

**Texas Instruments BAII Plus**  
***Tutorial for Use with Fundamentals 11/e and Concise 5/e***

This tutorial was developed for use with Brigham and Houston's *Fundamentals of Financial Management, 11/e* and *Concise, 5/e*, especially Chapter 2, the Time Value of Money. The calculator's 110-page manual covers all of its functions in detail, and it is worth the time to go through the manual. However, this does take time, and many of the calculator's features are not necessary for working the problems in the text. Therefore, we focus on just what's needed to work the text problems. We recommend that you read the text to get an idea about the concepts, then go through the tutorial to learn how to work the problems efficiently. The examples in the tutorial are identical to the examples in the text, which makes simultaneous coverage especially efficient.

Although the tutorial focuses on Chapter 2, it does have a section on Statistical Calculations, which are needed for Chapter 8 of the text. You can defer that part of the tutorial until you get to Chapter 8 of the text. Also, note that the TVM applications covered in text Chapter 2 and this tutorial are required for many text chapters, especially those dealing with bond and stock valuation and capital budgeting. Therefore, it will pay big dividends to learn how to use your calculator early in the course, like right now.

## **BASIC CALCULATOR FEATURES**

### **Turning the calculator ON and OFF**

To turn the calculator on and off, press **ON/OFF**. Note that turning the calculator off clears the display. Also, the calculator turns itself off about 10 minutes after the last keystroke to conserve the battery. Note too that it has continuous memory, so turning it off does not affect data stored in the registers even though the display goes to zero.

### **The Gold Shift Key, **2nd****

Most of the keys have white numbers or lettering directly on top and then gold lettering on the frame just above the keys. If the **2nd** key has not been pressed then the white keys are active. However, if you press **2nd**, then the gold keys are activated, and the word "2nd" appears in the upper left corner of the LCD display. Press the **2nd** key again and "2nd" goes away and the white keys are activated. The **2nd** key thus toggles between the primary (white) and secondary (gold) functions. After you press **2nd**, look only at the gold functions. In this tutorial, whenever you see **2nd**, the lettering on the next key will refer to the gold, not white, lettering.






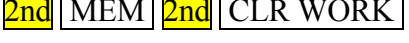
## Memories

The calculator has several different sets of memories, or registers. The ones we use most frequently, and discuss in the tutorial, are the TVM and Cash Flow memories. You can read about the others in the calculator manual.






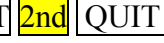

## Clearing the calculator







Clearing the calculator's memories is important because leftover data can lead to errors. You should get into the habit of automatically clearing memory before starting a new calculation. Occasionally, you will want to save data, but generally you will be entering all new data, so starting with a clear memory is the safest approach.

There are several different ways to clear data:

		clears numbers on the display one at a time.
		clears the entire display, but not the memory.
		clears all memories except that for the TVM.
		clears the TVM memory.
		clears the cash flow register
		clears certain special memories.

## Changing the decimal display

Depending on what you are doing, you may want no decimal places, two decimal places, 4 decimal places, etc. The number of decimals displayed can be changed easily. To demonstrate, type 5555.5555 and then press . If your display is currently set for two decimal places, the value will be truncated to 5555.56. To change the number of decimal places from 2 to 4, press     . Now if you type 5555.5555 and then press , the display will show 5,555.5555.

To change back from 4 decimal places to 2, press     . Now if you type 5555.5555 and then press , the display will show 5,555.56.

We usually set the display to 2 places, which is convenient when working with dollars and percentages. However, we often use 4 decimal places when dealing with interest rates and with rates of return that are entered as decimals.

## USING THE FINANCIAL FUNCTIONS

### Settings: Periods per Year (P/Y)

The TI BAII Plus usually comes out-of-the-box set to assume that 12 payments are made each year, or monthly.<sup>1</sup> Generally, though, most textbook problems are based on 1

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<sup>1</sup> We understand that TI may change the default setting to 1 payment per year.

payment per year. So, if the calculator is set for 12 payments/year and you tell it that there are 8 payments in a problem by setting  $N = 8$ , it assumes that they are made monthly, not annually, so the answer it calculates would be wrong.

