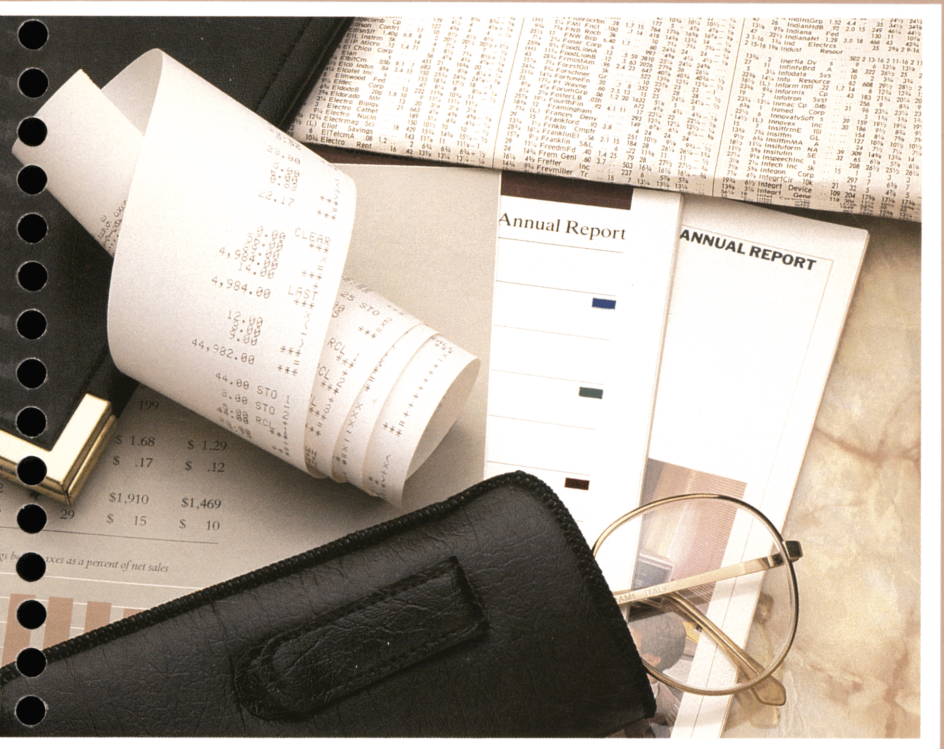
HEWLETT-PACKARD

Step-by-Step Solutions
For Your HP Calculator

Business Finance and Accounting



HP-17B
HP-19B
HP-27S

HEWLETT PACKARD

Business Finance and Accounting

Step-by-Step Solutions for Your HP-17B, HP-19B, or HP-27S Calculator

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Contents

How To Use This Book

The *Business Finance and Accounting* book provides sets of keystrokes and routines to assist you in making finance and accounting decisions. These routines can be used by anyone involved in finance or accounting in any business. This book is designed to show you how your HP business calculator can help in these areas.

Before you use the solutions in this book, you should be familiar with the following concepts from the owner's manual:

- The basics of your calculator – how to do arithmetic calculations, move from menu to menu, and use the menu keys to do calculations.
- Cash-flow sign convention (cash paid out is entered as a negative number and cash received is entered as a positive number).
- How to enter cash flows in a cash-flow list. (This function is not available on the HP-27S.)
- How to enter numbers for statistics.
- How to enter and use equations in the Solver.

Keys and Menu Selection

A key on the calculator keyboard is represented like this: EXIT. A shifted function appears with a shift key, like this: ■ CLEAR DATA. A menu label is represented like this: ≣ %CH ≣ (found in the %CHG menu). The arrow keys are represented by ↓ and ↑.

This book can be used with the HP-17B, HP-19B, and HP-27S calculators. Generally, the same keystrokes are used on all three calculators to perform a particular operation. However, there are some differences, which are summarized in the following table. Note that the cash-flow menus are available on the HP-27S using a Solver equation.

Keystroke Differences

HP-17B	HP-19B	HP-27S
To store a Solver equation and its menu:		
SOLVE NEW type equation INPUT CALC	SOLVE type equation CALC	■ SOLVE NEW type equation INPUT CALC
To edit a Solver equation:		
EDIT edit equation INPUT CALC	EDIT edit equation CALC	EDIT edit equation INPUT CALC
To display the cash-flow (CFLO) menu:		
CFLO	CFLO	Solver equations on pages 118 and 122
To display the correct menu for entering numbers into a sum list:		
SUM	SUM	■ STAT

Display Formats

The examples in this book show numbers displayed to two decimal places. If your display setting is otherwise, the answers in your display will not match exactly what is in this book. Refer to your owner's manual for more information about changing the number of decimal places in the display.

Entering Equations

When entering equations into your HP calculator, follow the Solver instructions in your owner's manual. The following hints help you with some common questions and error situations:

1. If the calculator displays INVALID EQUATION when you press CALC, the calculator does not understand something in the equation. When the equation returns to the display, the cursor blinks where the calculator detected the error. Check the equation in the

display against the equation in the book. Make sure the parentheses match and that the operators are where they should be.

2. If the calculator accepts the equation but your answer does not match the example, check the values stored in the variables by recalling them (press RCL, then the menu key). If the values are correct, return to the SOLVE menu and check the equation. (Press EXIT to return to the SOLVE menu and press ≡ EDIT ≡ to view and edit the equation.) Check the equation against the one in this book for accuracy. When you find an error, edit the equation.

3. If the calculator displays INSUFFICIENT MEMORY when you press INPUT or ≡ CALC ≡, you must clear portions of memory. Refer to your owner's manual for additional information.

The equations in this book use variable names that are intended to remind you of what to store. Feel free to change them.

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Financial Management

Break-Even Analysis

Break-even analysis is a technique for analyzing the relationships among fixed costs, variable costs, and income. Until the break-even point is reached (total costs equal total income), the producer operates at a loss. After the break-even point, each unit produced and sold makes a profit. The variables in the equation below are fixed costs, variable costs per unit, sales price per unit, number of units sold, and gross profit.

Entering and Using the PROFIT Equation:

1. Enter the *PROFIT* equation into the Solver.

   `PROFIT=#SOLD×(PRICE-VARC)-FIXC`

2. Display the *PROFIT* equation menu.
3. Store or calculate the following variables:
   - Gross profits in ≣ PROFI ≣.
   - Number of units sold in ≣ #SOL ≣.
   - Price per unit in ≣ PRICE ≣.
   - Variable costs per unit in ≣ VARC ≣.
   - Fixed costs in ≣ FIXC ≣.

Example: Part 1. Your product sells for $13. The fixed costs are $12,000. Variable costs are $6.75 per unit. Calculate the number of units that must be sold to break even (profit equals zero).

Display the *PROFIT* equation menu.

Keys:	Display:	Description:
0 PROFI	PROFIT=0.00	Stores break-even profit of zero.
13 PRICE	PRICE=13.00	Stores price per unit.
6.75 VARC	VARC=6.75	Stores variable costs per unit.
12000 FIXC	FIXC=12,000.00	Stores fixed costs.
#SOL	#SOLD=1,920.00	Calculates number that must be sold to break even.

Part 2. Calculate the gross profit if 2,500 units are sold.

2500 #SOL	#SOLD=2,500.00	Stores number sold.
PROFI	PROFIT=3,625.00	Calculates gross profit.

Part 3. You want a gross profit of $4,500 at the sales volume in part 2 (2,500 units). What should the sales price be?

4500 PROFI	PROFIT=4,500.00	Stores required gross profit.
PRICE	PRICE=13.35	Calculates required sales price.

Forecasting Based on History

One method of forecasting is to look at historical trends. Once you have historical data, the data are fit to a curve with time on the x-axis and the quantity you are forecasting on the y-axis. Linear curve fit is appropriate if you have a fairly constant growth rate; exponential curve fit is appropriate with compound growth, such as sales for a new product.

Use the following steps to forecast based on history:

1. In the SUM menu,* enter the time data (x data). Press [INPUT] after each item.
2. Name your list.
3. Get a new list and enter the historical data (y data).
4. Name your list.
5. In the FRCST menu, select the time list as your x-variable and the historical data list as your y-variable.†
6. If necessary, select the forecast model.
7. Key in the known value and press the menu key for that variable.
8. Press the menu key for the variable whose value you want to forecast.

Example 1: Forecasting Using Linear Curve Fit. You want to determine the sales forecast for the next two years using a linear curve fit. The following data represents your sales for the past five years.

* On the HP-27S, press ■ [STAT] to display the STAT menu.

† On the HP-19B, you don't select the y-variable. The current list is used.

Year	Sales ($)
1	130,600
2	160,750
3	205,900
4	210,000
5	240,650

The keystrokes for statistics on the HP-17B and HP-27S are slightly different than on the HP-19B. Two sets of steps follow. The first set is for the HP-17B and HP-27S. The second set, beginning on page 16, is for the HP-19B.

HP-17B and HP-27S Steps:

On the HP-17B, display the SUM menu. On the HP-27S, display the STAT menu.

Keys:	Display:	Description:
■ CLEAR DATA ≡ YES ≡ ≡ YES ≡	ITEM(1) = ?	Clears current list or gets a new one.
or		
≡ GET ≡ ≡ *NEW ≡		
1 INPUT		Enters time values.
2 INPUT		
3 INPUT		
4 INPUT		
5 INPUT	TOTAL = 15.00	
EXIT ≡ NAME ≡ YEAR INPUT		Names the list.
≡ GET ≡ ≡ *NEW ≡	ITEM(1) = ?	Displays a new list.
130600 INPUT		Enters sales data.
160750 INPUT		
205900 INPUT		
210000 INPUT		
240650 INPUT	TOTAL = 947,900.00	
EXIT ≡ NAME ≡ SALES INPUT		Names the list.

CALC MORE		Displays the FRCST menu.
FRCST	SELECT X VARIABLE	
YEAR	SELECT Y VARIABLE	Selects YEAR as *x*-variable.
SALES	LINEAR	Selects SALES as *y*-variable.*
6 YEAR	YEAR=6.00	Stores year 6 as the *x*-value.
SALES	SALES=270,385.00	Calculates sales forecast for year 6.
7 YEAR	YEAR=7.00	Stores year 7 as the *x*-value.
SALES	SALES=297,320.00	Calculates sales forecast for year 7.

HP-19B Steps:
On the HP-19B, display the SUM menu.

Keys:	**Display:**	**Description:**
■ CLEAR DATA YES	ITEM(1)=	Clears current list or gets a new one.
or		
GET *NEW		
1 INPUT		Enters time values.
2 INPUT		
3 INPUT		
4 INPUT		
5 INPUT	TOTAL=15.00	
NAME YEAR INPUT		Names the list.
GET *NEW	ITEM(1)=	Displays a new list.

* If LINEAR is not displayed, press MORE MODL LIN to change the model.

130600 [INPUT]		Enters sales data.
160750 [INPUT]		
205900 [INPUT]		
210000 [INPUT]		
240650 [INPUT]	TOTAL=947,900.00	
[NAME] SALES [INPUT]		Names the list.
[CALC] [MORE]		Displays the FRCST
[FRCST]	SELECT X VARIABLE	menu.
[YEAR]	SELECT A MODEL	Selects YEAR as *x*-variable.
[LIN]	LINEAR	Selects linear model.
6 [XLIST]	XLIST=6.00	Stores year 6 as the *x*-value.
[YLIST]	YLIST=270,385.00	Calculates sales forecast for year 6.
7 [XLIST]	XLIST=7.00	Stores year 7 as the *x*-value.
[YLIST]	YLIST=297,320.00	Calculates sales forecast for year 7.

Example 2: Forecasting Using Exponential Curve Fit. The sales history for your new product is shown below for the first six months after introduction. You would like to estimate the sales for December.

Month	Sales ($K)
June	31.7
July	52.5
August	48.3
September	56.6
October	72.7
November	90.9

The keystrokes for statistics on the HP-17B and HP-27S are slightly different from those used on the HP-19B. Two sets of steps follow. The first set is for the HP-17B and HP-27S. The second set, beginning on page 19, is for the HP-19B.

HP-17B and HP-27S Steps:

Part 1. Using the exponential model, estimate the sales for December.

On the HP-17B, display the SUM menu. On the HP-27S, display the STAT menu.

Keys:	Display:	Description:
■ CLEAR DATA YES YES	ITEM(1) = ?	Clears current list or gets a new one.
or GET *NEW		
1 INPUT 2 INPUT 3 INPUT 4 INPUT 5 INPUT 6 INPUT	TOTAL = 21.00	Enters month numbers.
EXIT NAME MONTH INPUT		Names the list.
GET *NEW	ITEM(1) = ?	Displays a new list.
31.7 INPUT 52.5 INPUT 48.3 INPUT 56.6 INPUT 72.7 INPUT 90.9 INPUT	TOTAL = 352.70	Enters sales data.
EXIT NAME MSLS INPUT		Names the list.
CALC MORE FRCST	SELECT X VARIABLE	Displays the FRCST menu.
MONT	SELECT Y VARIABLE	Selects MONTH as *x*-variable.
MSLS	LINEAR	Selects MSLS as *y*-variable.

MORE MODL	SELECT A MODEL	Selects exponential model.
EXP	EXPONENTIAL	
7 MONT	MONTH = 7.00	Stores month 7 as the x-value.
MSLS	MSLS = 105.78	Calculates projected sales for December, month 7.

Part 2. Calculate the monthly compound growth rate.

M × 100 =	18.29	Calculates estimate of monthly compound growth rate as a percent.

HP-19B Steps:

Part 1. Using the exponential model, estimate the sales for December. On the HP-19B, display the SUM menu.

Keys:	**Display:**	**Description:**
■ CLEAR DATA YES		Clears current list or
YES	ITEM(1) =	gets a new one.
or		
GET *NEW		
1 INPUT		Enters month numbers.
2 INPUT		
3 INPUT		
4 INPUT		
5 INPUT		
6 INPUT	TOTAL = 21.00	
NAME MONTH		Names the list.
INPUT		
GET *NEW	ITEM(1) =	Displays a new list.

31.7 [INPUT]		Enters sales data.
52.5 [INPUT]		
48.3 [INPUT]		
56.6 [INPUT]		
72.7 [INPUT]		
90.9 [INPUT]	TOTAL = 352.70	
[NAME] MSLS [INPUT]		Names the list.
[CALC] [MORE]		Displays the FRCST menu.
[FRCST]	SELECT X VARIABLE	
[MONT]	SELECT A MODEL	Selects MONTH as *x*-variable.
[EXP]	EXPONENTIAL	Selects exponential model.
7 [XLIST]	XLIST = 7.00	Stores month 7 as the *x*-value.
[YLIST]	YLIST = 105.78	Calculates projected sales for December, month 7.

Part 2. Calculate the monthly compound growth rate.

[M] [×] 100 [=]	18.29	Calculates estimate of monthly compound growth rate as a percent.

Simple Payback Period

The simple payback period method determines the length of time (in years) required for a business to recover its entire investment in a capital expenditure. Capital expenditures are purchases of assets, such as machinery or equipment, that have service periods of one year or more.

The shorter the payback period, the better; the sooner the investment is recovered, the sooner funds can be used for another project. For a capital expenditure to be considered profitable, its service period must exceed the length of the payback period.

Entering and Using the PBK Equation:

1. Enter the *PBK* equation into the Solver.

   `PBK=INV÷FLOW`

2. Display the *PBK* equation menu.
3. Store or calculate the following variables:
   - Length of time in years required to recover investment in ≣ PBK ≣.
   - Investment in capital expenditure in ≣ INV ≣.
   - Annual cash inflow for the life of the purchase in ≣ FLOW ≣.

Example: Part 1. You are considering a new machine costing $100,000. The annual cash inflow for the service period of the machine is $15,000. What is the payback period?

Display the *PBK* equation menu.

