, by what percentage do you increase its area?

4. By what percentage must you *decrease* $\frac{\sqrt{5}+1}{2}$ to get $\frac{\sqrt{5}-1}{2}$?

The Percentage Answers

1. Suppose a book's SRP is $20.00. Use the MU%P menu to find the dealer's cost: Press 20 PRICE 40 M%P COST COST=12.00

   But this dealer figured he could arrive at the SRP simply by adding 40% to his COST. So he used the MU%C menu and, knowing that the 12.00 was already stored in the COST register, he did this:

   40 M%C PRICE PRICE=16.80

   That's not nearly the SRP, is it? (Soon after, this dealer went out of business.)

2. First, you need to recognize that this is a %CHG problem. So, from the BUS menu, press %CHG. Then press 452 OLD 58 NEW %CH.

   There's the percent change of the 1929-1932 crash (notice that it's negative because the change was downward): %CHANGE=-87.17

   Next, key in the 2735 to reflect the hypothetical high level: 2735 OLD
   Now see what the corresponding low level would be. Press NEW

   NEW=350.95*

*"Toto, I don't think we're in Kansas anymore...."

3. First, you'd better figure out what the starting area is:

   [4][5][×][1][0][0][=] Answer: **4,500.00** (Save this for later: [STO][0])

   Next, you need to find the dimensions of the enlarged field:

   [1][0][0][+][9][%][=] Answer: **109.00**
   [4][5][+][9][%][=] Answer: **49.05**

   Now multiply the length by the width to get the area (notice that you can do this simply by using the [■][LAST] key): [×][■][LAST][=] Answer: **5,346.45**

   Now you need a %CHANGE calculation, so go to the %CHG menu and press: [STO] **NEW** (since your NEW area is now sitting there on the Calculator Line);

   Then press [RCL][0] **OLD** (see how to copy values between registers?); Finally, **%CH** gives you the increase in area: **%CHANGE=18.81**
   (If you had *decreased* it, the %CH would have been negative).

4. Again, the strategy is to calculate the two values you're going to compare, then use the %CHG menu to get the final answer:

   Press [5][■][√x][+][1][÷][2][=] (**1.61803398875** – use [DSP] **ALL**),
   and [5][■][√x][−][1][÷][2][=] (**0.6180339887**5)

   Now go to the %CHG menu and press [STO] **NEW** [■][LAST] **OLD** **%CH**

   Answer: **%CHANGE=-61.803398875**

   (Notice anything unusual about these numbers?)

Problem Understanding = Problem Solving

So much for percentages. Those really aren't all that interesting – or difficult – but they're a good way to get warmed up for the problems you're going to "drive through" now.

Before getting started on those, however, consider this little proverb about teaching (maybe you've heard it before):

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

This is certainly true for solving problems on your HP-17B.

In order for you to get it to solve your problems, you need to explain the problem to it – in the "picture language" it understands. So of course, you need to figure out that picture *for yourself* first.

Bottom Line:

You must be able to understand and define the problem for yourself
before you can possibly "explain" it to your calculator!

This Course will train you to understand and define the problems you encounter. If you can do that, the actual button-pushing is easy.

So don't be too impatient to start hitting keys here. For a little while, just park your calculator, 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.

The *assumption* of TVM is that money – any money – earns *interest* simply through the passage of time, because when you're not using it, you're renting it out (loaning it) for someone else to use.

Therefore, whenever you ask "How much money do I have?", you must also ask "What time is it?" Under the TVM assumption, the first question is meaningless without the second one.

And because time does affect the value of money in all such evaluations, it's actually useful to say that time *is* money (as long as you don't actually start believing that). That is, when comparing two different *amounts* of money, you can still *equate* them by considering the *time* difference between them.

That is, if $1.00 today will be worth $1.10 this time next year, then you can say it with an "equals" in it:

"1.00_{\text{now}}$ *equals* 1.10_{\text{next year}}$."

The Time literally adds the extra Value to the Money.

So when you reach into your pocket and find a dollar bill, you can view that as

1.00_{\text{now}}$, 1.10_{\text{next year}}$, or 2.59_{\text{ten years from now}}$.

Assuming a 10% annual interest rate, each of these is really the *same amount of money.*

How Does Interest Behave?

OK, so borrowed money earns interest over time. Everybody knows that.

But exactly how does that work? If you had nothing better to do but sit and watch the pennies of interest in your bank account accrue, what would the pattern look like?

It all depends on what kind of interest you were earning.

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

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

Example: Suppose you're earning **Simple Interest** of 1% per month in your bank account (nice if you can get it), and you have $100.00 sitting in there for 6 months. How much interest will you earn over the entire 6 months?

Solution: There will be exactly $6.00 in interest, because you earn 1% of the original $100.00 every month. That's one dollar per month for six months.

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 period – including any past interest earned.*

Example: Take that same $100.00 for six months, earning 1% per month, but this time it's **Compound Interest**. How much is earned over 6 months?

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

Now comes the second month: 1% of $101.00 is $1.01. And so on.

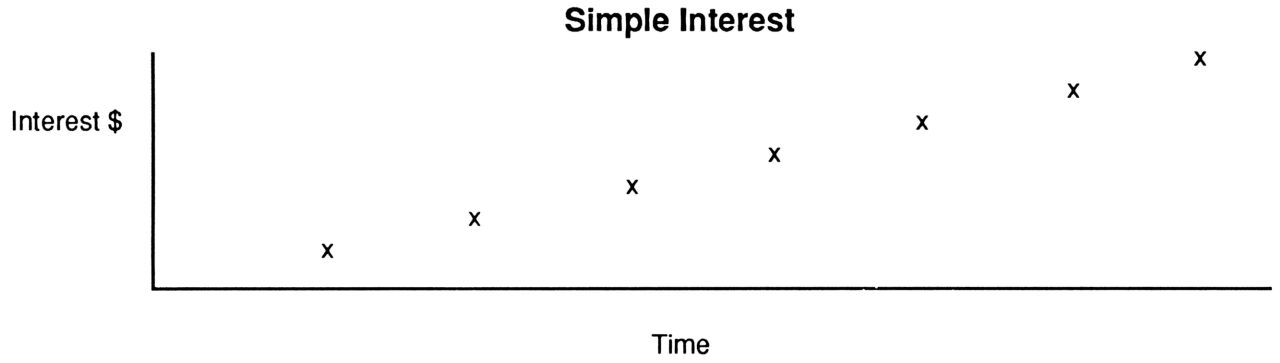
After 6 months, you'll have (roughly) $106.15 – more than the $106.00 you would have earned with Simple Interest.

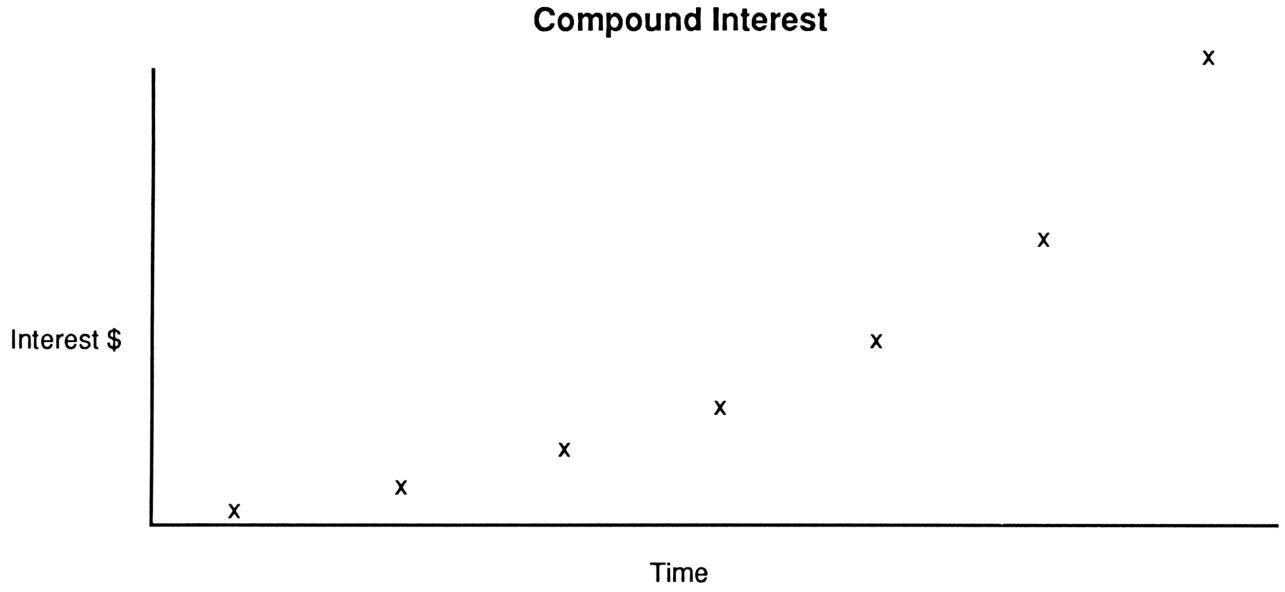
See the difference between this and the previous case?

With **Simple Interest**, no matter what month you're talking about, the interest earned is always based upon the amount owed at the *beginning* of the loan – that one *stationary point in time*. Interest is earned only on the original amount.

With **Compound Interest**, the interest earned is based upon the amount owed at some *other* point in time, and this point *moves*. Interest is earned not only on the original amount but also on all other interest already earned. Thus, you get the name, ***Compound*** **Interest**.

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





As you can see, compound interest grows faster than simple interest – which may help to explain why Compound Interest is used so much more widely.

In fact, since the TVM calculations on your HP-17B use Compound Interest, you're not going to hear a whole lot more about Simple Interest in this book. Anytime you see the word "interest" from here on out, you can take it to mean Compound Interest.

OK?

Now, all this may seem fairly obvious so far. But here are some subtleties that you should not overlook:

Sublety #1: In either form of interest, there is *exactly one* time period which is the Defined Interest Period (D.I.P.), and *exactly one* Defined Interest Rate (D.I.R.) corresponding to that period. No other approximations should be used in their places when you're calculating interest.

The examples with the $100.00 for six months stated specifically that interest accrues at 1% per month. So the D.I.P. is 1 month, and the corresponding D.I.R. is 1%.

However, it's conventional to quote interest rates on an annual basis. A bank would take that 1% per month, multiply it by the 12 months in a year, and say "12% Annual Percentage Rate."

But this A.P.R. is only a convenient approximation!

If you were to ask that bank to calculate your (compound) interest on $100.00 over 6 months, it would *not* use that 12% annual rate as is. It would always divide it by 12 to arrive at the D.I.P. and the D.I.R. Then it would go through exactly the same calculation as you did on page 85 to get your answer.

Always make sure that you know the D.I.R. and the the D.I.P. before you start a financial calculation.

Subtlety #2: In your 6-month account problem, you never stopped to ponder how much interest you had earned after, say, 2.5 months, or 3.79 months, or 4.61 months.

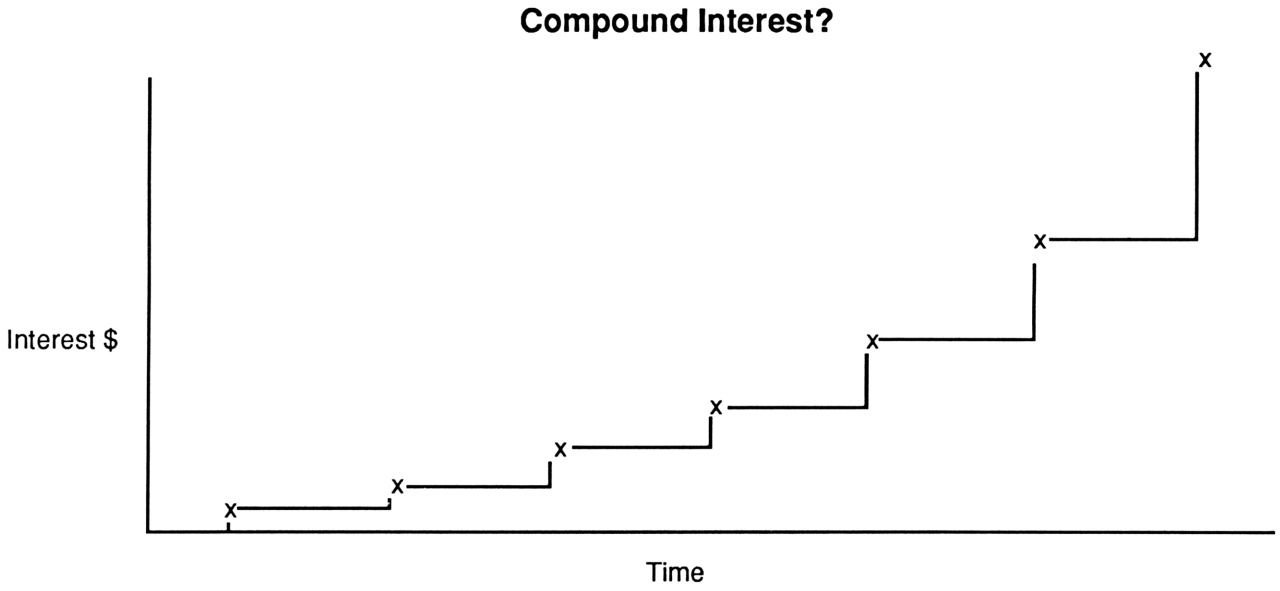
Why not?

Because you haven't been given the rules.

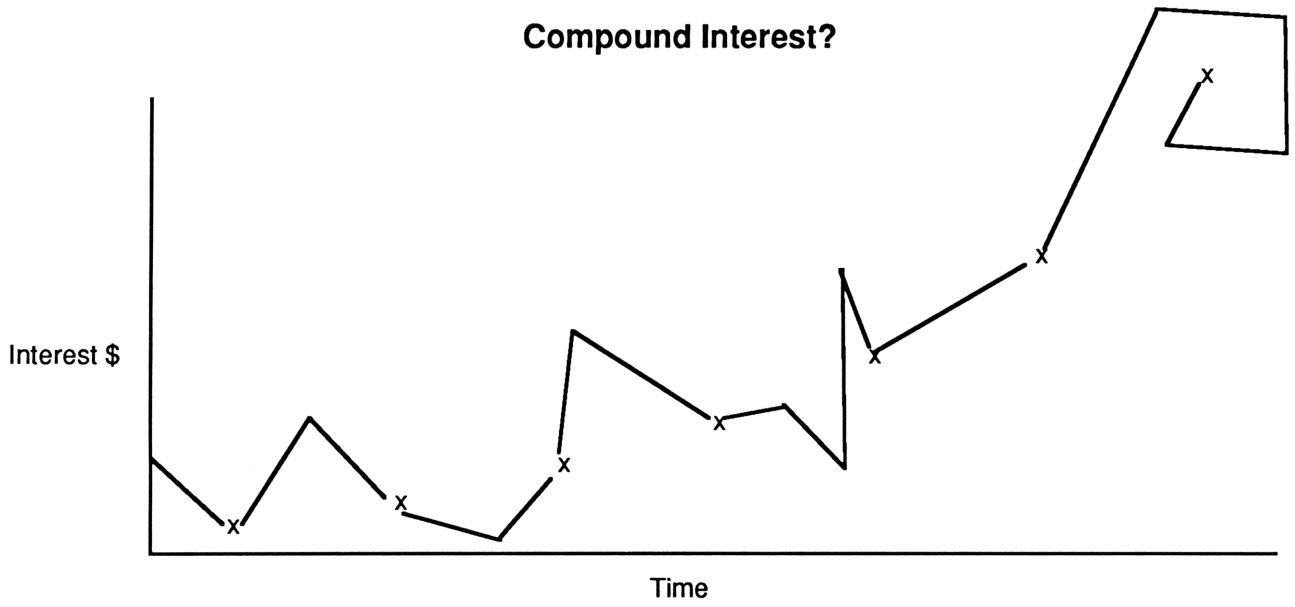
The D.I.R. and D.I.P. define only what the loan balance will be at *one point in each period* (usually the beginning or the end). There must be other definitions to determine how that balance proceeds from one point to the next.

That's why the points on the graph on page 86 aren't connected with lines. Knowing only the D.I.R. and the D.I.P., nobody can tell how those lines should be drawn.

For all you know, those lines might be drawn like this:



or this:



or who-knows-what-else.

All you know is the balance at *one point* in each Defined Interest Period.

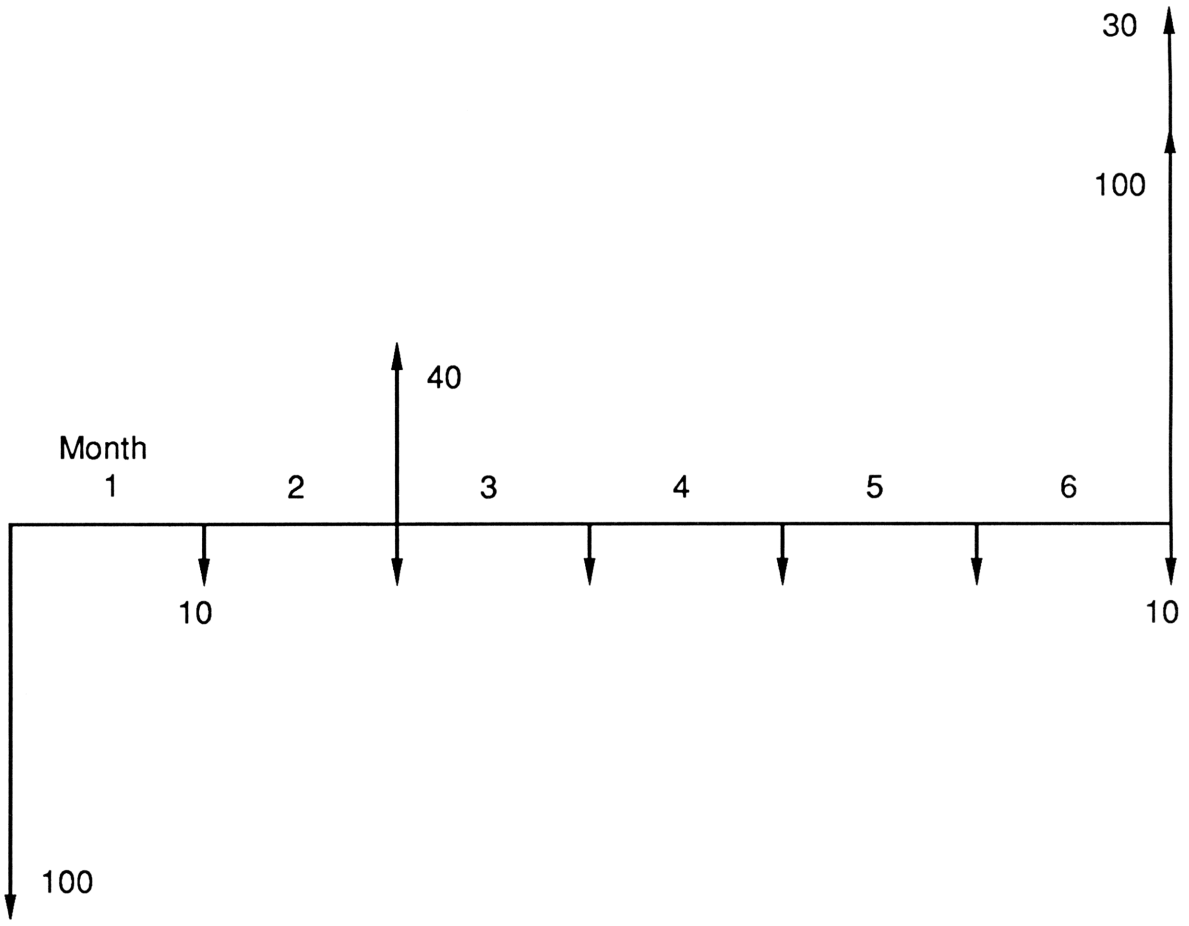
"Subtleties, subtleties...hmmm....Then what's the best way to picture my bank account with its $100.00 and this compound interest – if I can't draw a nice smooth curve of some kind?

And what if I deposit more into – or withdraw from – that account during those 6 months? How do I represent all *that* in one picture?"

Funny you should ask.... ☞

Cash-Flow Diagrams

This is a cash-flow diagram. It's the easiest way to define and understand any financial calculation:



The first thing to do in performing any financial calculation is...

Draw A Cash-Flow Diagram!

Write this in stone somewhere. It should become a reflex.

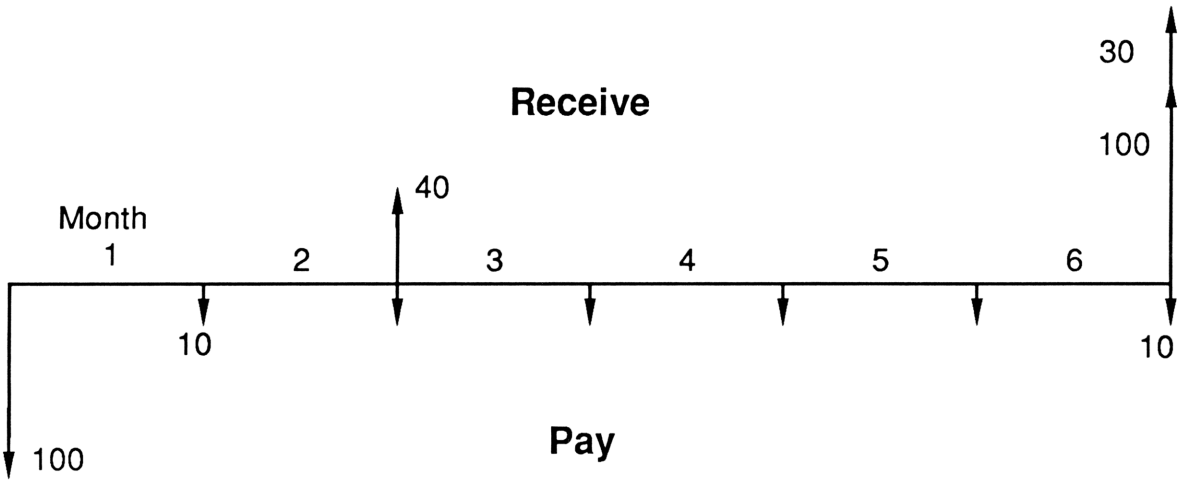
You don't need to be an artist to draw these diagrams. After all, they're just rough pictures to help you visualize the problem. But to make them really useful, it's best to stick to these rules:

1. Always pick the perspective of either a borrower or a lender (you might say "either a borrower or a lender be" – or you might not – depending upon your tolerance for ballistic vegetables).

   If you're buying money market shares, or putting money in a savings account, you should consider yourself the lender. If you're taking out a loan to buy a house or something, then obviously you're the borrower.

   The same loan will look very different on a cash-flow diagram, depending upon whether you're the lender or the borrower. So in drawing the picture, pick one perspective and stick with it!

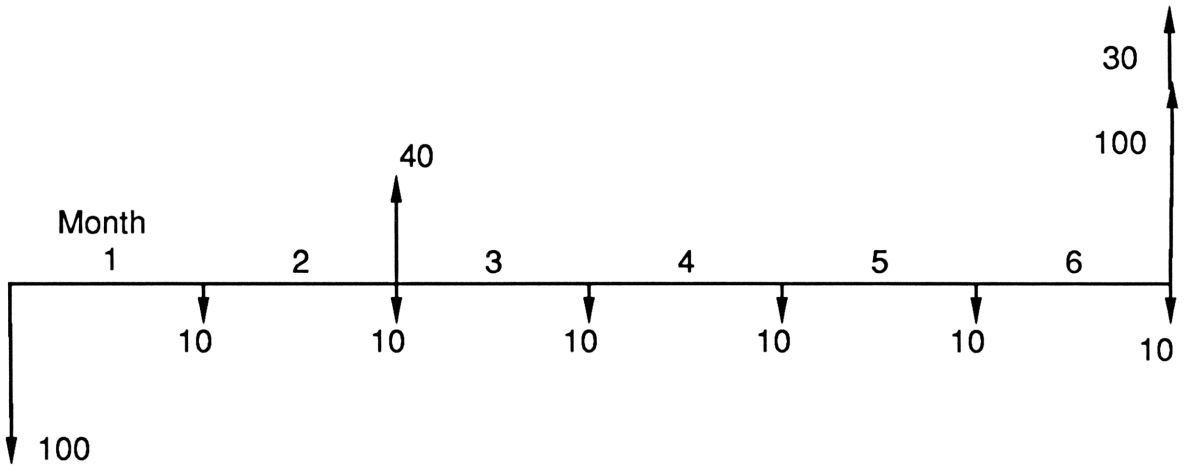
2. The vertical arrows on the diagram represent cash-flows – moments when you literally pull out your wallet to pay or receive cash. And once you've picked your perspective, the *directions* of the vertical arrows then denote the directions of the transactions. An *upward* arrow means that you *receive* money; a *downward* arrow means that you *pay* money:



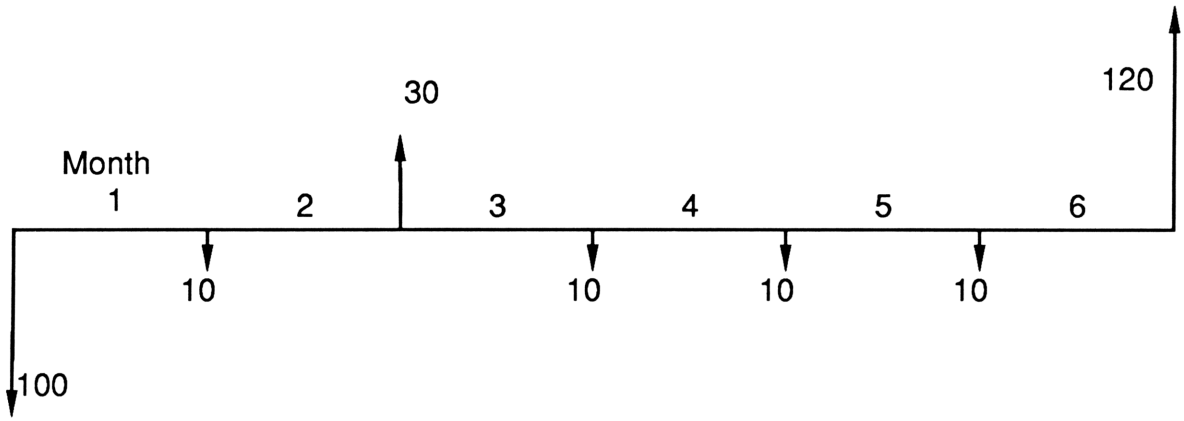
3. The lengths of the vertical arrows in your diagram should reflect the amounts of the transactions: A longer arrow means more money (but don't quibble over millimeters if the general idea is clear).

4. The horizontal direction represents time (flowing from left to right). Usually, this line is marked at regular intervals to denote the D.I.P.'s. That makes a lot of sense, because *your HP-17B is equipped to calculate compound interest problems where cash-flows occur once every D.I.P.*

5. Whenever you have multiple transactions that occur simultaneously, you can add them all together to obtain one net transaction. In other words, this:



is the same as this:



Those are the basic rules, all right? Now, it still may not seem very obvious why these diagrams are so useful. Maybe this will help:

The real beauty of a cash-flow diagram is that *you can make it simpler,* actually *adjusting* it to get a clearer picture of the situation.

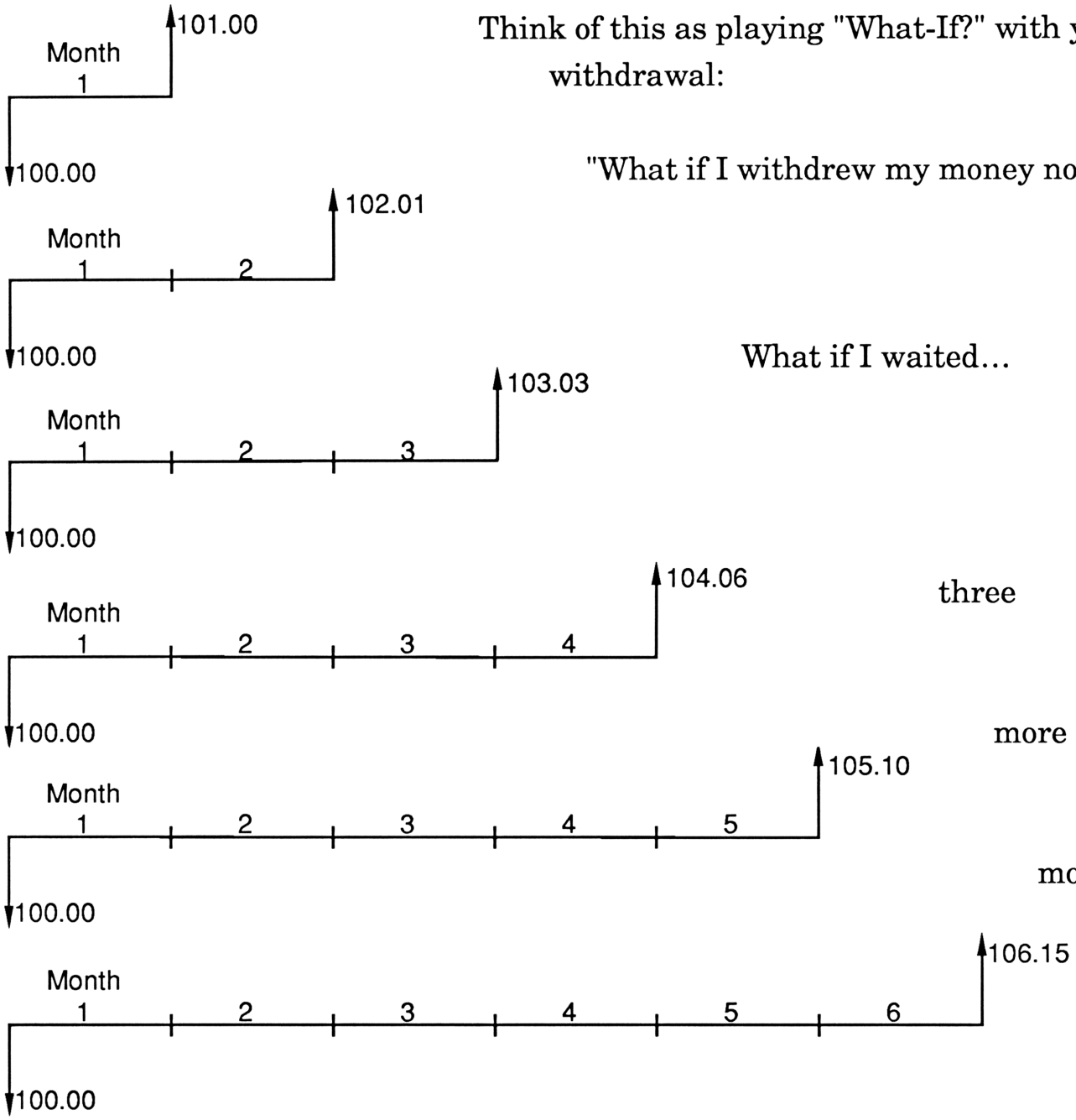
How does this work?

Go back to your $100.00 sitting in the bank account for 6 months. Under the rules of compound interest, here's a month-by-month summary of your account balance:

At The End Of	Your Balance Is
Month 1	$101.00
Month 2	102.01
Month 3	103.03
Month 4	104.06
Month 5	105.10
Month 6	106.15

Now think about that for a minute. Since you have the option of withdrawing your money at the end of any of these months, each of these withdrawal amounts are *equivalent to any other,* after taking into account the time involved.

And look at how these options look on cash-flow diagrams:



Think of this as playing "What-If?" with your withdrawal:

"What if I withdrew my money now?"

What if I waited...

three

more

months?"

Since each of these pictures is entirely equivalent to the others, what you're really doing is *sliding* a single cash-flow up and down the timeline, seeing how it would look at various times. And that's the real beauty of a cash-flow diagram:

*You can **slide** any cash-flow along the timeline of a cash-flow diagram and **retain complete accuracy** as long as you **increase** it (when sliding to the right) or **decrease** it (when sliding to the left) according to the **prevailing interest**.*

(Don't worry – you're going to put all these ideas to practice in just a few more pages. But keep grinning and bearing this, because it's very important to cover these things first, OK?)

Now then, look at what you know about the Time Value of Money so far:

- You know the difference between the two common types of interest;

- You know that of these two types, Compound Interest is much more widely used (and your HP-17B's TVM functions use it);

- You know how to draw cash-flow diagrams, using the five rules for making it the most clear and useful;

- 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 cash-flow diagram for your HP-17B. After all, it's supposed to do the calculating around here.

How can a machine possibly "see" or "understand" a picture that you've drawn on a piece of paper?

Drawing The Picture For Your Calculator

Time to rev up the machine again. From the MAIN Menu, press **FIN** **TVM**.