To check the payments per year setting, press  $2^{nd}$   $P/Y$ , and the display will show the assumed periods per year. If your calculator shows  $P/Y = 12$ , then it is assuming that payments are made on a monthly basis. However, the majority of the textbook problems assume  $P/Y = 1$ . To change the setting to one payment per year, press  $2^{nd}$   $P/Y$   $1$   $ENTER$ . Now the calculator is set to assume 1 P/Y. To confirm this setting, press  $2^{nd}$   $P/Y$ . We normally leave the calculator setting at 1 P/Y. If a problem calls for monthly payments, we adjust the number of periods and the interest rate as explained later in this tutorial.

### Settings: BEGIN and END Mode

An annuity provides payments for a specific number of periods. Those payments can come at either the beginning or the end of each period, and this is a very important difference. The calculator can be set to deal with either payment pattern by switching between BGN and END mode. Most annuities have end-of-period payments, and if no notation is shown on the display screen then the calculator is set at END Mode. To toggle between BGN and END modes, press  $2^{nd}$   $BGN$   $2^{nd}$   $SET$   $CE/C$ . The letters “BGN” appear in the display when the calculator is in BGN mode, but they are absent when in END mode. We recommend leaving the calculator in END mode, then switching to BGN when required, and then switching back to END when you are done. (Repeating these same keystrokes switches the calculator back to END mode. You no longer see “BGN” in the calculator display area.)

## THE TIME VALUE OF MONEY (TVM) WORKSHEET

The basic TVM equation has 5 variables, and the calculator has a key for each of them. The keys are located on the third row, with white notation:

$N$   $I/Y$   $PV$   $PMT$   $FV$

If you know any 4 of the 5 variables, the calculator will solve for the fifth, as we demonstrate in this section. Note that when you enter values for the variables, they go into the TVM memory, which is continuous, so you must clear the memory before starting a new calculation. Clear using these keystrokes:  $2^{nd}$   $CLR TVM$ .

### Example 1: Calculating the FV of a lump sum

What’s the FV of \$100 after 3 years if the interest rate is 5%?

First, clear by pressing  $2^{nd}$   $CLR TVM$ . This sets all the variables to zero. Next, enter the following data:

3     **N**  
5     **I/Y**  
100   **+/-** **PV**     The +/- key changes the 100 to -100.  
0     **PMT**             You could skip this step, but it's safer to enter the 0.

Now press **CPT** **FV** to get the answer, **\$115.76**. \* indicates a completed calculation. Note that you must press the **CPT** key **before** pressing the output key, **FV**. This tells the calculator to *compute* whatever comes next. Note also that you cannot type -100 to enter the negative \$100; you must enter 100 and then change its sign to – by pressing the **+/-** key. Typing -100 subtracts 100 from the previous entry and thus leads to an incorrect answer.

Since the PV was entered as a negative number, the FV is automatically displayed as a positive number.

**Example 2: Calculating the PV of a lump sum**

What is the PV of \$115.76 due in 3 years if the interest rate is 5%?

Clear the calculator with **2nd** **CLR TVM** **CE/C** and then enter the following data.

3     **N**  
5     **I/Y**  
0     **PMT**  
115.76 **FV**

Pressing **CPT** **PV** gives the answer, **-\$100.00**, because if we deposited \$100.00 today in an account that pays 5% per year, it would grow to \$115.76 after 3 years.

**Example 3: Calculating I/Y**

Assume you lend someone \$100 today and they must pay you \$150 after 10 years. No payments will occur between now and Year 10. What rate of return would you earn?

10     **N**  
100   **+/-** **PV**     Convert the 100 to -100 to indicate an outlay.  
0     **PMT**  
150   **FV**

Press **CPT** **I/Y** and the calculator provides the earned rate of return, **4.14**, which means 4.14%. Note that the calculator displays 4.14 rather than 0.0414 or 4.14%. Don't clear the calculator; we will use it for the next example.

**Example 4: Overriding a value to find a new interest rate, I/Y**

Suppose you want to modify the preceding example, lending only \$95 but still receiving \$150 after 10 years. What rate of return would you earn on the modified loan?