Keys:	Display:	Description:
100000 ≣ INV ≣	INV = 100,000.00	Stores investment.
15000 ≣ FLOW ≣	FLOW = 15,000.00	Stores yearly inflow.
≣ PBK ≣	PBK = 6.67	Calculates payback period in years.

Part 2. Your company desires a payback period of five years. What must the investment be to meet this goal?

5 PBK	PBK=5.00	Stores required payback period.
INV	INV=75,000.00	Calculates investment.

Using NPV and IRR% To Make Investment Decisions

Note

These procedures cannot be done on the HP-27S. For an equation to calculate *NPV* and *IRR%* on the HP-27S, refer to "Net Present Value and Internal Rate of Return on the HP-27S" on page 116.

Net present value (*NPV*) and internal rate of return (*IRR%*) are used to determine if an investment is acceptable. The built-in CFLO menu makes it easy to calculate these two values.

The method on the next page helps the decision-making process when choosing between two mutually exclusive options, such as deciding between two pieces of equipment. This method looks at the period-by-period difference between the two investments, then uses these differences as cash flows. The investment becomes the difference between option A and option B. If the net present value is positive at the desired rate of return, the more expensive option is the better one; otherwise, the less expensive option is better.

When the differences result in a conventional series of cash flows (one sign change), you can also look at the *IRR%* to determine which is the better investment. (Refer to your owner's manual for the definition of "conventional series of cash flows.") If the *IRR%* is higher than your required percent, the investment in the more expensive machine is a good investment.

If the differences are not a conventional series of cash flows (multiple sign changes), you can still use *NPV* to analyze the investment.

Use the following steps to calculate the *NPV* and *IRR%*:

1. Calculate the difference between the cash flows for the two options for each period (net cash flows).
2. In the CFLO menu, enter the net cash flows and number of periods into the cash-flow number list.
3. In the CFLO CALC menu:
   - To calculate the net present value, enter the periodic interest rate as a percent in [I%], then press [NPV].
   - To calculate the internal rate of return, press [IRR%].

Example. You want to choose between two equipment options. The table below summarizes the initial flows, the cash flows over the five-year life of the machines, and the difference between the two options (net cash flows).

	A	B	A-B
Initial Investment	$-35,000	$-25,000	$-10,000
Cost in year 1	-200	-1,300	1,100
Cost in year 2	-200	-1,400	1,200
Cost in year 3	-200	-2,500	2,300
Cost in year 4	-800	-2,500	1,700
Cost in year 5	15,000	7,000	8,000

Calculate the *NPV* and *IRR%* to determine which machine should be purchased. (Note that A-B is a conventional series of cash flows.) The required rate of return is 10%.

Display the *CFLO* menu.

Keys:	Display:	Description:
■ CLEAR DATA YES YES	FLOW(0)=?*	Clears current list or gets a new one.
or GET *NEW		
10000 +/− INPUT	FLOW(1)=?*	Stores the initial cash flow.
1100 INPUT INPUT	FLOW(2)=?	Stores FLOW(1).
1200 INPUT INPUT	FLOW(3)=?	Stores FLOW(2).
2300 INPUT INPUT	FLOW(4)=?	Stores FLOW(3).
1700 INPUT INPUT	FLOW(5)=?	Stores FLOW(4).
8000 INPUT	#TIMES(5)=1	Stores FLOW(5).

Skip the next step (pressing EXIT) if you have the HP-19B.

EXIT CALC		Displays the CALC menu.
10 I%	I%=10.00	Stores required return on investment.
NPV	NPV=−151.75	Calculates net present value.
IRR%	IRR%=9.56	Calculates internal rate of return.

Option B is the better choice because *NPV* is negative. The *IRR%* calculation tells you the same thing, that because *IRR%* is less than the required 10%, option B is the better choice.

---

* On the HP-19B, these prompts are INIT= and FLOW(1)=.

Economic Ordering Quantity

The economic ordering quantity (*EOQ*) is the optimum quantity to order each time an order is placed. It is based on the cost of placing and receiving an order, annual sales, holding cost (including warehousing costs, interest on funds tied up in inventory, insurance, and obsolescence), and the purchase price of the goods.

The equation assumes that usage is at a constant rate and that delivery lead times are constant.

Entering and Using the EOQ Equation:

1. Enter the *EOQ* equation into the Solver.*

   `EOQ=SQRT(2×CPO×#UNITS÷(HOLD%÷100×CPU))`

2. Display the *EOQ* equation menu.
3. Store or calculate the following variables:
   - Economic ordering quantity in [EOQ].
   - Cost of placing an order in [CPO].
   - Annual unit sales in [#UNI].
   - Holding costs as a percent of inventory value in [HOLD%].
   - Cost per unit in [CPU].

Example. Your annual sales are 10,000 units. Cost per unit is $4.73. Holding cost is 20% of inventory value, and the cost of placing and receiving an order is $35. What is the economic ordering quantity?

Display the *EOQ* equation menu.

*To key in the square-root function (SQRT), press [■] [√x].

Keys:	Display:	Description:
35 ≣ CPO ≣	CPO = 35.00	Stores cost of placing order.
10000 ≣ #UNI ≣	#UNITS = 10,000.00	Stores annual sales in units.
20 ≣ HOLD% ≣	HOLD% = 20.00	Stores holding cost.
4.73 ≣ CPU ≣	CPU = 4.73	Stores cost per unit.
≣ EOQ ≣	EOQ = 860.21	Calculates economic ordering quantity.

EOQ Using Discount and Tax Rates

The economic ordering quantity equation in this section includes the variables in the first equation, plus variables for the total tax rate and discount rate on the cost of capital.

Entering and Using the EOQ2 Equation:

1. Enter the *EOQ2* equation into the Solver.*

```
EOQ2=SQRT((2×(1-TAX%÷100)×CPO×#UNITS)÷
((1-TAX%÷100)×HOLD%÷100×CPU+DISC% ÷
100×CPU))
```

2. Display the *EOQ2* equation menu.

---

* To key in the square-root function (SQRT), press ■√x.

3. Store or calculate the following variables:

- Economic ordering quantity in EOQ2.
- Tax rate as a percent in TAX%.
- Cost of placing an order in CPO.
- Annual unit sales in #UNI.
- Holding costs as a percent of inventory value in HOLD%.
- Cost per unit in CPU.
- Discount rate as a percent in DISC%.

Example. A manufacturing company uses 1,500 units per year of a special part and estimates that it costs $30 to place an order. The inventory manager has estimated that holding costs are 4% per year. The finance department uses an 8% discount rate and a 40% tax rate. These units cost $21 per unit for all order quantities. What is the economic ordering quantity?

Display the *EOQ2* equation menu.

Keys:	**Display:**	**Description:**
40 TAX%	TAX% = 40.00	Stores tax rate.
30 CPO	CPO = 30.00	Stores cost of placing order.
1500 #UNI	#UNITS = 1,500.00	Stores annual sales in units.
4 HOLD%	HOLD% = 4.00	Stores holding cost.
MORE		Stores cost per unit.
21 CPU	CPU = 21.00	
8 DISC%	DISC% = 8.00	Stores discount rate.
MORE EOQ2	EOQ2 = 157.24	Calculates economic ordering quantity.

Cost of Failing To Take a Cash Discount

A cash discount gives a buyer a reduction in price if payment is made within a specified time period. For example, "2/10, net 30" means that the buyer can deduct 2 percent if payment is made within 10 days after the date of billing. If payment is not made within 10 days, the full amount must be paid by the 30th day.

The equation below calculates the cost of failing to take the cash discount. The cost is calculated as an annual interest rate charged for delaying payment.

Entering and Using the COST% Equation:

1. Enter the *COST%* equation into the Solver.

   ```
   COST%=DISC%÷(100-DISC%)×360÷
   (TOTDA-DISCDA)×100
   ```

2. Display the *COST%* equation menu.
3. Store the following variables:
   - Discount percent if the payment is made within the discount period in ≣ DISC% ≣.
   - Total number of days until the bill must be paid in ≣ TOTDA ≣.
   - Number of days for which the discount is available in ≣ DISCD ≣.
4. Press ≣ COST% ≣ to calculate the cost of failing to take the discount, expressed as an annual percentage interest rate.

Example 1. You receive a bill with credit terms 2/10, net 30. What is the cost of not taking the cash discount?

Display the *COST%* equation menu.

Keys:	Display:	Description:
2 [DISC%]	DISC% = 2.00	Stores discount rate.
30 [TOTDA]	TOTDA = 30.00	Stores total days.
10 [DISCD]	DISCDA = 10.00	Stores number of days discount is available.
[COST%]	COST% = 36.73	Calculates annual cost of not taking the cash discount.

Example 2. Another bill has credit terms 3/30, net 180. What is the cost of not taking this discount?

Keys:	Display:	Description:
3 [DISC%]	DISC% = 3.00	Stores discount rate.
180 [TOTDA]	TOTDA = 180.00	Stores total days.
30 [DISCD]	DISCDA = 30.00	Stores number of days discount is available.
[COST%]	COST% = 7.42	Calculates annual cost of not taking the cash discount.

Degree of Leverage

Leverage analyzes the fixed costs that are part of the cost of doing business. Equations for operating leverage, financial leverage, and combined leverage are included in this section.

Operating Leverage

Operating leverage focuses on a company's fixed operating costs. These costs include administrative costs, rent, and depreciation expenses and do not include interest on debt.

The degree of operating leverage is defined as the percentage change in earnings before interest and taxes as a result of a percentage change in units sold. The greater a firm's degree of operating leverage, the more its earnings before interest and taxes vary with unit sales fluctuations.

Entering and Using the OPLEV Equation:

1. Enter the *OPLEV* equation into the Solver.

   `OPLEV=1÷(1-FIXCO÷(#UNITS×(PRICE-VARCO)))`

2. Display the *OPLEV* equation menu.
3. Store or calculate the following variables:
   - Fixed costs in ≣ FIXCO ≣.
   - Number of units sold in ≣ #UNI ≣.
   - Price per unit in ≣ PRICE ≣.
   - Variable costs per unit in ≣ VARCO ≣.
   - Degree of operating leverage in ≣ OPLEV ≣.

Example 1. Your company sold 10,000 units last year at $20 each. Fixed costs were $50,000; variable costs per unit were $5. Calculate the degree of operating leverage.

Display the *OPLEV* equation menu.

Keys:	Display:	Description:
50000 [FIXCO]	FIXCO=50,000.00	Stores fixed costs.
10000 [#UNI]	#UNITS=10,000.00	Stores number of units sold.
20 [PRICE]	PRICE=20.00	Stores price per unit.
5 [VARCO]	VARCO=5.00	Stores variable costs per unit.
[OPLEV]	OPLEV=1.50	Calculates degree of operating leverage.

Financial Leverage

Financial leverage focuses on a company's financial fixed costs. The primary example of such a cost is the interest expense on borrowed funds.

The degree of financial leverage is defined as the percentage change in earnings per share that results from a percentage change in earnings before interest and taxes. The greater a firm's degree of financial leverage, the more the return on owner's equity fluctuates with changes in unit sales. The equation in this section includes the variables in the *OPLEV* equation plus interest expense.

Entering and Using the FLEV Equation:

1. Enter the *FLEV* equation into the Solver.

   ```
   FLEV=1÷(1-$INT÷(#UNITS×(PRICE-VARCO)-
   FIXCO))
   ```

2. Display the *FLEV* equation menu.

3. Store or calculate the following variables:
   - Annual interest expense in [$INT].
   - Number of units sold in [#UNI].
   - Price per unit in [PRICE].
   - Variable costs per unit in [VARCO].
   - Fixed costs in [FIXCO].
   - Degree of financial leverage in [FLEV].

Example 2. Your company sold 10,000 units last year at $20 each. Fixed costs were $50,000; variable costs per unit were $5. Your company's interest expense was $20,000. Four variables (*#UNITS, PRICE, VARCO,* and *FIXCO*) are the same as example 1 and need not be reentered if they are still stored.

Display the *FLEV* equation menu.

Keys:	Display:	Description:
10000 [#UNI]	#UNITS=10,000.00	Stores units sold.
20 [PRICE]	PRICE=20.00	Stores price per unit.
5 [VARCO]	VARCO=5.00	Stores variable costs per unit.
50000 [FIXCO]	FIXCO=50,000.00	Stores fixed costs.
20000 [$INT]	$INT=20,000.00	Stores interest expense.
[FLEV]	FLEV=1.25	Calculates financial leverage.

Combined Leverage

The degree of combined leverage measures the total leverage caused by both fixed operating costs and fixed financial costs.

Degree of combined leverage measures the percentage change in net after-tax earnings due to a one percent change in sales. Combined leverage increases as operating leverage and financial leverage increase. The degree of combined leverage measures the impact of the operating fixed costs and financial fixed costs on the variability of net income.

Entering and Using the COLEV Equation:

1. Enter the *COLEV* equation into the Solver.

   ```
   COLEV=1÷(1-(FIXCO+$INT)÷(#UNITS×(PRICE-
   VARCO)))
   ```

2. Display the *COLEV* equation menu.
3. Store or calculate the following variables:
   - Fixed costs in ≣ FIXCO ≣.
   - Annual interest expense in ≣ $INT ≣.
   - Number of units sold in ≣ #UNI ≣.
   - Price per unit in ≣ PRICE ≣.
   - Variable costs per unit in ≣ VARCO ≣.
   - Degree of combined leverage in ≣ COLEV ≣.

Example 3. Your company sold 10,000 units last year at $20 each. Fixed costs were $50,000; variable costs per unit were $5. Your company's interest expense was $20,000. Five variables (*#UNITS, PRICE, VARCO, FIXCO,* and *$INT*) are the same as example 2 and need not be reentered if they are still stored.

Display the *COLEV* equation menu.

Keys:	Display:	Description:
50000 ≣ FIXCO ≣	FIXCO = 50,000.00	Stores fixed costs.
20000 ≣ $INT ≣	$INT = 20,000.00	Stores interest expense.
10000 ≣ #UNI ≣	#UNITS = 10,000.00	Stores units sold.
20 ≣ PRICE ≣	PRICE = 20.00	Stores price per unit.
5 ≣ VARCO ≣	VARCO = 5.00	Stores variable costs per unit.
≣ COLEV ≣	COLEV = 1.88	Calculates combined leverage.

Cost of Capital

The cost of capital is a concept that determines the appropriate discount rate that a company (or a department of the firm) uses in evaluating various investment opportunities. The cost of capital is used as the interest rate in net present value calculations. This concept requires that a firm earn a return that is equal to or exceeds the cost of the funds used. Included in this section are the cost of debt, cost of preferred stock, cost of common stock (both the constant growth valuation approach and capital asset pricing model), and a weighted average cost of all capital.

Cost of Debt

The cost of debt to a firm is measured by the effective yield to maturity on the company's bonds. Since the interest paid to bond holders is tax deductible, the effective cost of debt is less than the yield to maturity.

Entering and Using the CD% Equation:

1. Enter the *CD%* equation into the Solver.

   `CD%=YLD%×(1-TAX%÷100)`

2. Display the *CD%* equation menu.
3. Store or calculate the following variables:
   - Cost of debt as a percent in ≣ CD% ≣.
   - Yield to maturity on bonds as a percent in ≣ YLD% ≣.
   - Tax bracket as a percent in ≣ TAX% ≣.

Example. Your company has outstanding debt in the form of bonds. The yield to maturity on these bonds is 12%, and your firm is in the 40% tax bracket. Calculate the cost of debt.

Display the *CD%* equation menu.

Keys:	Display:	Description:
12 ≣ YLD% ≣	YLD% = 12.00	Stores bond yield to maturity.
40 ≣ TAX% ≣	TAX% = 40.00	Stores tax percent.
≣ CD% ≣	CD% = 7.20	Calculates percent cost of debt.