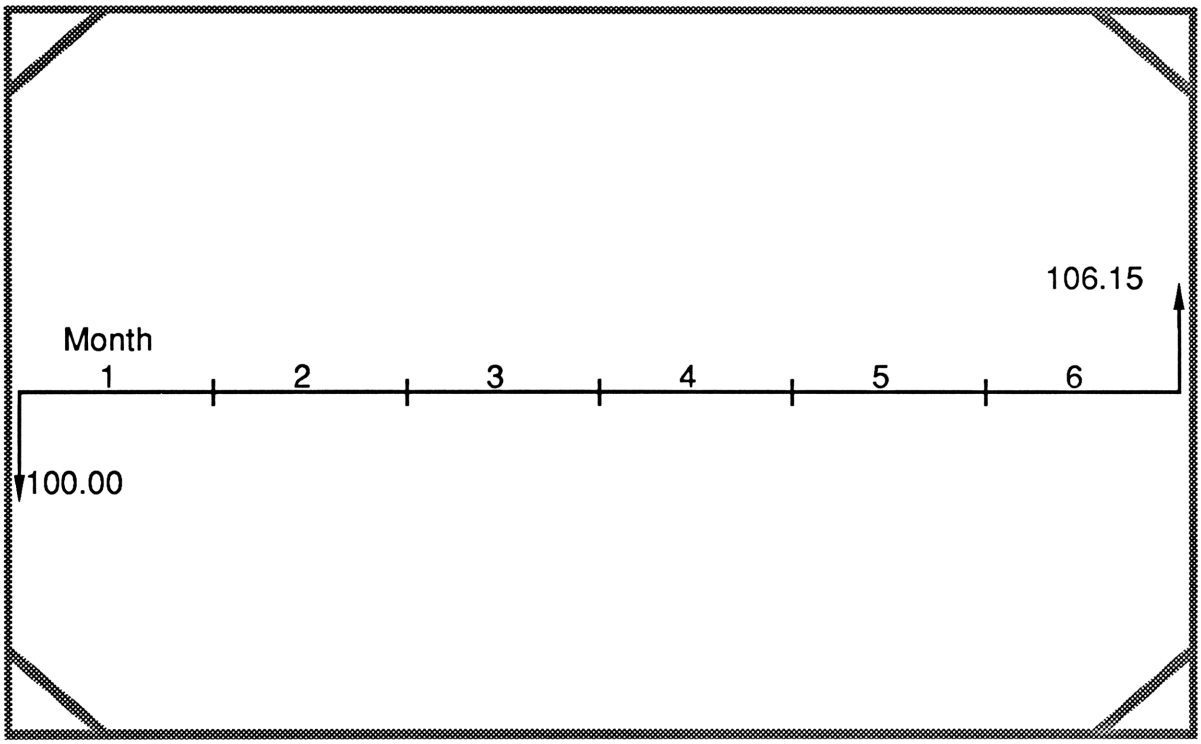
You'll see something like this:

(At this point, it's probably best to change the display setting back to FIX 2.)

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

N	Number of Defined Interest Periods (D.I.P.'s)
I%YR	annualized Interest % rate
PV	Present Value
PMT	PayMenT
FV	Future Value

Now, the best way to think about these keys is that they form a picture frame that you can place over the paper drawing of a cash-flow diagram:



First of all, you need to realize that the TVM keys are good *only* when your diagram shows steady, level cash-flows, *one for every period throughout the timeline* – as you see above.

If your cash-flow diagram has uneven or irregular cash-flows along its timeline, you can't use TVM.

The reason for this is the **PMT** (PayMenT) key.

When describing the diagram to your calculator, the amount of that steady, level cash-flow goes into the PMT register.

TVM calculations always have a PMT amount (it can even be $0.00, but it must be level and regular throughout the picture).

As for the other four TVM parameters:

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 over there on page 97 (it's the picture of your $100 bank account, assuming you wait until after month 6 to withdraw), here's what you would tell your HP-17B:

N = 6
PMT = 0.00
PV = -100.00
FV = 106.15

Notice the pattern here: 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 [+/–] key?).

By opening your bank account, you actually *loan* the bank $100.00, so it appears on your diagram as an outflow of cash; in your calculator as a -100.00

But you haven't completed that picture yet. What's I%YR?

Hmm...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 yet another level of menu beyond the TVM menu. Here you can vary certain parameters that affect the outcome of your TVM calculations.

For example, notice that message that says 12 P/YR (you've been seeing this message from the TVM menu, too, but here's where you can see what it means).

Your HP-17B is telling you that 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.

And how can you know that? *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; that's what you mean by a PMT, right?

And you *do* know the D.I.P. is one month, so there *are* 12 payments per year – no need to change that message (which you could do by using the **P/YR** key).

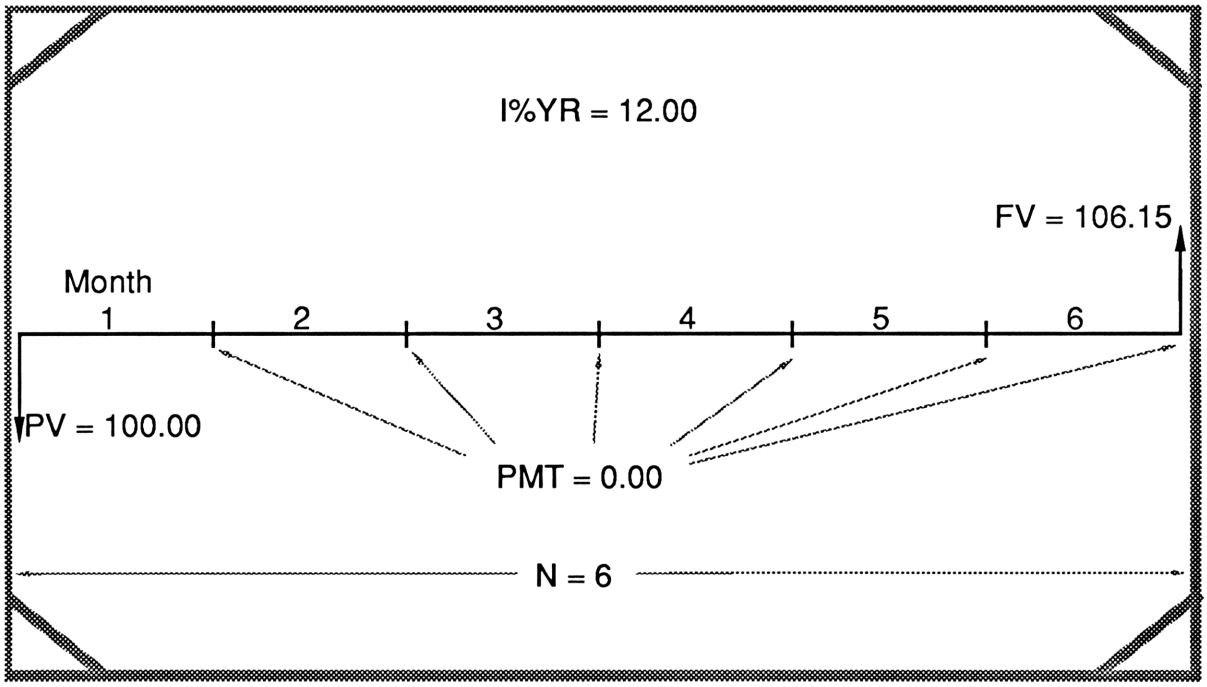
Now press [EXIT] to return back to the TVM menu.

Now you know that there are 12 PMT's per year.

But how does this help you to verify what I%YR should be? Because if you take the D.I.R. and multiply it by the number of D.I.P.'s per year, you'll get the I%YR. In other words,

$$1\% \times 12 = 12\%$$
$$\text{D.I.R.} \times \text{D.I.P.'s/year} = \text{I\%YR}$$

So here's the complete TVM picture of your 6-month bank account, which you've figured out in your head this first time:



Now test your calculator to see if it understands the "picture" you're "trying" to draw for it....

Verify: From the TVM menu, press

6 N
12 I%YR
100 +/- PV
0 PMT FV Result: FV=106.15 Right on the money!

Things to notice and remember:

1. Remember how 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 must always specify four out of the five.* Never ignore one of the variables 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 – therefore, positive.

   In fact, the machine insists that PV and FV always be of opposite sign – to keep this idea of investment and return. If you accidentally give it a PV and FV of the same sign (when solving for PMT or something else), it'll beep at you and tell you NO SOLUTION, because it must have both an investment and a return to be a meaningful TVM problem.

4. Now that once 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 and then FV, you are changing the analysis to the case where you withdraw your money after just one month. By pressing 2 N FV, you do the two-month scenario, and so on.

   See? You're playing the TVM version of the "What-If" game with the menu keys. Here 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 you never need to re-key in any number once it's stored in a TVM register. It's there to be used – or varied – over and over again.

   So, what if you let your account grow for a year (12 months)? How about 50 years?

   As you can see, the answers to each of these questions are merely variations on the same procedure you've already done!

   And notice, also, that by playing this TVM "What-If," you're actually using the TVM keys to "slide" your last (withdrawal) cash-flow up and down the timeline – just as you did on paper (page 94)!

A Typical Loan Problem

Yes, fans, at long last, 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 $110,000.00 home, putting down $10,000.00 and financing the rest in a 30-year mortgage with monthly payments. The quoted A.P.R. is 12.00%. What will your monthly payments be?

Solution: (If you already know how to solve this, go to page 111.)

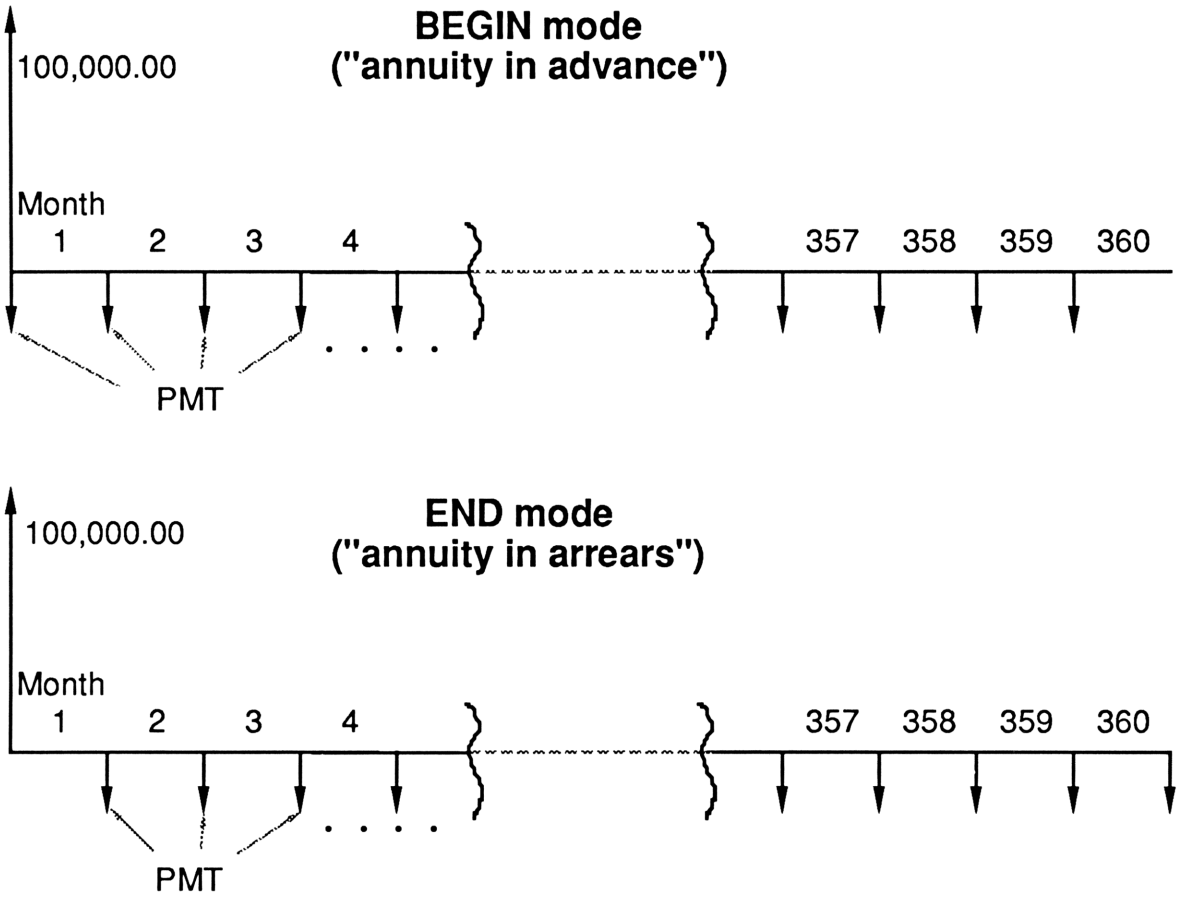
You can't solve this problem until you fill in some details that aren't specifically spelled out:

- Is this a BEGIN MODE or an END MODE problem?
- What is the D.I.P.?
- What is the D.I.R.?
- Why do you care about these things?

BEGIN or END?

Does it really 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?

Well, compare the two pictures on a cash-flow diagram:



As you can see, in the first case, a payment is due at the beginning of the loan – right after 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. So 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 going to be – 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.

Fine. Now, how do you tell your HP-17B to assume this too?

Like This: From the TVM menu, press the OTHER key and see this again:

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

Enough said, right?

Just don't forget to check this "little detail" for each new TVM problem! Usually, when you're at the TVM Menu itself, you won't be able to tell which mode your calculator is using (the only time you can is when you've just moved to that menu from somewhere else; you'll see a message on the Calculator Line. Of course, if you press CLR or start keying in numbers, then this message goes away).

Next detail to clear up:

What's the D.I.P.?

The problem says 12% A.P.R., and it's safe to assume compound interest, but it doesn't say how *often* this interest compounds. Is it yearly? After all, A.P.R. does stand for Annual Percentage Rate.

Yes'n 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 explicitly stated otherwise, the payment period *is* the compounding period (and vice versa).

Thus, the Defined Interest Period (D.I.P.) – the period over which interest *actually* compounds – is a month (wasn't the suspense killing you, though?)

And now you need to tell your HP-17B this detail also....

Clue It In: From the second "page" of the TVM menu, press [1][2] P/YR

(Your display has probably already been showing 12 P/YR, but do this anyway, just for practice.)

Next mystery: What's the D.I.R.? That is, what's the monthly rate of interest that corresponds to an A.P.R. of 12.00%?

It's "12 percent divided by 12 months per year," or 1% per month (remember the little discussion of A.P.R. back in Subtlety #1, on page 87?).

And now that you've decided this, you'll probably sleep better tonight, but you don't need to tell your calculator about your conclusion; it will *assume* it.

The nominal A.P.R. used to compute a loan payment
is exactly what I%YR means to the HP-17B.

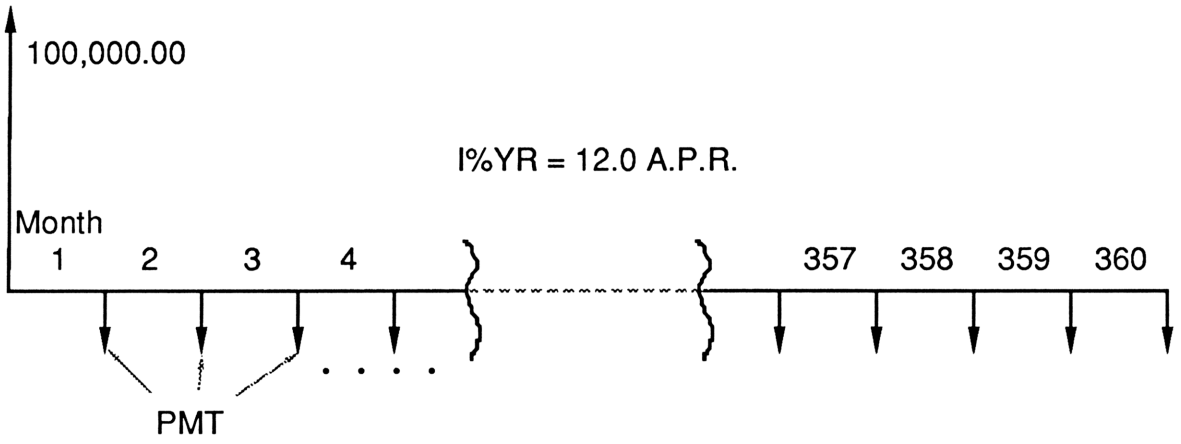
That is, to arrive at the actual interest rate to use in its calculations, a bank would take this *nominal* A.P.R. and divide it by the number of compounding periods in a year.

So when 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.

A Typical Loan Solution

Are you all set to solve this mortgage problem (finally)?

Fine, but don't forget to draw it in its final form on a cash-flow diagram:



Notice how it's drawn from the perspective of you – the borrower. Your loan is shown as positive (you *receive* it, right?). Then, of course, each payment is negative – because you *pay* it.

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

Read 'em and Whip: From the TVM Menu (of course), press 30 × 12 N 12 I%YR 100000 PV 0 FV.

Then press PMT to calculate the payment.

Answer: PMT=-1,028.61

Notice how your calculator knows that this PMT must be negative (a cash outflow). It's obeying its own sign convention, of course, and thus it agrees with your diagram!

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

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

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

All right, so you know that FV is zero. *But even so, you couldn'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 simply would have used whatever number was last stored into the FV register – no matter when that was.

Remember! A number in a continuous-memory machine like the HP-17B is like a budget deficit: It won't melt back to zero just because you ignore it.

A Typical Loan Quiz*

1. Review in your mind the checklist of all the little invisible steps you took to actually calculate the payment on that $100,000.00 mortgage.

*Pretty merciful quiz, don't you think? Actually, this mental checklist is a very important habit for you to develop, so take a bit of time here and see if you can tick off all the particulars you need to remember. A suggested version is on the next page in case you want to compare it against your checklist.

A Typical Loan Checklist

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 then set the P/YR accordingly. And you observed that the nominal 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, thereby establishing the directions of the cash-flows (up or down on the drawing, + 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. Therefore, the Future Value (FV) must be zero.

6. You plugged in all your known information (N = 360 months, I%YR = 12.00, PV = 100,000.00, FV = 0.00) and 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 $1,028.61 monthly mortgage payment. And that's assuming that your payment comes at the END of the month.

Question: What if it were at the BEGINning of the month? What would your payment amount be? By looking at the comparison diagrams on page 104, 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 TVM menu and change the annuity mode from END to BEGIN.

Then [EXIT] back to the TVM menu, and solve for PMT once again.

Answer: 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.

How are you saving this interest? Is the rate lower?

No. With BEGIN mode, you're still paying the same interest *rate,* but you are saving money, because you're *borrowing for a slightly shorter time.* From the diagram on page 104, 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 go shopping for better mortgage terms....

O Happy Day: Up jumps a lender who offers you all the same terms – 360 months, a payment at the end of each month – *except* it's only a 10.5% A.P.R.(!) What will your payment be?

A Mere Pittance: Again, leave all your TVM parameters alone, except for the ones you're now going to vary:

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

Right. But just this once, prove it to yourself by recalling each of the five TVM registers (this is just another friendly public service reminder that all your menu variables are just registers that you STO into and RCL from):

RCL N (N=360.00 Don't change it.)
RCL I%YR (I%YR=12.00 That's what to change.)
RCL PV (PV=100,000.00 Don't change it.)
RCL PMT (PMT=-1018.43 You're going to recalculate this after changing the I%YR.)
RCL FV (FV=0.00 Don't change it.)

OK, so change the interest rate: Press 10.5 I%YR

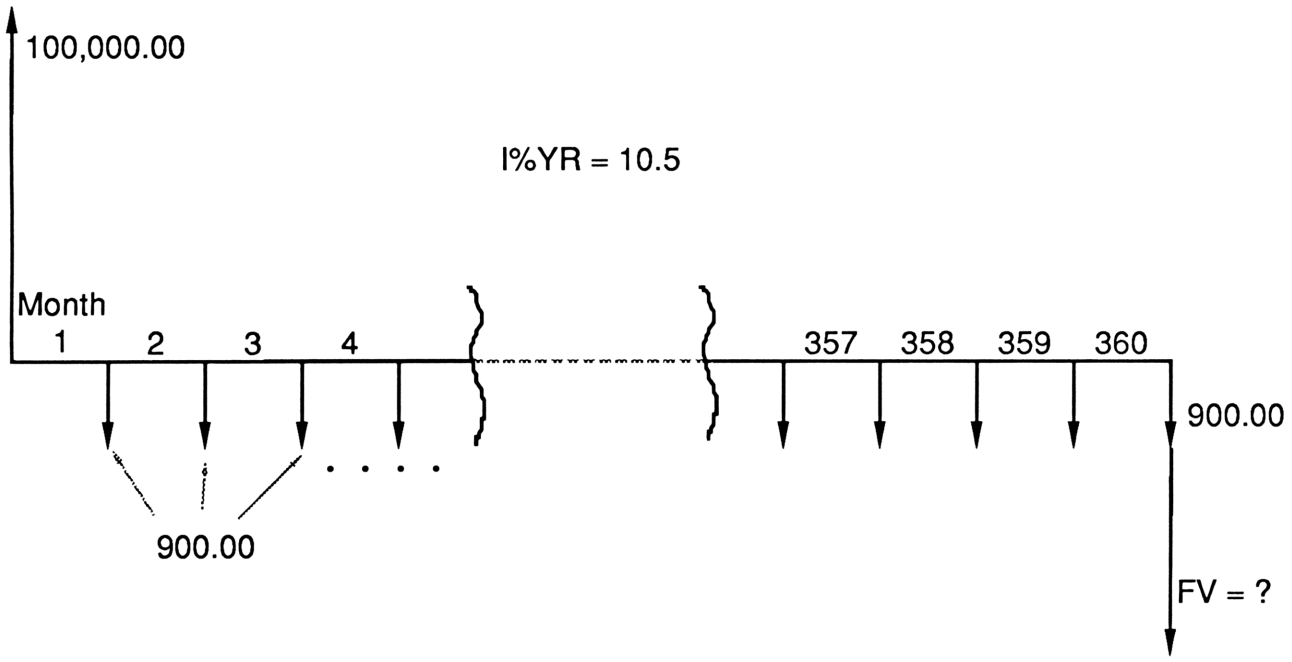
Then press PMT to see the good news: PMT=-914.74

Well...that's better – about $100.00 better.

But what if it's still too high? What if your absolute limit were $900.00 even?

That's OK. 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. You *know* there'll be this remaining balance, because the calculator just told you that it will require $914.74 per month to completely amortize this loan. If you pay even slightly less than that, there'll be some left over to pay at the end.

So here's the way this looks on a cash-flow diagram:



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're going to do now is specify the payment (rather than calculate it) and then find the Future Value.

Press 9 0 0 +/− **PMT** (remember why this should be negative?), and solve for the remaining balance: **FV**

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. And since this is an END mode problem, your last PMT occurs at the same time as this balloon payment.

(Looking back at that diagram on the previous page, can you see how clearly and succinctly all this information is shown?)

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-17B means by Future Value. You need to subtract out the amount of the final PMT.

You'll never get confused if you draw the cash-flow diagram.

So, what have you decided up to now?

You're going to borrow $100,000.00 at 10.5 A.P.R., repaying it in 360 end-of-the-month installments of $900.00 each, 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, how big a balloon payment could you stand? 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.

True, but if a few bucks a month now can save thousands in thirty years....

How about, say, a $20,000.00 balloon?

Fine. Now check to see what PMT this will demand.

Not Much More: As usual, vary only what you want to (this should be getting quite routine by now). Press [2][0][0][0][0][+/−] **FV** to specify the balloon. Then just press **PMT**, to find the corresponding payment.

Answer: PMT=-906.79

So those are the numbers you can live with, eh? Review them now with the RCL key (RCL N, RCL I%YR, etc.).

They should give you this summary of the TVM registers:

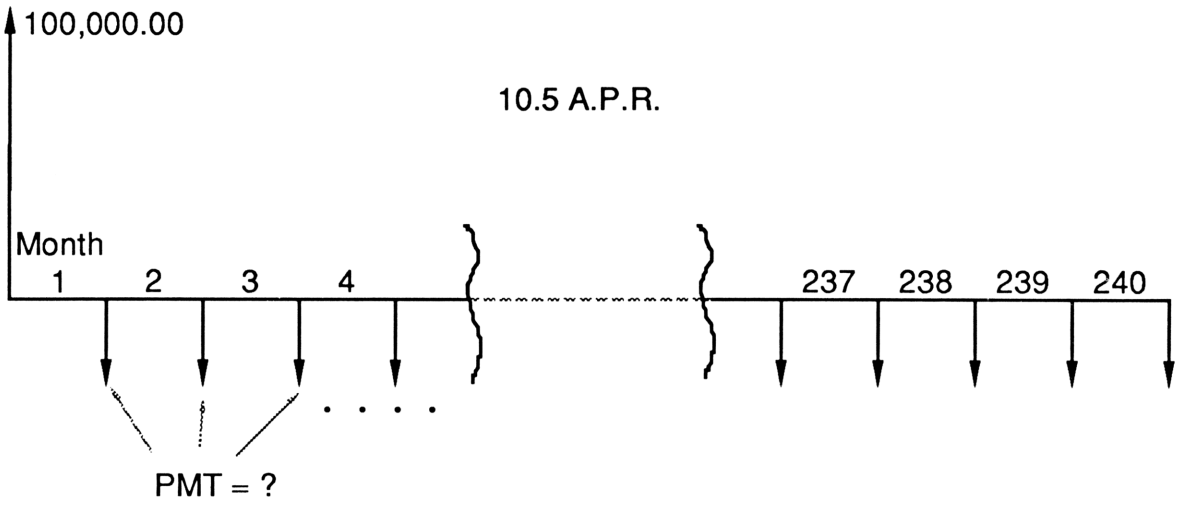
360	10.50	100,000.00	–906.79	–20,000.00
N	I%YR	PV	PMT	FV

The only problem is, your lender with the 10.5 A.P.R. won't agree to anything less than full amortization – no balloons allowed.

In fact, he's actually encouraging you to consider even higher payments – to shorten the term of the loan down to 25, 20, even 15 years.

Of course, you know you can't afford this much every month, but now that you've got a machine like the HP-17B, it doesn't hurt to play "What-If," right?

What if you had the same financing rate and amount, but, only a 20-year term (for example)? Your cash-flow diagram would look like this:



Play With The Term: Find the payment amount necessary to fully amortize this loan in 25, 20, and 15 years.

Solution: Change what you need to; leave the rest of the five parameters alone. Press 25 ⊠ 12 N (shorter term) 0 FV (no balloon allowed) and then solve for PMT

Answer: PMT=-944.18 Not too much more than your $914.74 – for five years' fewer payments!

Now try 20 years: Press 20 ⊠ 12 N, and then PMT.

Answer: PMT=-998.38

Finally, try 15 years: Press 15 ⊠ 12 N, then PMT.

Answer: PMT=-1,105.40

Did you realize that for a payment of about $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.

How much *could* you afford to finance at 10.5 A.P.R., with 30 years of $800 payments (end of the month, as usual)?

Check and See: Here's how your TVM registers look at this point (and you know how to verify it, right?):

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 finance:

[3][0][×][1][2] **N** (to return to the original concept of a 30-year term)

[8][0][0][+/–] **PMT** (what you'd like to get away with)

PV (find how much you could thus finance)

Answer: PV=87,456.61

So if you could come up with about $12,500 more in a down-payment, you could swing the $800.00 monthly installment. But you can't do that, and you *do* want the house, so keep your $900 limit, with a $20,000 balloon – and keep looking....

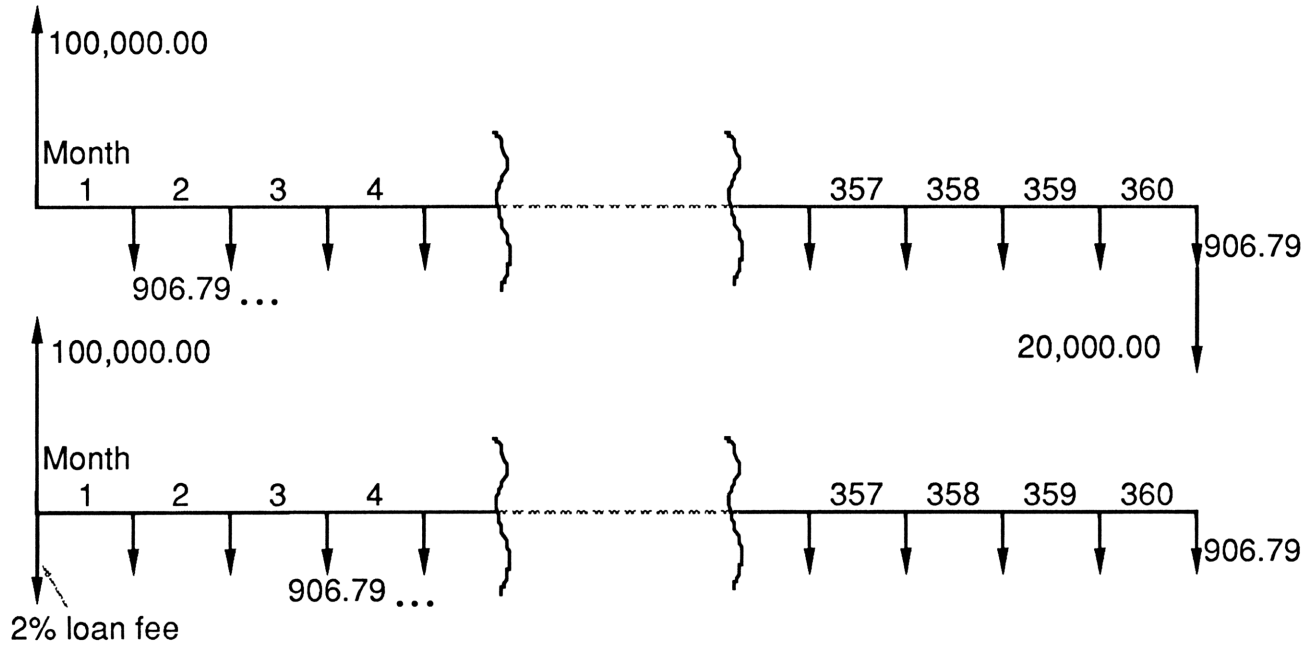
On The Road Again: Here's a lender who will loan you $100,000 in exchange for $906.79 payments (end of the month, as usual) for 360 months – period.

Hmm...that sounds at lot better than $906.79 a month, plus a $20,000.00 balloon, as you had back on page 117. What's the catch?

It's this: There's a *loan fee* (also known as "points up front") due and payable at the moment you sign the papers. This fee is 2% of the amount financed, and 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 $20,000.00 balloon?

Solution: Whenever you're trying to compare deals, of course, you should first diagram them:



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

Think about it: On page 117, you *know* you're paying 10.5 A.P.R., because that's what you *specified* when calculating your PMT. But here this lender here just pulled that payment amount out of the air (what a coincidence, eh?).

If you give your HP-17B this scenario to crunch, what will it tell you is the prevailing interest rate?

Here are the current contents of the TVM registers:

360	10.50	87,456.61	–800.00	0.00
N	I%YR	PV	PMT	FV

So change only the PV and PMT.

First, press 9 8 0 0 0 **PV**. Do you see why? Because you can net together simultaneous cash-flows on a cash-flow diagram.

So actually, with the $2,000 loan 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 it.

So press 9 0 6 · 7 9 +/– **PMT** and then **I%YR**, to figure the *real* A.P.R.... Answer: I%YR=10.64

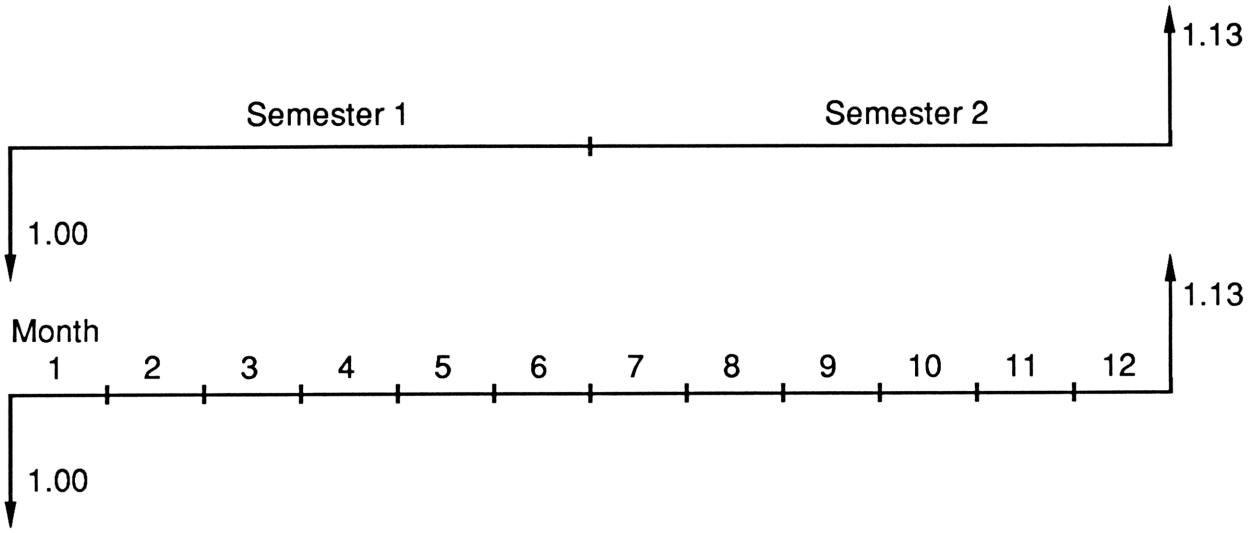
Aha! That loan fee effectively jacked up the rate *above* 10.5 A.P.R. Not so good!

Down But Not Out: Off you go again, still in search of that elusive Perfect Mortgage. Around the corner is yet another bank, which goes for all your terms – monthly payments, balloon, A.P.R., everything – *except* ...they are a Canadian lender, so their interest compounds *semiannually.*

Hmm... How do you compute a monthly payment with interest that compounds semiannually? Doesn't the payment period *always* need to match the interest period (the D.I.P.) on the HP-17B? ...Yep.

Time to punt? Nope. You merely need to *convert the semiannual compounding rate to its equivalent monthly rate. Then you can use TVM as usual.*

Think about it: If you can find a *monthly* interest rate that accrues in one year *exactly* the same amount of interest on a dollar as this *semiannual* rate, then they're really the same rate with different names, aren't they?



"If you can't tell the difference, there *is* no difference."