If you left data from the preceding example stored in your calculator, you can override (or replace) the PV of 100. Just enter 95  $\boxed{+/-}$   $\boxed{PV}$ , and when you press  $\boxed{CPT}$   $\boxed{I/Y}$ , you get **4.67%**, the new interest rate on the loan. You could override other variables similarly and thus do “what if” analyses to see how the output changes with changes in the inputs.

**Example 5: Calculating N**

Suppose you currently have \$500,000 in an account that is earning 4.5%. You want to find out how long it will take your account balance to reach \$1,000,000.

4.5	I/Y
500000	+/- PV
0	PMT
1000000	FV

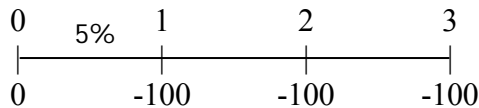
Press  $\boxed{CPT}$   $\boxed{N}$  and the calculator returns **15.75**, the number of years before your balance reaches \$1,000,000. Note that the calculator requires you to enter the interest rate as 4.5 rather than either 0.045 or 4.5%.

**Annuities**

Annuities can also be analyzed with the TVM keys. With lump sums, there are no payments, so  $PMT = 0$ . With annuities, we now have payments, so we must enter a non-zero value for PMT.

**Example 6: FV of an ordinary annuity**

What’s the FV of an ordinary annuity where we deposit \$100 at the end of each year for 3 years if the interest rate is 5%?



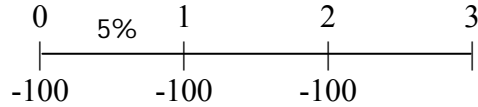
There is no beginning amount, so  $PV = 0$ . Thus N, I/Y, PV, and PMT are given, and we must solve for the FV:

3	N
5	I/Y
0	PV
100	+/- PMT

Now press **CPT** **FV** to find the answer,  $FV = \$315.25$ .

**Example 7: FV of an annuity due**

If the interest rate is 5%, what is the FV of an *annuity due* where we deposit \$100 at the beginning of each of the next 3 years?



After clearing, set the calculator to BGN mode and then enter values for the input variables:

**2nd** **BGN** **2nd** **SET** **CE/C** (to switch to BGN mode)  
3 **N**  
5 **I/Y**  
0 **PV**  
100 **+/-** **PMT**

When you press **CPT** **FV**, the answer,  $\$331.01$ , is displayed, along with the word “BGN.” Most text problems have end-of-period payments, so it’s a good idea to revert to END mode after a problem: **2nd** **BGN** **2nd** **SET** **CE/C**. (Note that you no longer see “BGN” in the calculator display area.)

**Example 8: PV of an ordinary annuity**

What’s the PV of the ordinary annuity discussed in Example 6?

Enter the following data:

3 **N**  
5 **I/Y**  
100 **+/-** **PMT**  
0 **FV**

Then, press **CPT** **PV** to get  $\$272.32$ . If the payments were to come at the beginning of the year (making it an annuity due), leave all the data in the calculator, and press **2nd** **BGN** **2nd** **SET** **CE/C** to set the calculator to BGN mode. Press **CPT** **PV** to find the PV of the annuity due,  $\$285.94$ . Again, revert to END mode after finishing this exercise.

**Example 9: Finding the payments for an annuity (PMT)**

You need \$10,000 five years from now. You plan to make 5 end-of-year payments into an account that pays 6%. How large must each payment be? What would each payment be if they were made at the beginning of the year?

Since payments are made at the end of each year, make sure the calculator is set to END mode. N, I/Y, PV, and FV are given, so we solve for the PMT:

5     N  
6     I/Y  
0     PV  
10000 FV

Now, press **CPT** **PMT** to get the answer, PMT = **-\$1,773.96**.

To find PMT if the annuity were an annuity due, then we would leave the data in the TVM register, switch to BGN mode, press **CE/C**, and then press **CPT** **PMT** to get **-\$1,673.55**.

**Example 10: Calculating the number of periods (N)**

You need \$10,000 to buy a boat. You will deposit \$1,200 at the end of each year in an account that pays 6% interest. How long will it take you to reach your \$10,000 goal?