Cost of Preferred Stock

The cost of preferred stock compares the annual dividend of the stock (usually a fixed amount) to the stock's market price. The annual dividend payment is divided by the net proceeds that the firm will receive from the sale of the preferred stock.

Entering and Using the CPS% Equation:

1. Enter the *CPS%* equation into the Solver.

   `CPS%=DIV÷(PRICE-SCOST)×100`

2. Display the *CPS%* equation menu.
3. Store or calculate the following variables:
   - Cost of preferred stock as a percent in ≣ CPS% ≣.
   - Annual dividend in ≣ DIV ≣.
   - Price of preferred stock in ≣ PRICE ≣.
   - Cost to sell the stock in ≣ SCOST ≣.

Example. Your company is considering selling preferred stock to finance a proposed expansion. The stock is expected to sell for $110 per share, and would pay annual dividends of $10 per share. The cost to sell the stock is $5 per share. Calculate the cost of capital for preferred stock.

Display the *CPS%* equation menu.

Keys:	Display:	Description:
10 ≣ DIV ≣	DIV = 10.00	Stores annual dividend.
110 ≣ PRICE ≣	PRICE = 110.00	Stores price per share.
5 ≣ SCOST ≣	SCOST = 5.00	Stores cost per share to sell.
≣ CPS% ≣	CPS% = 9.52	Calculates percent cost of preferred stock.

Cost of Common Stock (Constant Growth Valuation Approach)

This approach for determining the cost of common stock requires that the firm estimate what investors expect for future dividends. The assumed constant rate of growth and the current price of the stock are used to determine the stock holder's expected rate of return.

Entering and Using the CCS1% Equation:

1. Enter the *CCS1%* equation into the Solver.

   `CCS1%=100×(DIV1÷PRICE+GRW%÷100)`

2. Display the *CCS1%* equation menu.
3. Store or calculate the following variables:
   - Cost of common stock as a percent in ≣ CCS1% ≣.
   - Dividend at end of year one in ≣ DIV1 ≣.
   - Price of stock today in ≣ PRICE ≣.
   - Assumed constant rate of growth in dividends as a percentage in ≣ GRW% ≣.

Example. Your company's common stock is currently selling for $50 per share, and you plan to pay dividends at the end of the first year of $3 per share. Your firm also plans a growth rate of 8% per year in dividends. Calculate the cost of capital for common stock using the constant growth valuation approach.

Display the *CCS1%* equation menu.

Keys:	Display:	Description:
3 ≣ DIV1 ≣	DIV1 = 3.00	Stores first year dividend.
50 ≣ PRICE ≣	PRICE = 50.00	Stores today's price per share.
8 ≣ GRW% ≣	GRW% = 8.00	Stores growth rate of dividends.
≣ CCS1% ≣	CCS1% = 14.00	Calculates percent cost of common stock.

Cost of Common Stock (Capital Asset Pricing Model)

This approach for determining the cost of common stock is based on the beta value for the firm's common stock. The beta value is a measure of the volatility of the return on a particular stock relative to the market. Stocks with a beta of 1.0 have a risk equal to that of the market. Stocks with beta values exceeding 1.0 are riskier than the market; stocks with betas less than 1.0 are less risky than the market. Beta values can be found in stock market price publications available at public libraries.

Entering and Using the CCS2% Equation:

1. Enter the *CCS2%* equation into the Solver.

   `CCS2%=RTN%+BETA×(EXPT%−RTN%)`

2. Display the *CCS2%* equation menu.
3. Store or calculate the following variables:
   - Cost of common stock as a percent in ≣ CCS2% ≣.
   - Risk-free rate of return in the market in ≣ RTN% ≣.
   - Beta coefficient in ≣ BETA ≣.
   - Expected rate of return for the market as a whole in ≣ EXPT% ≣.

Example. Your company has collected the following data to calculate the cost of capital for common stock. The beta coefficient for the company is 1.6. The risk-free rate of return (the current rate of Treasury Bill securities) is 8%. The expected rate of return for the market as a whole is 10%. Calculate the cost of capital for common stock using the capital asset pricing model.

Display the *CCS2%* equation menu.

Keys:	Display:	Description:
8 ≣ RTN% ≣	RTN% = 8.00	Stores risk-free rate of return.
1.6 ≣ BETA ≣	BETA = 1.60	Stores beta coefficient.
10 ≣ EXPT% ≣	EXPT% = 10.00	Stores expected rate of return.
≣ CCS2% ≣	CCS2% = 11.20	Calculates percent cost of common stock.

Weighted Average Cost of Capital

The weighted average cost of capital reflects the cost of each component of capital (debt, preferred stock and common stock) weighted by the relative amount of each from the company's capital structure.

Entering and Using the WAV% Equation:

1. Enter the *WAV%* equation into the Solver.

   `WAV%×100=DEBT%×CD%+PS%×CPS%+CS%×CCS%`

2. Display the *WAV%* equation menu.
3. Store or calculate the following variables:
   - Weighted average cost of capital as a percent in ≣ WAV% ≣.
   - Proportion of capital that is debt in ≣ DEBT% ≣.
   - Cost of debt as a percent in ≣ CD% ≣.
   - Proportion of capital that is preferred stock in ≣ PS% ≣.
   - Cost of preferred stock as a percent in ≣ CPS% ≣.

- Proportion of capital that is common stock in ≣ CS% ≣.
- Cost of common stock as a percent in ≣ CCS% ≣.

Example. Calculate the weighted average cost of capital of a corporation with the following capital structure:

	% of Capital	% Cost
Debt	40	8
Preferred stock	10	11
Capital stock	50	14

Display the *WAV%* equation menu.

Keys:	Display:	Description:
40 ≣ DEBT% ≣	DEBT% = 40.00	Stores percent capital that is debt.
8 ≣ CD% ≣	CD% = 8.00	Stores cost of debt.
10 ≣ PS% ≣	PS% = 10.00	Stores percent capital that is preferred stock.
11 ≣ CPS% ≣	CPS% = 11.00	Stores cost of preferred stock.
≣ MORE ≣		
50 ≣ CS% ≣	CS% = 50.00	Stores percent capital that is common stock.
14 ≣ CCS% ≣	CCS% = 14.00	Stores cost of common stock.
≣ MORE ≣		
≣ WAV% ≣	WAV% = 11.30	Calculates weighted average cost of capital.

Rights Valuation

Many corporations have charters that contain a preemptive right provision. This provision requires that the current holders of common stock be given the first option to buy any new shares sold by the firm. Stockholders may choose to exercise their rights or to sell these rights in the marketplace. This section includes equations for rights on and rights off situations.

Rights On

The term "rights on" refers to the situation in which the purchase of a share of common stock includes a right to buy additional shares of common stock – usually at a favorable price. This situation is also referred to as "cum rights."

Entering and Using the RTON Equation:

1. Enter the *RTON* equation into the Solver.

   `RTON=(MVAL-PRICE)÷(#RTS+1)`

2. Display the *RTON* equation menu.
3. Store or calculate the following variables:
   - Value of one right in RTON.
   - Market value, rights on, in MVAL.
   - Subscription price in PRICE.
   - Number of rights required to purchase a new share of stock in #RTS.

Example. Your corporation has issued a rights offering to its common stockholders. The subscription price is $50, and five rights are required to purchase one of the new shares of stock. The stock is selling for $60 rights on. What is the value of one right?

Display the *RTON* equation menu.

Keys:	Display:	Description:
60 MVAL	MVAL=60.00	Stores market value.
50 PRICE	PRICE=50.00	Stores subscription price.
5 #RTS	#RTS=5.00	Stores number of rights required to purchase share.
RTON	RTON=1.67	Calculates value of one right.

Rights Off

The term "rights off" refers to the situation in which the purchase of common stock no longer includes any rights to buy additional shares of common stock in this firm. This situation is also referred to as "ex-rights."

Entering and Using the RTOFF Equation:

1. Enter the *RTOFF* equation into the Solver.

   `RTOFF=(MVAL-PRICE)÷#RTS`

2. Display the *RTOFF* equation menu.
3. Store or calculate the following variables:
   - Value of one right in RTOFF.
   - Market value ex-rights in MVAL.
   - Subscription price in PRICE.
   - Number of rights required to purchase a new share of stock in #RTS.

Example. Your corporation has issued a rights offering to its common stockholders. Eight rights plus $40 will buy one new share. The current market price of the stock is $56 ex-rights. What is the value of one right?

Display the *RTOFF* equation menu.

Keys:	Display:	Description:
56 MVAL	MVAL=56.00	Stores market value.
40 PRICE	PRICE=40.00	Stores subscription price.
8 #RTS	#RTS=8.00	Stores number of rights required to purchase share.
RTOFF	RTOFF=2.00	Calculates value of one right.

2

Financial Statement Analysis

Return on Equity

The return on equity ratio measures the profitability of a company relative to the amount of equity (ownership) capital invested. The measure is usually calculated each year; year-to-year comparisons identify trends in this measure. Return on equity is also used to compare companies or industries.

Entering and Using the ROE% Equation:

1. Enter the *ROE%* equation into the Solver.

   `ROE%=INCOME÷EQUI×100`

2. Display the *ROE%* equation menu.
3. Store or calculate the following variables:
   - Return on equity as a percent in ROE%.
   - Total net income after taxes in INCO.
   - Equity capital invested in the company (assets minus liabilities) in EQUI.

Example: Part 1. Your company has after-tax earnings of $2.5 million. The net worth is $18 million. What is the return on equity?

Display the *ROE%* equation menu.

Keys:	Display:	Description:
2500000 INCO	INCOME= 2,500,000.00	Stores income after taxes.
18000000 EQUI	EQUI=18,000,000.00	Stores equity investment.
ROE%	ROE%=13.89	Calculates percent return on equity.

Part 2. Your industry averages 14.76% ROE. Given the equity investment in part 1, what after-tax income would you need to match that return on equity?

14.76 ROE%	ROE% = 14.76	Stores industry return on equity.
INCO	INCOME = 2,656,800.00	Calculates income after taxes.

Bond Interest Coverage Ratio

The bond interest coverage ratio is a measure of a bond's quality and financial safety. It is a ratio of the funds available to pay interest during a given year to the interest requirements associated with a bond issue.

The calculation can be made several ways, depending on the legal status of different issues of bonds, interest costs on other than bond debt, and whether the company has issued preferred stock.

All other things being equal, the higher the coverage ratio, the higher the quality of the bond.

Entering and Using the COVER Equation:

1. Enter the *COVER* equation into the Solver.

   `COVER=(EARN+$INT)÷$INT`

2. Display the *COVER* equation menu.
3. Store or calculate the following variables:
   - Coverage ratio in ≣ COVER ≣.
   - Earnings before taxes in ≣ EARN ≣.
   - Annual interest payments in ≣ $INT ≣.

Example: Part 1. What is the interest coverage ratio of a bond with annual interest payments of $2 million and corporate earnings before taxes of $8 million?

Display the *COVER* equation menu.

Keys:	Display:	Description:
8000000 ≣ EARN ≣	EARN=8,000,000.00	Stores corporate earnings.
2000000 ≣ $INT ≣	$INT=2,000,000.00	Stores annual interest payments.
≣ COVER ≣	COVER=5.00	Calculates bond interest coverage ratio.

Five dollars of funds are available to pay each dollar of bond interest.

Part 2. Suppose the average bond interest coverage ratio in your industry is 4.85. Calculate how much you could pay in annual interest payments if you borrowed additional funds so that your bond interest coverage ratio matched that of the industry.

4.85 COVER	COVER = 4.85	Stores bond interest coverage ratio.
$INT	$INT = 2,077,922.08*	Calculates annual interest payments.

* The Solver searches for an iterative solution and displays intermediate estimates.

Price-to-Earnings Ratio

The price-to-earnings ratio is used by investors to indicate how much they are investing to obtain one dollar of earnings. Individual securities are often compared to the ratios of stock market indexes or averages.

Entering and Using the PERATIO Equation:

1. Enter the *PERATIO* equation into the Solver.

   PERATIO=PRICE÷EARN

2. Display the *PERATIO* equation menu.
3. Store or calculate the following variables:
   - Price-to-earnings ratio in ≣ PERAT ≣.
   - Current market price of one share of common stock in ≣ PRICE ≣.
   - Current earnings per share in ≣ EARN ≣.

Example: Part 1. Your company stock is selling for $75 per share and has earnings of $6 per share. Calculate the price-to-earnings ratio.

Display the *PERATIO* equation menu.

Keys:	Display:	Description:
75 ≣ PRICE ≣	PRICE=75.00	Stores price per share.
6 ≣ EARN ≣	EARN=6.00	Stores earnings per share.
≣ PERAT ≣	PERATIO=12.50	Calculates price-to-earnings ratio.

Part 2. The Dow Jones Industrial Average (DJIA) is $2,550. Earnings are $231.82. Is your stock doing better or worse than the DJIA in terms of price-to-earnings ratio?

2550 PRICE	PRICE = 2,550.00	Stores DJIA price.
231.82 EARN	EARN = 231.82	Stores DJIA earnings.
PERAT	PERATIO = 11.00	Calculates DJIA price-to-earnings ratio.

The price-to-earnings ratio for your stock is higher than that of the DJIA, indicating your stock is more attractive relative to the average stock.

Return on Investment

One way of evaluating a new investment is through a simple return on investment (ROI) analysis. Return on investment is the ratio of net profit after taxes to the assets used to make the net profit.

Although this calculation is simple to do on any calculator, using SOLVE makes it easy to try what-if situations and to analyze what you can do to meet a minimum return on investment.

Entering and Using the ROI% Equation:

1. Enter the *ROI%* equation into the Solver.

   `ROI%=($REV×PROF%÷100)÷$INV×100`

2. Display the *ROI%* equation menu.
3. Store or calculate the following variables:
   - Return on investment as a percent in ROI%.
   - Total revenues in $REV.
   - Net profit as a percent of revenue in PROF%.
   - Capital investment in the project or business in $INV.

Example: Part 1. A new store requires $480,000 in new assets. The anticipated revenues the first year are $1 million. Your net profit goal is 10%. Assuming the net profit goal is met, calculate the return on investment.

Display the *ROI%* equation menu.

Keys:	Display:	Description:
1000000 Σ $REV Σ	$REV = 1,000,000.00	Stores total anticipated revenues.
10 Σ PROF% Σ	PROF% = 10.00	Stores net profit percent.
480000 Σ $INV Σ	$INV = 480,000.00	Stores investment.
Σ ROI% Σ	ROI% = 20.83	Calculates percent return on investment.

Part 2. The store's sales are actually $750,000 in the first year. Calculate the return on investment.

750000 Σ $REV Σ	$REV = 750,000.00	Stores actual revenues.
Σ ROI% Σ	ROI% = 15.63	Calculates percent return on investment.

Part 3. At the level of revenues in part 2, what total investment can you make to achieve an ROI of 18%.

18 Σ ROI% Σ	ROI% = 18.00	Stores required return on investment.
Σ $INV Σ	$INV = 416,666.67	Calculates investment to reach this goal.

Part 4. Suppose you realize a 5% net profit on revenues of $750,000 (you stored this value in part 2). Your investments are $480,000. Calculate the return on investment.

5 Σ PROF% Σ	PROF% = 5.00	Stores net profit.
480000 Σ $INV Σ	$INV = 480,000.00	Stores investment.
Σ ROI% Σ	ROI% = 7.81	Calculates percent return on investment.

Financial Statement Ratios

This section lists ratios that are used to analyze and interpret the information in financial statements. Financial ratios for a particular company are significant when they are compared to the past performance of the company and to industry averages for other firms in the same industry.

There are differing approaches to calculating the ratios presented in this section. The approach used to calculate the ratios should be the same as the approach used to calculate the ratios for the industry averages.