Solution: The key here is to recognize that you need to do a side calculation first – to convert to an equivalent monthly rate. Then once you do that, you'll plug that rate into the TVM's I%YR register, and away you go.

First, starting from the MAIN Menu, press **FIN** and then **ICNV**. You'll see this:

You're concerned with periodic interest conversions (one period to another – not continuous compounding), so press **PER**. You'll see this:

Now do your little thought experiment: What EFFective rate is given by a 10.5 A.P.R. compounded 2 times per year? Press 2 **P** 10.5 **NOM%**, then **EFF%**
Answer: EFF%=10.78

Now for the "coope de grayce:" Turn around and change the P to 12, keep the EFF% right as it is and ask what NOM% would produce it. Answer: NOM%=10.28

Now leave that result right there on the Calculator Line, and go to the TVM menu ([EXIT] [EXIT] **TVM**).

Once you're there, the first thing you do is press [STO] **I%YR** (you cannot just press **I%YR**, 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)
I%YR = 10.28 (you just put this there – don't touch it)
PV = 100,000.00 (you'll probably need to key this in)
FV = -20,000.00 (this needs changing, too)

Solve for **PMT**: PMT=-889.80

That's less than your 906.79 for the monthly compounding case – which makes sense, right? After all, your equivalent monthly A.P.R. turned out to be 10.28, rather than 10.5.

"At last – a mortgage with a $20,000.00 balloon *and* payments of less than $900.00!"

All your shopping around and "What-Iffing" with your HP-17B has paid off!

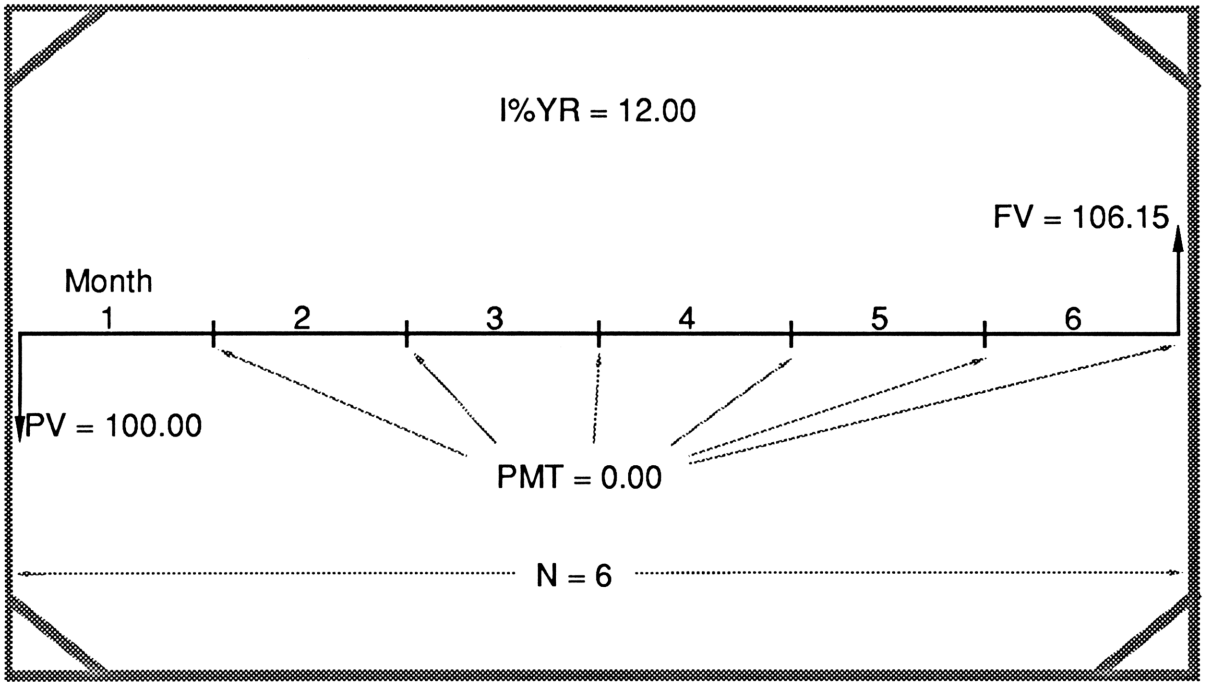
Review again exactly what you had to do here with this Canadian mortgage:

To convert the *quoted* A.P.R. into a *usable* A.P.R. (one matching the payment period), you had to do a side calculation with the ICNV menu.

In that side calculation, you found out what the quoted A.P.R. effectively does to a dollar in one year. Then you simply changed the number of compounding periods – to reflect the period you want to convert to – and asked what A.P.R. does the very same thing to a dollar in *that* number of periods.

Once you got your result, you used it as your I%YR in a straightforward TVM calculation.

And *all* this comes from your basic knowledge of the "picture" analysis of the Time Value of Money – where your five TVM variables form a "picture frame" of understanding that you place over your cash-flow diagram:



So by now, you should know how to solve these types of problems:

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

Ready to solo?...

A TVM Quiz

(You just *knew* this was coming, didn't you? Be sure to diagram each situation.)

1. A mortgage is written at 15.5% A.P.R. It amortizes totally in 30 years of $400 monthly payments (in arrears). What is the loan amount?

2. If the above loan had $350 payments – and annuity in advance – what would the remaining balance be after the 360th month? After the 120th month?

3. A finance company agrees to loan $100,000 at 17% A.P.R., compounded daily (on a 360-day year), in exchange for quarterly payments (in arrears) that will amortize the loan in 15 years. A 2% finance charge is due and payable at the beginning of the loan. (Good grief!)

   a. What is the payment amount?

   b. What is the remaining balance after 10 years?

   c. If the balloon is actually paid at that ten-year point, what's the quarterly-compounded A.P.R. really earned by the finance company?

   d. Would that A.P.R. have been different if the loan had continued on to full term (15 years)?

4. You want to buy an $86,000 home, with 10% down and the balance financed at 11% A.P.R., with monthly payments in arrears. Your maximum payment is $750. Can you totally amortize this loan in 20 years? If you were to make *whatever* payment is necessary to do so, what is the face value of the interest you would save – compared to a 30-year total amortization?

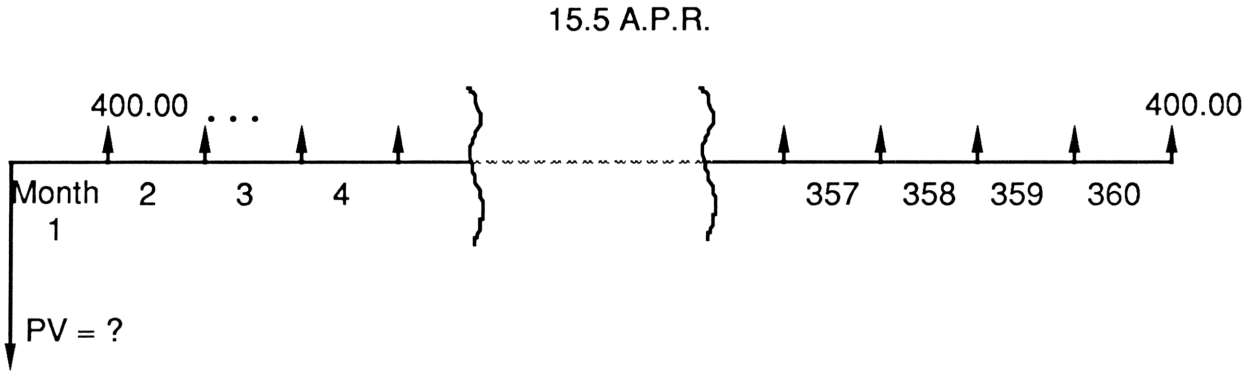
5. Which carries a higher interest rate: A $20,000 car loan with monthly payments of $440 (in arrears) and a balloon of $5000 in five years; or a credit card that charges 16.5% A.P.R., compounded daily?

6. If inflation is an *effective* 4% per year (compounded daily), and your tax bracket is 27%, what will be the true value (i.e. the buying power in terms of today's dollars) of a taxable account earning an *effective* 10% per year (compounded daily) into which you are paying $5.82 per day – every day – for 25 years? For 40 years? For 50 years?

7. If, at the beginning of your 26th year (happy birthday), you 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 balance compare with a similar account that you open at the beginning of your 33rd year and pay $2000 for *every year* up through your 60th year?

TVM Quiz Solutions

1. Here's the picture of the problem:



This is drawn from the perspective of the lender, right?

It's a pretty straightforward problem – just asking you to backtrack and figure out what amount was financed. That unknown would be the Present Value, wouldn't it?

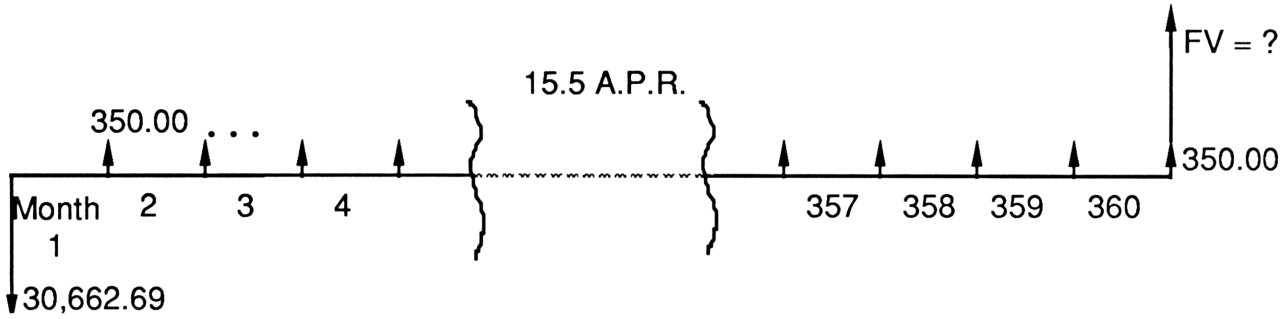
From the TVM Menu, press **OTHER** and check your annuity mode (should be END MODE) and P/YR (should be 12).

Then EXIT to TVM, and go for it:

30 × 12 **N**
15.5 **I%YR**
400 **PMT**
0 **FV** Then solve: **PV** Answer: PV=-30,662.69

(Sort of a weird amount for a mortgage)

2. Here is the variation on the previous problem:



Since you've just completed the original version of the problem, all those TVM parameters are still conveniently sitting in their registers. So change only what you have to: First, from the TVM Menu, press **OTHER** **BEG** (EXIT)

Then (3)(5)(0) **PMT** and **FV** to get the balloon left to pay after 30 years:

```
FV=353,916.61
```

Yikes! What's *that*? How could an innocent little $30,662.69 mortgage produce this howling monster balloon? ("But officer, there *must* be some mistake!...")

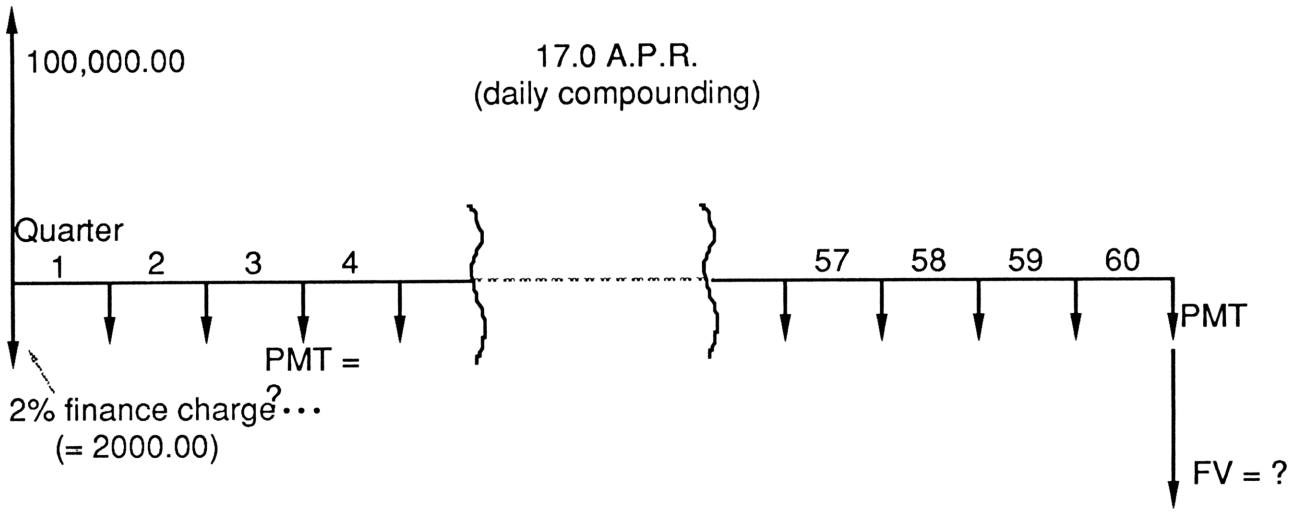
Nope: It turns out that $350 a month *doesn't even cover the interest* on the loan. Therefore, instead of covering all interest and eating away a little of the principal, which is what a normally amortizing payment is supposed to do, this anemic little payment *never touches* the principal and even fails to cover all the interest. So all that growth is the "uncovered" interest compounding for all those years. This is called *negative amortization.**

Look how far it gets in just 10 years: (1)(2)(0) **N** **FV**

```
FV=42,448.84
```

*Asked to name the most awesome force in the universe, Albert Einstein is said to have once replied, "Compound interest."

3. 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] [ICNV] [PER]

Then [1][7] [NOM%] [3][6][0] [P] [EFF%] EFF%=18.53

And [4] [P] [NOM%] NOM%=17.36

There you have it – the quarterly-compounding A.P.R. that does the same thing to a dollar in one year as does a daily-compounded 17% A.P.R.

So [EXIT] [EXIT] [TVM] and [STO] [I%YR].

Your correct quarterly A.P.R. is now in I%YR, safe and sound.

a. All right, the first question is, what's the payment amount? That's now a straightforward calculation. First, press OTHER END and 4 P/YR, to match the situation correctly. Then EXIT to TVM and fill in the numbers:

15 × 4 N (15 years of quarterly payments to amortize totally)
100000 PV (this is the amount being amortized; it's not reduced by the finance charge)
0 FV (payment amount must totally amortize in 15 years)
PMT PMT=-4,708.42

b. Now it's easy to find the remaining balance after 10 years (40 payments):

40 N FV FV=-62,101.87

c. To figure the finance company's *true* A.P.R., you now need to consider that they didn't really loan $100,000, but only $98,000. But they're still receiving the *payments* as calculated on $100,000, so the only thing you need to change before calculating I%YR is the PV:

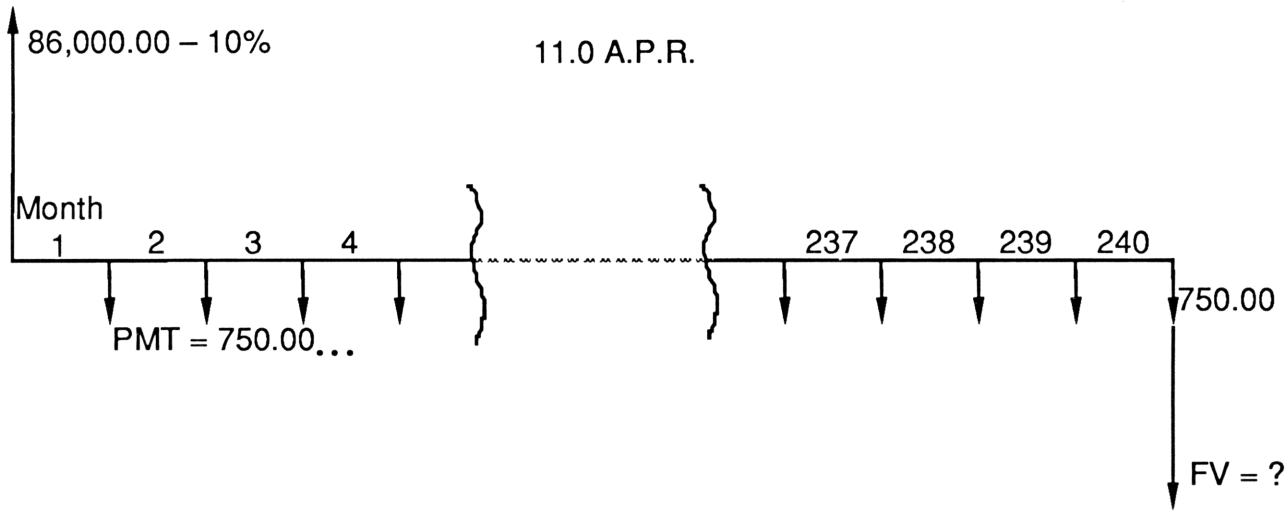
98000 PV I%YR I%YR=17.84

d. If you take the loan to term instead, N is now 60, and the FV is now zero, but all the other parameters apply from the calculation you just did:

60 N 0 FV I%YR I%YR=17.81

It *does* make a difference! Why? Because the finance charge is the same in either case, but its impact on the yield is "distributed" over more time in this latter case, thus "diluting" the "boosting" effect on the A.P.R.

4. Here's the scenario:



You want to vary N and see how it affects FV. If FV is a negative quantity, then that represents a balloon you'll have to pay at the end of the term. If FV is zero or positive, it means you either totally amortized the loan or actually *overpaid* it (thus showing a positive balance); the $750 payment is sufficient in that case. If not, then the payment must be higher – or the term must be longer.

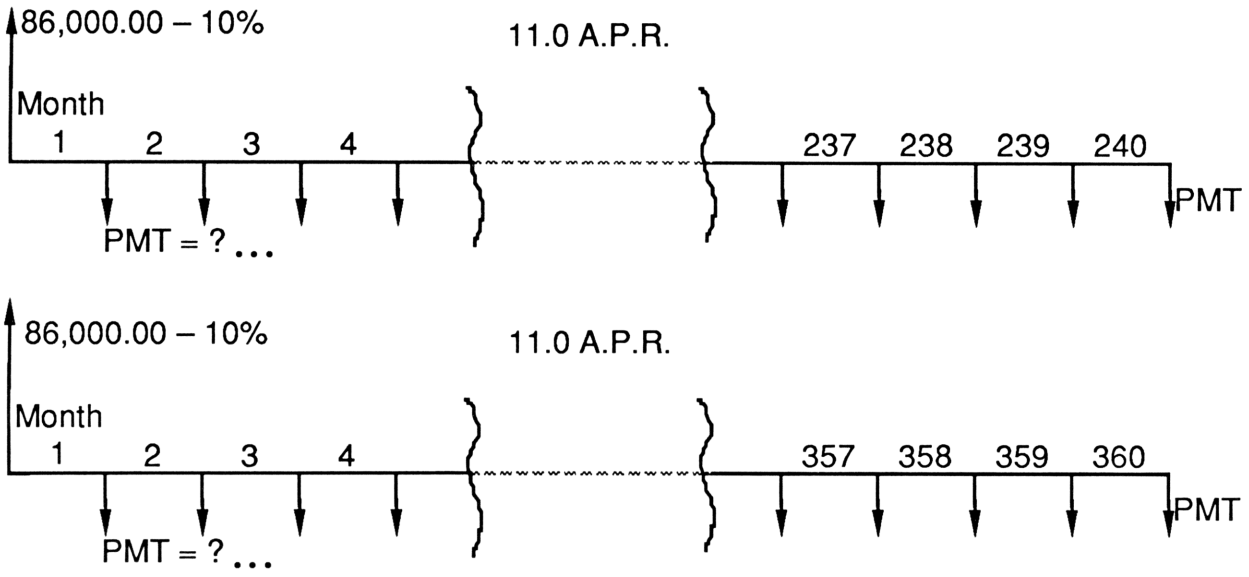
First, be sure you're set to **12 P/YR** and **END** mode.

Then, from the TVM menu, press

20 × 12 **N**
11 **I%YR**
86000 − 10% **PV**
750 +/− **PMT**
FV Answer: **FV=-42,341.66**

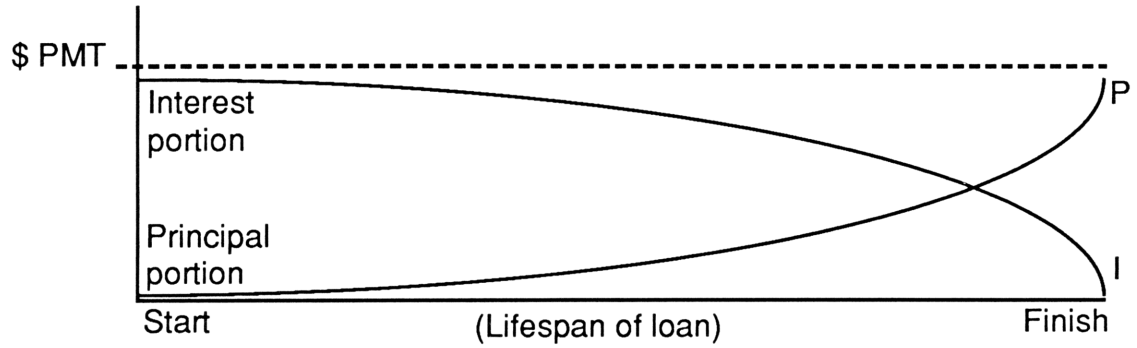
That's a balloon payment that you would need to *pay* (it's negative), so $750 is *not* enough to amortize the mortgage in 20 years.

As for the second part of the problem, you're comparing these two scenarios:



The question is, what is the face value of the *difference in interest* paid over these two terms?

Of course, every amortizing PMT does two things. It completely pays all interest accrued on the loan in that month, *and* it pays a little bit of the principal amount. Thus, the next month, there's a little less interest to pay and therefore a little more room to pay on principal, etc. Here's a rough picture of how the "P" and "I" portions of a payment change over the term of a mortgage:



Now, since both of the above loans are totally amortized, the principal paid in each case is the same – the total amount financed, $77,400. Thus, the difference in interest paid is simply the difference in total payments.

So to get the answer here is quite easy. Just solve for the payments in each case, multiply your answers by the *number* of payments in each case (giving you the total P & I paid in each case) and subtract:

Since everything is set up from the first part of the problem, press [0] [FV] to specify total amortization, then [PMT]. (Answer: PMT=-798.91)

Then [×] [RCL] [N] [=] [STO] [1] to save the total paid for that case (see how that arithmetic works – recalling from and storing to registers?)

Next, press [3][0] [×] [1][2] [N] [PMT] (Answer: PMT=-737.10)

And [×] [RCL] [N] [−] [RCL] [1] [=] (see how this arithmetic works?)

Answer: -73,616.08

That's the *face value of the difference* in payments for the two loans (it's negative because you subtracted the lesser, the 20-year amortization, from the greater, the 30-year case).

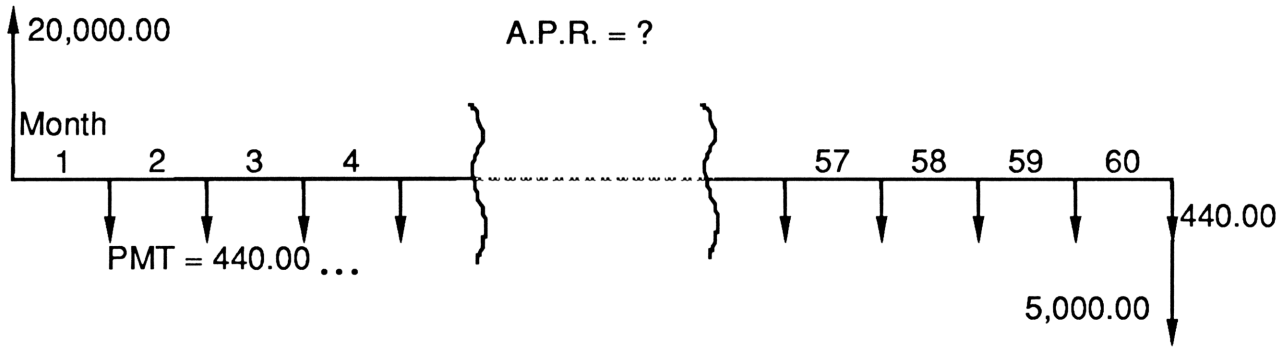
But why this phrase, "face value?"

It's because with the TVM assumption, you really can't equate amounts of money paid *unless they are transacted at the same time.* Clearly that's not the case here, since one loan goes on ten years longer than the other.

So it's not really correct to say that the 20-year case saves $73,616.08 over the 30-year case. After all, if you had a spare $737.10 per month for ten years, you'd be putting that money away in an interest-bearing account, wouldn't you? And after ten years, it would be worth *much more* than its face value.

It would have the *added value of time.*

5. This is just a comparison of two I%YR's, but you'll need some figgerin' with each before you can compare them directly. Here's the car loan diagram:



Just plug in all the knowns and solve for the unknown – the I%YR: From the TVM menu (after setting a monthly END mode, as usual), press

60 N	(five years' worth of months)
20000 PV	(pretend you're the borrower; you receive the loan)
440 +/– PMT	(negative because you pay this every month)
5000 +/– FV	(there's your balloon at the end)
I%YR	Answer: I%YR=16.70

As for the credit card rate, you don't even need a TVM calculation – just a quick trip to the ICNV menu:

From the TVM menu, press EXIT ICNV PER to get there, then 365 P 16.5 NOM%, and solve: EFF% (Answer: EFF%=17.93)

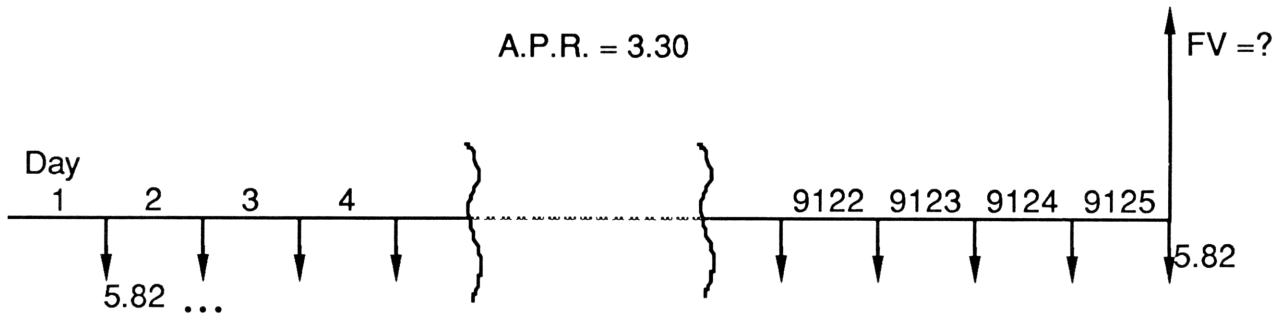
Now change things to a 12-period year and find the corresponding nominal rate: 12 P NOM% (Answer: NOM%=16.61)

That's slightly better than the 16.70% of your car loan. So actually, you would have done better to have charged your car on your credit card!

6. The first thing to realize is that inflation is a tax on the time value of your money. In other words, if you're money's face value is earning 10% per year, but inflation is raising the price of everything by 4% per year, then your interest is really accumulating you *actual* income at the rate of 6%, right?

   Secondly, something similar happens with an income tax. If all your interest is taxable, that means that 27 cents of every additional interest dollar goes you-know-where. So forgetting about inflation for a minute, the face value of your interest is decreased through taxation by 27% of 10%, right?

   You need to combine these two to find the effective "today's-dollar" rate at which you can accrue your savings: [10] [−] [27] [%] [−] [4] [=] **3.30** Isn't real great, is it? It's reality, though – so it's what you use in the TVM calculation:

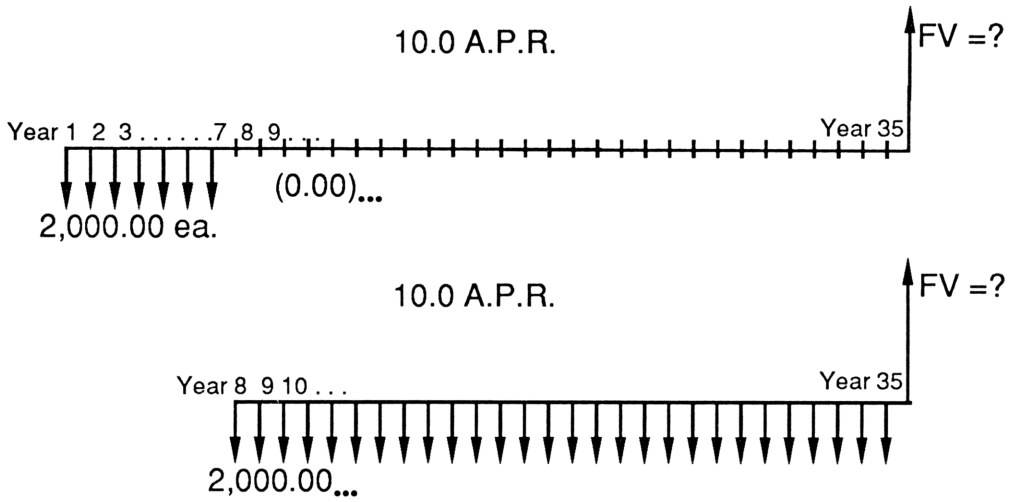


I/YR	(stores this real interest rate)
OTHER [365] **P/YR** [EXIT]	(END mode is OK)
[365] [×] [25] **N**	(ignore leap years)
[0] **PV**	(start with nothing saved)
[5] [•] [82] [+/−] **PMT**	(your daily savings)
FV	Answer: FV=82,512.68

Now vary the number of years: [365] [×] [40] **N** **FV**
Answer: FV=176,587.14

[365] [×] [50] **N** **FV** Answer: FV=270,789.77

7. This is a comparison of between the Future Values of two different scenarios:



Notice that the yearly payments are at the beginning of each year. The first thing to do, then, is to set your OTHER parameters appropriately: From TVM, press [OTHER] [1] [P/YR] [BEG] [EXIT].

After that, it's easy. First, you need to figure out what the account balance is at the end of your 7 years of saving: [7] [N] [10] [I%YR] [0] [PV] [2000] [+/-] [PMT] [FV] Answer: FV=20,871.78

Now let that amount "ride" for another 28 years, with no further payments into the account. To do that, you need to recognize that the answer you just got for FV will become your PV now (you're moving the entire TVM "picture frame" forward in time): So press [+/-] [PV] [0] [PMT] [28] [N] [FV]
Answer: FV=300,991.75

The second scenario: [28] [N] (unnecessary if you've just finished the first part of this problem) [0] [PV] [2000] [+/-] [PMT] [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.

By now you should be pretty comfortable with those TVM keys. It's amazing, all the different things they can tell you – if you set the problems up correctly, of course! Now, here's some space for your very own…

Notes and Doodles on TVM

...and here are a couple of good things to complete your N & D collection ☞

Amortization Schedules

Try This: From the TVM menu, go to the OTHER menu. There's one item there that you haven't used yet: **AMRT**.

Press it now; you should see this:

An AMoRTization schedule is an itemized listing of the principal and interest ("P and I") paid over any given number of periods within the term of a mortgage. Typically, for example, you would need to know the amount of interest you've paid in any tax year, because that interest is tax-deductible.

The thing to realize is that the AMRT menu is a set of side calculations, much like the ICNV menu, except that they use the values currently sitting in your TVM registers.

Like This: Just to get a feel for this, suppose you had a straightforward, 30-year, fully amortized mortgage for $100,000 at 10.5% A.P.R., with monthly payments in arrears. Use the AMRT menu to find the principal and interest you paid in each of the first three years, and what remaining balance was still due after the three years.

Solution: First, you fill in all the usual TVM values and parameters.

From the TVM menu, you press 360 **N** 10·5 **I%YR**, then 100000 **PV** 0 **FV** **OTHER** 12 **P/YR** **END** EXIT **PMT**
Result: PMT=-914.74 (This should look vaguely familiar)

Now go to AMRT, by pressing **OTHER** **AMRT**, and follow the display's directions. To amortize 12 payments at once, press 12 **#P**:

```
#P=12 PMTS: 1-12
#P  INT  PRIN  BAL  NEXT  TABLE
```

Now solve for whatever you need:

BAL: Bingo! BALANCE=99,499.48
INT: INTEREST=-10,476.36 (this is negative because AMRT follows the sign conventions you set up with TVM).
PRIN: PRINCIPAL=-500.52

To amortize the NEXT set of 12 payments, just press **NEXT**....etc.

Not bad, eh? Play around with the AMRT menu items (e.g. **TABLE** will let you print out any portion of the amortization schedule if you have a printer)!

Pennies and Particulars

There's one other important thing to note about the TVM keys: As you know, your HP-17B will use 12 digits in all of its arithmetic – indeed, in most of its calculations, including the TVM calculations.

For Example: Recall the current value that's sitting in the PMT register (from TVM, press RCL PMT). You'll see PMT=-914.74

But now set the display to show you all of its digits (press DSP ALL RCL PMT). This is how big the payment amount *really* is (to 9 places): PMT=-914.739294493

Problem is, nobody really 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 up: 914.740000000).

So key it in (DSP FIX 2 INPUT) 9 1 4 • 7 4 +/– PMT

Now *re*calculate the FV. What do you get and what does it mean?

You get FV=1.78, and it means that since you had to round your payment *up* slightly (by a fraction of a penny), you've technically *overpaid* your loan by $1.78, (assuming, of course that you haven't also rounded off any other numbers, such as the interest rate or remaining balance).

You can tell that this is an overpayment – due back to you – since it's positive. If you had rounded the payment *down,* you would probably have an underpaid balance – and the FV would have signified this with a minus sign.

So when using the TVM keys, remember to use real-life payment amounts (dollars and cents only) to finalize terms and balances.

Now, what about AMRT? After all, it uses the TVM values, too. Does it use any unrealistic penny fragments the TVM registers may hold?