First, clear the TVM memory and make sure you are in END mode. Then make these data entries:

6     I/Y  
0     PV  
1200 +/- PMT  
10000 FV

Now press **CPT** **N** to find the number of years, **6.96**, which you might round to 7. Notice that the PMT is entered as a negative because you are making a deposit, while FV is positive because you can withdraw it. Either PMT or FV must be negative—otherwise, the calculator will produce a nonsensical answer, in this case -11.90 years. Note too that if the payments occur at the beginning of each year, you would follow the same procedure, but here your calculator would be set to BGN mode. The answer would then be 6.63 years.

**Example 11: Calculating the interest rate (I/Y)**

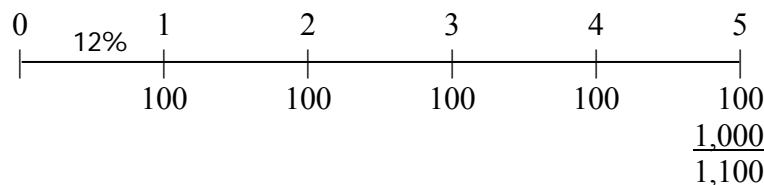
Continue with the previous example, but now assume you can only save \$1,200 at the end of each year. You still want to accumulate \$10,000 by the end of 5 years. What interest rate would you have to earn to reach this goal? Here are the keystrokes:

5     N  
0     PV  
1200 +/- PMT  
10000 FV

Make sure the calculator is in END mode, and press  $\boxed{\text{CPT}} \boxed{\text{I/Y}}$ . The required interest rate is **25.78%**. If the payments occurred at the beginning of the years, you would use the same keystrokes, but with the calculator set to BGN mode, and the answer would be 17.54%.

**Example 12: Uneven cash flows: annuity plus a lump sum**

Assume that you can buy a security that will make the payments shown on the following time line. What is the PV of this stream if the interest rate is 12%?



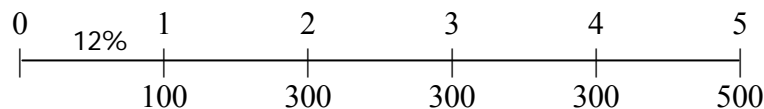
Here we have a 5-year ordinary annuity plus a \$1,000 lump sum at the end of Year 5. The calculator finds the PV of the annuity, the PV of the Year 5 lump sum payment, and then sums them, using the basic TVM keys as follows:

5      $\boxed{\text{N}}$   
 12     $\boxed{\text{I/Y}}$   
 100    $\boxed{\text{PMT}}$   
 1000    $\boxed{\text{FV}}$

Make sure the calculator is in END mode, and press  $\boxed{\text{CPT}} \boxed{\text{PV}}$  to find the PV, **-\$927.90**, which shows up as a negative because the PMT and the FV were inputted as positive numbers.

**Example 13: Irregular series of cash flows**

Assume that you can buy a security that will make the payments shown on the following time line. At an interest rate of 12%, what is the PV of the security?



This problem requires us to use the calculator's "cash flow register," where we enter a series of inputs and then perform a calculation based on these inputs.

Each cash flow could be entered one-by-one, but when adjacent cash flows are equal to one another, as is true for the \$300 in years 2, 3, and 4, then it is more efficient to enter them as a "group." We first enter the cash flows, then tell the calculator that we want to calculate the NPV, then specify the discount rate, and then tell the calculator to make the calculation.



Begin by pressing **2nd** **QUIT** to leave whatever operation you were in, then press the **CF** key to open the cash flow register, then press **2nd** **CLR WORK** to clear the cash flow register, and then enter the cash flows as shown below. As you enter the data, you will see the display prompting you for cash flow values and the number, or frequency, of times they occur. The frequency prompt assumes each CF occurs once, so you could accept this number by pressing the down arrow, but for grouped data, we override the 1 with the number of times the flow occurs, or with 3 for the \$300.