Ratio:	Equation:	Description:
Earnings per share	EPS=INC÷#SHR [Net income ÷ shares of stock outstanding]	Amount of profit per share of stock.
Dividend yield %	YLD%=DIV÷PRICE ×100 [Annual dividend per share ÷ current market price per share × 100]	Rate earned by the stockholders of the company.
Price-to-earnings ratio	PER=PRICE÷EARN [Current market price per share ÷ earnings per share]	Compares current market price of a stock to earnings per share for the company.
Book value per share	BVS=EQUI÷#SHR [Total stockholders' equity ÷ shares of stock outstanding]	Value of firm's net assets per share of stock in company.

Rate of return on assets%	RA%=OPINC÷ASSET ×100 [Income from operations ÷ average amount of assets × 100]	Compares profit from operations (profits before interest and taxes) to average assets used.
Rate of return on stockholders' equity%	RSE%=INC÷EQUI ×100 [Net income ÷ average stockholders' equity × 100]	Compares profits earned by company to average stockholder investment.
Inventory turnover	IT=CGS÷INV [Cost of goods sold ÷ average inventory]	Indicates how quickly inventory is turning over.
Accounts receivable turnover	ART=SLS÷AR [Net sales on credit ÷ average accounts receivable]	Indicates how quickly accounts receivable are being collected.
Average collection period	ACP=AR÷SLS [Accounts receivable ÷ average daily credit sales]	Indicates how quickly accounts receivable are being collected.
Asset turnover	AT=SLS÷ASSET [Total sales ÷ total assets]	Indicates extent of asset utilization.
Working capital	WC=ASSET−LIAB [Total current assets − total current liabilities]	Measure of liquidity or ability to pay short-term debt.
Current ratio	CR=ASSET÷LIAB [Total current assets ÷ total current liabilities]	Broad measure of a firm's short-term ability to pay debt.
Quick ratio	QR=(ASSET−INV) ÷LIAB [(Total current assets − inventories) ÷ current liabilities]	Restrictive measure of a firm's liquidity (also called the acid test ratio).

Times interest earned	TIE=OPINC÷INT [Operating income ÷ annual interest costs]	Extent to which a firm can pay (cover) its interest expense.
Debt ratio%	DR%=LIAB÷ASSET ×100 [Total liabilities ÷ total assets × 100]	Indicates the amount of leverage employed.
Equity ratio%	ER%=EQUI÷ASSET ×100 [Total stockholder's equity ÷ total assets × 100]	Indicates the amount of leverage employed.
Gross profit%	GP%=PROF÷SALES ×100 [Gross profit ÷ net sales × 100]	Indicates extent of mark-up used by the company.

Entering and Using the Financial Ratios:

1. Enter the equation into the Solver.
2. Display the equation menu.
3. Store the variables you know.
4. Press the ratio menu key to calculate the ratio.

Example 1: Earnings Per Share. Your company's net income is $90,000; 60,000 shares of stock are outstanding. Calculate the earnings per share.

Enter the *EPS* equation into the Solver.

```
EPS=INC÷#SHR
```

Display the *EPS* equation menu.

Keys:	Display:	Description:
90000 INC	INC=90,000.00	Stores net income.
60000 #SHR	#SHR=60,000.00	Stores number of shares of stock outstanding.
EPS	EPS=1.50	Calculates earnings per share.

Example 2: Dividend Yield. Your company's annual dividend per share is $.70; the current market price per share is $20. Calculate the dividend yield.

Enter the *YLD%* equation into the Solver.

`YLD%=DIV÷PRICE×100`

Display the *YLD%* equation menu.

Keys:	Display:	Description:
.7 DIV	DIV=0.70	Stores dividend per share.
20 PRICE	PRICE=20.00	Stores current market price per share.
YLD%	YLD%=3.50	Calculates dividend yield.

3

Cost Accounting and Auditing

Overhead Application Rate

Manufacturing (factory) overhead is an indirect manufacturing cost because it relates to the entire manufacturing operation. An overhead application rate is a method of allocating total overhead to either specific jobs or to individual units of inventory.

Entering and Using the OHD% Equation:

1. Enter the *OHD%* equation into the Solver.

   `OHD%=OEXP÷DEXP×100`

2. Display the *OHD%* equation menu.
3. Store or calculate the following variables:
   - Overhead application rate as a percent in ≣ OHD% ≣.
   - Overhead expense in ≣ OEXP ≣.
   - Direct expense (raw materials or direct labor, for example) in ≣ DEXP ≣.

Example. Your manufacturing firm has the following account balances for the year:

Raw material used	$500,000
Direct labor	100,000
Factory overhead	250,000

Part 1. Calculate the overhead application rate using direct labor as the direct expense.

Display the *OHD%* equation menu.

Keys:	Display:	Description:
250000 [OEXP]	OEXP = 250,000.00	Stores overhead expense.
100000 [DEXP]	DEXP = 100,000.00	Stores direct labor expense.
[OHD%]	OHD% = 250.00	Calculates percent overhead application rate.

Part 2. Calculate the overhead application rate using raw material as the direct expense.

500000 [DEXP]	DEXP = 500,000.00	Stores raw material expense.
[OHD%]	OHD% = 50.00	Calculates percent overhead application rate.

Labor, Material, and Overhead Variance

One objective of cost accounting systems is to determine the actual unit cost to manufacture a product. Cost systems are more useful when budgeted amounts are calculated prior to the start of operations. These budgeted amounts are called standard costs and are compared with the actual costs for a particular job or a particular department. Cost variances are the differences between standard costs and actual costs.

Rate Variance of Direct Labor

The rate variance for direct labor is the variance (difference) between the actual wage paid and the standard wage.

Entering and Using the RVAR Equation:

1. Enter the *RVAR* equation into the Solver.

   RVAR=(RATE−STRT)×HOURS

2. Display the *RVAR* equation menu.
3. Store or calculate the following variables:
   - Rate variance for direct labor in ≣ RVAR ≣.
   - Direct labor rate paid in ≣ RATE ≣.
   - Standard direct labor rate in ≣ STRT ≣.
   - Labor hours in ≣ HOURS ≣.

Example 1. Your standard labor rate is $8.50 per hour. Last month, 460 hours were worked at an actual labor rate of $9.30. Calculate the rate variance for direct labor.

Display the *RVAR* equation menu.

Keys:	Display:	Description:
9.3 RATE	RATE=9.30	Stores actual labor rate paid.
8.5 STRT	STRT=8.50	Stores standard labor rate.
460 HOURS	HOURS=460.00	Stores actual hours worked.
RVAR	RVAR=368.00	Calculates rate variance in dollars.

This is an unfavorable variance as you spent $368 more in direct labor than expected.

Efficiency Variance of Direct Labor

The efficiency variance for direct labor is the variance (difference) between the actual amount of labor used and the standard labor figure at a particular level of production.

Entering and Using the EVAR Equation:

1. Enter the *EVAR* equation into the Solver.

   `EVAR=(HOURS-STHR×#UNT)×STRT`

2. Display the *EVAR* equation menu.
3. Store or calculate the following variables:
   - Efficiency variance for direct labor in EVAR.
   - Labor hours in HOURS.
   - Standard hours per unit in STHR.
   - Number of units produced in #UNT.
   - Standard direct labor rate in STRT.

Example 2. Each table requires 2.5 standard labor hours, at the standard labor rate of $8.50. To produce 190 tables, direct labor worked 460 hours. Calculate the efficiency variance for direct labor.

Display the *EVAR* equation menu.

Keys:	Display:	Description:
460 ≣ HOURS ≣	HOURS = 460.00	Stores hours worked.
2.5 ≣ STHR ≣	STHR = 2.50	Stores standard labor hours per unit.
190 ≣ #UNT ≣	#UNT = 190.00	Stores units made.
8.5 ≣ STRT ≣	STRT = 8.50	Stores standard labor rate.
≣ EVAR ≣	EVAR = −127.50	Calculates efficiency variance, in dollars.

This is a favorable variance, as you spent $127.50 less in direct labor costs than expected.

Price Variance of Direct Materials

Price variance for direct materials is the variance (difference) between the actual price paid for materials and the standard price.

Entering and Using the PVAR Equation:

1. Enter the *PVAR* equation into the Solver.

   PVAR=(PRICE−STPR)×QUAN

2. Display the *PVAR* equation menu.
3. Store or calculate the following variables:
   - Price variance for direct materials in ≣ PVAR ≣.
   - Price paid for material in ≣ PRICE ≣.
   - Standard price of material in ≣ STPR ≣.
   - Quantity of material used in ≣ QUAN ≣.

Example 3. Your company manufactures plastic tables for children. Last month, 770 pounds of plastic, at $5.80 per pound, were used. The standard price per pound is $6. Calculate the price variance for direct materials.

Display the *PVAR* equation menu.

Keys:	Display:	Description:
5.8 ≣ PRICE ≣	PRICE = 5.80	Stores price.
6 ≣ STPR ≣	STPR = 6.00	Stores standard price.
770 ≣ QUAN ≣	QUAN = 770.00	Stores quantity used.
≣ PVAR ≣	PVAR = −154.00	Calculates the price variance, in dollars.

Since *PVAR* is negative, this is a favorable variance. The lower material price saved you $154.

Quantity Variance of Direct Materials

The quantity variance for direct materials is the variance (difference) between the actual quantity of materials used and the standard quantity that should have been used for a particular level of production.

Entering and Using the QVAR Equation:

1. Enter the *QVAR* equation into the Solver.

   QVAR=(QUAN−STQU×#UNT)×STPR

2. Display the *QVAR* equation menu.
3. Store or calculate the following variables:
   - Quantity variance for direct material in ≣ QVAR ≣.
   - Quantity of material used in ≣ QUAN ≣.
   - Standard quantity of material used per unit in ≣ STQU ≣.
   - Number of units produced in ≣ #UNT ≣.
   - Standard price for material in ≣ STPR ≣.

Example 4. Last month you made 190 tables, using 770 pounds of plastic. The standard quantity of plastic used in each table is 4 pounds. The standard price per pound of plastic is $6. Calculate the quantity variance for direct materials.

Display the *QVAR* equation menu.

Keys:	Display:	Description:
770 ≣ QUAN ≣	QUAN=770.00	Stores quantity used.
4 ≣ STQU ≣	STQU=4.00	Stores standard quantity per table.
190 ≣ #UNT ≣	#UNT=190.00	Stores units made.
6 ≣ STPR ≣	STPR=6.00	Stores standard price.
≣ QVAR ≣	QVAR=60.00	Calculates quantity variance, in dollars.

This is an unfavorable variance, as you spent more on material than expected.

Spending Variance of Factory Overhead

The spending variance for factory overhead is the variance (difference) between the actual factory overhead and the budgeted factory overhead for the level of production attained.

Entering and Using the SVAR Equation:

1. Enter the *SVAR* equation into the Solver.

   ```
   SVAR=OHD-(VAROH+FIXOH)
   ```

2. Display the *SVAR* equation menu.

3. Store or calculate the following variables:
   - Spending variance in overhead in SVAR.
   - Overhead in OHD.
   - Budgeted variable overhead in VAROH.
   - Budgeted fixed overhead in FIXOH.

Example 5. The overhead costs incurred for the month were $4,600. The budgeted fixed overhead was $1,938 and the budgeted variable overhead for the month was $2,907.00. Calculate the spending variance for factory overhead.

Display the *SVAR* equation menu.

Keys:	Display:	Description:
4600 OHD	OHD = 4,600.00	Stores overhead.
2907 VAROH	VAROH = 2,907.00	Stores variable overhead.
1938 FIXOH	FIXOH = 1,938.00	Stores fixed overhead.
SVAR	SVAR = −245.00	Calculates spending overhead variance, in dollars.

This is a favorable variance, as your overhead was lower than expected.

Volume Variance of Factory Overhead

The volume variance for factory overhead is the variance (difference) between budgeted overhead and the actual factory overhead.

Entering and Using the VVAR Equation:

1. Enter the *VVAR* equation into the Solver.

   VVAR=BFOH−APFOH

2. Display the *VVAR* equation menu.

3. Store or calculate the following variables:
   - Volume variance in overhead in ≣ VVAR ≣.
   - Budgeted factory overhead in ≣ BFOH ≣.
   - Applied factory overhead in ≣ APFOH ≣.

Example 6. The factory overhead applied to 190 tables is $4,692, and the total budgeted overhead for 190 tables is $4,845. Calculate the volume variance for factory overhead.

Display the *VVAR* equation menu.

Keys:	Display:	Description:
4845 ≣ BFOH ≣	BFOH=4,845.00	Stores budgeted overhead.
4692 ≣ APFOH ≣	APFOH=4,692.00	Stores applied overhead.
≣ VVAR ≣	VVAR=153.00	Calculates volume variance in overhead.

This is an unfavorable variance, as your volume overhead variance was higher than expected.

Overhead Variance on Direct Labor

The overhead variance on direct labor is the variance (difference) between the actual labor hours used and the standard (budgeted) labor hours multiplied by the standard wage. The result is multiplied by the standard overhead rate.

Entering and Using the OVAR Equation:

1. Enter the *OVAR* equation into the Solver.

   OVAR=(ACTHR−STDHR)×STDRT×STOHD÷100

2. Display the *OVAR* equation menu.

3. Store or calculate the following variables:
   - Overhead variance on direct labor in [OVAR].
   - Actual hours worked in [ACTHR].
   - Standard hours in [STDHR].
   - Standard labor rate in [STDRT].
   - Standard overhead rate, as a percentage, in [STOHD].

Example 7. You estimated that you would recover overhead based on 475 standard labor hours, using a standard labor rate of $8.50 per hour. Instead of working 475 hours, you actually worked 460 hours. The standard overhead rate is 120%. Calculate the overhead variance on direct labor.

Display the *OVAR* equation menu.

Keys:	Display:	Description:
475 [STDHR]	STDHR = 475.00	Stores standard labor hours.
460 [ACTHR]	ACTHR = 460.00	Stores actual hours worked.
8.50 [STDRT]	STDRT = 8.50	Stores standard labor rate.
120 [STOHD]	STOHD = 120.00	Stores the standard overhead rate.
[OVAR]	OVAR = −153.00	Calculates the overhead variance on direct labor.

This is a favorable variance, as your overhead recovery on the labor is lower than expected.

Selecting Random Numbers

Note

This procedure cannot be done on the HP-17B.

Generating a list of random numbers within a range is useful when you want to look at a random sample of anything – for example, random inspection of products coming off an assembly line, questionnaires distributed to a random number of employees, or audit a random selection of invoices.

The equation below selects random numbers within a range that you enter.

Entering and Using the RAND Equation:

1. Enter the *RAND* equation into the Solver.

   `RAND=LO+IP(MOD(RAN#×(HI−LO+1):HI−LO+1))`

2. Display the *RAND* equation menu.
3. Store the following variables:
   - Lowest number in the range in ≣ LO ≣.
   - Highest number in the range in ≣ HI ≣.
4. Press ≣ RAND ≣ to calculate the random number.

When you use the *RAND* equation, remember the following:

- Use integers only for [LO] and [HI].
- [HI] must be greater than [LO].
- The values in [LO] and [HI] are included in the numbers that can be generated. In the example below, 12,001 and 13,500 could be calculated.
- The same number may be calculated more than once.
- Calculate all at once the numbers you want to use. For example, if you want 25 numbers, calculate all 25 in a sequence.

Example. An auditor wants to look at 25 invoices selected at random from a set of invoices numbered 12,001 through 13,500. Generate the numbers of the invoices to audit.

Display the *RAND* equation menu.

Keys:	**Display:**	**Description:**
12001 [LO]	LO = 12,001.00	Stores the low invoice number.
13500 [HI]	HI = 13,500.00	Stores the high invoice number.
[RAND]	RAND = 13,371.00*	Calculates first invoice number.
[RAND]	RAND = 13,047.00*	Calculates second invoice number.