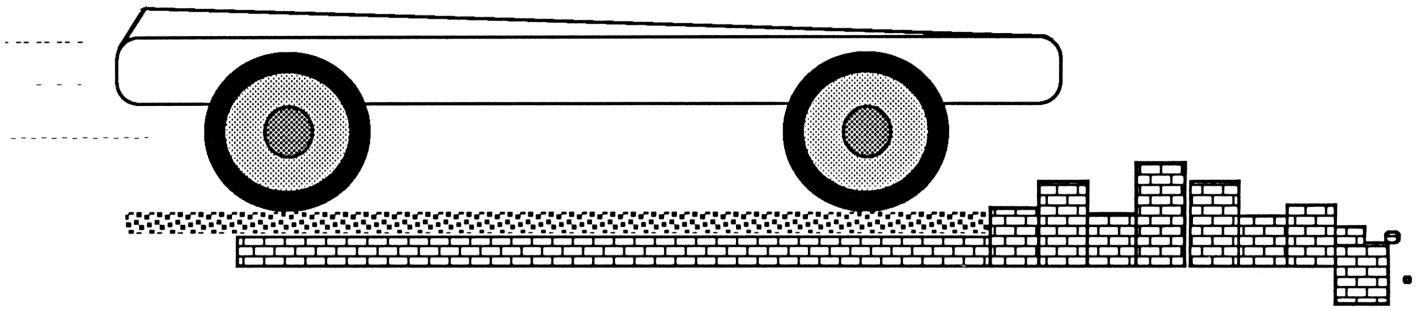
Nope.

With AMRT, HP basically took care of this concern for you: *Except for the I%YR variable (which is always used to its complete 12 digits), the AMRT menu uses TVM values only up to the number of digits the display is set to show.*

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

Prove It: Go back on your own and re-run the AMRT example on page 143, except this time, run it with a DISP ALL setting.... Then try it with a FIX 4 setting....

See how the results differ slightly? Of course, you'll usually want the FIX 2 setting, but it's good to know and see the difference.



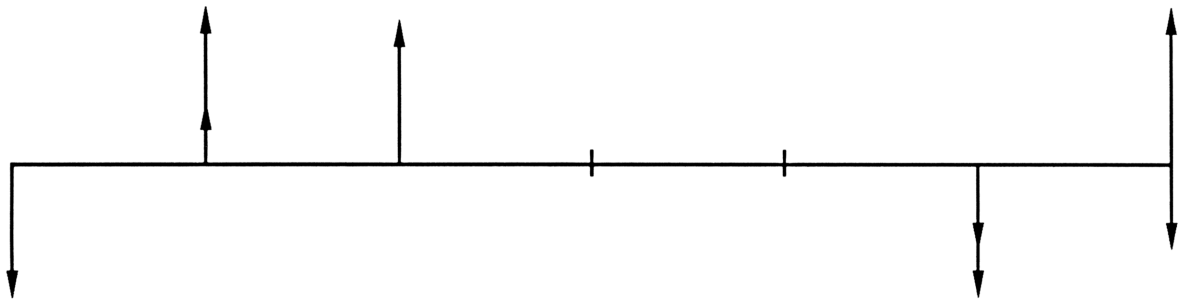
ROUGH ROADS: The CFLO Menu

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 may vary once in awhile – sometimes quite often.

Like this:



Notice that there *is* a cash-flow for every period here (zero is a cash-flow). But if you had cash-flows that occurred at random *time* intervals, you'd be all out of luck, for there's no calculation built into your HP-17B that will analyze such a situation for you.

In order for your calculator to help you solve for unknowns in any cash-flow scenario, the cash-flow ***amounts*** *may be uneven, but their* ***occurrences*** *must still be regular – once per period.*

OK, fine. The above picture still falls within those limitations, but how do you deal with it? It may be solvable, but not with the TVM keys, because there's no level PMT.

Hint: You use the CFLO menu instead....

Go Find It: From the MAIN menu, press **FIN**, but then – instead of **TVM** – press **CFLO**. You'll see something like this:

Now, remember your list of numbers (back on pages 60-66)? These CFLO lists are very similar. You can key in values, move up and down the list with the ▲ and ▼ keys (and ■▲ and ■▼, too – remember what they do?).

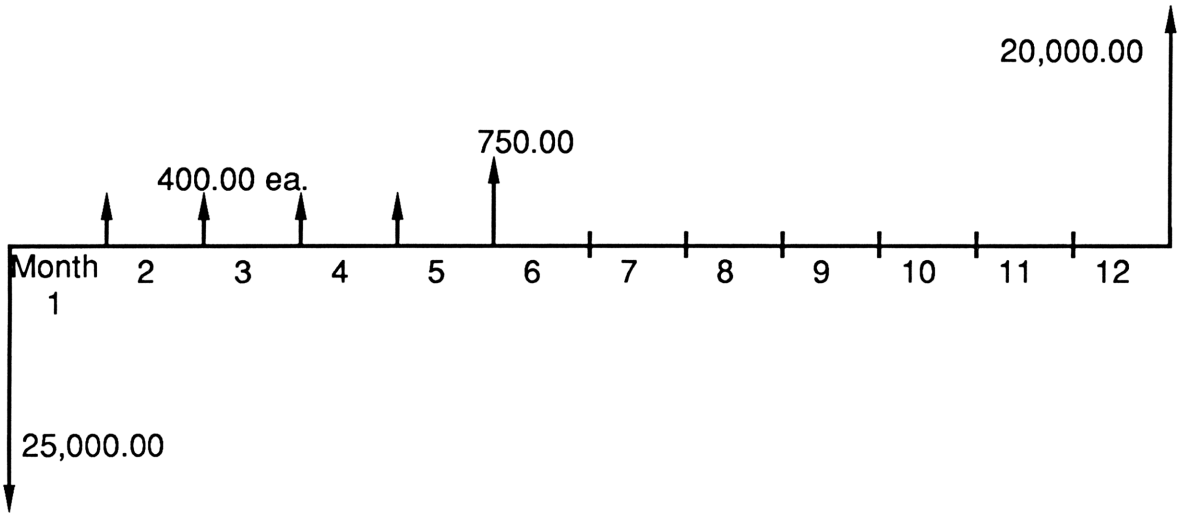
This kind of list is just a *specially reserved kind for representing cash-flow diagrams.*

You've already seen how the TVM values "draw the picture for your calculator." But now you're working under a different set of circumstances, because there's no PMT value you can use.

The key is this: To draw a picture of an *uneven* cash-flow situation, you use the concept of *cash-flow groups.*

What Are Cash-Flow Groups?

Take a look at this typical uneven cash-flow scenario:



After thinking for a minute, you could describe it quite succinctly like this:

"The initial cash-flow is -25,000."

"The amount of the first cash-flow group is 400.
The number of times this occurs in a row is 4."

"The amount of the next cash-flow group is 750.
The number of times it occurs in a row is 1."

The amount of the next cash-flow group is 0.
The number of times it occurs in a row is 6."

The amount of the next cash-flow group is 20,000.
The number of time it occurs in a row is 1."

That's the basic idea right there.

You treat the very first cash-flow (called FLOW(0)) separately, because it usually represents the one-time investment (the negative) cash-flow of the scenario.

Other than that, though, you just read off the groups, left to right, noting how many times each cash-flow amount occurs in a row, keying this information into your CFLO list. Got it?

Do It: Key into your CFLO list that scenario on the previous page.

Here's How: First, of course, go to the CFLO menu so that your display looks like that shown on page 148. Then *watch your display* as you press [CLEAR DATA] [YES] and then:

[2] [5] [0] [0] [0] [+/–] [INPUT]

[4] [0] [0] [INPUT] [4] [INPUT]

[7] [5] [0] [INPUT] [1] [INPUT]

[0] [INPUT] [6] [INPUT]

[2] [0] [0] [0] [0] [INPUT] [1] [INPUT]

No sweat, right? And did you notice your display as you were doing this? The Calculator Line shows you which item you're currently working on, and the FLOW( )= and #TIMES= help you figure out what that item is.

Keep in mind that FLOW(0) always occurs only "1 time in a row." It's the first cash-flow group *after* that which is called FLOW(1).

Something else that's good to notice: Every time you key in a cash-flow amount, the machine starts out by automatically 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 [INPUT]! Very handy.*

Change Your Mind: Go to the top of the list and step down through it to see if it's all correct. Then change the *amounts* (not the number of times each occurs in a row) as follows:

(0):	-22,000
(1):	250
(2):	400
(4):	25,000

Solution: Press [■][▲] (to jump to the top, remember?), then [▼][▼] [▼][▼][▼][▼][▼], to check the display against your diagram. Then, to change the numbers, press

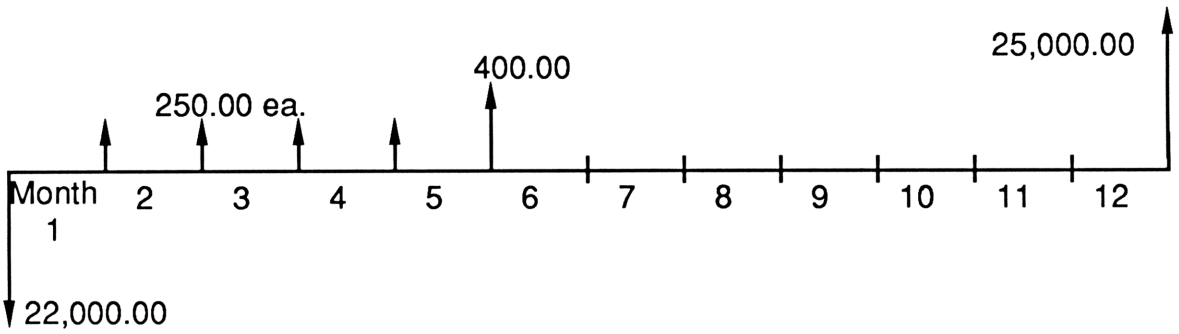
[■][▲] [2][2][0][0][0] [+/−] [INPUT]
[2][5][0] [INPUT]
[▼] [4][0][0] [INPUT]
[▼][▼][▼] [2][5][0][0][0] [INPUT]

(Of course, you can change the numbers in any order, but it just means more moving around with [▼] and [▲].)

---

*The last item on the CFLO menu is a toggle key called #T?. If *all* the cashflows in a list occur only once each, you can use this toggle to turn off the #TIMES prompting altogether – very thoughtful of HP, no?

With the changed numbers, your situation now looks like this:

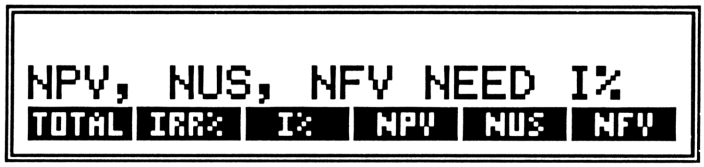


Well, wunderbar. Now what? What do you do with a CFLO list? First, you should NAME it ("FRED") to save it (remember how to do this? – page 66):

EXIT NAME FGHI F RSTUV R ABCDE E ABCDE D INPUT

Now, see that first item on the CFLO menu? It's CALC.

Give It A Poke: You'll see this menu come up:



This is the CFLO CALCulations menu. This is where you'll finally end up to "crunch" your answers – once you've drawn the picture correctly.

Notice the message across the top. It's telling you that you need to key in some interest rate, called I%, before you can calculate the quantities called NPV, NUS, and NFV....Why? What are those things, anyway?

What Is NPV?

There you are with that nice cash-flow scenario, and not knowing what to do with it. Well, it turns out to be a real-life situation – an opportunity you're being offered to help your friend get a business started over the course of the next year.

The budding entrepreneur has figured that he'll need $22,000 up front. He even 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. And for the entire one-year 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 for a minute: The Time Value of Money is *the interest value that time adds to money.* A little bit now is entirely equivalent to more later, and the equalizer is the interest rate that acts over that time.

Your friend is claiming that your $22,000 given to him now is *entirely equivalent* to his giving you $250/month for four months, $400 for one month, $0/month for six months, and then $25,000, *assuming an interest rate* of 19.175 A.P.R.

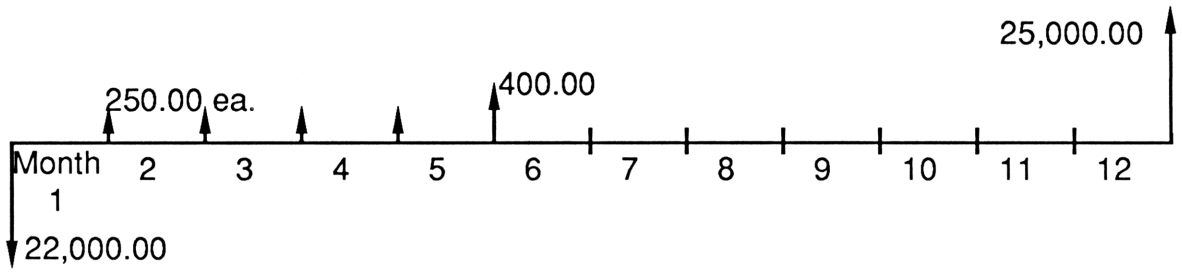
Can you somehow prove this equivalence?

Yes – with NPV.

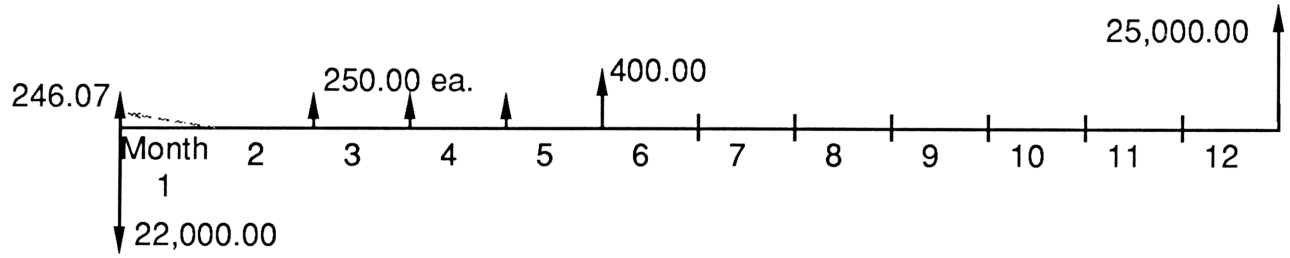
Do you recall (from pages 93-95) that on any cash-flow diagram, you can slide cash-flows up and down the diagram – as long as you let them grow or shrink according to the prevailing interest rate?

Well, what if you were to take each of the cash-flows of this proposal and slide them back to the beginning of the timeline, letting each one of them shrink according to the 19.175 A.P.R.?

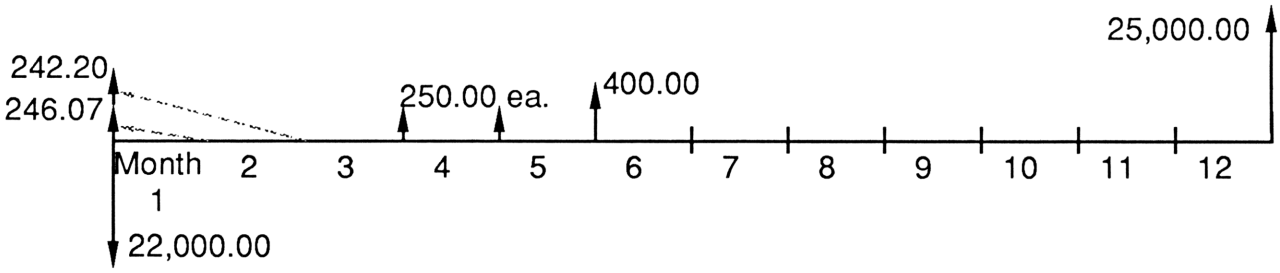
Here's the starting situation:



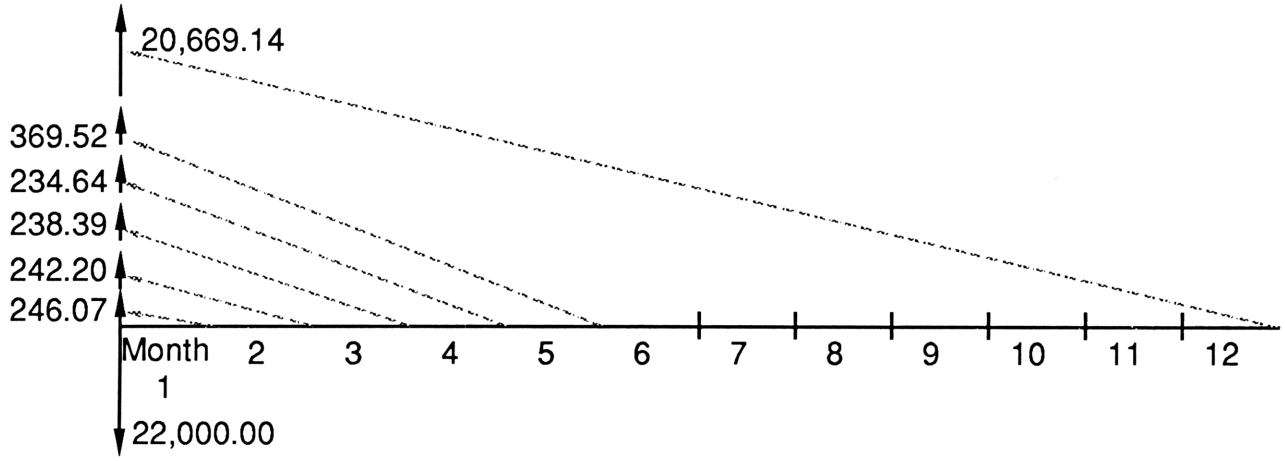
Here it is after you've slid that first $250 back. See how it's reduced? It shrank, according to the prevailing 19.175 A.P.R.:



And here it is after the second $250 slides back. It amounts to even less, of course, because it had a longer "slide-and-shrink" treatment:

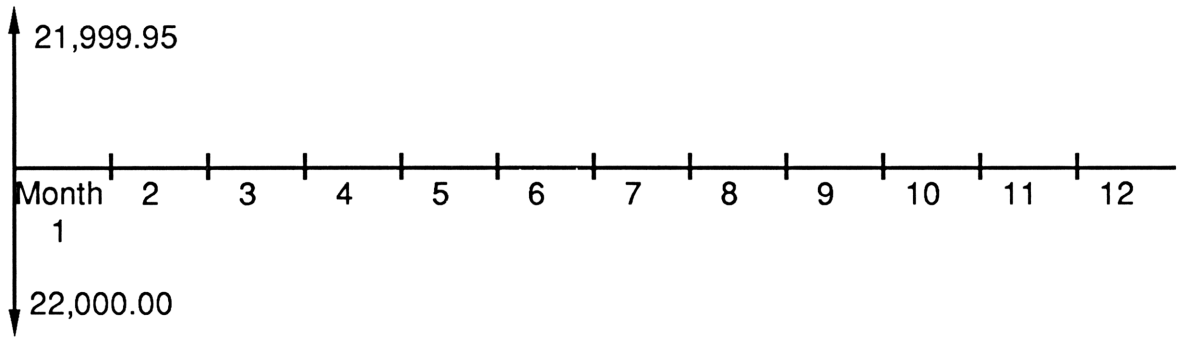


And so on, until the picture looked like this:



All the cash-flows have been slid back and stacked up (the zero cash flows would still be zero, right?).

Of course, another rule of cash-flow diagrams is that 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 had said all along: Your $22,000 investment in him *was* equivalent to all his various repayments to you, *if* you account for everything under a prevailing rate of 19.175% A.P.R.*

And that's what NPV is: *A sliding-back-and-summing-up of all cash flows – at the beginning of the timeline!*

*Incidentally, because this prevailing rate tends to *discount* (shrink) the value of money as you slide the cash-flows back, it's also called the *discount rate.*

Of course, the idea here is that your calculator can compute this NPV for you in the blink of an eye. And since you've already keyed in the whole picture, you're ready to use that CALC menu 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 prevailing ("discount") rate in the "sliding" process.

Clue It In: Tell your HP-17B to use a 19.175 A.P.R. as the prevailing discount rate in this cash-flow scenario.

Solution: Do you just key in 19.175 and press I%? Nope.

You're probably remembering the TVM menu, where you never need to worry about actually converting the A.P.R. to a D.I.R., because the machine will do it for you – once you tell it the P/YR.

But here in the CFLO menu, you can't do that; you need to *manually* convert any A.P.R. to its correct form (monthly in this case). That is, you need to press 19.175 ÷ 12 I% (= 1.60)

Now you're ready to ask the machine to do all that sliding and summing for you. If your paper analysis has been correct, then the NPV should be zero (or very nearly that), because it will *net together* everything at the beginning of the timeline, thus adding your initial -22,000 to that tall stack of positive cash-flows that were discounted back from the future. Since these two are equal and opposite, they *ought* to net out to be zero, right?

So press NPV, and see: NPV=-0.05

Now, take a look at 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 – just in case you want that for any reason: 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? (No fair using your calculator!)

Silly Answer: A zero discount rate means you're sliding *without shrinking at all,* right? In other words, you're just moving all the cash-flows, as is, back to the beginning of the timeline and summing them.

What should you get? It's the same as taking the TOTAL, which you just did, above: 4,400.00

To Make Sure: Do it. Press 0 **I%**, then **NPV**.

Answer: NPV=4,400.00

(Ain't concepts fun, though?)

But what does that 4,400.00 mean here, anyway? And what was the meaning of that leftover nickel (-0.05) from the analysis of your friend's proposal? What *is* the meaning of NPV?

To answer that, look at this simple demonstration....

Problem: If you assume that the discount rate is 19.175 A.P.R. then the Net Present Value (NPV) of the deal your friend has offered is *zero,* right? After all the sliding-back-and-summing is said and done, all your in-vestments exactly balance all your returns.

What's the NPV to you of this same situation if you wanted a 20% A.P.R. instead?

Solution: Press [2][0][÷][1][2] [I%] [NPV]

Answer: NPV=-170.01

Now, what does this number mean?

It means that *if* the value of your money *to you* (that is, what you could expect to yield with it in some *other,* similar investment) is really 20% A.P.R., then you would *lose* $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 zero, meaning that *it had the same value as any other investment that yielded 19.175% A.P.R.* i.e. "zero difference."

In other words, the NPV represents a kind of advisory number that compares the cash-flow scenario you're analyzing with a hypothetical investment yielding exactly the discount rate, I%. If the resulting NPV is *positive,* this means the scenario is earning you *more* for your money than the discount rate; if the NPV is *negative,* it's yielding *less* (and if it's zero, then, of course, there's no difference).

That's why it's usually wise to use as a discount rate a rate that you really *could* yield in another investment of similar risk and liquidity. The NPV is then a very good indicator of any investment's value to you *relative to what else you could do with that money.*

A good case in point is that 4,400.00 NPV you got by assuming a discount rate of zero (back on page 157). $4,400 is a lot of money, and it's a *positive* NPV here.

What it's telling you is this:

"If the yield on your money in other investments of similar risk and liquidity is *really* 0%, then you come out $4,400 *farther ahead* by putting your money into *this* scenario rather than putting it into any of those 0%-yielding others."

So that's what you're looking at when you solve any cash-flow scenario for NPV, OK?

Now, see if these problems and solutions make sense to you....

An NPV Quiz

(Draw those cash-flow diagrams!)

1. A loan is written at 15% A.P.R., with $450 monthly payments (in arrears), for 30 years. What is the loan amount? Find it with an NPV calculation (no fair cheating with the TVM keys!). Do the same for annuity in advance.

2. How much money should you deposit now in a bank account that pays you 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?

3. Remember that comparison of IRA's (back on page 129)? The idea was that 7 early years of investment were more valuable after 28 years than if you made similar investments for each of those later 28 years. Prove this once again with the CFLO CALC menu.

4. Suppose that, for an initial investment of $10,000, you could choose between two different schedules for receiving your returns. Under the first option, you would get $1000 back after Year 1, another $1000 after Year 2, $2000 after Year 3, $3000 after Year 4, $5000 after Year 5, and $8000 after Year 6. Under the second option, you would get $2800 back after each of the six Years. If other comparable investments could yield you 16% A.P.R., which of these options would you choose?

   What *even* re-payment stream *would* be equivalent to the uneven stream?

5. You're considering the purchase of a contract – 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 this mortgage is willing to discount it to you so that you can earn 16% on your investment. How much should you pay the bank for the right to "inherit" this contract (begin to receive its payments) at the end of the third year of the second mortgage?

6. If, in your bargaining with the bank over the contract purchase in the previous problem, you managed to talk the purchase price down to where your yield was 17.5% A.P.R., how much money did you save yourself?

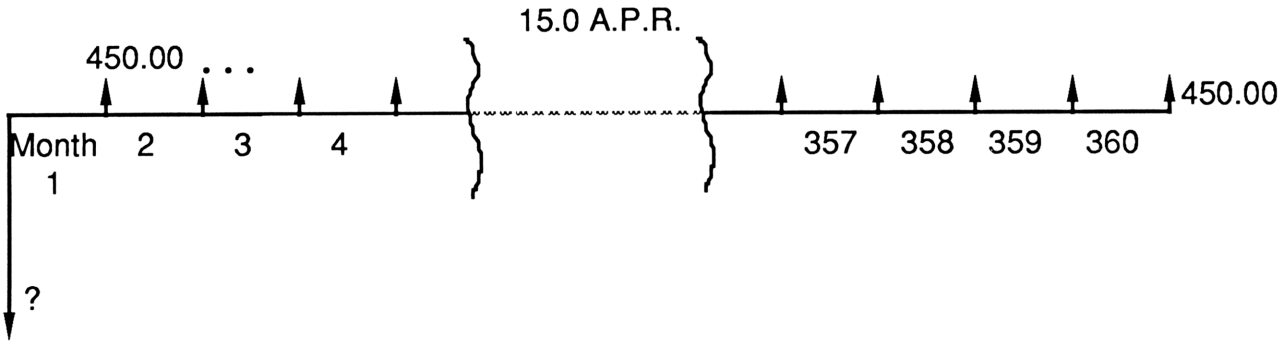
7. You have $20,000 in cash, and next January, you have to move to a new town for a 5-year contract job. A quick check of that town's housing market shows that you can buy a $95,000 home (including all closing costs) for the $20,000 down and the balanced financed at 10.5% A.P.R. for 30 years, but paid off in 5 years with a balloon payment. Insurance and maintenance are about $50/month, property taxes will cost you around $1200/year, and your marginal income tax bracket is 27%. With the way things are going, you can probably expect to sell the house yourself in five years for about $145,000.

   On the other hand, you could rent that same house for $750/month (paid at the beginning of the month, of course) and just salt away your $20,000 in a (no-load) mutual fund which has prospects of yielding about 15% A.P.R. (compounded monthly) over a five year period.

"To buy or not to buy – that is the question."

NPV Quiz Solutions

1. Here's the situation (as a lender would look at it):



Not too tough – but you're not allowed to use TVM. Fortunately, it's just as easy with CFLO.

To begin, GET a *NEW list (press GET :NEW from the CFLO menu).

Now, the key to this problem is realizing that your unknown is a cash-flow occurring at the *beginning of the timeline.* Consider this: If you were to analyze the rest of your cash-flow list – but ignore this unknown Flow – what would the resulting NPV be? It would be the exact amount of your unknown Flow (but with the opposite *sign*), right? Recall how the sum of all discounted negative flows exactly balanced the sum of all discounted positive flows in the NPV of your friend's scenario (page 156).

This *must* be the case, right? In order for the quoted 15% A.P.R. to represent the interest rate in this mortgage, it must be the discount rate for which the entire scenario's NPV is zero. If it produced an NPV of either more or less than zero, then the mortgage's yield would be either more or less (respectively) than that 15% A.P.R.

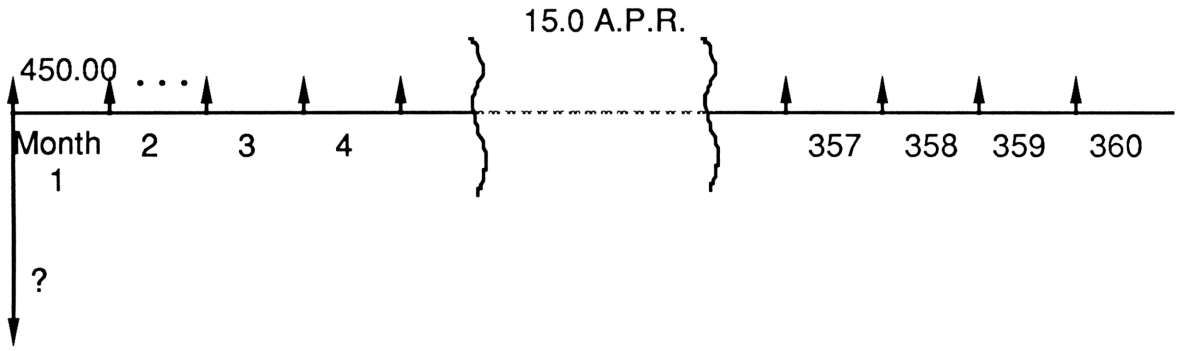
So you use this "incomplete" NPV to figure out what *other* cash-flow must have happened there at the beginning of the timeline to "zero out" that NPV.

So just key in your cash-flow groups, left-to-right, ignoring the fact that there must be some other flow at the beginning of the timeline:

0 INPUT	(there's no *other* beginning cash-flow – besides the unknown you're temporarily ignoring)
450 INPUT 360 INPUT	(30 years' worth of $450 payments)

That's the whole picture, in those few keystrokes! Now, to calculate, press EXIT CALC and 15 ÷ 12 I% to give the monthly discount rate. Then NPV Answer: NPV=35,588.76

So now you know the amount financed: -$35,588.76 (from you, the lender). Now redraw the picture for the case of Annuity In Advance:



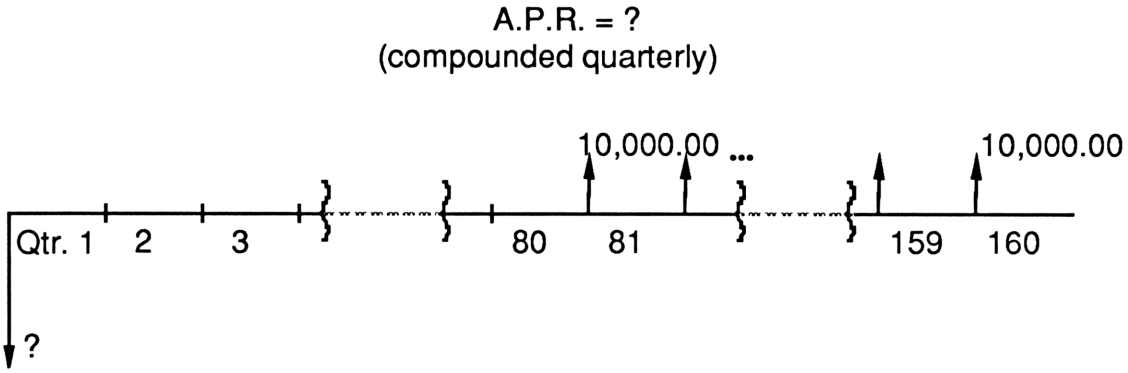
Again, find the unknown flow at the beginning by ignoring it (EXIT to the CFLO menu to modify your list now):

■▲ 450 INPUT	(in BEGIN MODE, there's a PMT right away)
▼	(change only the frequency of FLOW(1))
359 INPUT 0 INPUT INPUT	(the end of the 360th month has no cash-flow)
EXIT CALC NPV	Answer: NPV=36,033.62

So your amount of your initial investment must have been -$36,033.62

This "omit-a-cash-flow-and-then-read-it-off-the-NPV" trick is simple, but it will work *only* when your unknown flow is at the *beginning* of the timeline.

2. Here's the situation:



Again, the problem is to figure out what that unknown cash-flow is at the beginning of the timeline. The only fly in the ointment is the fact that you're going to have *quarterly* cash-flows but a *monthly* compounding of interest....

("this sounds like a job for... ...ICNV!")

Start at the MAIN menu and press **FIN** **ICNV** **PER**. Then: 8 **NOM%** 12 **P** and **EFF%** Answer: EFF%=8.30

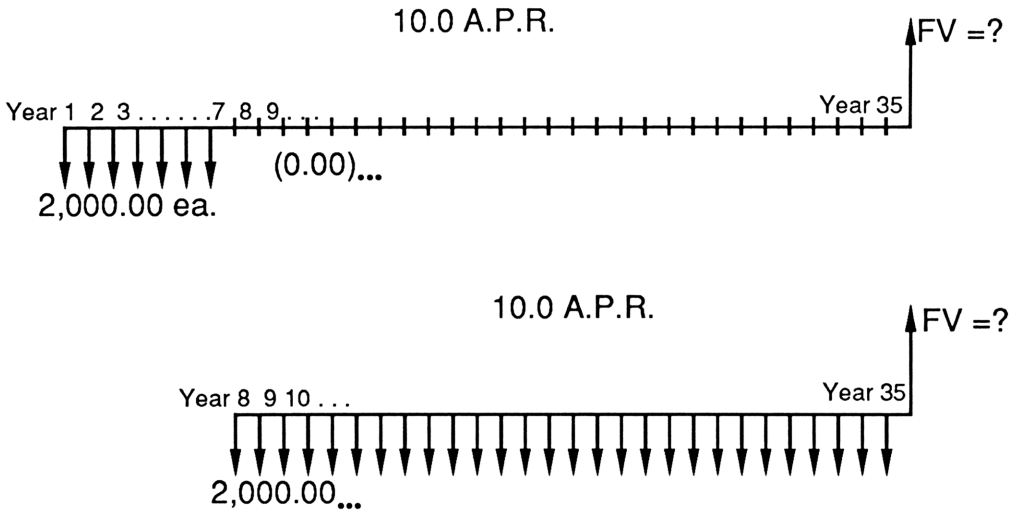
Now switch to a quarterly compounding and see what NOM% this requires: 4 **P** **NOM%** Answer: NOM%=8.05

Now store this for later use (STO 0)and head on over to the CFLO menu to draw the above picture:

EXIT EXIT **CFLO** CLEAR DATA **YES**
0 INPUT (nothing else happens at the beginning, except your unknown flow, which you ignore for now.)
0 INPUT 79 INPUT (20 years less one quarter of no cash-flows)
10000 INPUT 80 INPUT (20 years of withdrawals)
EXIT **CALC** RCL 0 ÷ 4 **I%** **NPV** Answer: NPV=81,967.88

Change to $15,000 withdrawals: EXIT ▲▲ 15000 INPUT EXIT **CALC** **NPV**
Answer: NPV=122,951.83

3. Here are the two alternatives:



Your strategy is to build each diagram as a list, but instead of finding the Net *Present* Value (NPV), you're going to find the Net *Future* Value (NFV), which is also a convenient item on the CFLO CALC menu.