<b>2nd</b> <b>QUIT</b> <b>CF</b>	Leaves whatever you were doing and Opens the cash flow register.
<b>2nd</b> <b>CLR WORK</b>	Clears any previous data in the cash flow register.
0 <b>ENTER</b> <b>↓</b>	Enters CF <sub>0</sub> , then moves down to specify CF <sub>1</sub> shown in the display as C01.
100 <b>ENTER</b> <b>↓</b>	Enters CF <sub>1</sub> , and the down arrow takes us down to specify the number of times this CF occurs, F 01 = with a prompt of 1. This is correct, so we accept by pressing <b>ENTER</b> .
300 <b>ENTER</b> <b>↓</b> <b>ENTER</b> <b>↓</b>	Accepts the 1, then moves down to take the next CF. Enters CF <sub>2</sub> as 300 and then moves down to specify the number of times this CF occurs. The prompt is 1, but that is incorrect in this instance.
3 <b>ENTER</b> <b>↓</b>	This tells the calculator that 300 occurs 3 times and then takes us down to specify the next cash flow.
500 <b>ENTER</b> <b>↓</b>	Enters the 500 and takes us down to specify the number of times this cash flow occurs.
<b>ENTER</b> <b>↓</b>	Tells the calculator that this CF occurs 1 time and then takes us down to specify the next cash flow. There are no more cash flows, so we are through entering cash flows.

Note that with grouped data, the CF subscripts deviate from those on the time line, e.g., the \$500 is CF<sub>5</sub> on the time line but CF<sub>3</sub> in the CF register. Thus, the CFs in the register are the unique cash flows in the series.

Once the CFs have been entered as shown above, we tell the calculator to calculate the NPV.<sup>2</sup> It needs an interest rate, so at the prompt we specify 12%. Here are the keystrokes:

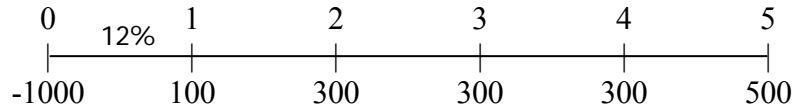
**NPV** **12** **ENTER** **↓** **CPT** .

<sup>2</sup> NPV stands for Net Present Value. Our stream has no negative cash flows, but if there were some negative flows, the calculator would net them out to produce the NPV. There is a negative flow in the next example.

Pressing the **NPV** key tells the calculator that we want to calculate the NPV. It then prompts us to enter the interest rate, which in the example is 12%, so we enter 12. The down arrow and the **CPT** key complete the entries, and the answer is **\$1,016.35**.

**Example 14: The Internal Rate of Return (IRR)**

Assume that we invest \$1,000 today (t = 0) and expect to receive an uneven set of cash flows in the future. Here is the CF time line:



What rate of return will we earn on the \$1,000 investment? Here are the entries:

<b>CF</b>			
<b>2nd</b> <b>CLR WORK</b>			
1000	<b>+/-</b> <b>ENTER</b> <b>↓</b>	Enters CF <sub>0</sub> and then asks for CF <sub>1</sub>	
100	<b>ENTER</b> <b>↓</b>	Enters CF <sub>1</sub> and asks for its frequency	
	<b>ENTER</b> <b>↓</b>	Accepts the 1 and asks for CF <sub>2</sub>	
300	<b>ENTER</b> <b>↓</b>	Enters CF <sub>2</sub> and asks for its frequency	
3	<b>ENTER</b> <b>↓</b>	Enters the 3 and asks for next cash flow	
500	<b>ENTER</b> <b>↓</b>	Enters CF <sub>3</sub> = \$500 and asks for its frequency	
	<b>ENTER</b> <b>↓</b>	Accepts the 1 and asks for CF <sub>4</sub>	

With the data entered, press **IRR** **CPT** to solve for the interest rate, which is **12.55%**. So, if we make this investment, we will earn 12.55% on our money. At 12.55%, the sum of the inflow PVs is equal to the \$1,000 investment.

Leave the data in the calculator, and we will show you how to calculate the NPV without entering new data except for the interest rate. Assuming I/Y = 12%, simply press **NPV** **12** **ENTER** **↓** **CPT** and you will get the NPV, which is **\$16.35**. The NPV and IRR are used in capital budgeting, and we virtually always calculate both with a given set of cash flow data. The important point is that you need to enter the cash flow only once to get both the NPV and the IRR.