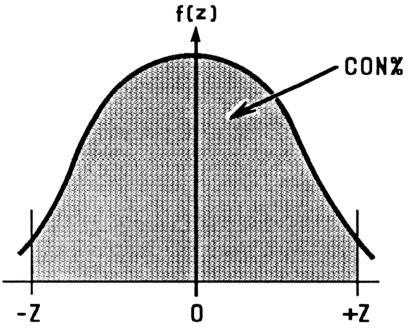
Continue pressing [RAND] for additional invoice numbers.

---

* The random numbers you calculate will probably not be the same as the random numbers calculated in this example. The calculator uses the time on the system clock as the "seed" to initiate the sequence of numbers.

Calculating the Standard Normal Variate

Your calculator can be used to calculate the standard normal variate (Z). The Z value calculated is the same value you would find in a statistical table that gives Z for a two-tailed region, as shown below:



The CONFIDENCE equation is used to calculate the Z value for a specified confidence level. There are always two possible solutions for Z, only one of which is positive. The useful range for Z is a positive number between 0 and 4. Therefore, the guesses you enter to estimate Z should be between 0 and 4.

Entering and Using the CONFIDENCE Equation:

1. Enter the CONFIDENCE equation into the Solver.*

```
CONFIDENCE:1÷(1-CON%÷100)=
(1+.049867347×Z+.0211410061×Z^2
+.0032776263×Z^3+3.80036E-5×Z^4+
4.88906E-5×Z^5+5.383E-6×Z^6)^16
```

2. Display the CONFIDENCE equation menu.
3. Store or calculate the following variables:
   - Confidence level estimate as a percentage in ≣ CON% ≣.
   - Standard normal variate in ≣ Z ≣.

Example 1. You would like to estimate the actual dollar value of your company's inventory with 90% confidence. Calculate *Z*.

Display the CONFIDENCE equation menu.

Keys:	Display:	Description:
90 ≣ CON% ≣	CON% = 90.00	Stores confidence level.
0 ≣ Z ≣	Z = 0.00	Stores first guess for *Z*.
4 ≣ Z ≣	Z = 4.00	Stores second guess for *Z*.
≣ Z ≣	Z = 1.64	Calculates *Z*.

---

* Source: Abramowitz and Stegun, *Handbook of Mathematical Functions*. National Bureau of Standards, 1972, pp 932.

To key in ^ on the HP-17B and HP-27S, press ■ [y^x].

Estimating Inventory Value Using Random Sampling

Four steps are involved in estimating inventory value using random sampling.

1. Calculate the standard normal variate (Z) for the desired confidence level.
2. Calculate the sample size required for the desired confidence interval.
3. Calculate a point estimate of the total inventory, in dollars.
4. Calculate the confidence interval estimate.

Calculating the Sample Size Required

To calculate the sample size, you will need the standard normal variate (Z) and standard deviation (S). Z can be found using the procedures on pages 70 and 71, or it can be looked up in a statistics text. S can be obtained from analysis of historical data. With Z and a reasonable choice for S, you can estimate inventory value using the SIZE equation.

Entering and Using the SIZE Equation:

1. Enter the SIZE equation into the Solver.*

   ```
   SIZE:D=Z×SQRT(#POP×S^2÷SSIZE×(#POP-
   SSIZE))
   ```

2. Display the SIZE equation menu.
3. Store or calculate the following variables:

---

* To key in the square-root function (SQRT), press ■ [√x].
To key in ^ on the HP-17B and HP-27S, press ■ [y^x].

- One-half the confidence interval width, in dollars, in [D].
- The standard normal variate in [Z].
- The number of elements in the population in [#POP].
- The standard deviation in [S].
- The required sample size in [SSIZE].

Example 1. You would like to estimate the actual dollar value of your company's inventory. The estimate should be within $5,000 (5% of estimated inventory) with 90% confidence. Your firm has 1,015 types of parts in inventory. Similar data collected last year produced an estimate of the standard deviation for the part value of $20.78.

Keys:	Display:	Description:
5000 [D]	D=5,000.00	Stores one half of the confidence interval, in dollars.
1.64 [Z]	Z=1.64	Stores the standard normal variate (obtain from a statistical table or calculate using the example on pages 70 and 71).
1015 [#POP]	#POP=1,015.00	Stores the number of elements in the population.
20.78 [S]	S=20.78	Stores the standard deviation.
[SSIZE]	SSIZE=45.70*	Calculates the required sample size.

A sample size of at least 46 types of parts must be taken from the population of 1,015 part type numbers.

---

* The Solver searches for an iterative solution and displays intermediate estimates.

Calculating a Point Estimate of the Total Inventory

A point estimate of the total inventory size is obtained by finding the mean of the sample and multiplying it by the total number of part types.

Example 2. The sample of 46 types of parts is taken from the population of 1,015 part types.

To calculate the point estimate of the total inventory, you must:

1. Choose at random the part types to be counted. The number of part types must be greater than or equal to *SSIZE*.
2. For each part type, count the number of parts. Multiply the number of parts by the value per part. Enter this value into a SUM (HP-17B or HP-19B) or STAT (HP-27S) list.
3. Calculate the mean and standard deviation of the data in the list. (Refer to your owner's manual if you are not familiar with how to do this.)
4. Multiply the total number of part types by the mean to calculate the point estimate of the total inventory value.

Suppose that after completing the four steps above, you arrive at a mean of $100.17 and a standard deviation of $19.18.

The point estimate of the total inventory dollars is then:

$1015 \times \$100.17 = \$101,672.55$

Estimating the Confidence Interval

The confidence interval for the total inventory value can then be calculated as follows:

Keys:	Display:	Description:
19.18 [S]	S = 19.18	Stores standard deviation.
46 [SSIZE]	SSIZE = 46.00	Stores sample size.
[D]	D = 4,599.48	Calculates one-half the confidence interval, in dollars.

With 90% confidence, you can conclude that the total dollar value of inventory is:

$101,672.55 ± 4,599.48 ($97,073.07 to 106,272.03)

Source: Richards and LaCava, *Business Statistics, Why and When.* McGraw-Hill, 1978, pp 132, 139, and 142.

4

Production and Inventory Analysis

Priority Scheduling Rule

Priority scheduling rules are used to determine the order in which customer orders should be worked. The priority scheduling rule in this section uses an index based on the number of work hours until the delivery date, the processing time for the order, and the number of operations remaining to complete the order. The lower the index, the higher the priority. The equation assumes that eight hours are worked per day.

Entering and Using the INDX Equation:

1. Enter the *INDX* equation into the Solver.

   `INDX=(#DAY×8−TIME)÷#OPS`

2. Display the *INDX* equation menu.
3. Store or calculate the following variables:
   - Days until delivery date in ≣ #DAY ≣.
   - Total processing time in ≣ TIME ≣.
   - Number of remaining operations in ≣ #OPS ≣.
   - Priority index in ≣ INDX ≣.

Example: Part 1. You have an order to ship in two weeks (ten days). The job has 30 hours of processing time and five operations remaining. What is the priority index?

Display the *INDX* equation menu.

Keys:	Display:	Description:
10 ≣ #DAY ≣	#DAY=10.00	Stores days to delivery date.
30 ≣ TIME ≣	TIME=30.00	Stores remaining processing time.
5 ≣ #OPS ≣	#OPS=5.00	Stores remaining operations.
≣ INDX ≣	INDX=10.00	Calculates priority index.

Part 2. You have another customer whose order is also due in ten days. That order has four operations remaining, which take 45 hours. Which order has the highest priority?

45 TIME	TIME=45.00	Stores remaining processing time.
4 #OPS	#OPS=4.00	Stores remaining operations.
INDX	INDX=8.75	Calculates priority index.

This order has a lower priority index, and thus, the higher priority.

Part 3. Your second customer changes the specifications on his order. The changes decrease your processing time to 39 hours. Which order now has the higher priority?

39 TIME	TIME=39.00	Stores remaining processing time.
INDX	INDX=10.25	Calculates priority index.

Customer one now has the higher priority.

Source: Tom Hendrick, *Production/Operations Management*. Irwin Publishing, 1985.

Daily Production Rate

Knowing a daily production rate helps manufacturers spread production and shipping needs over the month for the most efficient use of people and equipment. The daily production rate equation can also be used to compare production, shipment, or order rates for months with different numbers of working days.

Although production rate is simple to calculate, using the Solver means you don't have to reenter values when you have many calculations to do, or to try what-if situations.

Entering and Using the RATE Equation:

1. Enter the *RATE* equation into the Solver.

   RATE=UNIT÷DAYS

2. Display the *RATE* equation menu.
3. Store or calculate the following variables:
   - Daily rate in ≣ RATE ≣.
   - Total units for the month in ≣ UNIT ≣.
   - Number of work days in the month in ≣ DAYS ≣.

Example: Part 1. The production goal for January is 1,760 units. January has 22 work days. What quantity must be produced each day to meet the plan?

Display the *RATE* equation menu.

Keys:	Display:	Description:
1760 ≣ UNIT ≣	UNIT = 1,760.00	Stores production for the month.
22 ≣ DAYS ≣	DAYS = 22.00	Stores number of work days in the month.
≣ RATE ≣	RATE = 80.00	Calculates daily production rate.

Part 2. You have to calculate daily production rates for other products as well. The monthly production rates on three other products are:

Product	# Units Per Month
1	2477
2	700
3	4800

Keys:	Display:	Description:
2477 [UNIT]	UNIT=2,477.00	Stores units.
[RATE]	RATE=112.59	Calculates daily rate for product #1.
700 [UNIT]	UNIT=700.00	Stores units.
[RATE]	RATE=31.82	Calculates daily rate for product #2.
4800 [UNIT]	UNIT=4,800.00	Stores units.
[RATE]	RATE=218.18	Calculates daily rate for product #3.

Part 3. Capacity constraints prevent producing more than 225 units per day of product #3. February has only 19 work days. What is the maximum number of units of product #3 that can be produced?

225 [RATE]	RATE=225.00	Stores maximum daily rate.
19 [DAYS]	DAYS=19.00	Stores number of work days in the month.
[UNIT]	UNIT=4,275.00	Calculates units that can be produced in February.

Predicting Labor Hours Using Learning Rates

Learning curves are useful in analyzing new production processes to determine how productivity will improve over time. As the production team becomes more proficient, labor hours per unit decrease, leading to lower costs.

Entering and Using the LHRS Equation:

1. Enter the *LHRS* equation into the Solver.*

   `LHRS=U1HRS×UNIT#^(LN(LRN%÷100)÷LN(2))`

2. Display the *LHRS* equation menu.
3. Store or calculate the following variables:
   - Average time to produce each unit in ≣ LHRS ≣.
   - Time to produce the first unit in ≣ U1HRS ≣.
   - Number of the unit of interest in ≣ UNIT ≣.
   - Learning rate as a percent in ≣ LRN% ≣.

Example 1: Calculate the Learning Rate From Historical Data

For a certain production process, you know that the first unit took 100 hours to produce, and that by the 16th unit, you were averaging 41 hours per unit. What is the learning rate for this process?

Display the *LHRS* equation menu.

* To key in ^ on the HP-17B and HP-27S, press ■ [y^x].

Keys:	Display:	Description:
41 [LHRS]	LHRS = 41.00	Stores average hours to produce units 1 through 16.
100 [U1HRS]	U1HRS = 100.00	Stores hours to produce unit 1.
16 [UNIT]	UNIT# = 16.00	Stores unit number.
[LRN%]	LRN% = 80.02 *	Calculates learning rate.

Example 2: Calculate the Hours To Produce a Unit. You are starting production on a new item. You expect the learning rate on the new product to be 80%. The first unit took 70 hours. Calculate the average production rate when you reach unit 20.

Keys:	Display:	Description:
70 [U1HRS]	U1HRS = 70.00	Stores hours to produce unit 1.
20 [UNIT]	UNIT# = 20.00	Stores unit number.
80 [LRN%]	LRN% = 80.00	Stores learning rate.
[LHRS]	LHRS = 26.68	Calculates average hours to produce unit 20.

* The Solver searches for an iterative solution and displays intermediate estimates.

Forecasting Manufacturing Rates of Accessories

Many products have optional accessories or peripheral products. For example, cars have lots of extras, and computers have software and optional equipment.

The production rates of these optional items are often based on a percentage of the sales of the main product. The following equation helps determine production rates of these optional products.

Although this calculation is simple to do on any calculator, using the Solver means you don't have to reenter values to calculate many optional products for one main product, or to try what-if situations.

Entering and Using the %MAIN Equation:

1. Enter the *%MAIN* equation into the Solver.

   `%MAIN=#OPT÷MAIN×100`

2. Display the *%MAIN* equation menu.
3. Store or calculate the following variables:
   - Percent of main product in %MAI.
   - Units of the optional product in #OPT.
   - Units of the main product in MAIN.

Example: Part 1. Seventy-five percent of your customers are expected to order a particular software product to use with your computer. The computer is forecasted to sell 1,100 units per month. What should your manufacturing plan be for the software product?

Display the *%MAIN* equation menu.

Keys:	Display:	Description:
75 [%MAI]	%MAIN=75.00	Stores percent expected to buy the software.
1100 [MAIN]	MAIN=1,100.00	Stores computer forecast.
[#OPT]	#OPT=825.00	Calculates number of optional units to manufacture.

Part 2. Last month, computer orders were 900 and software orders were 750. The computer forecast is 1,100 units. How much software should be produced to reflect last month's actual sales rate?

750 [#OPT]	#OPT=750.00	Stores number of software products sold.
900 [MAIN]	MAIN=900.00	Stores number of computers sold.
[%MAI]	%MAIN=83.33	Calculates percent of computer sales.
1100 [MAIN]	MAIN=1,100.00	Stores computer forecast.
[#OPT]	#OPT=916.67	Calculates new forecast for software.

Estimating Inventory Availability

Availability estimates tell you approximately how long your inventory will last, based on forecasted rates or use rates. The equation below can be applied to finished goods or production parts.

This equation calculates availability in weeks, based on inventory on hand and use per month. The equation assumes 4.33 weeks per month. You can alter the equation to fit other situations. For example, if you omit × 4.33, the equation calculates availability in months.

Entering and Using the AVAIL Equation:

1. Enter the *AVAIL* equation into the Solver.

   `AVAIL=(INV÷USE)×4.33`

2. Display the *AVAIL* equation menu.
3. Store or calculate the following variables:
   - Availability in weeks in ≣ AVAIL ≣.
   - Inventory on hand in ≣ INV ≣.
   - Forecasted or use per month in ≣ USE ≣.

Example: Part 1. You have 800 units available at the end of the month. The forecast for the next month is 1,200 units. How long will your supply last?

Display the *AVAIL* equation menu.

Keys:	Display:	Description:
800 ≣ INV ≣	INV = 800.00	Stores current inventory.
1200 ≣ USE ≣	USE = 1,200.00	Stores forecast.
≣ AVAIL ≣	AVAIL = 2.89	Calculates weeks of availability.

Part 2. You like to keep seven weeks of supply on hand. What should your inventory be?

7 AVAIL	AVAIL = 7.00	Stores weeks of availability.
INV	INV = 1,939.95	Calculates inventory needs.

Replacing Equipment

Mechanical equipment depreciates in value while the cost of maintenance and operation goes up. As these costs rise, an optimal point in time is reached when the equipment should be replaced. This optimal point can be determined by looking at the optimum service life and the minimum average total cost (ATC) of the equipment. These values can be calculated if you know the purchase price, the operation and maintenance costs for the first year, and the annual rates of increase in operation and maintenance costs.