Option A – the save-a-little-bit-early plan: At the CFLO menu, either clear the current list with ■ CLEAR DATA or NAME it and GET a *NEW list. Then

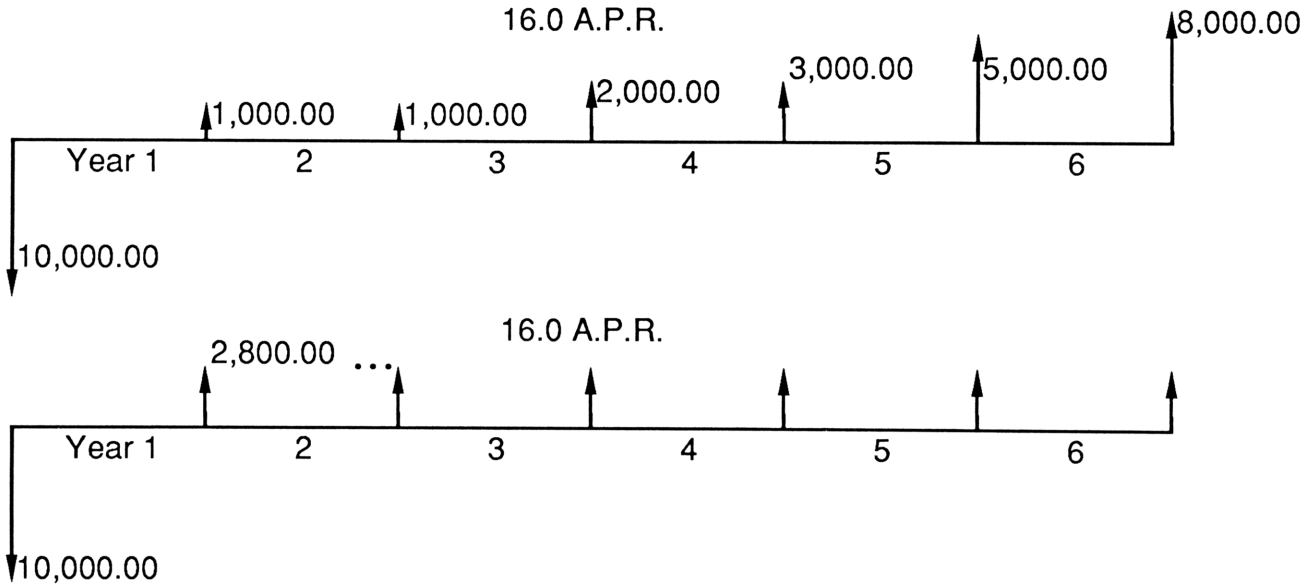
2 0 0 0 INPUT
2 0 0 0 INPUT 6 INPUT
0 INPUT 2 9 INPUT EXIT
CALC 1 0 I% NFV Answer: NFV=300,991.75

Option B (the save-a-lot-more-later plan): EXIT to the CFLO menu, ■ ▲, then

0 INPUT 0 INPUT
▼ 2 0 0 0 INPUT 2 8 INPUT
0 INPUT INPUT EXIT
CALC NFV Answer: NFV=295,261.86

No doubt about it – a stitch in time....

4. Here are your alternatives:



From the CFLO menu, clear or name the current list, then begin a new list:

1 0 0 0 0 +/– INPUT
2 8 0 0 INPUT 6 INPUT EXIT CALC 1 6 I% NPV Ans: NPV=317.26

OK, that's the simple, even cash-flow option. Now EXIT to CFLO, and NAME this list EVEN: NAME ABCDE E RSTUV V ABCDE E NOPQR N INPUT. Then GET NEW for the other case:

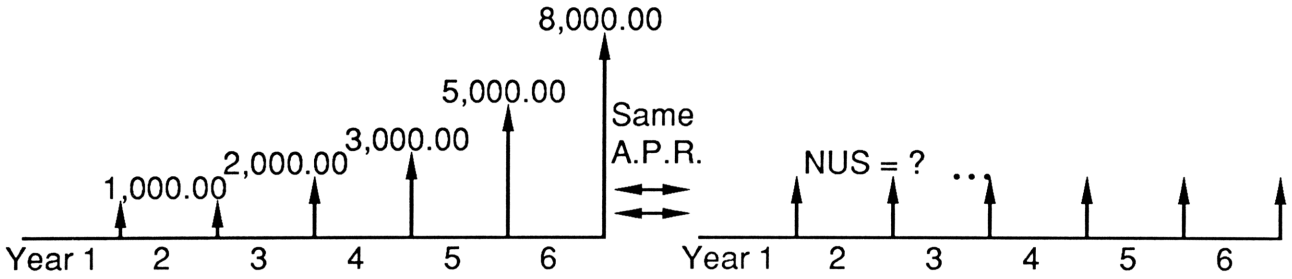
1 0 0 0 0 +/– INPUT
1 0 0 0 INPUT 2 INPUT
2 0 0 0 INPUT INPUT
3 0 0 0 INPUT INPUT
5 0 0 0 INPUT INPUT
8 0 0 0 INPUT INPUT EXIT CALC NPV Answer: NPV=207.52

(Guess you ought to NAME this list UNEVEN: EXIT NAME RSTUV U NOPQR N ABCDE E RSTUV V ABCDE E NOPQR N INPUT)

So NPV makes it clear that the EVEN case here is worth slightly more to you.

Now how about the second part of this question: What uniform stream of payments *would* be equivalent to the uneven situation? It's a stream of payments slightly *less* than $2800, since the NPV of the uneven situation was only slightly less than the NPV of the $2800 stream. Make sense?

All right. This is a question you can 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:



As shown, you're not interested in replacing the initial -$10,000. That's a "given" in either case. You're analyzing only the uneven cash-flows to see what uniform yearly cash-flow could replace each of those 6 uneven returns.

So just modify your uneven situation by omitting the initial investment:

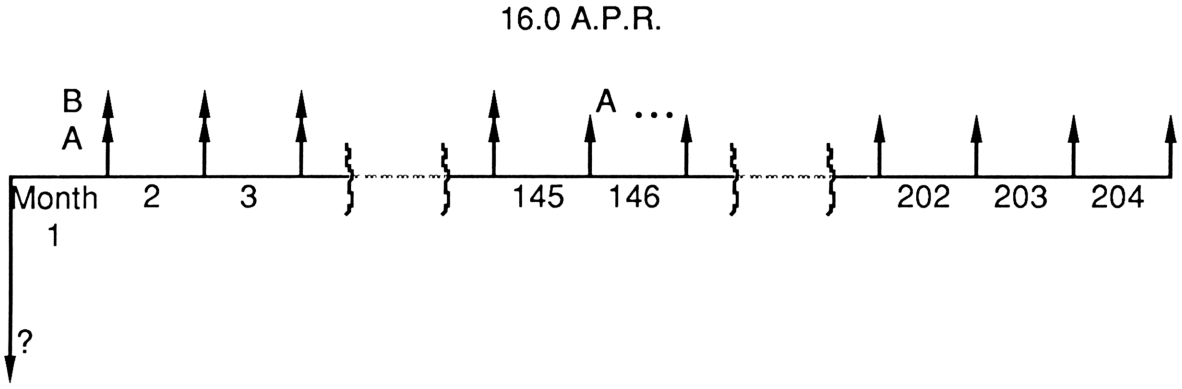
[▲] [0] [INPUT] [EXIT] **CALC** and then **NUS** Answer: NUS=2,770.22

So your uneven payment scenario has exactly the same value to you as does an even payment scenario where the payments are $2,770.22. That seems plausible enough, doesn't it? After all, it's only slightly less than $2800, as you predicted above. Store this: [STO] [0]

Now prove that equivalency: [EXIT] and **GET** **EVEN**. Then [▲] [▼], and [RCL] [0] [INPUT] to replace the $2800 with this NUS. Now the NPV should be exactly that of the uneven case, right? Then [EXIT] **CALC** and **NPV**

Answer: NPV=207.52 Q.E.D!

5. As the investor, you'll be the new lender, so you adopt that perspective. For 12 years, you'll be receiving payments on both the first and second mortgages (144 combined payments). After those 12 years, the first mortgage will have been fully amortized, but payments on the second mortgage will continue for another 5 years (60 months). It's all there on the picture:



Of course, before you can key in this situation to your CFLO analysis, you need to figure out how much each of those mortgage payments are. Looks like it's time to pay a little visit to the TVM menu (press [MAIN] [FIN] [TVM]): Seeing that your PMT parameters are OK (12P/YR & END MODE), go:

Payment A: [3][6][0] [N]
[1][2] [I%YR]
[9][0][0][0][0] [+/−] [PV]
[0] [FV] [PMT]

Answer: PMT=925.75

Store that for future use: [STO] [1]

Payment B: [2][4][0] [N]
[1][3] [I%YR]
[3][0][0][0][0] [+/−] [PV]
[PMT]

Answer: PMT=351.47

Store that for future use, also: [STO] [2]
...and off you go to the CFLO menu: [EXIT] [CFLO]

Now then, draw the complete picture for your calculator (omitting for now the unknown investment you're making right at the start – just like in problems 1 and 2 of this quiz):

First, GET a *NEW list: GET *NEW

Then 0 INPUT	(no initial cash-flow besides the unknown)
RCL 1 + RCL 2 INPUT	(your combined payments
1 4 4 INPUT	for 12 years)
RCL 2 INPUT 6 0 INPUT EXIT	(that's the 5 extra years of payment B)
CALC 1 6 ÷ 1 2 I% NPV	Answer: NPV=83,714.73

That's what you should pay for this double mortgage.

6. Good news: If you've just completed problem 5, above, then the answer to this one is very simple. In fact, it's the same diagram with a different A.P.R.!

Just STO 0 to save the resulting NPV from above, then 1 7 • 5 ÷ 1 2 I% and NPV

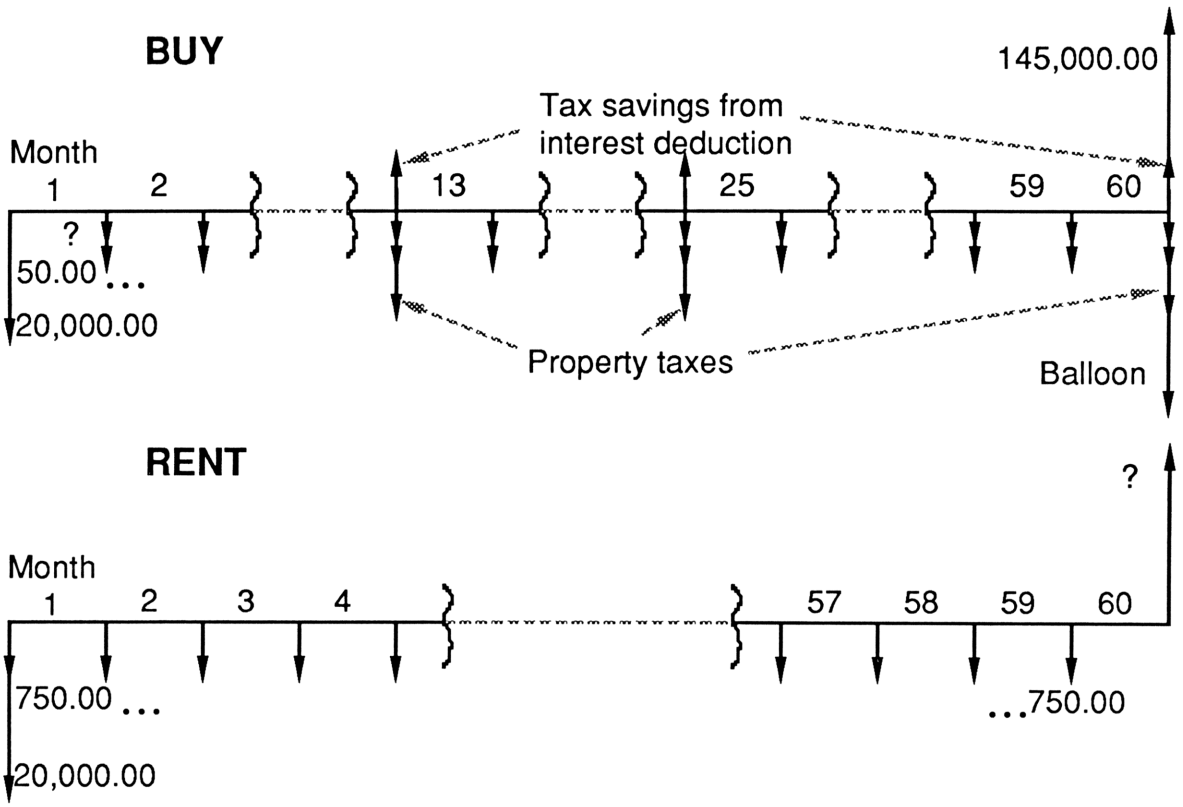
Answer: NPV=78,431.74

That's what you would pay to yield 17.5%. So you would have saved the *difference* between this and the 16% price. So:

+/– + RCL 0 = Answer: 5,283.00

Pays to bargain, doesn't it?

7. Here are the two options:



Problem is, there are a whole lot of unknown cash-flows up there. Before you can tell which is the better deal, see if you can't fill in some of the blanks....

First, by how much will $20,000 grow in five years at 15% A.P.R.? Keep in mind that it's a no-load (no brokerage or sales fee) fund, with *taxable* yearly dividend distributions. So the fund's 15% growth rate is reduced by your marginal tax rate: [15] [−] [27] [%] [=] Answer: **10.95**

This is your net A.P.R. (compounded monthly) on that mutual fund. This is what you would use to figure the Future Value of $20,000 after 5 years. So, from the TVM menu, press:

[STO] [I/YR]
[60] [N]
[20000] [+/−] [PV]
[0] [PMT], then [FV]. Answer: **FV=34,492.76**

OK, you're getting there; the simple RENT picture is more or less complete.

What about the BUY picture?

The key here is also income taxes: You can assume that any gains you make upon resale of your home won't be taxed, because you'll soon buy another home elsewhere. But the other consideration is that the interest in your monthly payments and your property taxes are tax-deductible. This means, essentially, that the government is going to reimburse you 27% of your interest tab and of your property tax bill, when taxes come due, because these are your tax savings.

So you've got some heavy-duty calculating to do:

- First of all, you need to figure out the PMT amount you'll have to make for 60 months.

- Then you'll have to figure out what the remaining balloon will be in five years, when you resell the home.

- Then you'll have to figure out how much your tax savings will be, year by year, and put these in the picture, too.

- Then you'll need to take the NPV of the whole mess, using the after-tax yield of your mutual fund (10.95) as your discount rate, since that's your alternative investment, right? But even there, you need to find the equivalent monthly rate, since all your cash-flows in both scenarios occur monthly.

- There's just about everything here but the kitchen sink, isn't there?

Time's a-wastin'....

- The PMT amount (start from the TVM menu): Press 360 N 10.5 I%YR 75000 +/- PV 0 FV PMT

  Answer: PMT=686.05

  Add to that the monthly maintenance and insurance: + 50 = +/-
  Answer: -736.05 Store this monthly cash-flow for later: STO 0

- The balloon amount: Now that you have the payment, change the term and figure the FV: 60 N FV Answer: FV=72,661.28

- Your tax savings: First of all, you can assume that you pay your property and income taxes at the same time – at the end of each year.

  Of course, it's easy to figure your *net* property tax bill per year:
  1200 − 27% = 876.00

  Your interest deduction isn't so straightforward. But that's what the AMRT menu is there for! From TVM, press OTHER and AMRT.

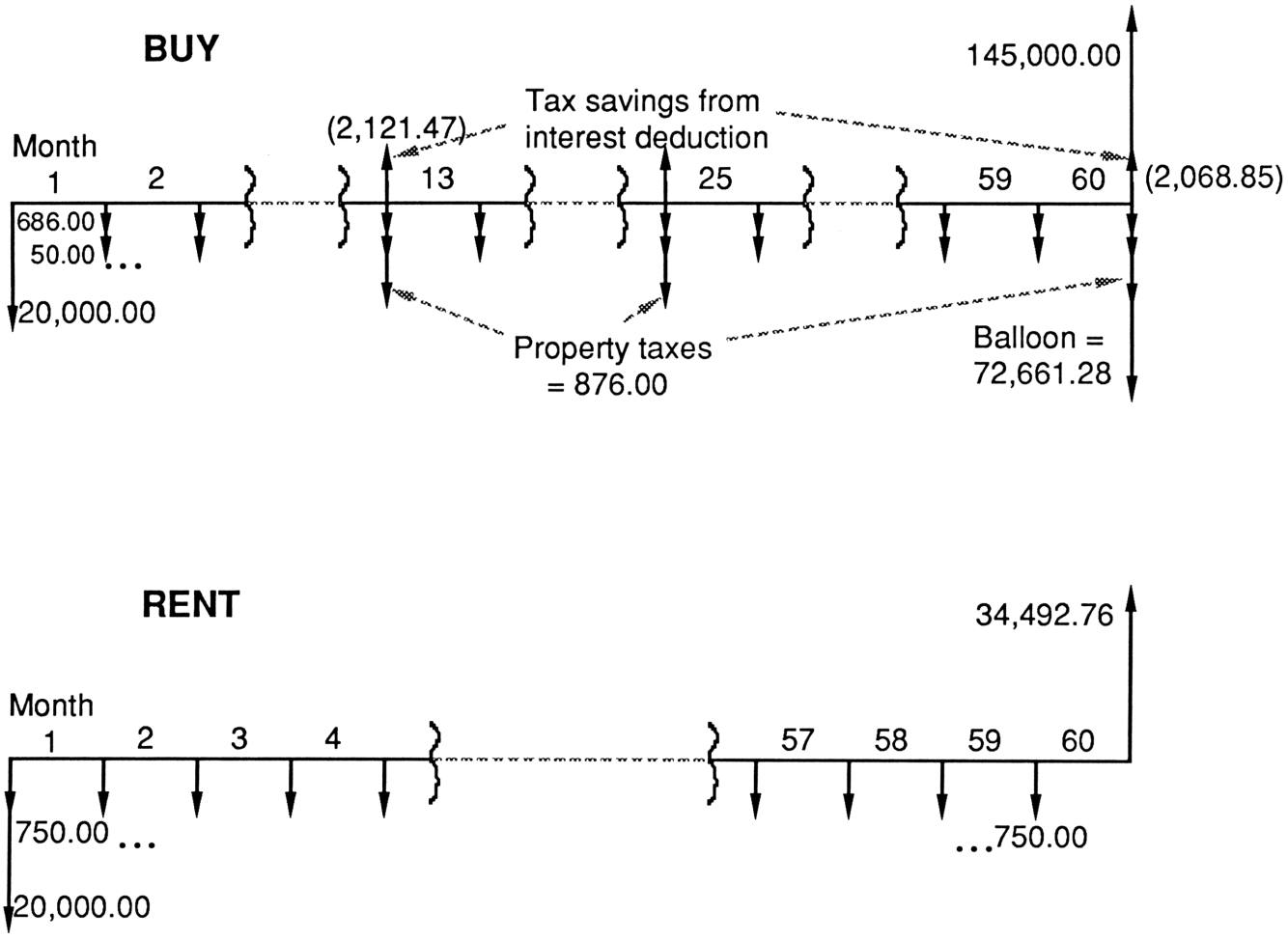
  Then 12 #P INT Result: INTEREST=7,857.28
  Take 27% of this and save it for later: × 27% = STO 1 (2,121.47)

  Now repeat this procedure (using the NEXT key) for years 2-5:

  NEXT INT × 27% = STO 2 (2,110.30) These will appear as
  NEXT INT × 27% = STO 3 (2,097.90) positive cash-flows, since
  NEXT INT × 27% = STO 4 (2,084.14) they are your tax savings
  NEXT INT × 27% = STO 5 (2,068.85) from deductible interest.

Notice how slowly principal is chipped away in the early stages of a mortgage. Most of every payment is interest (as you can tell from the balloon, too; after five years, it's only slightly less than the amount financed). But the principal *is* decreasing, and after a while it would shrink much more quickly.

So here are your two final pictures:



Now head to the CFLO menu for the final battle: (▮ MAIN FIN CFLO)....

At last, you can build the complete pictures for your HP-17B. Here's the *rent* scenario:

[CLEAR DATA] [YES]
[2][0][7][5][0] [+/–] [INPUT]
[7][5][0] [+/–] [INPUT] [5][9] [INPUT]
[3][4][4][9][2][.][7][6] [INPUT] [INPUT] [EXIT]
[CALC] [1][0][.][9][5] [÷] [1][2] [I%] [NPV] Answer: NPV=-34,849.49

Save this to compare, if you want: [STO] [7] and [EXIT]

And now for the really big mess – the *buy* scenario:

[CLEAR DATA] [YES] [2][0][0][0][0] [+/–] [INPUT]
[RCL] [0] [INPUT] [1][1] [INPUT]
[RCL] [0] [–] [8][7][6] [+] [RCL] [1] [=] [INPUT] [INPUT]
[RCL] [0] [INPUT] [1][1] [INPUT]
[RCL] [0] [–] [8][7][6] [+] [RCL] [2] [=] [INPUT] [INPUT]
[RCL] [0] [INPUT] [1][1] [INPUT]
[RCL] [0] [–] [8][7][6] [+] [RCL] [3] [=] [INPUT] [INPUT]
[RCL] [0] [INPUT] [1][1] [INPUT]
[RCL] [0] [–] [8][7][6] [+] [RCL] [4] [=] [INPUT] [INPUT]
[RCL] [0] [INPUT] [1][1] [INPUT]
[RCL] [0] [–] [8][7][6] [+] [RCL] [5] [+] [1][4][5][0][0][0] [–] [7][2][6][6][1][.][2][8] [=] [INPUT] [INPUT]
[EXIT] [CALC] [1][0][.][9][5] [÷] [1][2] [I%] [NPV] Answer: NPV=-7,484.64

Aha! As you can see, neither scenario is exactly a steal. In fact, both are net *expenses* – negative – to you. But it's also clear that the cost will be far less to you if you *buy* the house ([RCL] [7] to compare).

IRR%

By now, you've probably noticed that there's an item on your CFLO CALC menu that you've not used yet: IRR% (and it's probably your favorite, too, isn't it?).

Well, it's time to take a look at what Internal Rate of Return (IRR%) is all about.

In 25 Words Or Less:

> "Internal Rate of Return (IRR%) is the discount rate that produces a Net Present Value (NPV) of zero for any given cash-flow situation."

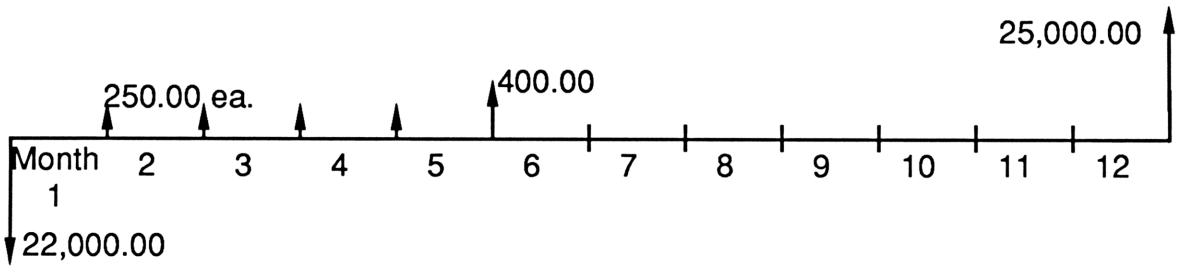
Remember your friend, the "ontra-pra-nooer"? Remember his claim about your 19.175% A.P.R. "yield" on his plan (page 153)?

You proved he was right by proving that your returns *balanced* your investment if you discounted those returns back to the beginning of the timeline, using this promised 19.175% as your slide-and-shrink rate.

It's that balancing notion again – that's what IRR% is all about. It does a series of NPV calculations "in its head," using various discount rates on a kind of trial-and-error basis, until it arrives at a discount rate that produces an NPV of zero.

So where do you suppose your friend got that 19.175? Lucky guess, maybe?

No, he probably had an HP-17B up his sleeve.



Prove It: Find the IRR% of your friend's proposal (the diagram above has been reproduced from page 154, for easier reference).

Solution: Luckily, that scenario is the list you named FRED, so from the CFLO menu, GET that list now (you can clear the current list if necessary): **GET** **FRED**. Now, without any further ado, just go to the CALC menu and ask for the IRR%:

CALC **IRR%** Answer: IRR%=1.60

Uh... ...hmm...that's not exactly 19.175% is it?

Hold your horses! Remember that all the discount rates in the CFLO menu are periodic, not annualized (and this trait is *different* than the I%YR of the TVM menu). The *periods* in your friend's scenario are *months,* so the IRR% calculated was also monthly.

So annualize it: ⊠ 1 2 = 19.17 That's better.

And look at ALL its known decimal places: DSP **ALL** 19.1747627

See? It *was* just about 19.175 (but not exactly, which explains why – when you used *exactly* 19.175 on page 156 – you had that leftover nickel!).

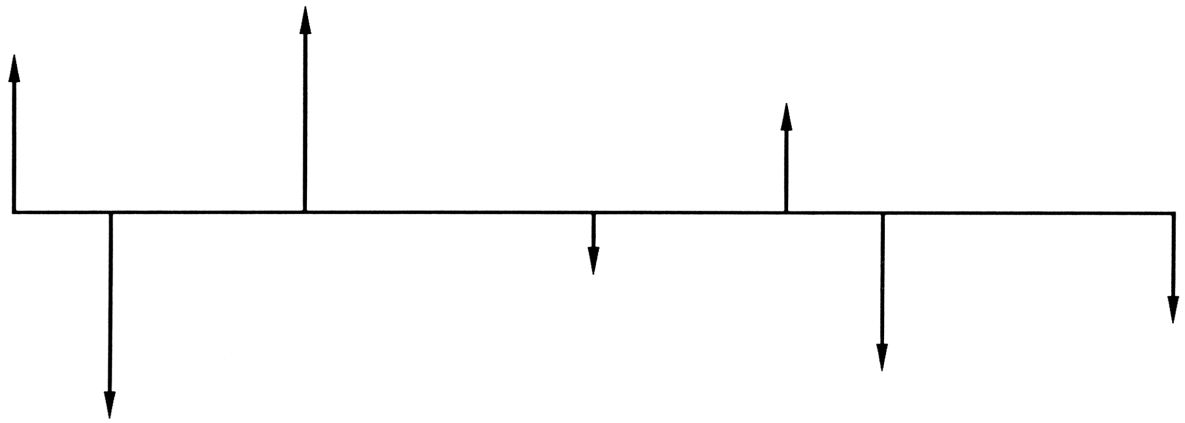
So in many cash-flow scenarios, IRR% is a convenient shortcut to find what discount rate is governing the situation. In that respect, you could think of it as your "yield" on your investment, and many people do rely heavily upon IRR% to tell them their "yields."

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!

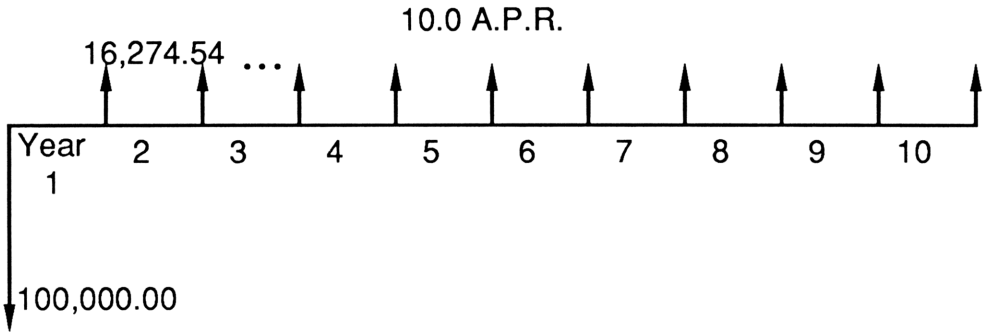
You can often spot such multiple situations because they tend to flip-flop their cash-flows a lot, maybe with some investments first, then some returns, then some more investments, etc., like this:



Of course, a good, clean, 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:

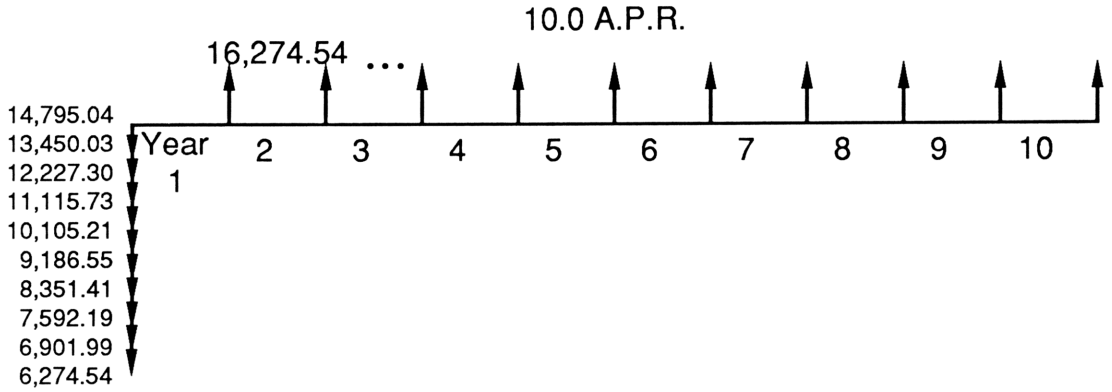


At the beginning, you invested $100,000, and over the next ten years you received steady, even returns on that investment. The IRR% ("yield") for this situation is 10%. So you yielded 10% per year on $100,000 for ten years, right?

Wrong! You *actually* yielded:

10% for *one* year on $14, 795.04, then pocketed the resulting $16, 274.54
10% for *two* years on $13, 450.03, then pocketed the resulting $16, 274.54
10% for *three* years on $12,227.30, then pocketed the resulting $16, 274.54
...and so on (you can use TVM to confirm these numbers).

In other words, this is the real picture:



It's very important to bear in mind that *any* cash-flow situation is really made up of many little investment/return pairs like this. After all, that's exactly what NPV does: it identifies and transforms each cash-flow into its "slid-and-shrunk" counterpart back at the beginning, using a discount rate to do the shrinking.

So the discount rate is the *rate of return* on each of these little "internal" investment/return pairs – because it's the number that was used to compute the discounted amount in the first place.

The point is this: An IRR% "yield" makes no assumptions whatsoever 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.* As far as it's concerned, the minute you got your money back, the growth stopped.

This means that you actually yielded 10% for *ten years* only on the $6,274.54. An easy way to illustrate this to yourself is to add up all the returns of this investment – all the money you have in your pocket at the end of 10 years. It comes to $162,745.39.

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, aren't they? But in both cases your yield would be 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 $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!

Now then: Traps or no traps, you'd better get some practice with IRR%....

Practice With IRR%

(Remember to draw those cash-flow diagrams!)

1. Use IRR% to compare the yields between two similar investment options. The only difference is that one of them is an IRA; the other is not:

   It's a mutual fund, into which you put $2000 at the beginning of every year for 35 years. You'll start enjoying the fruits of your savings at the end of the 35th year. Assume that the fund grows at 15% A.P.R. and that your marginal income tax bracket is 27%.

2. Suppose you're a lender offering a property owner a "wrap-around" mortgage – a kind of mix between a second mortgage and a straight refinancing. Here's the situation:

   The owner has a 10-year mortgage for $180,000, at 10.5% A.P.R., on which she still owes $2,073.07 per month for 4 more years, plus a balloon payment of $75,000 at the end of that 10th year. She wishes to borrow an additional $35,000 and let you assume the payment schedule of the original mortgage. She then wants to amortize her refinanced debt to you over 20 years, with a $40,000 balloon payment at the end. You agree to "wrap" her mortgage like this, refinancing everything at 13.5% A.P.R., plus a finance charge of 2% on the *new* money loaned.

   What is the overall A.P.R. that she's paying over the entire 26 years?

   What is your overall *yield*?