**Example 15: Effective Annual Rate (EAR, or EFF%)**

If interest is paid more than once per year, as is true for most bonds, mortgages, auto loans, and so forth, then we need to calculate an *effective annual rate* for use in TVM calculations. The following equation is used to convert nominal rates to effective rates:

$$EAR = EFF\% = \left( 1 + \frac{I_{NOM}}{M} \right)^M - 1,$$

Here  $I_{\text{NOM}}$  is the stated rate and  $M$  is the number of compounding periods per year. The calculator is programmed to solve this equation. Here is an example: What is the EAR (or EFF%) on a bank account that pays a stated (or nominal) rate of 5% but with semiannual (twice yearly) compounding?

First, you could solve the equation arithmetically:

To begin, set the calculator to 6 decimal places, **2nd** **FORMAT** **6** **ENTER**. Next, use the calculator's arithmetic keys to solve this equation:  $\text{EFF}\% = (1 + 0.05/2)^2 - 1$ . Here are the keystrokes:

.05 **÷** 2 **=** **+** 1 **=** **x<sup>2</sup>** **-** 1 **=** which gives  $0.050625 = 5.0625\%$ .

Alternatively, you could use the calculator's interest conversion function. Clear the calculator's display so it reads 0.000000, then type these keystrokes:

<b>2nd</b> <b>I CONV</b>	This accesses the interest conversion worksheet.
<b>5</b> <b>ENTER</b> <b>↑</b>	Enters 5% as the nominal rate and then goes to C/Y, or compounding periods per year.
<b>2</b> <b>ENTER</b>	This enters 2 as the periods per year.
<b>↓</b> <b>↓</b> <b>CPT</b>	This calculates the effective rate.

The EAR or EFF% is **5.0625%**.

If there had been 12 compounding periods per year, the effective rate would have been 5.1162%. To see this, press the up arrow twice to get to the C/Y (compounding periods per year) slot, replace the 2 with 12 by pressing **12** **ENTER**, and then press the down arrow key twice to get back to the EFF display, and press **CPT** to get **5.116190%**. Set your calculator back to 2 decimal places by pressing **2nd** **FORMAT** **2** **ENTER** before beginning the next example and clear the calculator's display so it reads 0.00.

**Example 16: PV with semiannual compounding**

A \$100 lump sum is due in 10 years. If the appropriate discount rate is 5%, compounded semiannually, what is the PV of the \$100?

We can find the PV in two ways. First, with the TVM keys we could use the EFF% of 5.0625% as calculated above and then enter  $N = 10$ ,  $I/Y = 5.0625$ ,  $PMT = 0$ , and  $FV = 100$ . Then, press **CPT** **PV** to find **-\$61.03**. Alternatively, we could divide the nominal rate by 2 to get the semiannual rate and multiply the number of years by 2 to get the number of semiannual periods and then proceed as shown below:

$10 \times 2 =$	<b>N</b>	(enters 20 periods for N)
$5 \div 2 =$	<b>I/Y</b>	(enters the 2.5% semiannual rate)
0	<b>PMT</b>	(because there are no annual payments)
100	<b>FV</b>	(this is the one payment we will receive as an inflow)

Pressing **CPT** **PV** provides the answer, **-\$61.03**. Note that it's the same as the answer found with the EFF% and 10 years rather than 20 semiannual periods. (Remember, the PV shows up as a negative because PMT and FV were entered as positive numbers.)

**Example 17: Loan amortization**

In this example we use the calculator to get the data needed for an amortization table for a 5-year, 6%, annual payment, loan of \$100,000 as shown in Table 2-4 in the textbook. You should look at that table as you work through the following calculations.

First, we find the required loan payment. After checking to be sure P/Y is set to 1 payment per year and that you are in END mode, make these entries:

**2nd** **QUIT** **2nd** **CLR TVM**  
5 **N**  
6 **I/Y**  
100000 **PV**  
0 **FV**  
**CPT** **PMT** = **-\$23,739.64**. This is the required annual payment.

Now we need to determine the amount of interest and repayment of principal in each payment, and the balance at the end of Year 1. Leaving the data in the calculator, enter these keystrokes:

**2nd** **AMORT** **2nd** **CLR WORK** Display shows P1 = 1.00. This indicates that we are now working with the first PMT.