Entering and Using the ATC and LIFE Equations:

1. Enter the average total cost (*ATC*) equation into the Solver.

   `ATC=LIFE-(OPIN+MTIN)÷2+OPCO1+MTCO1`

2. Enter the service life (*LIFE*) equation into the Solver.*

   `LIFE=SQRT(2×PRICE÷(OPIN+MTIN))`

3. Display the *LIFE* equation menu.
4. Store the following variables:
   - Purchase price (less any trade-in) in ≣ PRICE ≣.
   - Yearly dollar increase in operating costs in ≣ OPIN ≣.
   - Yearly dollar increase in maintenance costs in ≣ MTIN ≣.
5. Press ≣ LIFE ≣ to calculate the optimum service life.
6. Display the *ATC* equation menu.
7. Store the following variables:
   - First year operating costs in ≣ OPCO1 ≣.
   - First year maintenance costs in ≣ MTCO1 ≣.
   - ≣ LIFE ≣, ≣ OPIN ≣, and ≣ MTIN ≣ variables are already stored.
8. Press ≣ ATC ≣ to calculate the minimum average total cost.

---

* To key in the square-root function (SQRT), press ■[√x].

Example. Your company has a piece of equipment that was purchased for $28,000. The maintenance costs in the first year were $2,000; operating costs were $14,000. Maintenance costs are expected to increase by $1,200 each year; operating costs are expected to increase by $1,500 each year. What is the optimum service life and minimum average total cost?

Display the *LIFE* equation menu.

Keys:	Display:	Description:
28000 [PRICE]	PRICE = 28,000.00	Stores purchase price.
1500 [OPIN]	OPIN = 1,500.00	Stores yearly increase in operating costs.
1200 [MTIN]	MTIN = 1,200.00	Stores yearly increase in maintenance costs.
[LIFE]	LIFE = 4.55	Calculates optimum service life.
[EXIT]		Displays SOLVE menu.
[↓] or [↑]	ATC = LIFE – (OPIN +	Selects *ATC* equation.
[CALC]		Displays ATC menu.
14000 [OPCO1]	OPCO1 = 14,000.00	Stores first year operating costs.
2000 [MTCO1]	MTCO1 = 2,000.00	Stores first year maintenance costs.
[ATC]	ATC = 14,654.55	Calculates minimum average total cost.

According to this model, average annual costs are decreasing for the first 4.5 years. After that time, costs are increasing.

Estimating Inventory Investment Versus Expected Shipment Dollars

It is useful to know the inventory cost required to produce units and to compare inventory costs to the expected revenue from shipping those products. This procedure uses three equations to calculate the three parts: the dollars shipped, the dollars in inventory, then the difference between the two. If you're interested only in the difference, the three equations are combined into one on page 91.

Entering and Using the Equations:

1. Enter the *$DIFF* equation into the Solver.

   `$DIFF=$SHIP-$INV`

2. Enter the *$SHIP* equation into the Solver.

   `$SHIP=(PRICE×(1-%DISC÷100))×#UNT`

3. Enter the *$INV* equation into the Solver.

   `$INV=COSTS×#UNT`

4. Display the *$INV* equation menu.
5. Store the following variables:
   - Standard cost per unit (labor, material, overhead) in ≣ COSTS ≣.
   - Number of units produced and shipped in ≣ #UNT ≣.
6. Press ≣ $INV ≣ to calculate the inventory investment.
7. Display the *$SHIP* equation menu.
8. Store the following variables:
   - Price of the product in ≣ PRICE ≣.
   - Discount rate as a percent at shipment in ≣ %DISC ≣.
   - Number of units produced and shipped in ≣ #UNT ≣. (If this value was stored in step 5, you don't have to store it again.)
9. Press ≣ $SHI ≣ to calculate the expected shipment dollars.
10. Display the *$DIFF* equation menu.

11. Press $ \equiv \boxed{\$DIF} \equiv $ to calculate the difference between inventory investment and the expected shipment dollars. (Values were calculated and stored in $ \equiv \boxed{\$INV} \equiv $ and $ \equiv \boxed{\$SHI} \equiv $ in steps 6 and 9.)

Example. You plan to ship 100 units. The list price per unit is $3,000, and the units are shipped at a 40% discount. The production cost per unit is $1,500. What is the difference between inventory investment and shipment dollars?

Display the *$INV* equation menu.

Keys:	**Display:**	**Description:**
1500 $ \equiv \boxed{COSTS} \equiv $	COSTS = 1,500.00	Stores cost per unit.
100 $ \equiv \boxed{\#UNT} \equiv $	#UNT = 100.00	Stores number of units.
$ \equiv \boxed{\$INV} \equiv $	$INV = 150,000.00	Calculates dollars of inventory.
EXIT		Displays SOLVE menu.
↓ or ↑	$SHIP = (PRICE×	Selects *$SHIP* equation.
$ \equiv \boxed{CALC} \equiv $		Displays *$SHIP* menu.
3000 $ \equiv \boxed{PRICE} \equiv $	PRICE = 3,000.00	Stores unit price.
40 $ \equiv \boxed{\%DISC} \equiv $	%DISC = 40.00	Stores discount rate.
$ \equiv \boxed{\$SHI} \equiv $	$SHIP = 180,000.00	Calculates dollars of shipments.
EXIT		Displays SOLVE menu.
↓ or ↑	$DIFF = $SHIP − $INV	Selects *$DIFF* equation.
$ \equiv \boxed{CALC} \equiv $		Displays *$DIFF* menu.
$ \equiv \boxed{\$DIF} \equiv $	$DIFF = 30,000.00	Calculates dollar difference between shipments and inventory.

Combining the Equations:

You may not be interested in the values for *$SHIP* and *$INV,* but only the final value, *$DIFF*. The three equations on page 89 can be combined into one, as follows:

```
$DIFF=#UNT×(PRICE×(1-%DISC÷100)-COST)
```

To use this equation, store or calculate the following variables:

- Dollar difference between inventory investment and expected shipments in $DIF.
- Number of units produced and shipped in #UNT.
- Price of the product in PRICE.
- Discount rate as a percent at shipment in %DISC.
- Standard cost per unit (labor, material, overhead) in COST.

Evaluation of Costs Associated With Seasonal or Perishable Inventory

Excess inventory of seasonal or fad products may have a salvage value below cost. You may even have to pay to dispose of excess inventory of perishable goods, which results in a negative salvage value. However, if insufficient inventory is available, costs in the form of lost sales, good will, and customer loyalty are incurred. The equation below helps evaluate the relationship among these costs.

Entering and Using the SCOST Equation:

1. Enter the *SCOST* equation into the Solver.

   ```
   SCOST=(COST-SALV)÷PROB%×100-PRICE+SALV
   ```

2. Display the *SCOST* equation menu.
3. Store or calculate the following variables:
   - Shortage cost per unit in SCOST.
   - Unit cost of the product in COST.
   - Unit salvage value (negative, if you must pay to dispose of the product) in SALV.
   - Probability of stockout in PROB%.
   - Unit price of the product in PRICE.

Example: Part 1. A store is considering the sale of poinsettias at Christmas. Each poinsettia costs $6 and the selling price is $11. You estimate that at an inventory of 1,000, the probability of excess inventory is 15%. The salvage value is $4. Calculate the shortage cost per unit.

Display the *SCOST* equation menu.

Keys:	Display:	Description:
6 [COST]	COST = 6.00	Stores unit cost of the product.
11 [PRICE]	PRICE = 11.00	Stores unit price of the product.
15 [PROB%]	PROB% = 15.00	Stores probability of stockout.
4 [SALV]	SALV = 4.00	Stores unit salvage value.
[SCOST]	SCOST = 6.33	Calculates cost of stockout shortage.

Part 2. What is the optimal probability of stockout if the cost of stockout shortage is the gross profit ($11 minus $6) plus $10 per unit for lost goodwill, customer loyalty, and future sales to the customer who comes in expecting to participate in your seasonal special?

11 [−] 6 [+] 10		Stores cost of stockout shortage.
[SCOST]	SCOST = 15.00	
[PROB%]	PROB% = 9.09	Calculates probability of stockout.

This value indicates that you should order enough stock so that you have a 9% or less chance of running out during the seasonal selling season.

Source: McClain and Thomas, *Operations Management, Production of Goods and Services*. Prentice-Hall, 1980, pp 290-292.

Manufacturing Strategy Analysis

If your firm has similar production facilities at two locations, you may want to evaluate the financial impact of changing the production of a component or product from one location to another. The equation below helps you analyze such a decision, based on the estimated costs and savings in making the change.

Entering and Using the INV Equation:

1. Enter the *INV* equation into the Solver.*

   `INV=FRCST×(CURR-NEW-ADDIT)×USPV(I%:#PER)`

2. Display the *INV* equation menu.
3. Store or calculate the following variables:
   - Initial investment required to make the change in ≣ INV ≣.
   - Periodic forecast or production volume in ≣ FRCST ≣.
   - Current manufacturing cost of each item in ≣ CURR ≣.
   - New manufacturing cost if the change is made in ≣ NEW ≣.
   - Any additional costs per item created by the change (such as freight, duty, or increased overhead) in ≣ ADDIT ≣.
   - Interest rate per period as a percent in ≣ I% ≣.
   - Number of periods to break even in ≣ #PER ≣.†

* The equation contains the USPV function, which must be keyed in exactly as indicated in the equation. To key in : on the HP-17B and HP-27S, press ≣ WXYZ ≣ ≣ OTHER ≣ ≣ : ≣ .

† If *#PER* is negative, the new cost plus additional costs is greater than current costs, indicating this is not a good investment, and will never break even.

Example: Part 1. A company is currently manufacturing an item for $110. By moving the operation to another site, certain economies and additional costs would be incurred. You estimate that the same item could be manufactured for $90. The move would cost $150,000, including equipment, training of new workers, retraining of the current workers, and relocation of key personnel. Freight costs of $5.30 per item would also be required to move the product back to the distribution center. If the company requires a 20% annual return on investment, how long will it take for this move to break even? The forecast is 4,500 units per year.

Display the *INV* equation menu.

Keys:	**Display:**	**Description:**
150000 INV	INV=150,000.00	Stores initial investment.
4500 FRCST	FRCST=4,500.00	Stores forecasted production.
110 CURR	CURR=110.00	Stores current manufacturing costs.
90 NEW	NEW=90.00	Stores new manufacturing costs.
5.3 ADDIT	ADDIT=5.30	Stores additional freight costs.
MORE		
20 I%	I%=20.00	Stores required annual return on investment.
#PER	#PER=3.31*	Calculates number of years to break even.

* The Solver searches for an iterative solution and displays intermediate estimates.

Part 2. If the additional freight cost rose to $8.80, how long would it take to break even?

MORE		
8.8 ADDIT	ADDIT = 8.80	Stores new freight cost.
MORE		
#PER	#PER = 4.96*	Calculates number of years to break even.

* The Solver searches for an iterative solution and displays intermediate estimates.

Work Sample Survey Size

Work sampling can be used to collect information about work flow and idle time. The equation below helps determine the number of operations needed to assure that your work sampling will give you accurate results. It uses the standard normal variate (Z), which you can find using the procedures on pages 70 and 71 or look up in a statistics text. The equation assumes you have made a small number of observations, and thus, have a preliminary estimate of the survey results.

Entering and Using the SSIZE Equation:

1. Enter the *SSIZE* equation into the Solver. *

   ```
   SSIZE=Z^2÷(%ACC÷100)^2×(1−#OCC÷#OBS)
   ÷#OCC×#OBS
   ```

2. Display the *SSIZE* equation menu.
3. Store or calculate the following variables:
   - Sample size in ≣ SSIZE ≣.
   - Normal distribution value in ≣ Z ≣.
   - Desired percentage accuracy in ≣ %ACC ≣.
   - Number of occurrences in your small sample in ≣ #OCC ≣.
   - Number of observations in your small sample in ≣ #OBS ≣.

Example: Part 1. You wish to identify the amount of idle time in your service department. You made 20 random observations, and on three occasions, an employee was idle. Now you want to conduct a statistically valid survey. How many observations are needed to be 95% sure of your results (normal distribution value = 1.96) with an accuracy of ±10%?

Display the *SSIZE* equation menu.

---

* To key in ^ on the HP-17B and HP-27S, press ■ [y^x].

Keys:	Display:	Description:
1.96 [Z]	Z=1.96	Stores normal distribution.
10 [%ACC]	%ACC=10.00	Stores accuracy you desire.
3 [#OCC]	#OCC=3.00	Stores number of occurrences from your preliminary sample.
20 [#OBS]	#OBS=20.00	Stores number of preliminary observations.
[SSIZE]	SSIZE=2,176.91	Calculates number of observations to assure desired accuracy.

Part 2. You have the time and budget for 1500 observations only. With that number of observations, what is your accuracy?

1500 [SSIZE]	SSIZE=1,500.00	Stores sample size.
[%ACC]	%ACC=12.05	Calculates accuracy achieved with 1500 observations.

Source: James Dilworth, *Production and Operations Management*. Random House, 1983, pp 577-588.

Productivity Measurements

There are many ways to measure productivity. This section looks at productivity as a ratio of outputs to inputs – an index – first with a single resource, then with multiple resources.

Single Resource Productivity Measurement

Labor is a common resource for productivity measurement. A comparison of several ratios of output in units or dollars to labor input in units or dollars results in a productivity index that indicates whether labor productivity is increasing or decreasing.

Entering and Using the INDEX Equation:

1. Enter the *INDEX* equation into the Solver. *

   ```
   INDEX:IF(S(NDX1):OUT1÷IN1-NDX1:
   IF(S(NDX2):OUT2÷IN2-NDX2:(NDX2-NDX1)
   ÷NDX1×100-%CHG))
   ```

2. Display the *INDEX* equation menu.
3. Store or calculate the following variables:
   - Output in units or dollars for first period in ≣ OUT1 ≣.
   - Input in units or dollars for first period in ≣ IN1 ≣.
   - Productivity index for first period in ≣ NDX1 ≣.
   - Output in units or dollars for second period in ≣ OUT2 ≣.
   - Input in units or dollars for second period in ≣ IN2 ≣.
   - Productivity index for second period in ≣ NDX2 ≣.
   - Percent change in the index in ≣ %CHG ≣.

* To key in : on the HP-17B and HP-27S, press [WXYZ] [OTHER] ≣ : ≣ .

Example. Last month you produced 600 units, worth $1,400, in 80 hours at $7.00 per labor hour. This month 660 units were produced, worth $1,500, in 85 hours at $7.20 per labor hour (a 2.86% increase in hourly labor cost).

Part 1. Calculate the unit productivity index (number of units produced divided by labor hours) for last month and this month, then find the percent change in the index.

Display the *INDEX* equation menu.

Keys:	Display:	Description:
600 OUT1	OUT1 = 600.00	Stores unit output for last month.
80 IN1	IN1 = 80.00	Stores labor input for last month.
NDX1	NDX1 = 7.50	Calculates unit productivity for last month.
660 OUT2	OUT2 = 660.00	Stores unit output for this month.
85 IN2	IN2 = 85.00	Stores labor input for this month.
MORE NDX2	NDX2 = 7.76	Calculates unit productivity for this month.
%CHG	%CHG = 3.53	Calculates percent change from last month to this month.

Unit productivity rose from last month to this month by 3.53%.

Part 2. Calculate value productivity (dollar value of units produced divided by dollar value of labor) for last month and this month, then find the percent change. The dollar value of the units produced last month was $1,400; for this month it was $1,500. The labor cost last month was 80 hours at $7 per hour; for this month, it was 85 hours at $7.20 per hour.

1400 [OUT1]	OUT1 = 1,400.00	Stores dollar value of units produced last month.
7 [×] 80 [IN1]	IN1 = 560.00	Stores labor cost last month.
[NDX1]	NDX1 = 2.50	Calculates value productivity for last month.
1500 [OUT2]	OUT2 = 1,500.00	Stores dollar value of units produced this month.
7.2 [×] 85 [IN2]	IN2 = 612.00	Stores labor costs this month.
[MORE] [NDX2]	NDX2 = 2.45	Calculates value productivity for this month.
[%CHG]	%CHG = −1.96	Calculates percent change from last month to this month.