3. In a sudden, violent attack of prudence, you sold all your shares in three stock mutual funds on August 31, 1987, for the following amounts:

A: $34,319
B: $13,526
C: $22,410

You had originally put money into these funds in the following schedule:

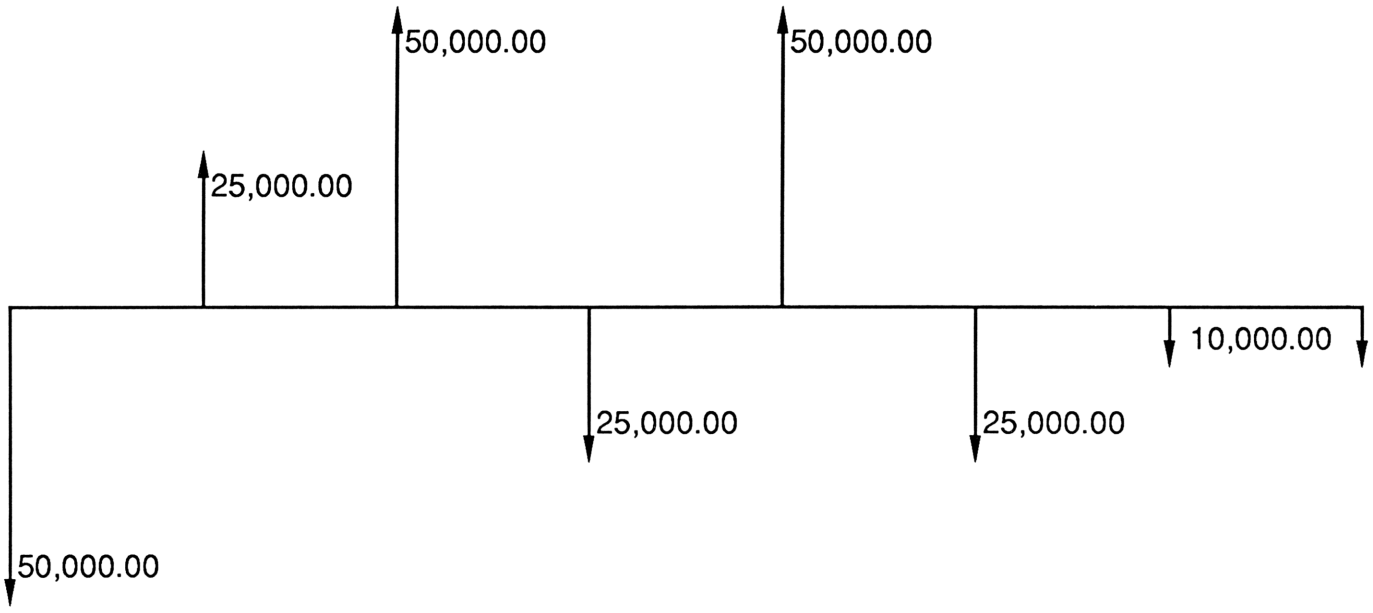
Fund	Date	Amount Invested
A	9-30-82	$ 3000
B	3-15-83	1000
C	5-31-83	2500
A	6-30-83	2500
B	11-15-83	1000
C	4-15-84	2500
A	5-31-84	3500
B	8-15-84	1000
C	10-15-84	3000
A	12-31-84	3000
B	4-15-85	1500
C	6-30-85	4000

Assuming there were no sales loads (commissions upon purchase or redemption) on any of these funds, what was your overall annualized yield on your investments?

4. You are considering a partial investment in low-income housing to help revitalize an urban area. Because the project will be getting construction funds, rent subsidies, rebates, and operating loans from many different sources, your investments and returns will be distributed over quite a bit of time, and they'll alternate, like this:

End of Year	Cash-Flow
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

Of course, the corresponding cash-flow diagram looks like this:



What would be your yield on this proposed investment scenario?

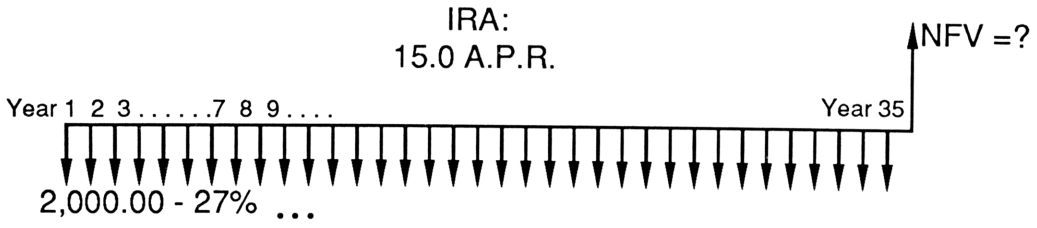
Results of Practice With IRR%

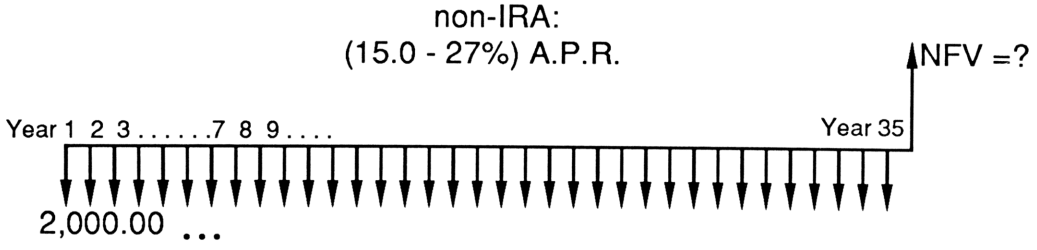
1. The key to this problem is in recognizing the tax benefits of an IRA:

   - First of all, your contributions are tax-deductible. That means (in your case) that the government is subsidizing 27% of your yearly $2000 contribution (because if you didn't contribute, you'd owe that much extra to the government, because the $2000 would then be taxable). So you're really paying only part of the yearly contribution out of your own pocket.

   - Secondly, all earnings on the IRA are also tax-sheltered. The account keeps *and re-earns* on every penny it earns!

   Of course, neither of these benefits applies to the non-IRA mutual fund. So here are the two pictures for comparison:





For the IRA case, your strategy will be to figure out the Net Future Value of those $2000 contributions. Once you know that, it becomes your final cash-flow. But then you change the contributions to what you *actually* contributed ($2000 less 27%) and find the IRR% of this modified picture.

From the CFLO menu, get a new list. Then:

2000 +/– INPUT
2000 +/– INPUT 34 INPUT
0 INPUT INPUT (this is the point at the end of the 35th year. Of course, here is where you could cash it all in if you wanted to, but since you don't know that amount, you leave it blank – similar to what you did in the NPV calculation with the unknown at the front end.)

EXIT CALC 15 I% NFV Answer: NFV=-2,026,691.36

That's what your account would be worth in 35 years (forget the minus sign; your unknown total is a *positive* quantity – to *balance* this NFV, remember?).

So change the sign (+/–) and EXIT ▲▲ INPUT (you need this extra INPUT here to get rid of the menu on the Menu Line) and INPUT to replace the zero with the real cash-flow there at the end of the line.

Next, press ■▲ and 2000 – 27% = +/– INPUT INPUT to represent what you're really paying into the account out of your pocket.

Finally, EXIT CALC IRR% Answer: IRR%=16.26

The tax benefits *increase the yield* on the account.

For the non-IRA case, you compute the (negative of the) ending balance by changing the picture back to $2000/year out-of-pocket and zero coming back at the end:

EXIT ■▲
2000 +/− INPUT INPUT
▼ 0 INPUT

But you must also reduce the *growth rate* according to the tax consideration:
EXIT CALC
15 − 27 % = I% , then NFV
Answer: NFV=-749,217.95

That's barely a third of what you'd have with an IRA!

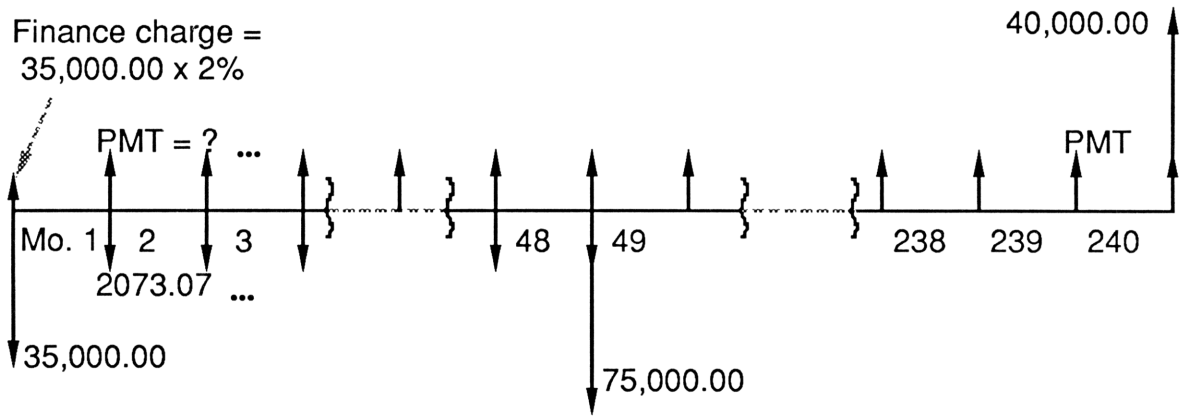
And look at the yield:

EXIT INPUT
+/− ▲ INPUT
EXIT CALC IRR% Answer: IRR%=10.95

(Actually, you knew this already – from figuring the growth rate that is 27% less than 15.0 A.P.R., above.)

So you're yielding nearly two-thirds less in money and about one-third less in growth rate, all because of the tax differences between an IRA and a taxable account!

2. Here's the situation as it would appear to you:



Do you see how the wrapped mortgage works? You (the lender) agree to "inherit" the borrower's original payments, but you turn around and loan her more money, collecting a payment from her that's large enough to cover both loans.

Of course, you'll need to fill in a few blanks here before you can compute the yield:

- You know the payment you'll be making to the original lender, but you don't know the payment the borrower will be making to you.

- And you can't figure that out until you know the total amount being re-financed.

- And you can't figure *that* out until you figure the remaining balance on the original mortgage. So that's where to start, then....

From the TVM menu, press (OTHER 12 P/YR END EXIT, as needed. Then):

72 N
10.5 I%YR
180000 +/- PV
2073.07 PMT
FV

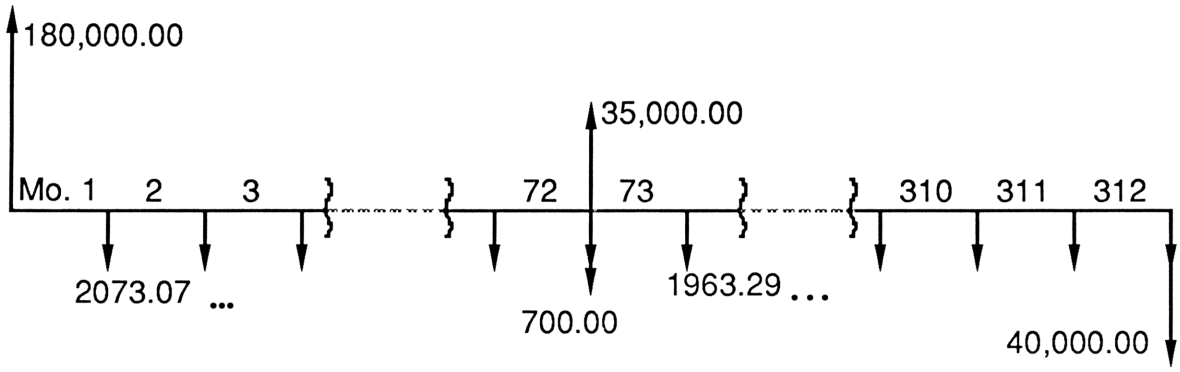
Answer: FV=130,336.87

Now add the new money you will loan her: + 35000 = , and amortize the total over 20 years, at 13.5% A.P.R., with a $40,000 balloon at the end:

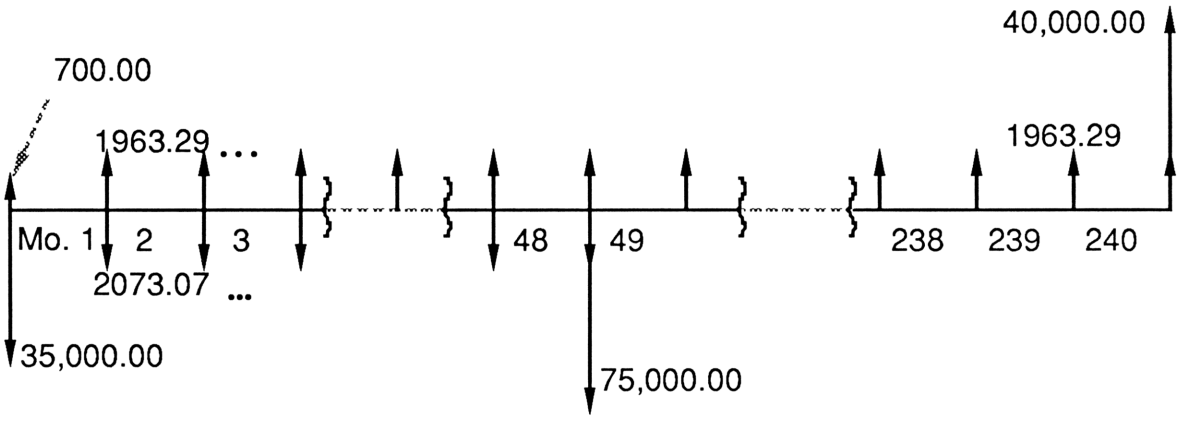
+/- PV
240 N
13.5 I%YR
40000 FV
PMT

Answer: PMT=1,963.29

So here are the completed pictures, from the borrower's (her) point of view:



and the lender's (your) point of view:



Now it's a piece of cake to compute the rates of money growth in either case, because both can be given by IRR%.

To find *her* rate, start with a new or clear list, then fill it in:

18000 INPUT
2073.07 +/- INPUT 71 INPUT
2073.07 +/- + (35000 − 2%) = INPUT INPUT
1963.29 +/- INPUT 239 INPUT
1963.29 + 40000 = +/- INPUT INPUT EXIT
CALC IRR% IRR%=0.99
Annualize it: × 12 = Answer: 11.86

And for *your* rate: EXIT ■▲ 35000 − 2% = +/- INPUT
1963.29 − 2073.07 = INPUT 47 INPUT
▲▲ RCL INPUT ▼▼ − 75000 = INPUT INPUT
RCL INPUT +/- INPUT 191 INPUT
▲▲ RCL INPUT ▼▼ + 40000 = INPUT INPUT EXIT
CALC IRR% IRR%=1.26
Annualize it: × 12 = Answer: 15.18

Why the difference? It's because part of her financing happened at 10.5% – before you ever came along. Her situation is a good example of a blended rate problem, where the overall rate she pays is somewhere between the two rates on the two separate loans involved.

"But why is her rate positive? After all, she's *paying* the interest, isn't she?"

Yes, but you need to remember that while *cash-flows* have a sign convention (- for paying, + for receiving), the ± sign of an *interest rate* only indicates which direction you need to slide cash-flows on the timeline to see them grow. It says nothing about *who* is paying or receiving those cash-flows.

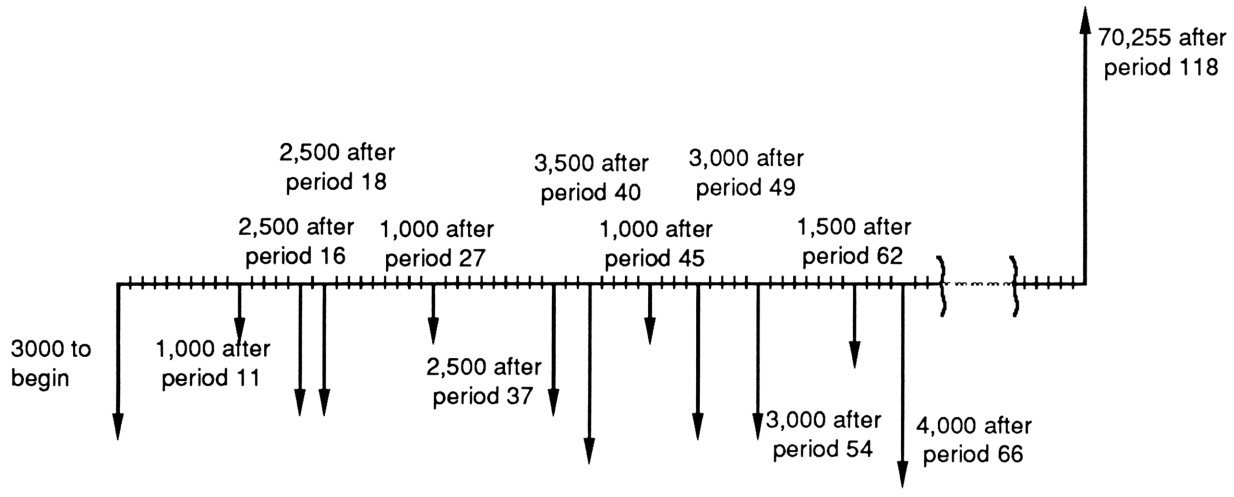
3. You may have realized by now that if you're going to figure an overall rate of return on these investments, then it doesn't matter which fund you put them into; they're all going to appear on the same cash-flow diagram, right? So you can entirely ignore the different fund designations (A-B-C) in the problem statement. That's just a smoke screen.

   But there's a different problem: Those time periods between cash-flows seem too ragged. After all, it's one thing to deal with uneven cash-flows; that's something your HP-17B can do very well, thank you. But it sure can't do much with *uneven time increments* between those cash-flows.

   But before you punt, look at the dates of those investments. Aren't they all at the end of a month or in the middle of a month? Well, what if you designated the period on your cash-flow line to be a half-month (i.e. 24 per year)?

   Now granted, that's a little imprecise, because some months have more days than others, etc. But the error will be only a day or two in any case, and since the analysis as a whole spans about 5 years, this approximation is going to give you a very good idea of your investments' yield. You wouldn't quote this yield in a legal contract or anything, but it will sure be close for the purposes of comparing it to other investments. All right?

   So, using the half-monthly period approximation, here's the picture:



Set 'em up and knock 'em down: From the CFLO menu, clear the current list or get a new one. Then

3 0 0 0 +/− INPUT
0 INPUT 1 0 INPUT
1 0 0 0 +/− INPUT INPUT
0 INPUT 4 INPUT
2 5 0 0 +/− INPUT INPUT
0 INPUT INPUT
2 5 0 0 +/− INPUT INPUT
0 INPUT 8 INPUT
1 0 0 0 +/− INPUT INPUT
0 INPUT 9 INPUT
2 5 0 0 +/− INPUT INPUT
0 INPUT 2 INPUT
3 5 0 0 +/− INPUT INPUT
0 INPUT 4 INPUT
1 0 0 0 +/− INPUT INPUT
0 INPUT 3 INPUT
3 0 0 0 +/− INPUT INPUT
0 INPUT 4 INPUT
3 0 0 0 +/− INPUT INPUT
0 INPUT 7 INPUT
1 5 0 0 +/− INPUT INPUT
0 INPUT 3 INPUT
4 0 0 0 +/− INPUT INPUT
0 INPUT 5 1 INPUT
3 4 3 1 9 + 1 3 5 2 6 + 2 2 4 1 0 = INPUT INPUT EXIT

CALC IRR% Answer: IRR%=1.09 Annualize: × 2 4 = 26.22

Not bad!

4. Nothing to it, right? Just start a new CFLO list and key this in:

5 0 0 0 0 +/− INPUT
2 5 0 0 0 INPUT INPUT
5 0 0 0 0 INPUT INPUT
2 5 0 0 0 +/− INPUT INPUT
5 0 0 0 0 INPUT INPUT
2 5 0 0 0 +/− INPUT INPUT
1 0 0 0 0 +/− INPUT INPUT
1 0 0 0 0 +/− INPUT INPUT EXIT
CALC IRR% ...whoa! What's this?

```
MANY/NO SOLUTIONS; KEY
IN GUESS; [STO] {IRR%}
```

It's telling you that this is one of those problems that has *more than one IRR%* – more than one discount rate that will give an NPV of zero. It says to key in your guess and press STO IRR%. It will then home in on the nearest solution.

OK, what would be a good starting guess? Well what would you *like* to be yielding here – something modest, say, 12%? So press 1 2 STO IRR%.

Result: IRR%=17.77 Not bad at all.

But you've already been warned that there is at least one other solution! You'd better try to flush one more out – just for comparison. To be on the safe side, guess more pessimistically this time: 0 STO IRR%.

Result: IRR%=-9.49 *Argh!*
Which IRR% is right? Will you be losing or making money on this deal?

The ugly truth? *Neither one* is necessarily "right."

Remember: IRR% is simply a discount rate that happens to make the NPV balance at zero. It doesn't necessarily have anything to do with "gain" or "loss." As you saw in problem number 2 of this quiz, a rate's sign has nothing to do with "receiving" or "paying" – rather, it has only to do with the direction you must slide cash-flows to get them to shrink or grow.

This is one of those times when you simply cannot look to IRR% to tell you your "yield."

"Hmmm...OK... ...so now what?"

Well, it turns out that there's a very sound and logical way to reason yourself into a good estimation of your "yield." It's called *"Modified IRR"* (also known as "Management IRR") – and it *is* based upon real-world costs and yields:

When you invest money in any one place, you're choosing *not* to invest it somewhere else, right? Presumably, you do so because this investment best suits your needs. It has acceptable levels of risk and liquidity and – within those constraints – a relatively high rate of return. So when considering this or any investment scenario, you'd ask yourself some realistic questions....

Question: Where are you going to get the money at each of the required dates for the investments?

Answer: From some bank account or another equally liquid investment. You'd be very foolish (and uncomfortable) to keep this kind of money under your mattress until you needed it. Surely it would be wiser to be holding this money in the highest-yielding account possible – say, a money market account – provided that it was *liquid* and *secure.* That way, you're sure to be able to get your money when you've promised it for this housing contract.

Fine. Picture such a "safe-rate" account in your mind, and assume that this is where you keep your money until it's needed for the housing project.

Next Question: As you receive returns on the housing investments, what will you do with that money until the end of this venture?

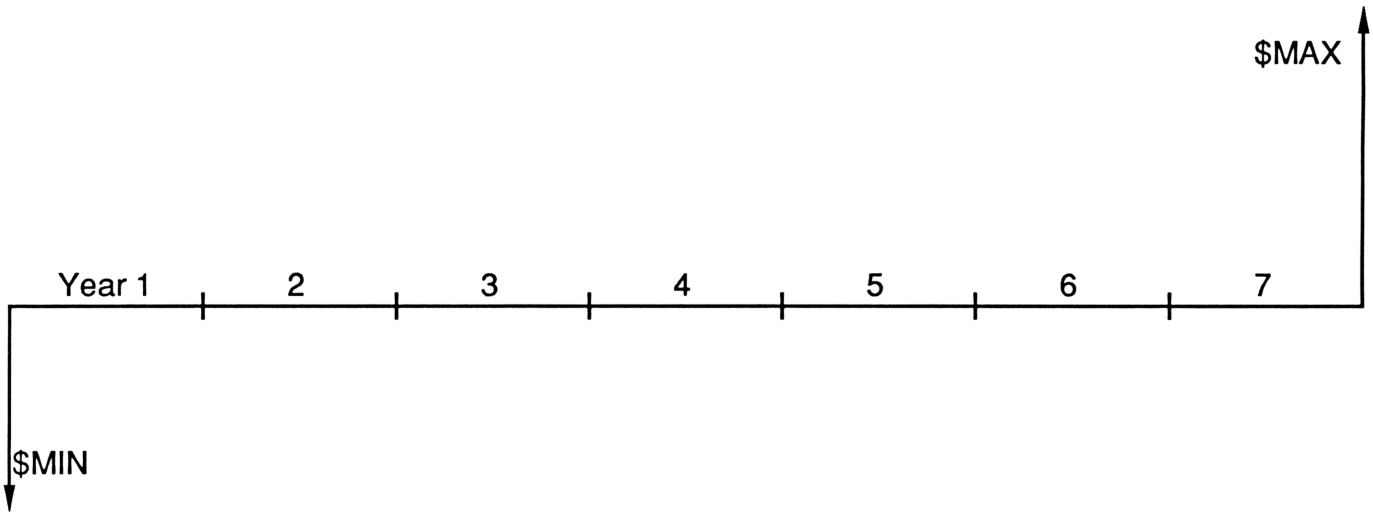
Next Answer: Well, you could simply put it right back into your safe-rate account. But the housing venture was more risky than that, and if you've agreed to it, you're clearly *willing to risk that much money to that degree.* So why not let your returns "ride" in some other equally risky investment – say, a stock fund or something like that – until the end of your housing venture? All right, suppose you do that. Call that account your "risk-rate" account.

See what's going on here? You hold all necessary investment money at a safe rate *until you invest,* but once you get it back, you let it ride in a higher-yielding ("risk-rate") account until the end of whole investment venture.

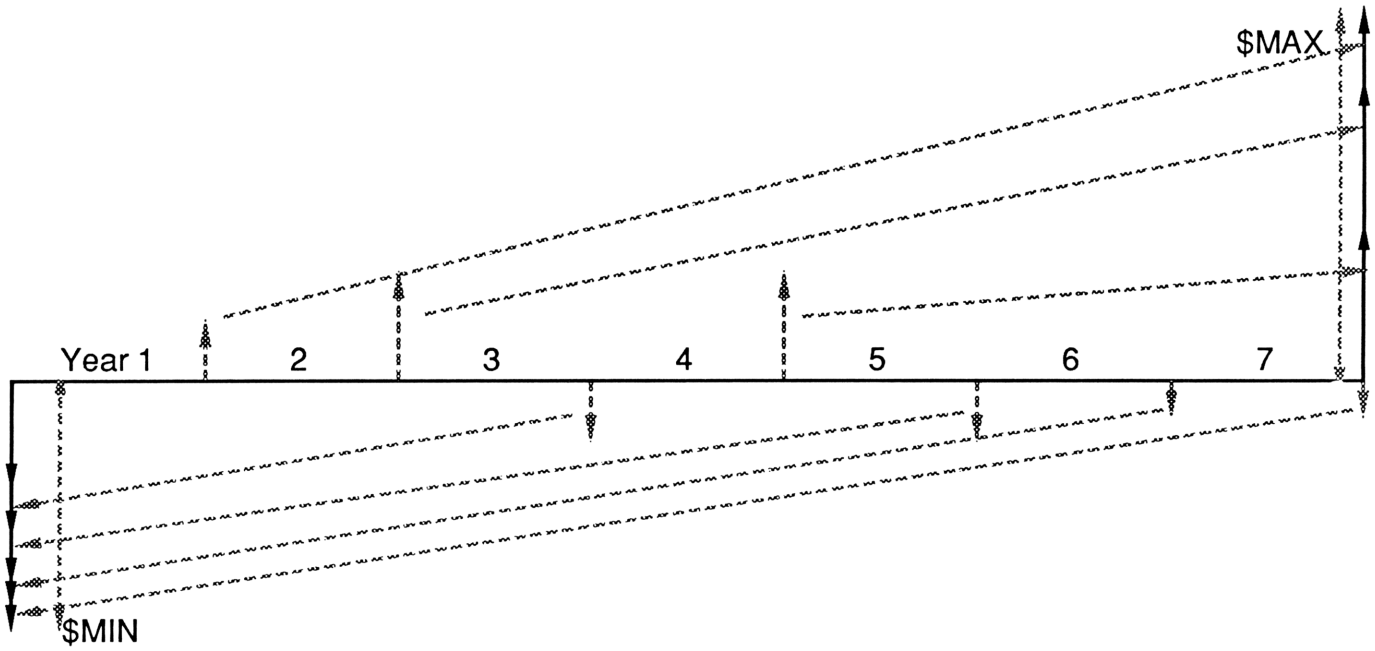
So how do you translate all this into an overall yield called an MIRR? Well, knowing your safe-rate/risk-rate strategy, what's the very minimum amount of money ($MIN) you'll actually need to *commit* at the *beginning* of the housing deal in order to get the ball rolling? Clearly, it's *just enough* so that when you deposit it in your safe-rate bank account, it will grow sufficiently to *exactly* supply all your necessary housing *investments* (and that sounds very much like a Net Present Value), right?

And what's the maximum amount of money ($MAX) you can expect to hold in your hands at the very end of this whole venture? Clearly, it's the *ending value* of your risk-rate account, where you have promptly deposited all the *returns* from the housing project (and that sounds very much like a Net Future Value).

Aha! What you're saying is this: You can reasonably model this entire investment proposal as a simple, one-investment/one-return scheme, with the investment being $MIN and the return being $MAX!



And here's the picture of how you arrive at $MIN and $MAX:



This is what MIRR does.

Its method is to find the NPV of all your investments (negative cash-flows), using the safe rate; and to find the NFV of all your returns (positive cash-flows), using the risk rate. It's just a huge sliding procedure that uses two different discount rates – one for sliding the negative cash-flows backward, the other for sliding the positive ones forward.

This is a superb example of how useful the "slide-and-shrink" (or "slide-and-grow") capabilities of a cash-flow diagram can be.

So your mission now is clear:

Build two different cash-flow lists in your HP-17B – one being the timeline with all the negative cash-flows, the other with all the positives. You find the NPV ($MIN) of the first list, using a discount rate that reflects what you could earn in some safe-rate bank account; you find the NFV ($MAX) of the second list, using a "risk rate" that reflects the relative risk and liquidity of the housing venture.

With those two numbers, you can then simply use TVM to find the growth rate that transforms $MIN into $MAX over the course of these 7 years.

Now, for the purposes of this problem, you can assume that a safe rate would be a money market fund at, say, 5.5% A.P.R. (compounded yearly). And you can guess that this housing venture is about like an aggressive mortgage fund, yielding, say, 18% A.P.R. (also converted to yearly compounding).

Fortunately, you've already keyed in the entire scenario. So, to do the NPV and NFV of the negatives and positives, all you need to do is "zero out" the unwanted cash-flows:

EXIT to the CFLO menu, then

■▲

▼ 0 INPUT

▼ 0 INPUT

▼▼▼ 0 INPUT EXIT

CALC 5 • 5 I% NPV Answer: NPV=-104,545.53

That's $MIN, the NPV of all your needed investment money. So store it away for safekeeping: STO 1

Next, EXIT to the list again, and ■▲. Then

0 INPUT

2 5 0 0 0 INPUT

▼ 5 0 0 0 0 INPUT

▼ 0 INPUT

▼ 5 0 0 0 0 INPUT

▼ 0 INPUT

▼ 0 INPUT

▼ 0 INPUT EXIT

CALC 1 8 I% NFV Answer: NFV=264,028.34

Heading for the home stretch:

EXIT EXIT TVM STO FV

RCL 1 STO PV

7 N

0 PMT OTHER 1 P/YR END

EXIT I%YR Answer: I%YR=14.15

That's your MIRR – a pretty good estimate of your investments' rate of return in this housing scenario!

Rest Area

Need a break? It's probably time to stop, stretch your legs, and look at your map. You've really been traveling all over the place, visiting all these built-in money formulas:

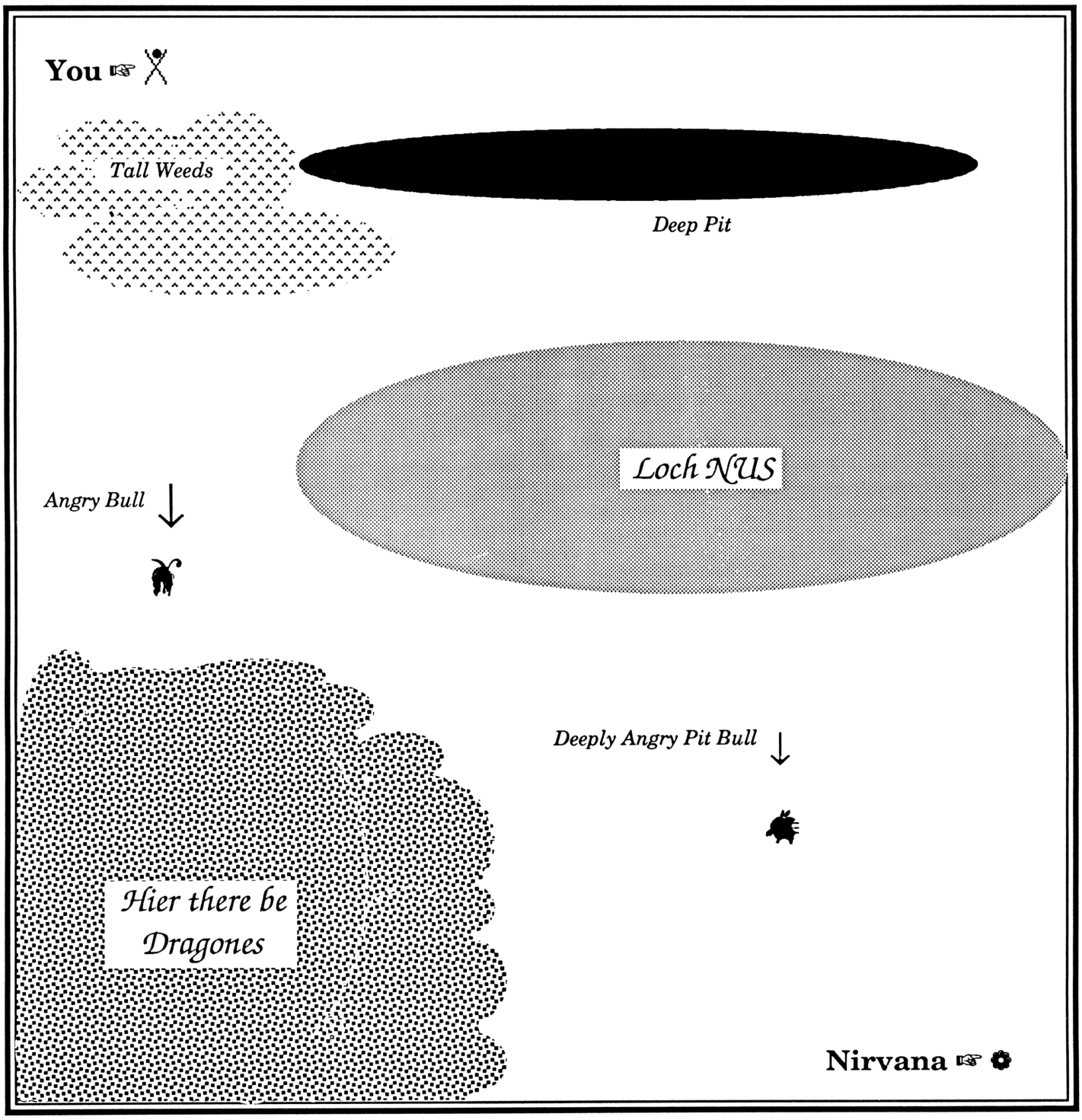
- In the previous chapter, you saw a whole slew of variations on amortized loans, including balloon payments, negative amortization, loans fees, differing annuity modes, etc. TVM was the menu to use on these "smooth-road" problems, since they all involved a steady PMT amount. You also used the ICNV menu to convert interest rates for these problems. Then you used TVM to analyze tax and inflation considerations and the benefits of an IRA.