**↓** **↓** BAL = 82,260.36. Balance at the end of Year 1.  
**↓** PRN = -17,739.64. Amount of principal repaid in Year 1.  
**↓** INT = -6,000.00. Amount of interest paid in Year 1.  
**↓** Takes us back to the Period 1 starting point. Could press the down arrows to cycle through the results for principal, interest, and remaining balance again.

**CPT** Calculates values for Year 2.  
**↓** **↓** BAL = 63,456.34. Balance at end of Year 2.  
**↓** PRN = -18,804.02. Amount of principal repaid in Year 2.  
**↓** INT = -4,935.62. Interest in Year 2.  
**↓** Takes us back to the Period 2 starting point.

**CPT** Calculates data for Year 3.  
**↓** **↓** BAL = 43,524.08. Balance at end of Year 3.  
**↓** PRN = -19,932.26. Amount of principal repaid in Year 3.  
**↓** INT = -3,807.38. Interest in Year 3.  
**↓** Takes us back to the Period 3 starting point.

**CPT** Calculates data for Year 4.  
**↓ ↓** BAL = 22,395.88. Balance at end of Year 4.  
**↓** PRN = -21,128.20. Amount of principal repaid in Year 4.  
**↓** INT = -2,611.44. Interest in Year 4.  
**↓** Takes us back to the Period 4 starting point.

**CPT** Calculates data for Year 5.  
**↓ ↓** BAL = -0.01. Balance at end of Year 5. Would round to zero.  
**↓** PRN = -22,395.89. Amount of principal repaid in Year 5.  
**↓** INT = -1,343.75. Interest in Year 5.

If you wrote all this out, you would have the Table 2-4 amortization schedule. The final balance of -0.01 would be rounded to 0.00. More can be done with the amortization feature, including working with monthly payment loans, but we refer you to the calculator manual for these applications.

## USING THE STATISTICAL FUNCTIONS

This section is tied to Chapter 8, Risk and Rates of Return. The BAII Plus can also perform several statistical functions. In this tutorial, we will focus on the mean (or arithmetic average), the standard deviation, and regression analysis. To begin, note that there are two types of data—complete population data and sample data. We have population data if we have information on every possible data point. For example, if there were 5,000 publicly traded companies and we knew last year’s rate of return for each one, then we would be dealing with population data. However, if we collected data on just 200 of the 5,000 firms, we would have sample data.

Another example of population data is where you are given a probability distribution of a particular stock’s expected returns. If all possibilities are included, which means that the probabilities sum to 1, then we have population rather than sample data. Here’s an example of probability data:

<u>Outcome</u>	<u>Probability</u>	<u>Return</u>
Terrible	0.10	-18%
Poor	0.20	-6
Expected	0.40	12
Good	0.20	30
Excellent	<u>0.10</u>	42
	<u>1.00</u>	

We generally use statistical analysis in two ways: (1) To get an idea about something that occurred in the past, like the average rate of return on publicly owned stocks and the extent to which different firms deviated from that average. We would use the mean (average) to

get an idea of the central tendency of returns and the standard deviation to get an idea about the variations about that mean. (2) To predict future outcomes, like the rate of return on a stock during the coming year. For predictions, we typically rely on regression analysis.

We are most concerned with the mean (average expected return) and the standard deviation (which measures the dispersion of possible returns from the mean). These values can be calculated with the TI BAII Plus as shown below.

The 12% has the highest probability, the -6% and +30% are next, and the -18% and the +42% have the lowest probabilities. We can then enter each return into the calculator in proportion to its probability of its occurrence. You must select the data-entry portion of the statistics worksheet first, then clear any previous data entries, and then enter the data. Here are the keystrokes:

2nd	DATA	Selects the data-entry portion of the statistics worksheet.			
2nd	CLR WORK	Clears any previous data entries.			
18	+/-	ENTER	↓	↓	This enters -18 as the data entry and tells the calculator there is no Y variable associated with the X variable. There's a 10% probability, or 1 in 10, so enter once.
6	+/-	ENTER	↓	↓	20% probability, or 2 in 10, so enter twice.
6	+/-	ENTER	↓	↓	
12	ENTER	↓	↓	40% probability, or 4 in 10, so enter four times.	
12	ENTER	↓	↓		
12	ENTER	↓	↓		
12	ENTER	↓	↓		
30	ENTER	↓	↓	20% probability, or 2 in 10, so enter twice.	
30	ENTER	↓	↓		
42	ENTER	↓	↓	10% probability, or 1 in 10, so enter once.	