Value productivity declined from last month to this month by 1.96%.

Part 3. Calculate the unit sales price (dollar value of units produced divided by units produced) for last month and this month, then find the percent change. Dollar sales last month were $1,400; this month they were $1,500. Last month 600 units were produced; this month 660 units were produced.

1400 [OUT1]	OUT1 = 1,400.00	Stores dollar sales last month.
600 [IN1]	IN1 = 600.00	Stores units produced last month.
[NDX1]	NDX1 = 2.33	Calculates unit sales price last month.
1500 [OUT2]	OUT2 = 1,500.00	Stores dollar sales this month.
660 [IN2]	IN2 = 660.00	Stores units produced this month.

MORE NDX2	NDX2 = 2.27	Calculates unit sales price this month.
%CHG	%CHG = −2.60	Calculates percent change in unit sales price.

Unit sales price declined from last month to this month by 2.6%.

Part 4. Calculate unit labor cost productivity (dollar value of labor divided by units produced) for last month and this month, then find the percent change. Last month you produced 600 units in 80 hours at $7 per hour. This month you produced 660 units in 85 hours at $7.20 per hour.

7 × 80 OUT1	OUT1 = 560.00	Stores labor costs last month.
600 IN1	IN1 = 600.00	Stores number of units produced last month.
NDX1	NDX1 = 0.93	Calculates unit labor cost last month.
7.2 × 85 OUT2	OUT2 = 612.00	Stores labor costs this month.
660 IN2	IN2 = 660.00	Stores units produced this month.
MORE		
NDX2	NDX2 = 0.93	Calculates unit labor costs this month.
%CHG	%CHG = −0.65	Calculates percent change in unit labor cost.

Unit labor costs declined from last month to this month by .65%.

These ratios are useful for analyzing performance. In this case, unit productivity increased by 3.53%, while value productivity declined by 1.96%. The causes of the decline in value productivity show up in the change in unit sales price, which declined 2.6%, and the .65% decline in unit labor costs.

Wages increased 2.86%, but unit productivity increased by 3.53%, which more than offset the wage increase. This is reflected in the lesser decline in unit labor costs when compared to unit sales price.

Multiple Resource Plus Inflation Productivity Measurement

The productivity index in this section is a ratio like the previous equation, but more resources are used in the index. Sales are the output; labor, energy, materials, and capital are the inputs. By watching this index over time, you can track the productivity of your company.

This equation can be used to calculate profitability as well as productivity. However, remember that prices and costs may inflate at different rates when using the index over time. The equation on page 106 can be used to calculate a partial index that includes inflation.

Entering and Using the MRIN Equation:

1. Enter the *MRIN* equation into the Solver.

```
MRIN=SALES÷(1+IS%÷100)÷(LABOR÷(1+IL%÷
100)+ENERGY÷(1+IE%÷100)+PARTS
÷(1+IP%÷100)+CAPIT÷(1+IC%÷100))
```

2. Display the *MRIN* equation menu.
3. Store or calculate the following variables:
   - Sales in dollars in [SALES].
   - Inflation in product prices as a percentage in [IS%] (must be 0 for base year).
   - Labor costs in [LABOR].
   - Inflation in labor costs as a percentage in [IL%] (must be 0 for base year).
   - Energy costs in [ENER].
   - Inflation in energy costs as a percentage in [IE%] (must be 0 for base year).
   - Material costs in [PARTS].
   - Inflation in material costs as a percentage in [IP%] (must be 0 for base year).

- Capital costs in CAPIT.
- Inflation in capital costs as a percentage in IC% (must be 0 for base year).
- Productivity index in MRIN.

Example. The following table gives data for the base year and base year plus one.

Resource	Menu key	Base year*	Base year+1
Sales	SALES	$480,000	$540,000
Inflation in sales price	IS%		6%
Labor costs	LABOR	180,000	203,000
Inflation in labor costs	IL%		7%
Energy costs	ENER	9,000	10,000
Inflation in energy costs	IE%		2%
Material costs	PARTS	210,000	230,000
Inflation in material costs	IP%		12%
Capital costs	CAPIT	41,000	38,000
Inflation in capital costs	IC%		1%

Part 1. What is the productivity index for the base year?

Display the *MRIN* equation menu.

Keys:	Display:	Description:
■ CLEAR DATA		Clears *MRIN* variables.

* By definition, inflation in the base year is zero.

480000 SALES	SALES = 480,000.00	Stores known values.
180000 LABOR	LABOR = 180,000.00	
MORE		
9000 ENER	ENERGY = 9,000.00	
210000 PARTS	PARTS = 210,000.00	
41000 CAPIT	CAPIT = 41,000.00	
MORE MORE		Calculates productivity
MRIN	MRIN = 1.09	index for base year.
STO 0		Stores productivity index in register 0.
540000 SALES	SALES = 540,000.00	Stores sales, costs, and
6 IS%	IS% = 6.00	inflation rates for base
203000 LABOR	LABOR = 203,000.00	year plus one.
7 IL%	IL% = 7.00	
MORE		
10000 ENER	ENERGY = 10,000.00	
2 IE%	IE% = 2.00	
230000 PARTS	PARTS = 230,000.00	
12 IP%	IP% = 12.00	
38000 CAPIT	CAPIT = 38,000.00	
MORE		
1 IC%	IC% = 1.00	
MORE MRIN	MRIN = 1.15	Calculates productivity index.
STO 1		Stores productivity index in register 1.
■ MAIN*		Displays MAIN menu.
BUS %CHG		Displays %CHG menu.
RCL 1 NEW	NEW = 1.15	Stores new and old
RCL 0 OLD	OLD = 1.09	indexes.
%CH	%CHANGE = 5.53	Calculates percent change in the productivity index.

* On the HP-27S, press ■ %CHG, instead of ■ MAIN BUS %CHG.

Productivity rose 5.5%. If you are interested in breaking this information down, use the single resource index equation (*SRIN*) to calculate partial indexes, such as sales divided by labor or sales divided by material.

Entering and Using the SRIN Equation:

1. Enter the *SRIN* equation into the Solver.

   ```
   SRIN=SALES÷(1+IS%÷100)÷(INPT÷(1+II%
   ÷100))
   ```

2. Display the *SRIN* equation menu.
3. Store or calculate the following variables:
   - Partial productivity index in [SRIN].
   - Sales in dollars in [SALES].
   - Inflation in product prices as a percentage in [IS%] (must be 0 for base year).
   - Dollar value of your input variable (labor, energy, materials, or capital) in [INPT].
   - Inflation in input variable as a percentage in [II%] (must be 0 for base year).

Example. Calculate partial indexes with labor as the input variable, and find the percent change. Sales for the base period was $480,000; for the base period plus one, $540,000. Labor costs for the base period were $180,000; for the base period plus one, $203,000. Inflation rate in prices was 6%. Inflation rate in labor costs was 7%.

Display the *SRIN* equation menu.

Keys:	Display:	Description:
■ [CLEAR DATA]		Clears *SRIN* variables.
480000 [SALES]	SALES=480,000.00	Stores sales for base period.

180000 INPT	INPT = 180,000.00	Stores labor costs for base period.
SRIN	SRIN = 2.67	Calculates partial index for base period.
STO 0		Stores partial index in register 0.
540000 SALES	SALES = 540,000.00	Stores sales for base period plus one.
6 IS%	IS% = 6.00	Stores inflation in prices for base year plus one.
203000 INPT	INPT = 203,000.00	Stores labor costs for base period plus one.
7 II%	II% = 7.00	Stores inflation in labor costs for base plus one.
SRIN	SRIN = 2.69	Calculates partial index for base plus one.
STO 1		Stores partial index in register 1.
■ MAIN*		Displays MAIN menu.
BUS %CHG		Displays %CHG menu.
RCL 1 NEW	NEW = 2.69	Stores new and old indexes.
RCL 0 OLD	OLD = 2.67	
%CH	%CHANGE = 0.69	Calculates percent change in labor productivity.

Labor productivity rose .69% from the base year to base year plus one. Inflation in labor costs was 7% (from the table on page 104). According to these figures, improving labor productivity is an area that needs attention.

---

* On the HP-27S, press ■ %CHG, instead of ■ MAIN BUS %CHG.

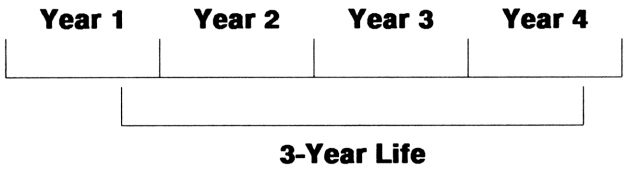
5

Depreciation, NPV, and IRR% Calculations on the HP-27S

Depreciation Calculations on the HP-27S

Four methods of depreciation are included in this section: straight-line, sum-of-the-years' digits, declining-balance, and Accelerated Cost Recovery System.

Note for straight-line, sum-of-the-years'-digits, and declining-balance depreciation: If the number of months in the first calendar year is less than 12, the amount of depreciation in the first year and last year will be less than a full year's depreciation. The actual number of years that depreciation will occur is equal to the life plus one. For example, a drill has a life of three years and is purchased three months before year end. The following time diagram shows that depreciation will occur over four calendar years.



Straight-Line Depreciation

Entering and Using the SL Equation:

1. Enter the *SL* equation into the Solver.

   `SL=(BASIS-SALV)÷LIFE×#MO÷12`

2. Display the *SL* equation menu.
3. Store the following variables:
   - Depreciable cost basis of the asset at acquisition in ≣ BASIS ≣.
   - Salvage value in ≣ SALV ≣.
   - Useful life expectancy in ≣ LIFE ≣.
   - Number of months in the year that you depreciate the asset in ≣ #MO ≣.
4. Press ≣ SL ≣ to calculate the straight-line depreciation on the asset for the year.

Example 1: Part 1. On September 1, your company purchased a machine for $10,000. Its useful life is five years, and the salvage value is $500. There are four months remaining in the first year. Calculate the depreciation for the first year.

Display the *SL* equation menu.

Keys:	Display:	Description:
10000 [BASIS]	BASIS = 10,000.00	Stores book value.
500 [SALV]	SALV = 500.00	Stores salvage value.
5 [LIFE]	LIFE = 5.00	Stores useful life.
4 [#MO]	#MO = 4.00	Stores number of months in the year asset is depreciated.
[SL]	SL = 633.33	Calculates straight-line depreciation for year one.

Part 2. Calculate the depreciation for years two, three, four, and five.

12 [#MO]	#MO = 12.00	Stores number of months asset is depreciated.
[SL]	SL = 1,900.00	Calculates straight-line depreciation for years two, three, four, and five.

Part 3. Calculate the depreciation for year six. The remaining depreciable life is eight months.

8 [#MO]	#MO=8.00	Stores number of months in the year that asset is depreciated.
[SL]	SL=1,266.67	Calculates depreciation for eight months of year six.

Sum-of-the-Years'-Digits Depreciation

Entering and Using the SOYD Equation:

1. Enter the *SOYD* equation into the Solver.*

   ```
   SOYD=IF(YR#=1:#MO:12×(LIFE-#MO÷12-
   YR#+2)÷LIFE)×(BASIS-SALV)÷(6×LIFE+6)
   ```

2. Display the *SOYD* equation menu.
3. Store the following variables:
   - Year number in [YR#].
   - Number of months in the year that you depreciate the asset in [#MO].
   - Useful life expectancy in [LIFE].
   - Depreciable cost basis of the asset at acquisition in [BASIS].
   - Salvage value in [SALV].
4. Press [SOYD] to calculate the depreciation for the year.

Example 2. On May 1, you purchased an asset for $25,000, with a useful life of 10 years and a $1,500 salvage value. There are eight months remaining in the first year. Calculate the depreciation for the first three years.

Display the *SOYD* equation menu.

---

* To key in : on the HP-17B and HP-27S, press [WXYZ] [MORE] [:] .

Keys:	Display:	Description:
1 [YR#]	YR# = 1.00	Stores year number.
8 [#MO]	#MO = 8.00	Stores number of months in the first year asset is depreciated.
10 [LIFE]	LIFE = 10.00	Stores useful life.
25000 [BASIS]	BASIS = 25,000.00	Stores book value.
1500 [SALV]	SALV = 1,500.00	Stores salvage value.
[SOYD]	SOYD = 2,848.48	Calculates depreciation for year one.
2 [YR#]	YR# = 2.00	Stores year number.
[SOYD]	SOYD = 3,987.88	Calculates depreciation for year two.
3 [YR#]	YR# = 3.00	Stores year number.
[SOYD]	SOYD = 3,560.61	Calculates depreciation for year three.

Declining-Balance Depreciation

Entering and Using the DB Equation:

1. Enter the *DB* equation into the Solver.

   `DB=BASIS×(FACT%÷(100×LIFE))×#MO÷12`

2. Display the *DB* equation menu.
3. Store the following variables:
   - Depreciable cost basis of the asset in [BASIS].
   - Declining-balance factor as a percent in [FACT%].
   - Useful life expectancy in [LIFE].
   - Number of months in the year that you depreciate the asset in [#MO].
4. Press [DB] to calculate the depreciation for the first year.

5. For subsequent years, change ≡ #MO ≡ to 12, subtract the depreciation from the remaining depreciable cost basis, and store the new value by pressing [STO] [−] ≡ BASIS ≡. Repeat step 4 to calculate depreciation for the next year.

Example 3. On September 1, you purchase a machine for $50,000. This machine has a six-year life. There are four months remaining in the first year. Calculate the depreciation for the first three years using a declining-balance factor of 150%.

Display the *DB* equation menu.

Keys:	**Display:**	**Description:**
50000 ≡ BASIS ≡	BASIS = 50,000.00	Stores book value.
150 ≡ FACT% ≡	FACT% = 150.00	Stores declining-balance factor.
6 ≡ LIFE ≡	LIFE = 6.00	Stores useful life.
4 ≡ #MO ≡	#MO = 4.00	Stores number of months in the year asset is depreciated.
≡ DB ≡	DB = 4,166.67	Calculates depreciation for year one.
[STO] [−] ≡ BASIS ≡	DB = 4,166.67	Calculates and stores remaining book value.
12 ≡ #MO ≡	#MO = 12.00	Stores number of months in the year asset is depreciated.
≡ DB ≡	DB = 11,458.33	Calculates depreciation for year two.
[STO] [−] ≡ BASIS ≡	DB = 11,458.33	Calculates and stores remaining book value.
≡ DB ≡	DB = 8,593.75	Calculates depreciation for year three.

Accelerated Cost Recovery System

Tables are typically used to find the appropriate ACRS recovery percentage. (Refer to Internal Revenue Service Publication 534 on Depreciation for the ACRS tables.) The percentage varies with the life of the investment and when the investment was made. The equation below determines the depreciation amount based on your input of the recovery percentages.

The cost recovery deduction is equal to the original book value times the ACRS percentage from the appropriate table. The basis value need not be reduced by the salvage value.

Entering and Using the ACRS Equation:

1. Enter the *ACRS* equation into the Solver.

   ACRS=ACRS%÷100×BASIS

2. Display the *ACRS* equation menu.
3. Store the following variables:
   - Recovery percentage from the table in ≣ ACRS% ≣.
   - Depreciable cost basis of the asset at acquisition in ≣ BASIS ≣.
4. Press ≣ ACRS ≣ to calculate the depreciation for the period.

Example 4. A piece of equipment was purchased for $13,950 in 1986. Find the depreciation for the equipment's five-year life. The recovery percentages for years 1 through 5 are 20%, 32%, 24%, 16%, and 8%.

Display the *ACRS* equation menu.