- Next, in this chapter, you saw how to build an uneven cash-flow diagram for the "rougher roads," using the CFLO menu. You then learned what NPV does – and what it can mean to you – and used it to: plan a retirement annuity, re-demonstrate an IRA, discount the purchase of a double mortgage, choose between two different investments, and whether to rent or buy a house.

- Then it was on to IRR%. You saw how IRR% *can* represent your yield – but not necessarily! You then demonstrated with IRR% the tax benefits of an IRA, you figured the actual A.P.R. of a wraparound mortgage, the yield on a set of mutual funds, and also when *not* to use IRR% (rather, MIRR instead).

No wonder you needed a break! That was a long, 2-chapter road course through the money "destinations" in your HP-17B. In fact, you're now "street-legal" – fully licensed for any of the menus *built into* your HP-17B – congratulations!

But what if you want to go *somewhere else?* What if the calculation you need just isn't in the HP-17B already?... "...It's time to go '4-wheelin'!"



NO ROADS: The SOLVE Menu

Memory Space: The Final Frontier

So much for civilization. Now you're on your own.

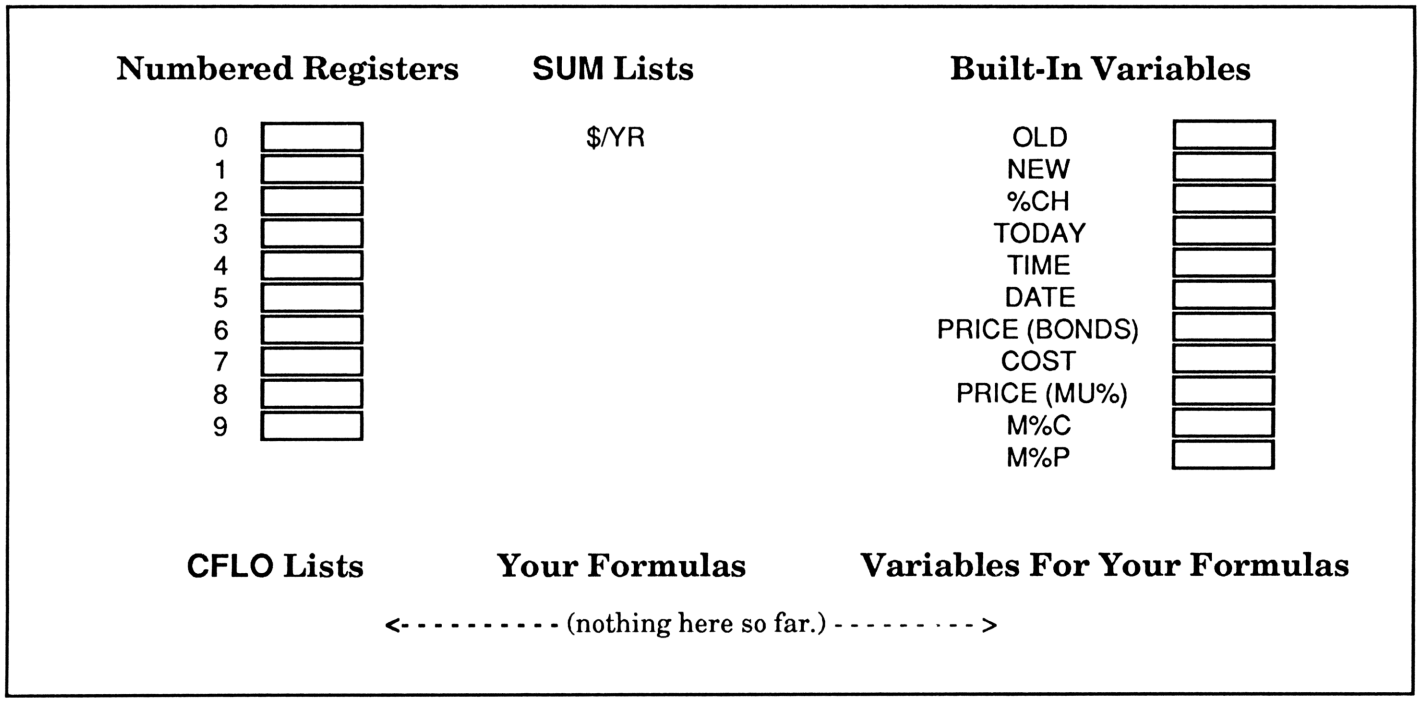
Now you need to learn how to solve a problem for which there is no calculation already built into your HP-17B – a place that just isn't on the map.

Good news: You can literally add to your calculator's "map"
– invent your own solutions!

Not only that, but once you've invented them, you can *store* them in the memory of the machine, in your personal *list* of solutions, where they'll reside thereafter until you need them again (of course, you can erase them, too – wipe them clean – either intentionally or... otherwise).

But most importantly, since these customized solutions take up space in the memory of your HP-17B, you'll need to know a little more about that memory before you start building your personalized list....

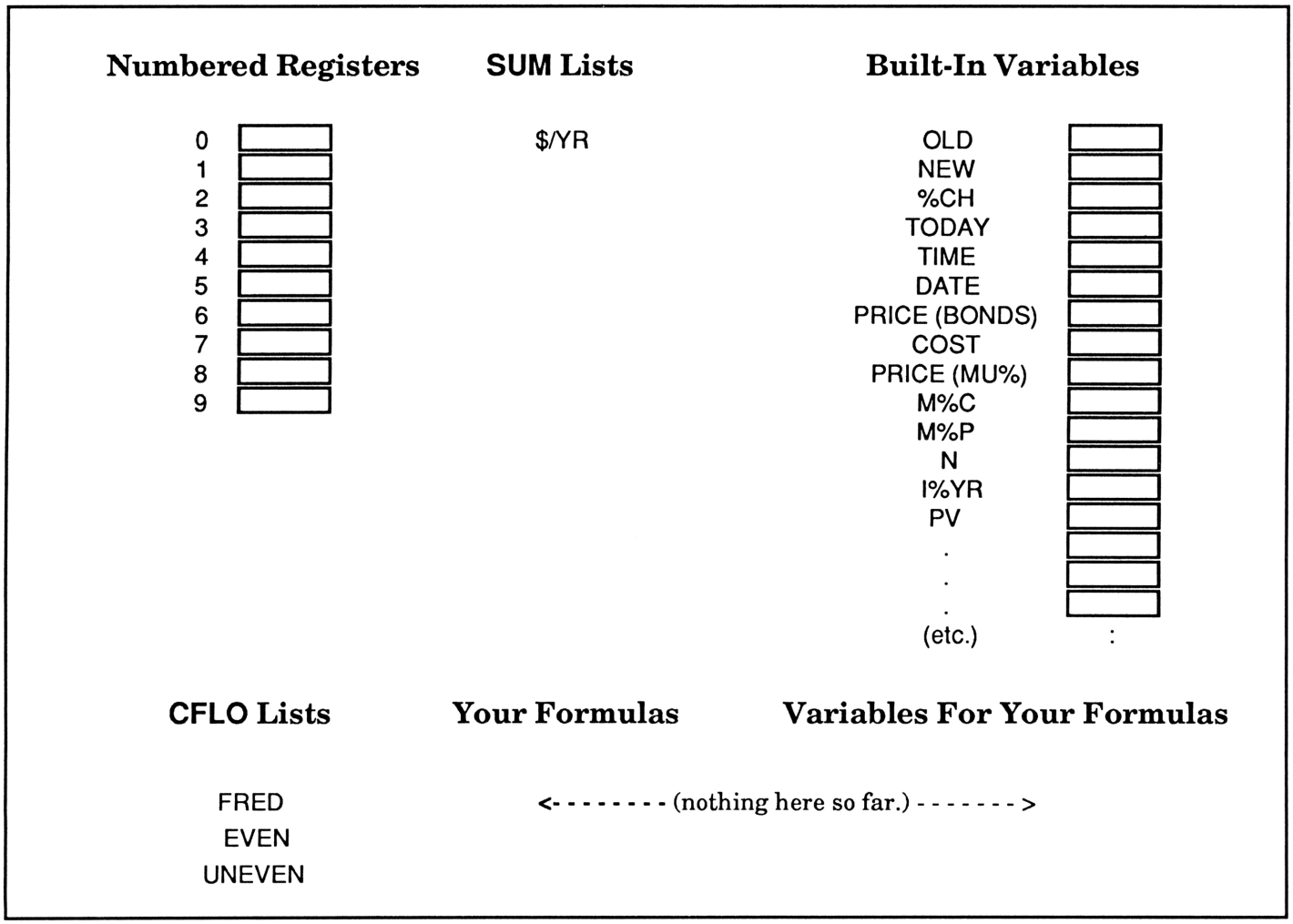
Look back for a moment to the diagram back on page 77. It's a diagram of the different built-in registers you had discovered up to then. Here it is again:



A Picture of Memory

But all those registers that you discovered are created from formulas that are *built into the machine.* You can reset these variables to zero, *but you can't erase the formulas themselves.*

Well, that's different from the "user memory," where you can create (and delete) lists and registers of your own. For example, here's a more complete picture of your HP-17B's memory at this point:



Remember those CFLO lists you built and named? They're still there, too, just waiting for you to go GET them again – whenever you need them.

Of course, you'll notice that you haven't created any equations or equation variables yet – which is what this chapter is all about:

Full Speed Ahead: From the MAIN menu, press the **SOLVE** key, and enter the world of your HP-17B's equation solver:

This is the SOLVE menu – where you need to go whenever you want to create or use a menu of your own.

Now press **NEW**.

Here's a menu you'll certainly recognize! Remember how to type characters with this ALPHA menu?

So here you are, ready to type in an equation – a useful formula that creates its own menu for you....

Creating Your Own Formulas

For openers, since you're "driving" through this Easy Course, how about a simple little formula to help you figure your gas mileage?

Have At It: Type in an equation for gas mileage. Then use it to 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, press JKLM M NOPQ P FGHI G (=) JKLM M FGHI I JKLM L ABCDE E (÷) FGHI G ABCDE A JKLM L INPUT.

Then press CALC....The machine "verifies" your formula, checking to make sure that it understands the equation you gave it. Then....voila! Your own mileage menu:

And you know what to do now, right?

350 MILE
12 GAL
MPG Answer: MPG=29.17

Now for that old familiar "what-iffing:" Change the number of gallons to the maximum: 15 GAL. And figure how many miles you could have gone: MILE Answer: MILE=437.50

Fine. You're happy with the equation – but suppose you'd like to rename the variables in it....

Edit Your Formula: Instead of MILE, you want MILS; and instead of GAL, you want GALS.

Solution: EXIT to the SOLVE menu. Now press EDIT and notice that the blinking cursor is back.

Time to edit: Press -->>. Of course, this jumps you to the far right-hand end of the equation. So, since you're "in the neighborhood" anyway, you might as well type ALPHA RSTUV S, to make GAL into GALS.

Next, press EXIT to get back to the editing menu, then <-- <-- <-- <-- <-- <-- to move the cursor over the E in MILE. You want to insert an S, so again: ALPHA RSTUV S EXIT.

And of course, you'll need to DELete that pesky E, but since the cursor is still sitting over it, you just press DEL. Now INPUT to make it official, and there you are!

Finally, press CALC, to allow the calulator to verify the formula again, and you'll see your modified variable names come up in the menu.

Next Problem: Many service stations sell gasoline by the liter instead of the gallon. 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 one U.S. gallon).

Solution: From the SOLVE menu, press **NEW** and type:

JKLM **L** **RSTUV** **T** **RSTUV** **R** **RSTUV** **S** (=)
FGHI **G** **ABCDE** **A** **JKLM** **L** **RSTUV** **S**
(×) (3) (.) (7) (8) (5) (INPUT)

Now **CALC** ...there it is – a conversion formula!

Try It: On another trip, you used 40.7 liters to cover 306 miles. What was your mileage?

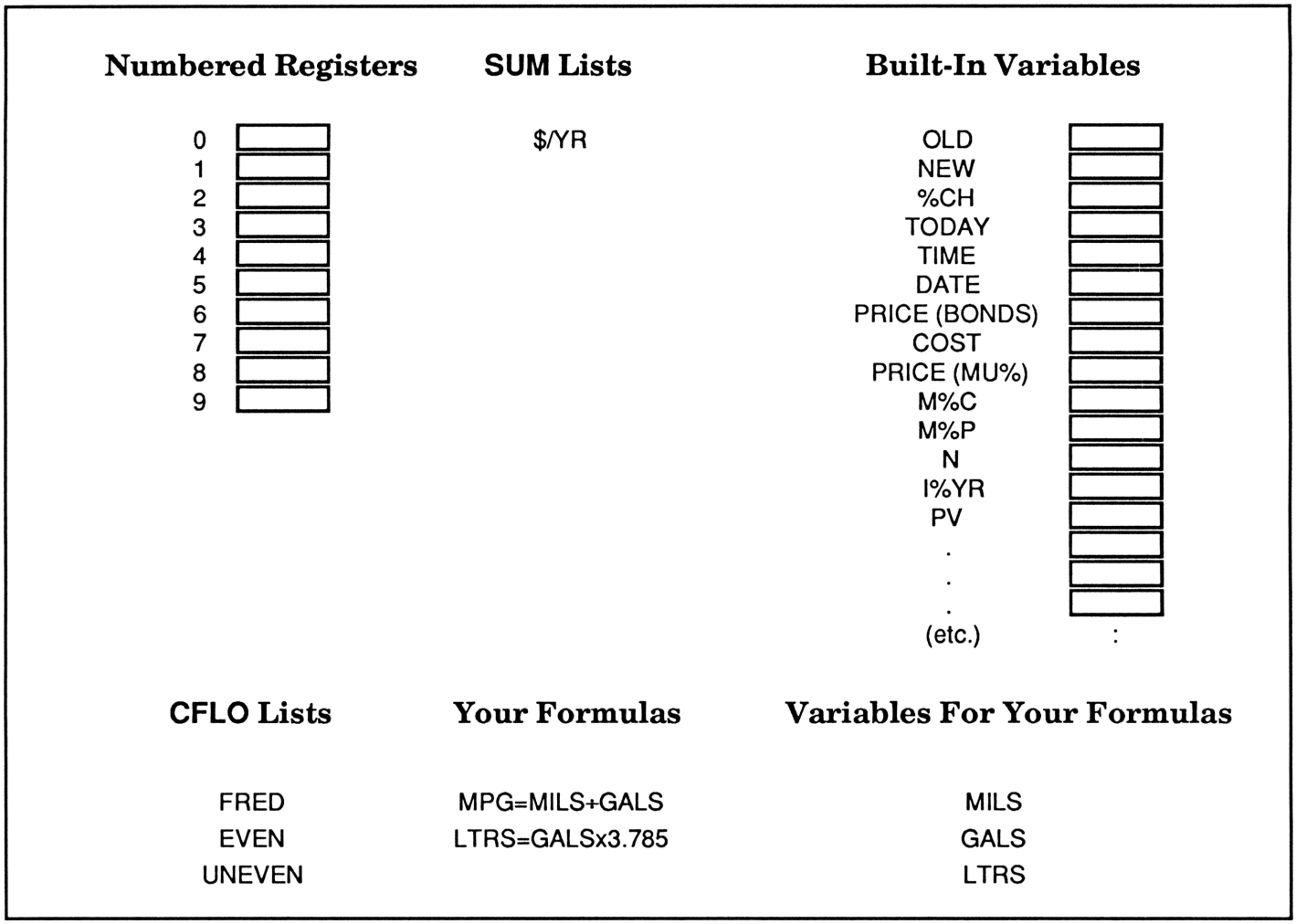
Solution: From your LTRS-GALS menu, press (4) (0) (.) (7) **LTRS**, then **GALS**.
Answer: GALS=10.75

Now (EXIT) to SOLVE, *and press* (▲). Why? Because you now have a collection – a list– of equations, and you move through that list in the same way you move through a SUM list or a CFLO list – with the (▲) and (▼) keys (■(▲) and ■(▼), too)!

So **CALC** with this equation...*Notice*...if you now (RCL) **GALS**, the gallons are *already set* at 10.75. *By spelling the GALS variable the same in each equation, you create a shared variable.*

Just key in what you need in order to finish the calculation:
(3) (0) (6) **MILS** and **MPG** Answer: MPG=28.46

Take a look at a memory diagram of your machine now:



If you're curious about how much more room you have, just press ■ MEM to read off the percentage of the total available memory that's still available....

Did you realize what an incredible arsenal of calculating power you had here? You've barely made a dent in the memory!

Now try another problem, just to get more familiar with the rules of the SOLVE menu....

??: A construction contractor often needs to quote the square-footage area of the rectangular concrete slabs he lays, and he then needs to find the cubic yardage of mixed concrete needed for the job. The only things he knows are the length and width (in feet) of the slab, and its depth in inches – and he can order concrete only in whole cubic yards (no extra fractions of yards). Write two SOLVE formulas to help him. Could you do it in one formula?

»: Hmm...First of all, you get an area by multiplying a length by a width, so the area formula isn't too much of a problem:

```
AREA=LONG×WIDE
```

But (happily enough) you also need to know the area to find the volume, right? After all, volume is what you get when you multiply length by width by depth, or – to put it another way – multiply *area* by depth:

```
VOL=AREA×DEEP
```

Nothing to this formula business, right? Not really – but here's a caution: These formulas *won't work* if you don't keep your units consistent. That is, you can't expect to come up with a volume in cubic yards by giving the length and width in feet (for example) and the depth in inches. To use the above formulas *as is,* you need to key in all your dimensions *in the same unit* – feet, inches, furlongs, light years, whatever.

Don't mix units! After all what kind of unit is a "foot x foot x inch?" It's not a cubic foot or a cubic inch, or a cubic anything, really. It's some kind of hybrid mix – and they just don't sell batches of concrete measured that way.

So you need to decide the units you're going to use when keying in your length, width and depth.

Suggestion: Make it easy on yourself and let the calculator do some converting for you. Use the units you would most likely use in reality – depth in inches and length and width in feet. And you'll want to see the area in (square) feet and the volume in (cubic) yards.

Now how do your formulas need to look?

Well, your area formula doesn't need to change at all, does it? If you multiply feet by feet, you're going to get an area in (square) feet:

```
FTAR=FTLG×FTWD
```

You've just changed the names of the dimensions to remind yourself what units to use. This is a very good habit to develop as you write more of your own formulas – try to make the name of a variable tell you as much as possible about what it means.

As for the depth formula, it will need a little more "massaging" to get it right. You can convert inches to feet by dividing the number of inches by 12, right?

Like this:

```
VLYD=FTLG×FTWD×(INDP÷12)
```

But now you have the volume in cubic *feet,* don't you? To convert to cubic yards, you'll need to divide the whole mess by 27 (because there are 27 cubic feet in one cubic yard). Thus:

```
VLYD=(FTLG×FTWD×(INDP÷12))÷27
```

A few words about those parentheses: You don't actually need them here. In this example, they're in there just to remind you of the reasons for the 12 and the 27. But if you left them out, the calculation would come out the same, because × and ÷ have the same *priority of evaluation* in a formula.

You see, the calculator doesn't look at a formula in quite the same way as it looks at the calculator line when you're doing an arithmetic problem.

For instance, to compute *on the Calculator Line* some value, 2 + (3 x 5), you would need to press [2] [+] [(] [3] [×] [5] [=], because the machine just works left-to-right if you don't use parentheses.

But the *SOLVE formula* A=2+3×5 would produce the same result without the parentheses, because the × has a *higher priority of evaluation* than the +. The HP-17B does *not* simply work left-to-right when evaluating a SOLVE formula; it evaluates according to this list of different operations:

- First come the *functions,* e.g. SQRT(A+B) – "the square root of A+B."
- Next comes *exponentiation,* such as A^5 – "A to the fifth power."
- Next in line are multiplication (×) and division (÷).
- Last of all come addition (+) and subtraction (−).

Of course, whenever there's more than one operation with the same priority, *then* the calculator works left-to-right!

So that's the set of rules you can use to tell if you really need parentheses in your formulas. Of course, if this is too much to remember all the time, you can just use parentheses anyway to be on the safe side.

Now then – back to the problem of those concrete slabs. Here are the two formulas you've developed by now – without the unnecessary parentheses:

FTAR=FTLG×FTWD

VLYD=FTLG×FTWD×INDP÷12÷27

But isn't dividing something by 12 and then by 27 the same as dividing it by 324 (which is 12 x 27)? (righto) Well, then:

FTAR=FTLG×FTWD

VLYD=FTLG×FTWD×INDP÷324

Another thing: Notice that you could *share* the variable called FTAR between these two formulas:

FTAR=FTLG×FTWD

VLYD=FTAR×INDP÷324

See how you substituted FTAR for FTLG×FTWD?

Now you can conveniently use the first equation to quote the area of a given slab, then jump right over to the second equation and compute the yards of concrete necessary – simply by keying in the inches of depth – because the AREA will already be calculated and sitting there!

So that's it then....

...oops...didn't the problem state that the contractor could order concrete loads only in whole cubic yards? (Yep)

You need to round your calculation *up* to the next whole cubic yard (you don't round it down because then you wouldn't have enough for the job), right?

How are you going to adjust the equation for that?

Like this: Take your raw cubic yards requirement, add 1 whole yard, and then keep just the whole-yards portion of the result.

Thus, if your raw needs were 3.4 yards, you'd calculate that to be IP(3.4+1), where IP stands for the *Integer Portion.*

The IP of (3.4+1) is the IP of 4.5, which is just 4. So your calculator would give you an order recommendation of 4 cubic yards, when the slab called for 3.4.

That's correct.

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 the slab is going to need *exactly* 2.0 yards, you don't want to order an entire extra yard....the formula doesn't seem to be perfect yet.

To fix it, just use some common sense: If the raw requirements turned out to be 2.01 yards, would you then order 3 yards? Probably not.

How about for 2.1 yards? ...mmm... – guess you'd better, right?

So change your formula to reflect this judgement – adding just a hair *less* than a whole yard, like this: IP(2.0+.9) That fixes your problem, doesn't it? Therefore:

FTAR=FTLG×FTWD

VLYD=IP(FTAR×INDP÷324+.9)

Key these in and test them out: From the SOLVE menu, press ▼ NEW to begin a new entry at the bottom of your growing list of formulas. Then:

FGHI F RSTUV T ABCDE A RSTUV R = FGHI F RSTUV T
JKLM L FGHI G × FGHI F RSTUV T WXYZ W ABCDE D

Finally, INPUT CALC....Looks OK on the menu, doesn't it?

Try it: 40 FTLG 30 FTWD FTAR Answer: FTAR=1,200.00

Looks good. Now EXIT and ▼ and NEW to do the bigger equation...(by now you've surely got a very clear idea about how to key in characters, so instead of trying to read a lot of keystrokes, see if you can type just by looking at the written version of the equation. And keep in mind that the digits, math operations, and parentheses are right on the keyboard anyway):

VLYD=IP(FTAR×INDP÷324+.9)

Then INPUT, CALC, and press RCL FTAR, just to see if your shared FTAR variable is working correctly: FTAR=1,200.00 Right on!

So you've got this slab that's 30 feet by 40 feet. Suppose it's 6 inches deep. How many cubic yards of concrete should you order?

Press 6 INDP and VLYD Answer: VLYD=23.00 Bingo!

So there you have it. Now, to answer the last part of the problem, *could you* put both of these calculations in 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 been developing these two equations:

FTAR=FTLG×FTWD

VLYD=IP(FTAR×INDP÷324+.9)

And when you CALCulate with either of these, it comes up on its own menu, of course. But notice that you always solve for one of the variables by using the given values of *all* the others – every one of them is used in the calculation to find the "unknown."

It *seems,* therefore, as if you must have only one "unknown;" the rest must all be "knowns." And that's why it seems that you *cannot* have a single formula for *both* the FTAR or the VLYD – because that would be two unknowns in the same equation.

Ah, but that's where the HP-17B "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 (for one brief shining moment) to those happy, golden days of algebra class, and *rewrite* both of your concrete formulas so that everything is on one side of the = and a zero is on the other:

FTAR-FTLG×FTWD=0

VLYD-IP(FTLG×FTWD×INDP÷324+.9)=0

Remember how to do this ("adding the negative to both sides of the equation")?

And notice that the FTAR is a variable of the first equation only. If you were to keep it as a shared variable, it would be the *unknown* in the first equation and a *known* in the second one. There's nothing wrong with that, but it would mean that you would always have to solve for the FTAR *before* solving for the VLYD, and that would be defeating the purpose here – to allow you to use just one menu to solve for either unknown, *in any order you want.*

Therefore, you'll need to be able to find VLYD from your FTLG and FTWD, which are always *knowns* that you must key in anyway.

This is true in general: If you have a set of equations with one or more shared variables that are normally *unknowns,* then it's not as useful to combine them as it would be if they're all knowns – because it limits the order in which you may calculate.

OK, so you've got these two formulas that you want to somehow combine into one. All you need now is to know about IF(S)....*

*In fact, for the rest of this chapter, you may find it useful to have your owner's manual handy and opened to Table 11-2 – just to get an idea of all the different handy "phrases" in your HP-17B's SOLVE vocabulary.

Here's the way to combine them:

```
IF(S(FTAR):FTAR-FTLG×FTWD:VLYD-
  IP(FTLG×FTWD×INDP÷324+.9))=0
```

This formula is saying:

"IF you're Solving for FTAR, *then* (and here's the first :)

```
FTAR-FTLG×FTWD=0
```

otherwise (IF you're Solving for something *other* than FTAR – this is the second :),

```
VLYD-IP(FTLG×FTWD×INDP÷324+.9)=0
```

See? You had to make the two equations equal the same thing (zero) so that you could combine them into one formula with this IF(S... thing.

Ready to try keying this in?

All right, first DELETe your separate FTAR equation: From the SOLVE menu, move the pointer with the ▲ key until it's pointing to your FTAR formula. Then press DELET...

Notice that you then have the option to delete the formula and its variables or just the variables. If you were to choose just the variables, the formula would remain in your list, but none of its variables would exist in the machine's memory until the next time you CALCulated with it, at which time they would be re-created. This is just to save memory. Anyway, you definitely want to delete both the formula and its variables here.

You should now be looking at the VLYD formula. Hmm...Since *this* long thing is a pain to key in, why not EDIT it to create your combined formula?

Press EDIT then ALPHA, and type the portion of the combined formula that you need to insert: IF(S(FTAR):FTAR-FTLG×FTWD: (recall that the : is in the OTHER portion of the ALPHA menu. And notice how the display shows you an ellipsis (...) when a formula runs off either end.)

Now press EXIT to return to the editing menu, and move the cursor over 4 places: --> --> --> -->. Replace the = with - (by pressing − and DEL). Next, replace the other FTAR with FTLG×FTWD : --> --> --> --> --> DEL DEL and then ALPHA and type LG×FTWD.

Now EXIT and go to the rend of the formula to finish it: -->>) = 0 INPUT
And CALC to check it with your 30- by 40- foot slab:

3 0 FTWD 4 0 FTLG 6 INDP and VLYD Answer: VLYD=23.00

Now find the FTAR Answer: FTAR=1,200.00

See? You can now calculate either unknown – in either order you want!

Think you got the hang of this IF(S)... business? Try one more...

For The Road: Remember your gas mileage formula and your liters-gallons conversion formula? Can you combine them into a single formula that allows you to compute your mileage (miles per gallon) no matter whether you buy gasoline in liters or gallons?

A Good Route: Here are two formulas now in your HP-17B's memory.

```
MPG=MILS÷GALS

LTRS=GALS×3.785
```

Of course, you could have written the second one as

```
GALS=LTRS÷3.785
```

And so what would the formula for mileage be if you bought gasoline by the liter? It would be this:

```
MPGL=MILS÷(LTRS÷3.785)
```

How's that? Because gallons are simply "liters divided by 3.785."

Notice that you need to use a second unknown (MPGL) to solve for the mileage in the second formula. That's the pattern of the IF(S) – you have two formulas with two separate unknowns. You rearrange each of them to get zero on the right side, and then – zingo! – you scoop them both into a single formula....

Rearranging:

```
MPG-MILS÷GALS=0

MPGL-MILS÷LTRS×3.785=0
```

Now comes the "zingo" part:

```
IF(S(MPG)
 :MPG-MILS÷GALS
 :MPGL-MILS÷LTRS×3.785)=0
```

Key this in: At the SOLVE menu, delete the two separate formulas shown on page 217, by pressing ▲ and ▼ until you're "pointing" to each of them. Then use DELET.

Now you're ready to begin a new equation, so press ■▼ to find the bottom of your list, and NEW to begin. Then start hammering away, typing in the above equation....

When you finish, press INPUT and CALC to test it – try that first mileage problem you did back on page 203:

350 MILS 12 GALS MPG Answer: MPG=29.17

And what if you went the same distance on 50 liters?

50 LTRS MPGL Answer: MPGL=26.50

Got the idea? OK, try these – to complete your "off-road training!..."

More Practice Solving More Practice SOLVE Problems

1. You are a lineman for the county, and you drive the main road an awful lot. Fortunately, the county does reimburse you for your use of your own car (and fuel) for this work-related travel. You generally receive 21 cents per mile as reimbursement, paid to you monthly. Find a way to use the SOLVE menu to simplify these monthly mileage calculations.

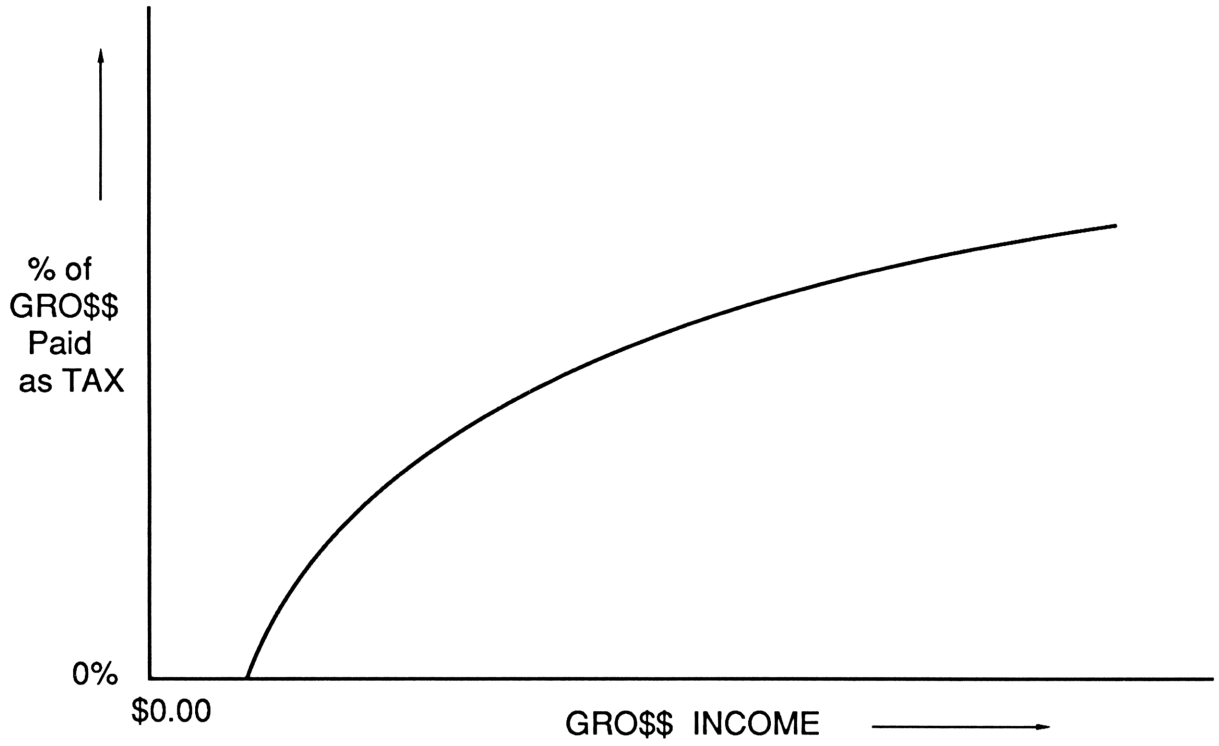
2. Your company does direct-mail advertising to generate mail-order sales. The response on mailings varies from 1% to 4%, depending upon the particular list you rent and the time of year. Without accounting for the cost of the mailing, the average profit per response is $14.45. The mailing cost varies from 24 cents to 30 cents per flyer. Develop an equation to help you calculate the total earnings from a mailing.

   If you mail out 145,000 flyers, the cost per flyer is 24 cents. What response do you need to break even? What are your earnings if you have a 3.26% response?

3. Your friend is an obstetrician with a brand-new HP-17B. Since you've now become rather good with your calculator, she has come to you for help in writing a combination of two formulas for her day-to-day work:

   The first formula should take the estimated starting date for a woman's pregnancy and calculate her delivery date (280 days later). The other one takes today's date and the expected delivery date and calculates the number of weeks and days the pregnancy has progressed so far.

4. Suppose the Federal Income tax became a tax on *gross* income (no deductions allowed – might cut down on the paperwork and cheating, no?). Suppose, also, that it were still *progressively structured, but without discrete brackets.* That is, the percentage of your gross income you pay as a tax would be given by a *continuous curve,* with higher earners paying a higher percentage, like this:



And suppose that the *equation* to figure your tax for the year – according to the above sliding scale – were given by the IRS as

$$TAX = .005 \times GROSS \times LOG(GROSS)$$

where the GROSS is your gross income for the year (LOG is a calculation that produces a curve of the above shape).

Problem: If you're paid monthly or on any other basis other than annually, the payroll clerk needs a set of equations to help him/her compute how much to withhold from your paycheck – for any given pay period in the year.

5. Write a formula that lets you see what your retirement annuity *could* be – over any given number of years – in terms of today's "purchasing power," if you were allowed to invest the money that you annually contribute (on the average) to Social Security instead. Assume that you could invest it in some taxable interest-bearing account, allowing for an average inflation rate and income tax bracket, and assuming steady work for a given number of years. Write the formula so that you first see the lump-sum amount in the account at the time you begin to draw the annuity.

   Then, to test this, calculate the buying power that would accrue over 40 years of earnings in an account paying 15% A.P.R., with an average monthly contribution of $150, a 5% inflation rate, and a 30% tax bracket. What monthly amount could you then draw from that account for 40 more years? For 30 years? 20 years?

   Then *recalculate these annuity amounts,* varying the above scenario with each of the following assumptions (separately):

   - a 27% tax bracket;
   - a 33% tax bracket;
   - a 4% average inflation rate.
   - a 6% average inflation rate.

How To Practice Solving More Practice SOLVE Problems

1. The actual arithmetic for figuring your monthly reimbursement is pretty trivial, isn't it?

   $RMB=MILS x .21

   The real problem is to figure out how to keep track of that mileage all through the month, right?

   To get a handle on this, talk yourself through an example. Formulas like these can come to you easily if you take a little time, sit down with a pencil and paper, and talk to yourself. After all, before you can tell the calculator how to do it, you have to decide how you would do it manually – on paper, right?

   "Hmm...I'd use the odometer on the car...and every time I made a business-related trip, I'd have to note the starting mileage, the ending mileage – and then subtract the two to get the net reimbursable mileage.

   "But how many trips will I take in any month? I don't know – it varies. So I can't exactly use an equation like this:

   MILS=(END1-START1)+(END2-START2)+(END3-START3)...

   because I don't know how long it has to be!"

   It *is* a problem, isn't it?

   But wait...isn't this kind of sequential record-keeping problem just tailor-made for using *lists of numbers* (i.e. from the SUM menu)?

Great news: *You can use lists in SOLVE formulas!!*

Picture this: You have two lists, named START and END. ITEM(1) in your start list is your odometer reading at the start of your first business trip of the month; ITEM(1) in your END list is the reading at the end of that trip, etc.

You simply sum up each list, subtract the total of the START list from the total of the END list, and there's your mileage for the month!

After figuring your reimbursement amount, you can clear each of the lists (or start new ones with different names if you need to keep your records for awhile).

So how do you refer to and use SUM lists in a SOLVE formula? Like this:

ITEM(START:3) would denote the third entry in your START list; ITEM (END:1) would mean the first entry in your END list, etc. Get the idea? This is the SOLVE menu's language for referring to items in a SUM list.

OK, but how do you sum all these items? You don't even know how long each list is – the same problem that made just a plain old formula out of the question.

Aha! Also in the SOLVE menu's vocabulary is the phrase SIZES(). It understands that to mean the *current length* of the list given in the parentheses. Thus, SIZES(START) would stand for the number of items in your START list, for example.

"Fine, but how do I sum all of these items – even if I know how many there are?"

How sweet it is: There's also a phrase for summing! (They sure have thought of everything, haven't they?)

To use this SOLVE language to sum all the items in your END list, for example, you would do it like this:

TOTAL=∑(N:1:SIZES(END):1:ITEM(END:N))

Here's how your machine "reads" this:

TOTAL is going to be the result of a sum of numbers. That sum uses the variable N as its counter. In other words, since it's supposed to sum only a certain number of items, the N is how it remembers which item it's *currently adding* to its sum.

The summing should start with N at 1 (this is the first 1 inside the parentheses), and continue until N is equal to SIZES(END), which is the length of the list called END; and N should proceed 1 at a time (as opposed to skipping every other item or something like that). That's the meaning of the second 1.

Notice how each item in this summation command is separated by a :
– a fairly standard thing with SOLVE, as you've discovered by now, right?

Finally, the items to be summed are ITEM(END:N), *which will be every item in the END list, as N proceeds from 1 to the length of that list,* right?

There you have it – the total of the entire list!

So, knowing all that, how would you sum the *difference* between corresponding items in two lists? Like this:

Σ(N:1:SIZES(END):1:ITEM(END:N)-ITEM(START:N))

(You can use the SIZES of the END list as the length of both the END and the START lists, because they'll be the same length, right?)

Therefore, here's how the final reimbursement calculation should look:

```
$RMB=.21×
Σ(N:1:SIZES(END):1:ITEM(END:N)-ITEM(START:N))
```

Be sure that all your parentheses match! This looks like a mess, but you now know how it all works, right? You've simply said – in SOLVE language – a statement that goes like this:

"Reimbursement is equal to twenty-one cents times the *sum of the differences* of each pair of corresponding END and START odometer readings as they appear in the two lists named such."

So key it in and try a problem: From the SOLVE menu, press ▼ to find the bottom of your list, and NEW to begin. Then type in the above equation (and remember that any strange, non-alphabetical characters will probably be hiding in that OTHER menu)....

Now press INPUT,then CALC. Incidentally (as you may have already discoverd), if the machine beeps at you and rejects your equation, it automatically goes into the edit menu and points with the cursor at what it doesn't understand – so you can correct the typo with a minimum of searching or rekeying.

All set? Then it's time to test it!

Suppose you had 4 trips in a given month, and that the odometer readings were

Trip	START Reading	END Reading
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

How much should you be reimbursed?

First, you'd better establish your two lists. From the MAIN menu, press **SUM** **GET** **NEW**, then

4 5 6 7 8 • 9 INPUT
4 7 1 4 2 • 8 INPUT
4 8 1 2 3 • 4 INPUT
4 9 0 1 2 • 3 INPUT EXIT **NAME** START (type this) INPUT

Then **GET** **NEW** and

4 6 1 1 1 INPUT
4 7 3 7 6 • 5 INPUT
4 8 5 7 1 • 4 INPUT
5 0 9 8 7 • 6 INPUT EXIT **NAME** END (type this) INPUT

Now head for the SOLVE menu (EXIT **SOLVE**) and "point" to the $RMB formula, **CALC** and **$RMB** (you may need to press **$RMB** twice to get it to calculate).

Answer: **$RMB=648.71**

(Ain't it wunnerful?)

2. After that first problem, this should be pretty easy. Again, just walk yourself through it:

   First of all, if you know the TOTaL number of flyers you send out, and you know the percentage of these that return as orders (%RET), then how many ORDerS do you receive? It's

   TOTL x (%RET÷100), right?

   See how the %RET percentage is converted into its true fraction this way?

   Now, the cost of the whole mailing is simply the COST *per piece* times the TOTaL pieces mailed: COST x TOTL

   And so your overall EARNings will be $14.45 times the number of ORDerS, *less* the cost of the mailing. In other words,

   EARN = 14.45 x (TOTL x (%RET÷100)) - (COST x TOTL)

   Weed out all the unnecessary parentheses (knowing, as you do, the calculating priorities of the HP-17B), and you've got it:

   EARN=14.45×TOTL×%RET÷100-COST×TOTL

   Now key it in. From the SOLVE menu, press ■▼ to find the bottom of your list, and NEW to begin. Then type in the above equation....

   ...and press INPUT ,then CALC.

Now solve the test problems:

You want to know the break-even (i.e. *zero* EARNings) response percentage for 145,000 pieces, costing 24 cents each:

0 EARN 145000 TOTL .24 COST %RET

Answer: %RET=1.66

And what are the earnings with a 3.26% return response to this mailing?

3.26 %RET EARN Answer: EARN=33,505.15

That's the kind of cold, hard "what-iffing" you *always* need to do before making a decision with this kind of money, isn't it?

And that's how the HP-17B can do it for you.

3. This is another one of those combination-formula problems – where you have two distinct formulas, each with its own single unknown.

   As usual, your strategy is to develop each formula separately – in the proper format, with everything on the left and a zero on the right– and then combine them with the IF(S) language.

   OK, but how do you get the HP-17B to use a calendar, anyway?

   Simple: Use the calendar functions it has in its SOLVE vocabulary: For example, DATE(12.191959 : 44) is a phrase that means this:

   "The date which is 44 days after December 19th, 1959"

   (Remember the format with which you set the time – 'way back at the beginning of the course? You key in dates in MM.DDYYYY format, where the MM are the digits representing the month, the DD the day of the month, and the YYYY the year).

   So the first formula isn't very tough at all:

   DUE=DATE(START:280)

   or, in proper ready-to-be-combined format:

   DUE-DATE(START:280)=0

As for the second formula, that's a bit tougher.

Fortunately, there's another phrase in the HP-17B's calendar vocabulary. It works like this:

DDAYS(12.191959:3.311960:1)

This is the Difference in DAYS (the number of days) between the two given dates, according to one of three possible calendars: Calendar 1 (as in this example) is the actual calendar – leap years and all; Calendar 2 doesn't recognize leap years; and Calendar 3 assumes that a year is made up of 12 identical 30-day months.

Of course, you and your obstetrician friend are interested in reality, so you'll be using Calendar 1 in your formula.

Now, if a normal term of pregnancy is 280 days, then if you found out how many more days the pregnancy was expected to go (from TODAY) before the DUE date and subtracted that number from 280, you'd have the number of days it has progressed so far, correct?

OK, and how would you write this? How about this?

PROG = 280 - (DDAYS(TODAY:DUE:1))

That will work just fine – except that it's going to give you the number of *days* the pregnancy has progressed up to now. That isn't quite what your friend needs; she'd like this to be expressed in terms of *weeks and days.*

That's different....

How are you going to produce two pieces of information from the single number (the number of days, PROG)?

You're going to take a lesson from your HP-17B – cheat a little.

Notice how the machine can actually get *three* pieces of information out of one number when it's expressing a date: 12.191959. In this one number, which is just an untidy little fraction between 12 and 13, you can represent the month, day and year.

Well then, why couldn't you convert your PROG days into a number of the format WW.D, where the WW would represent the number of whole weeks progressed so far, and the D would give the odd days (no more than 6, right)?

Your doctor friend could then easily read off each part of the answer – especially if you name it W.D as a reminder.

So "W.D = something" is your second formula.

Next problem: How do you actually do the conversion?

No problem: Dipping once again into your machine's seemingly bottomless bag of SOLVE tricks, you come up with IDIV and MOD.

IDIV is Integer DIVision, where the first number is divided by the second, but any remainder is thrown out. For example,

IDIV(10:3) = 3 and IDIV(13:5) = 2

So you can easily extract the number of whole weeks contained in PROG days:

W = IDIV(PROG:7)

And what about the odd days? That's what MOD is all about. MOD gives the *remainder* of any division:

MOD(10:3) = 1 and MOD(13:5) = 3

Your odd days, D, will therefore be D = MOD(PROG:7)

OK, are you all set *now?*

Not quite. Your final number must be of the form W.D, so you need to divide D by 10 (to get it beyond the decimal point), then add this to the W to get the correct format. Your final second formula will therefore look something like this:

W.D = IDIV(PROG:7) + (MOD(PROG:7) ÷ 10)

Now replace PROG with what it really is: 280 - (DDAYS(TODAY:DUE:1)) ; and here's your second formula:

```
W.D=IDIV(280-(DDAYS(TODAY:DUE:1)):7)+
 (MOD(280-(DDAYS(TODAY:DUE:1)):7)÷10)
```

Now format it so that you can properly put it into a combination formula:

```
W.D-IDIV(280-(DDAYS(TODAY:DUE:1)):7)-
(MOD(280-(DDAYS(TODAY:DUE:1)):7)÷10)=0
```

Ready to combine this and the simple DUE-date-prediction formula (shown again below)?

```
DUE-DATE(START:280)=0
```

Here goes nothing:

```
IF(S(DUE)
:DUE-DATE(START:280)
:W.D-IDIV(280-(DDAYS(TODAY:DUE:1)):7)-(MOD
(280-(DDAYS(TODAY:DUE:1)):7)÷10))=0
```

It's broken up here so that you can see the two alternatives to the IF(S) more easily. Remember how that works: IF you press DUE to Solve for the DUE date, the first equation (after the first :) will be used; if you solve for anything else, the second equation (after the second :) will govern.

But in any case, the variables for both will appear on one menu.

Go for it. ☞

Here it is again so that it's easier to type from:

```
IF(S(DUE)
:DUE-DATE(START:280)
:W.D-IDIV(280-(DDAYS(TODAY:DUE:1)):7)-(MOD
(280-(DDAYS(TODAY:DUE:1)):7)÷10))=0
```

Start in the usual way – at the SOLVE menu with a fresh formula at the bottom of your list (press ▼ NEW). Then type away!...When you're through, press INPUT, of course, then CALC and try a couple of problems (you might want to set the display to FIX 6 for these):

If a woman's due date is thought to be April 22, 1988, and today is November 25, 1987, how many weeks and days is she into her pregnancy?

Press 4.22198 DUE 11.251987 TODAY, then W.D

Answer: W.D=18.500000

She's 18 weeks and 5 days into her pregnancy.

If a revised estimate puts the start of the pregnancy at July 11, 1987, what is a better estimate of the due date?

Press 7.11198 7 START DUE Answer: DUE=4.161988

A good guess for a birth day is April 16, 1988.

4. As usual, put yourself in the role of that payroll clerk, and walk through the process manually, as if you didn't have any automated computing tools to help you:

   Since the tax a person *owes* at any given point in the year is dependent upon how much he/she has earned *up to that point in the year,* you're going to need some kind of cumulative record of earnings and tax withheld "to date," right? So how about a list of earnings already earned and a corresponding list of taxes already withheld? If you set things up like that, then your procedure is pretty easy:

   You would take the current pay period's earnings and add it to the list of cumulative earnings.

   Then you would total that list and find the appropriate *total tax* for the year-to-date *total earnings.*

   Then you would *subtract* from that *total tax* any taxes already withheld (that's the current sum of your list of taxes). The result of this subtraction is the amount of tax to withhold for this pay period – and you would then enter it as the latest entry to your list of taxes already withheld!

Does this suggest a good way to solve this on your HP-17B? Envision it like this:

You create a SUM list called EARN, whose items are all the gross earnings for all the pay periods. When you issue pay for a new pay period, the first thing to do is to add that period's gross pay amount as a new item on the bottom of the list.

Next, you go to the SOLVE menu and use a formula to figure the tax to withhold for this period.

Finally, you go back to the SUM menu and append this tax withholding amount to the bottom of a second list, called TAX – a list of the tax amounts withheld for the year's pay periods.

This doesn't seem so tough when you use lists, does it?

Notice how this solution is different than your mileage reimbursement solution. In that case, you entered all your list information first (in two lists – same as here), and then you went to the SOLVE menu to get your answer.

But here, you enter information in one list, go to the SOLVE menu to calculate your answer, and then return to the SUM menu to record this answer in another list – so that you'll be able to get an accurate answer for *next* pay period.

OK, you know how to create and fill in lists, so the only real problem left to solve is the formula you're going to need....

Remember the SOLVE language for referring to an item in a list?

The 4th item in your EARN list would be ITEM(EARN:4), right? And recall that the length of (number of items) in that list is denoted as SIZES(EARN). So the Σ notation for summing all the amounts in your EARNings list is

Σ(N:1:SIZES(EARN):1:ITEM(EARN:N))

This is the running total of cumulative earnings for the year. This is the GROSS amount you use in the IRS' formula:

TAX = .005 x GROSS x LOG(GROSS)

Once you find the TAX on that GROSS amount, you then need to subtract the total of all taxes *already withheld.* And that total would be this:

Σ(N:1:SIZES(TAX):1:ITEM(TAX:N))

See why? Notice that this TAX-withheld list would be one item shorter (at this point in the calculation) than your EARNings list, but it is the accurate total of all tax withheld before this current period, right?

Now put it all together to find CTAX (your Current TAX to withhold). Here's how you would make each of the substitutions:

CTAX = TAX - Taxes Already Withheld
= TAX - Σ(N:1:SIZES(TAX):1:ITEM(TAX:N))
= .005 x GROSS x LOG(GROSS) - Σ(N:1:SIZES(TAX):1:ITEM(TAX:N))

OK so far? The only substitution left to make now is for the GROSS amount, which you know as Σ(N:1:SIZES(EARN):1:ITEM(EARN:N))

Go for it:

```
                    CTAX=
.005×Σ(N:1:SIZES(EARN):1:ITEM(EARN:N))×
LOG(Σ(N:1:SIZES(EARN):1:ITEM(EARN:N)))-
    Σ(N:1:SIZES(TAX):1:ITEM(TAX:N))
```

Study this until you've picked out all the parts. It's not nearly as horrendous as it looks when you know where each part came from, is it?

Now key it in. From the SOLVE menu, begin a new formula as usual (press ▼ NEW). Then type, then INPUT, then CALC.

Now test it with this scenario: This is the fourth pay period of the year, with your first three pay periods looking like this:

GROSS EARNINGS	TAX WITHHELD
$2,200.00	$36.77
2,500.00	49.53
1,600.00	33.38

And for this fourth pay period, your gross earnings are $3,300.00

Go to the SUM menu and build your two lists (and you might as well put your 4th-period pay into the EARN list right now):

GET :NEW
2200 INPUT
2500 INPUT
1600 INPUT
3300 INPUT EXIT
Now give this list the name EARN (and press INPUT when you've finished typing this name).

Next, GET :NEW
36•77 INPUT
49•53 INPUT
33•38 INPUT EXIT
Now give this list the name TAX (and press INPUT when you've finished typing this name).

And off you go to the SOLVE menu, where you "point" to the tax formula (actually you're probably still pointing to it anyway), and

CALC CTAX (you might need to press this twice) Answer: CTAX=71.47

That's how much to withhold on this paycheck, so save it: STO 4.

Now go right back to the TAX list (EXIT EXIT :SUM GET TAX) and put this amount as the fourth item:

(▼ – probably not necessary) RCL 4 INPUT

Nothing to it!

5. Of course, you *could* do this entire set of calculations with the TVM menu, but if you're doing some intensive "what-iffing" with certain items (e.g. the inflation rate or tax bracket), this demands a lot of *re*calculation for every variation. So by writing a very smart SOLVE formula, you can spend your time thinking and planning different annuity options– rather than recalculating!

   How smart must this formula be? It has to do certain TVM-style problems – and the SOLVE menu's vocabulary *does* cover such things – but in a slightly different way than the actual TVM menu. There are four TVM "phrases" in that vocabulary (shown on the last page of your HP manual's Table 11-2):

   • SPPV(i%:n) gives you the *Present Value* (the equivalent value today) of a Single Payment (i.e. a *single cash-flow*) of *one dollar,* invested n periods in the future, where i% is the compounding rate per period. For example, SPPV (1:12) is about $0.8874, since *one dollar* compounded for 12 months at 1% per month is equivalent to 88.74 cents today. Get the idea?

   • There's SPFV(i%:n), also. It gives you the *Future Value* of a Single Payment (a single *cash-flow*) of *one dollar,* invested now and compounded for n periods at i% per period. For example, SPFV(1:6) is about $1.0615, as you know from page 94 (it's the same problem – just $1.00 instead of $100.00).

   • USPV(i%:n) gives you the *Present Value* of a Uniform Stream of n *one-dollar payments* (PMT's) – in END mode – at a discount rate of i% per period. Thus, USPV(1:360) is $97.22 (check this with the TVM menu if you wish; recall that the 1% here is 1% per *period,* not per year. This $97.22, for example, is the loan amount that could be completely amortized (no Future Value) by 360 months of $1.00 payments, at 1% *per month* – i.e. 12% I%YR, right?).

   • Similarly, USFV(i%:n) gives you the *Future Value* of a Uniform Stream of n *one-dollar payments* (PMT's) – in END mode – at a discount rate of i% per period. Thus, USFV(1:360) is about $3,494.96 (again, check this with TVM).

Notice how for each of these four "phrases," you need two "knowns" *inside* the parentheses (i% and n) to compute the "unknown" value represented *outside* the parentheses (SPPV, SPFV, USPV, and PSFV). And keep in mind that the USPV and USFV "phrases" make an additional assumption about the annuity mode of those one-dollar payments: END mode (annuity in arrears).

But what good are calculations that only work for cash-flows of one dollar? **Aha!** Isn't it true that if each of these four "phrases" used the assumption of *two*-dollar cash-flows, their calculations would be exactly *twice* as large? And if they used $5 cash-flows, wouldn't the results be 5 times as much, etc.?

Well, if you have a Present Value of, say, $23,456.78, and you want to figure out what that will grow into after, say, 48 months at .8% per month, then all you need to do *in the SOLVE menu* is compute SPFV(.8:48), which is that very calculation for *one* dollar – and then *multiply the result* by 23,456.78!

Of course, the same argument applies when you're going the other way (with SPPV). So this is a quick and easy way to find the Present Value or Future Value of *any* single cash-flow within a SOLVE equation.

And how about USPV and USFV? What are they good for? *They can be used to calculate a PMT amount for any END mode TVM problem.*

After all, isn't it true that if you take the Present Value of a stream of one-dollar payments, the resulting number is exactly what loan amount will be completely amortized (no FV remaining) by those payments? And if the payments are twice as big, the amount financeable is also twice as big, etc. So suppose you have a loan amount (i.e. a known PV) of $345,678.90, to be completely amortized over 360 months at 12% A.P.R. (that's 1% per month, keep in mind). If you compute USPV(1:360), this will give you an amount financed of 97.22. But your amount financed is "345,678.90/97.22" times as large; *therefore your payment must be 345,678.90/97.22 times as big, also!*

Starting to see how you can build TVM solutions even in the SOLVE menu? All right, so which of these "almost-TVM phrases" are you likely to use in building your solution to the problem at hand?

Well, you'll need to calculate some future lump sum of buying power ("$LMP") that results from a uniform series of investments from your paycheck. That sounds like a USFV.

And the retirement annuity you can then draw from that ($ANN) – that's a PMT calculation that you can do by dividing your $LMP by some USPV, right? That's using the very method you just saw on the previous page, isn't it?

OK, so $LMP and $ANN are your final *unknowns.*

Now, what *other knowns* will you have?

- You'll have an average amount you invest each month (call it $INV);
- You'll have an average yearly inflation rate (%INF);
- You'll have your assumed tax bracket (TAX%);
- You'll have the APR growth rate of your investment account;
- You'll know the number of work years (#WYR) over which you invested in this account;
- And you'll know the number of retirement years (#RYR) over which you draw an annuity from the resulting lump sum.

See how you can tick these variables off – just by rereading the problem?

Notice the assumptions about the time periods involved: You need to give your inflation rate, account A.P.R., work and retirement data in terms of *years,* but your investment amount and your retirement annuity will be *monthly.* Be sure to do the proper conversions in your formulas!

So, knowing the names for all your variables, can you begin to piece together chunks of the formula? Sure you can. And while you're at it, you might as well note that it's a *combined* formula (since there are two unknowns: $LMP and $ANN), so you'd better treat each formula separately, then combine them at the end, with that IF(S) language – remember?

First, figure out what your lump-sum of buying power will be. It's a Future Value, all right – based upon a steady, monthly investment, so you need to convert everything to *months* when you use the USFV "phrase:"

$LMP=USFV((APR-TAX%÷100xAPR-%INF)÷12:#WYRx12)x$INV

See how to figure each one of the parameters inside the parentheses?

Remember how to get at an effective growth rate on a taxable account – and how to account for inflation, too? That's what all the mess is there in the i% slot of the USFV formula (see page 138 if you've forgotten the reasons for it). Then you need to divide it by 12 to get the monthly rate.

Yes, by the way – the END mode assumption of the USFV is correct, since you get paid at the end of the month – and that's how you invest – out of your paycheck. And at the very end of the formula is the final multiplication – where you make the proportional adjsutment from dollar-sized payments to $INV-sized payments!

Now put this formula into proper format for combining:

```
$LMP-(USFV((APR-TAX%÷100×APR-%INF)÷12
      :#WYR×12)×$INV)=0
```

And there's half your problem solved right there (but don't key this in yet)!

Now for the annuity question: You're going to assume the same conditions of tax bracket and inflation (questionable at best, but the future always is, eh?). But now you're going to vary the *term* over which you *amortize* $LMP, paying yourself the monthly payments as an annuity.

How about this as a start?

$ANN=$LMP÷USPV((APR-TAX%÷100xAPR-%INF)÷12:#RYRx12)

Walking through this, can you see where each of the knowns originated?

- The *i%yr* is the same assumption as before;

- The *n* slot is filled with the number of retirement months you'll have (you give it years and it converts to months);

  And there's where the trick comes in – the one about dividing the amount to be amortized ($LMP) by the present value of the $1 payments (USPV), to get the *true* size of the payments ($ANN) that will amortize the $LMP.

OK, now convert that to proper "combinable" format:

$ANN-($LMP÷USPV((APR-TAX%÷100×APR-%INF)÷12:
#RYR×12))=0

And rewrite your first part here for reference:

$LMP-(USFV((APR-TAX%÷100×APR-%INF)÷12
:#WYR×12)×$INV)=0

"Prepare to merge...."

"MERGE:"

```
                    IF(S($ANN)
:$ANN-($LMP÷USPV((APR-TAX%÷100×APR-%INF)÷12
                    :#RYR×12))
:$LMP-(USFV((APR-TAX%÷100×APR-%INF)÷12
                    :#WYR×12)×$INV))=0
```

Now start a new equation at the bottom of your list of SOLVE formulas and key all that in....

Then [INPUT]....remember, "If at first, it doesn't like it, edit, edit some more."

Now, think it'll fly? It's Kitty Hawk time:

[CALC] [MORE] [1][5][0] [$INV]
[4][0] [#WYR]
[MORE] [3][0] [TAX%]
[5] [%INF]
[1][5] [APR] [$LMP] Answer: $LMP=261,155.94

Remember that these answers are in terms of *today's* buying power.

Now play with the term of your monthly annuity from that lump sum:

[MORE] [4][0] [#RYR] [MORE] [$ANN] Answer: $ANN=1,346.96
[MORE] [3][0] [#RYR] [MORE] [$ANN] Answer: $ANN=1,482.81
[MORE] [2][0] [#RYR] [MORE] [$ANN] Answer: $ANN=1,796.46

Now re-do the whole thing, varying the inflation rate and your tax bracket to see how your 40- , 30- , and 20-year annuity would be affected:

27 TAX% $LMP	Answer: $LMP=294,702.23
MORE 40 #RYR MORE $ANN	Answer: $ANN=1,611.23
MORE 30 #RYR MORE $ANN	Answer: $ANN=1,757.43
MORE 20 #RYR MORE $ANN	Answer: $ANN=2,102.85

33 TAX% $LMP	Answer: $LMP=231,912.75
MORE 40 #RYR MORE $ANN	Answer: $ANN=1,125.97
MORE 30 #RYR MORE $ANN	Answer: $ANN=1,252.05
MORE 20 #RYR MORE $ANN	Answer: $ANN=1,536.93

30 TAX%	
4 %INF $LMP	Answer: $LMP=342,542.84
MORE 40 #RYR MORE $ANN	Answer: $ANN=2,005.44
MORE 30 #RYR MORE $ANN	Answer: $ANN=2,165.10
MORE 20 #RYR MORE $ANN	Answer: $ANN=2,553.91

6 %INF $LMP	Answer: $LMP=201,172.60
MORE 40 #RYR MORE $ANN	Answer: $ANN=904.40
MORE 30 #RYR MORE $ANN	Answer: $ANN=1,019.31
MORE 20 #RYR MORE $ANN	Answer: $ANN=1,272.72

That's what inflation and taxes can do to your retirement savings!

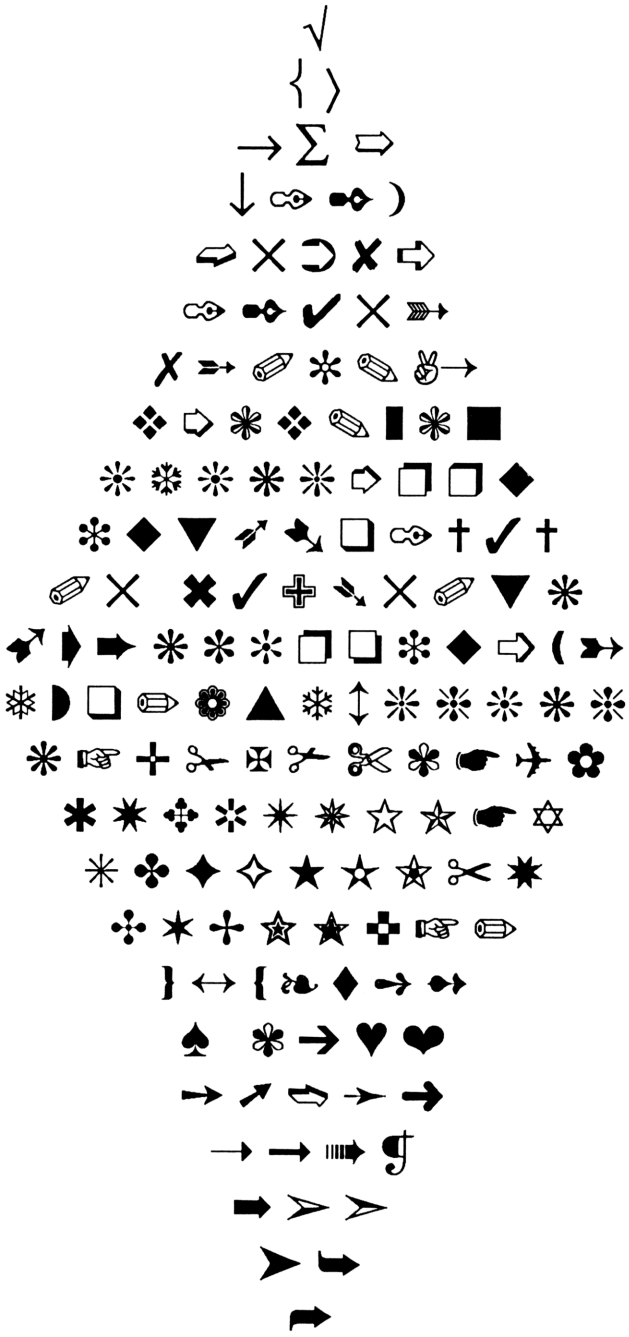
And now aren't you glad you didn't recalculate all this "by hand" with the TVM menu?)! The SOLVE menu is truly the place to be for "What-Iffing" at its best!

So those are the rudiments of SOLVE.

But there's a lot more you could do with it, if you wanted to learn some more complicated ways of building the equations.

A good place to start looking for more ideas is your owner's manual. There you'll find a chapter that more fully describes all the different functions and formulas you can use to build equations– along with some very impressive examples of what you can do with such calculating power!

But even if you don't get any more complicated than the problems you've just seen, even *that* much power in your pocket is sure handy, eh? After all, you don't need to be stunt-certified to go over cliffs before your "4-wheeling" skills pay off, right?



Points Of Interest

"The Book Stops Here"

That's about it – the end of the Easy Course, the bottom of the hill (notice the official-looking designation posted below). You're now a fully qualified HP-17B driver – "street-legal" *and* "wilderness-trained!"

Of course, it *doesn't* mean you've seen it *all.*

As we said at the start, this book doesn't even pretend to cover all of the many uses of your machine. In fact, we've totally ignored many of its useful functions, because (as we also promised at the beginning), we thought those areas were very well-explained in the manual that came with your calculator. Because you now know how to work with menus and play "What-If?", they should all be fairly straightforward.

So if you now want to explore those other topics, here's the list for you, along with the chapter numbers where they appear in your owner's manual:

Chapter 7: **Bonds**
Chapter 8: **Depreciation**
Chapter 9: **Running Total and Statistics**
Chapter 10: **Time, Appointments, and Date Arithmetic**
Chapter 12: **Printing**

Explore them – enjoy them – and get the most out of your HP-17B!

Lower Right-Hand Corner
↓
□

Notes (Yours)

So how did you like this book? Do you find yourself wishing we had covered other things? More of the same things?

Or did you find any mistakes, typos, or other little mysteries we ought to know about (yes, we usually have a few innocent-looking little boo-boos. Did any of them leap out and grab you by the lapels)?

Please let us hear from you. Your comments are our only way of knowing whether these books help or not. And we always read and reply to our mail! So drop us a note (there's room for comments on the back of the order forms ☞):

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Anyway, thanks for going along for the ride. When all is said and done, we hope that this book will have said and done a lot of it for you, helping you and your HP-17B become good business partners – and stay good friends.

By the way, if you liked this book, here's a full list of books that you or someone you know might enjoy:

- An Easy Course in Using the HP-27S
- An Easy Course in Using the HP-17B
- An Easy Course in Using the HP-19B
- An Easy Course in Using the HP-28S
- An Easy Course in Using the HP-28C
- An Easy Course in Using the HP-16C
- Computer Science on Your HP-41 (Using the HP Advantage ROM)
- The HP Business Consultant (HP-18C) Training Guide
- Statics For Students (Using the HP Advantage ROM)
- The HP-12C Pocket Guide
- An Easy Course in Programming the HP-11C and HP-15C
- An Easy Course in Using the HP-12C
- An Easy Course in Programming the HP-41

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