Keys:	Display:	Description:
13950 BASIS	BASIS = 13,950.00	Stores book value.
20 ACRS%	ACRS% = 20.00	Stores recovery percentage for year one.
ACRS	ACRS = 2,790.00	Calculates depreciation for year one.
32 ACRS%	ACRS% = 32.00	Stores recovery percentage for year two.
ACRS	ACRS = 4,464.00	Calculates depreciation for year two.
24 ACRS%	ACRS% = 24.00	Stores recovery percentage for year three.
ACRS	ACRS = 3,348.00	Calculates depreciation for year three.
16 ACRS%	ACRS% = 16.00	Stores recovery percentage for year four.
ACRS	ACRS = 2,232.00	Calculates depreciation for year four.
8 ACRS%	ACRS% = 8.00	Stores recovery percentage for year five.
ACRS	ACRS = 1,116.00	Calculates depreciation for year five.

Net Present Value and Internal Rate of Return on the HP-27S

A common decision in business is choosing between two alternative investments. One way of evaluating investment alternatives is to use net present value or internal rate of return.

Included in this section are two equations for calculating net present value or internal rate of return on a series of cash flows occurring at regular intervals for a given interest (discount) rate. One equation is for cash flows (money paid out or received) that do not repeat. These are called ungrouped cash flows. The second equation is for cash flows that do repeat. These are called grouped cash flows.

The internal rate of return is the interest (discount) rate at which the net present value of the cash flows equals zero. You calculate the internal rate of return by storing 0 as the net present value (*NPV*) and then solving for the interest rate (*I%*).

The cash flows are stored in a STAT list. Money paid out is stored as a negative number; money received is stored as a positive number. (For more information about cash flows and sign conventions, refer to the HP-27S owner's manual.) Be sure to name the STAT list with the same name used in the Solver equation. The examples in this section use *FLOWS* as the list name. You can change the name in the equation to something other than *FLOWS,* if you wish.

To create a cash-flow list, be sure your cash flows are occurring at regular intervals and at the end of each period.* If a period is skipped, enter zero for its cash flow.

---

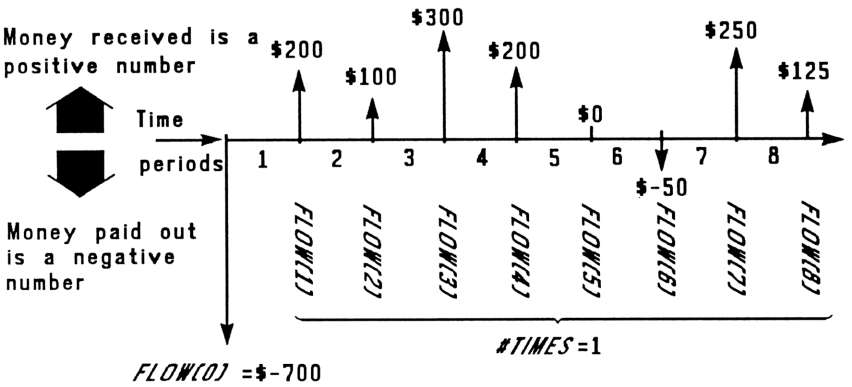
* If the cash flows occur at the beginning of each period, then combine the first flow with the initial flow (which can increase or decrease the flow), and move each cash flow up one period. Remember, a payment made at the beginning of period 2 is equivalent to the same payment made at the end of period 1, and so on.

If your cash flows are ungrouped, use the UNGROUPED equation, and store the cash flows in ungrouped format in a STAT list. The initial cash flow is stored in *ITEM(1)*, the second cash flow is stored in *ITEM(2)*, the third cash flow is stored in *ITEM(3)*, and so on.

If your cash flows are grouped, use the GROUPED equation, and store the cash flows in pairs, or grouped format, in a STAT list. The data for each group is stored by entering two numbers. The first number is the cash flow amount, and the second is the number of cash flows in that group. *ITEM(1)* contains the cash flow amount for the first group, *ITEM(2)* contains the number of consecutive times it occurs, *ITEM(3)* contains the cash flow amount for the next group, *ITEM(4)* contains the number of consecutive times it occurs, and so on.

Ungrouped Cash Flows

In a series of ungrouped cash flows, each flow is different from the one before it. Each flow occurs one time.



The horizontal timeline is divided into equal compounding periods. The vertical lines represent the cash flows. For money received, the line points up (positive); for money paid out, the line points down (negative). In this case, the investor has invested $700. This investment has generated a series of cash flows, starting at the end of the first period. Notice that there is no cash flow (a cash flow of zero) for period five, and that the investor pays a small amount in period six.

Entering and Using the UNGROUPED Equation:

1. Enter the UNGROUPED equation into the Solver.* FLOWS is the name of the STAT list in which you will store the cash flows.

   ```
   UNGROUPED:Σ(J:1:SIZES(FLOWS):1:
   ITEM(FLOWS:J)×SPPV(I%:J-1))=NPV
   ```

2. Enter all the cash flows into a STAT list. Name the list FLOWS, the same name used in the Solver equation.
3. Display the UNGROUPED equation menu.
4. To calculate net present value (*NPV*):
   - Store the periodic interest rate in ≣ I% ≣.
   - Press ≣ NPV ≣ to calculate the net present value.
5. To calculate internal rate of return (*IRR%*):
   - Store zero in ≣ NPV ≣.
   - Press ≣ I% ≣ to calculate the internal rate of return.

Example 1. You want to purchase a punch press machine. Machine A has a larger initial investment, but has lower upkeep expenses and a positive salvage value. Machine B costs less initially, but upkeep is more costly, and the salvage value is negative. You want to compare the two equipment options.

---

* To key in : on the HP-17B and HP-27S, press ≣ WXYZ ≣ ≣ OTHER ≣ ≣ : ≣. To key in Σ, press ≣ WXYZ ≣ ≣ OTHER ≣ ≣ MORE ≣ ≣ Σ ≣.

The table below lists the projected costs for the two machines over their five-year lives, summarizing the initial flows, the cash flows during the five years, and the difference between the two options (net cash flows).

	A	B	A-B
Initial Investment	$-250,000	$-170,000	$-80,000
Cost in year 1	-12,000	-17,000	5,000
Cost in year 2	-35,000	-39,500	4,500
Cost in year 3	-45,000	-50,500	5,500
Cost in year 4	-12,000	-16,000	4,000
Cost in year 5	100,000	-15,000	115,000

The column headed A-B is treated as the investment in a net present value or internal rate of return calculation. If the investment is attractive (*NPV* is positive, or *IRR%* is greater than required), it is better to spend the additional $80,000 on machine A and get the benefit of the lower maintenance costs and the salvage value. If the investment is not attractive (*NPV* is negative or *IRR%* is less than required), it is better to buy machine B and to bear the higher maintenance costs each year.

Enter the data into the STAT list. Name the list *FLOWS*. Then use the UNGROUPED equation to calculate the *NPV* and *IRR%* to determine which machine should be purchased. (Note that this is a conventional series of cash flows, which means that the cash flows change sign only once.) The required rate of return is 10.5%.

Display the STAT menu.

Keys:	Display:	Description:
■ MODES FIX 2 INPUT		Sets display to two places.
■ CLEAR DATA YES	ITEM(1) = ?	Clears current list or gets a new one.
or GET *NEW		
80000 +/− INPUT	ITEM(2) = ?	Stores the initial cash flow.
5000 INPUT	ITEM(3) = ?	Stores cash flow for year one.
4500 INPUT	ITEM(4) = ?	Stores cash flow for year two.
5500 INPUT	ITEM(5) = ?	Stores cash flow for year three.
4000 INPUT	ITEM(6) = ?	Stores cash flow for year four.
115000 INPUT	ITEM(7) = ?	Stores cash flow for year five.
EXIT NAME FLOWS INPUT		Names the list.

Display the UNGROUPED equation menu.

Keys:	Display:	Description:
0 NPV	NPV = 0.00	Stores net present value.
I%	I% = 11.93*	Calculates internal rate of return.
10.5 I%	I% = 10.50	Stores requires return.

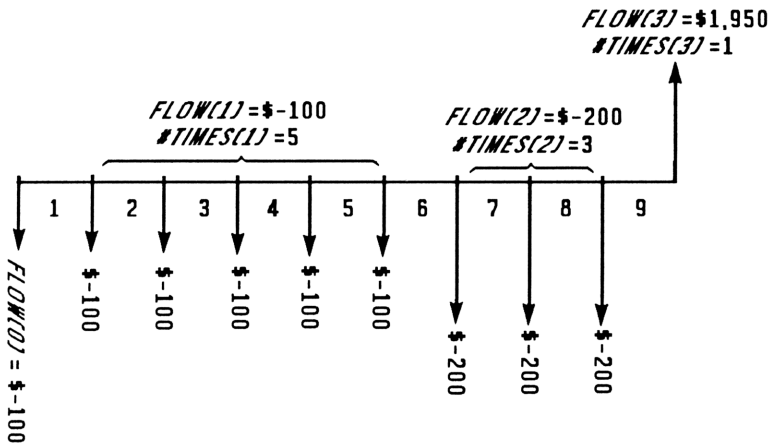
* The Solver searches for an iterative solution and displays intermediate estimates.

NPV	NPV = 4,774.63	Calculates net present value.

Option A is the better choice because *NPV* is positive. The *I%* calculation tells you the same thing – that because *I%* is more than the required 10%, option A is the better choice.

Grouped Cash Flows

Consecutive, equal cash flows are called grouped cash flows. The series shown below is grouped into two sets of consecutive, equal cash flows:



After an initial payment of $100, the investor pays $100 at the end of periods one through five, and $200 at the end of periods six through eight. The investment returns $1,950 at the end of period nine.

Entering and Using the GROUPED Equation:

1. Enter the GROUPED equation into the Solver.* *FLOWS* is the name of the STAT list in which you will store the cash flows.

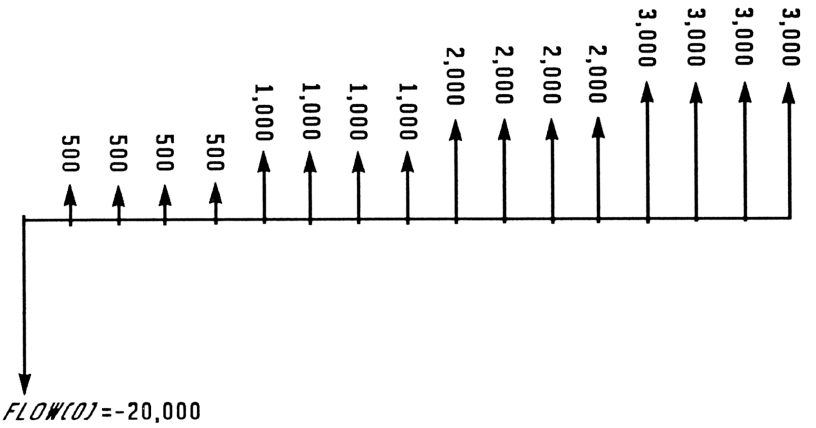
```
GROUPED:Σ(J:2:SIZES(FLOWS):2:
ITEM(FLOWS:J-1)×USPV(I%:ITEM
(FLOWS:J))×SPPV(I%:Σ(L:2:J-2:2:
ITEM(FLOWS:L))-1))=NPV
```

2. Enter all the cash flows into a STAT list. For each cash flow group, enter the cash flow amount as one item, then the number of cash flows in that group as the next item. Name the list *FLOWS*, the name used in the Solver equation.
3. Display the GROUPED equation menu.
4. To calculate net present value (*NPV*):
   - Store the periodic interest rate in [I%].
   - Press [NPV] to calculate the net present value.
5. To calculate internal rate of return (*IRR%*):
   - Store zero in [NPV].
   - Press [I%] to calculate the internal rate of return.

Example 2. You have the following investment opportunity. The cash flows occur quarterly.

Your initial investment:	$20,000
Quarterly payments you receive:	4 at $500
	4 at $1,000
	4 at $2,000
	4 at $3,000

* To key in : on the HP-17B and HP-27S, press [WXYZ] [OTHER] [:]. To key in Σ, press [WXYZ] [OTHER] [MORE] [Σ].



Enter the data into the STAT list as cash flow groups. Name the list *FLOWS*. Then use the GROUPED equation to calculate the annual internal rate of return for this investment (I%×4).

Display the STAT menu.

Keys:	**Display:**	**Description:**
■ MODES FIX 2 INPUT		Sets display to two places.
■ CLEAR DATA YES YES		Clears current list or gets a new one.
or		
GET *NEW	ITEM(1)=?	
20000 +/- INPUT	ITEM(2)=?	Stores the initial cash flow.
1 INPUT	ITEM(3)=?	Stores number of times initial cash flow occurs.
500 INPUT	ITEM(4)=?	Stores first grouped cash flow.

4 [INPUT]	ITEM(5)=?	Stores number of times cash flow occurs.
1000 [INPUT]	ITEM(6)=?	Stores second grouped cash flow.
4 [INPUT]	ITEM(7)=?	Stores number of times cash flow occurs.
2000 [INPUT]	ITEM(8)=?	Stores third grouped cash flow.
4 [INPUT]	ITEM(9)=?	Stores number of times cash flow occurs.
3000 [INPUT]	ITEM(10)=?	Stores fourth grouped cash flow.
4 [INPUT]	ITEM(11)=?	Stores number of times cash flow occurs.
[EXIT] [NAME] FLOWS [INPUT]		Names the list FLOWS.

Display the GROUPED equation menu.

Keys:	**Display:**	**Description:**
0 [NPV]	NPV=0.00	Stores net present value.
[I%]	I%=2.43*	Calculates quarterly internal rate of return.
[×] 4 [=]	9.72	Calculates annual internal rate of return.

* The Solver searches for an iterative solution and displays intermediate estimates.

Notes on Internal Rate of Return Calculations

When calculating the internal rate of return, the Solver searches iteratively for a solution. This process may take a relatively long time, sometimes several minutes. To interrupt the calculation, press any key.

Storing guesses can help the Solver find the desired solution more quickly. To store two guesses, key in the first guess and press [I%]. Key in the second guess and press [I%], and then press [I%] again to calculate the result.

For a "conventional investment," only one solution exists. A conventional investment means that the sequence of cash flows changes sign only once, and the sum of the cash flows is positive.

Cash flows that do not meet the conventional investment criteria can be more complex because there may be more than one mathematical solution to the problem, or there may be no solution. In these situations, storing initial guesses is important.

For more information, refer to an HP-17B or HP-19B owner's manual.

More Step-by-Step Solutions for Your HP-17B, HP-19B, or HP-27S Calculator

These additional books offer a variety of examples and keystroke procedures to help set up your calculations the way *you* need them.

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Step-by-Step Solutions for Your HP-17B, HP-19B, or HP-27S Calculator

This book contains a variety of examples, equations, and keystrokes to provide solutions for finance, accounting, and manufacturing professions.

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- **Financial Statement Analysis**
  Return on Equity • Bond Interest Coverage Ratio • Price-to-Earnings Ratio • Return on Investment • Financial Statement Ratios
- **Cost Accounting and Auditing**
  Overhead Application Rate • Labor, Material, and Overhead Variance • Selecting Random Numbers* • Calculating the Standard Normal Variate • Estimating Inventory Value Using Random Sampling
- **Production and Inventory Analysis**
  Priority Scheduling Rule • Daily Production Rate • Predicting Labor Hours Using Learning Rates • Forecasting Manufacturing Rates of Accessories • Estimating Inventory Availability • Replacing Equipment • Estimating Inventory Investment Versus Expected Shipment Dollars • Evaluation of Costs Associated With Seasonal or Perishable Inventory • Manufacturing Strategy Analysis • Work Sample Survey Size • Productivity Measurements
- **Depreciation, NPV, and IRR Calculations on the HP-27S**
  Depreciation Calculations on the HP-27S • Net present Value and Internal Rate of Return on the HP-27S

* This procedure cannot be used on the HP-17B.

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