As you enter the data, the display first shows X01, then Y01 (you press the down arrow key to indicate that there is no Y variable associated with the X variable), then X02, etc. for every entry. This tells us how many entries are stored in the calculator. The last data entry will show X10 before you press the first of the two arrow keys. Here our probabilities were all divisible by 10 and hence easy to work with. If the probabilities had been irregular, say 6% for one return, 13% for another, etc., this procedure would be more trouble than it would be worth, and it would be easier to just use the formulas to calculate the mean and standard deviation. If we have sample data, like annual stock market returns, each data point has an equal chance of occurring, so we would just enter each one once.

Once the data have been entered, we can find the mean and standard deviation as discussed below.

**Example 18: Population mean and standard deviation**

With the data stored in the calculator as shown above, we can find the expected return (mean, or average) and the standard deviation ( $\sigma$ ) with these keystrokes:

2nd	STAT	Selects the statistical calculation portion of the statistics worksheet.
-----	------	--

- 2nd** **CLR WORK** Clears any previous statistical entries. Now “LIN” should appear on your calculator’s display area.
- 2nd** **SET** Press these 2 keys 4 times until “1-V” (meaning one variable calculation method) is shown on your calculator’s display area.
- ↓ ↓** , which gives the mean, or expected, return, **12.00%**. (We entered the percentages as whole numbers so 12.00 appears.)
- ↓ ↓** , which gives the standard deviation ( $\sigma_x$ ), **17.60%**. (Again, we entered the percentages as whole numbers, so 17.60 appears.)

Other statistical data can be obtained with these data; however, we leave their discussion to statistical texts and courses.

**Working with sample data**

We often work with historical stock market returns, such as the returns shown below for the market and for Stock Y from 2001 to 2005. This is a sample because it would be possible to obtain data for many other time periods. Normally, we would use more observations to increase our confidence in the results; however, we use a 5 data point example for simplicity.

Year	Return	
	Market	Stock Y
2001	23.2%	56.8%
2002	-10.1	-23.1
2003	-8.3	-31.0
2004	28.2	32.8
2005	10.1	11.1

**Example 19: Sample mean and standard deviation**

What is the mean (average) and standard deviation ( $\sigma$ ) of returns on the market and on Stock Y over the past 5 years?

First, the data must be entered into the calculator. Now, we are entering two fields of data: market returns and Stock Y’s returns. In the calculator, the first variable entered (market returns) is the independent variable (X) and the second variable is the dependent variable (Y).

**2nd** **DATA** **2nd** **CLR WORK**

23.2	<b>ENTER</b>	<b>↓</b>	56.8	<b>ENTER</b>	<b>↓</b>		
10.1	<b>+/-</b>	<b>ENTER</b>	<b>↓</b>	23.1	<b>+/-</b>	<b>ENTER</b>	<b>↓</b>
8.3	<b>+/-</b>	<b>ENTER</b>	<b>↓</b>	31.0	<b>+/-</b>	<b>ENTER</b>	<b>↓</b>

28.2	ENTER	↓	32.8	ENTER	↓
10.1	ENTER	↓	11.1	ENTER	↓
	2nd	STAT			

We normally work with the numbers in their raw form and with linear relationships. However, after you press **2nd** **STAT** you could change to some nonlinear form, or to work with only one variable, by scrolling through the options by repeatedly pressing **2nd** **SET**. For our example, though, stop on **LIN** because we will do a linear regression.

The important statistics have now been calculated, and you can see them after pressing **2nd** **STAT** by using the **↓** key to scroll through the output data. Stop when you get to  $\sigma_Y$ .

$n$	= 5.00	(pairs of data)
$\bar{x}$	= 8.62	(mean of X, the market return)
$S_X$	= 17.57	(sample standard deviation of X, the market return)
$\sigma_X$	= 15.72	(population standard deviation of X, the market return)
$\bar{y}$	= 9.32	(mean of Y, Stock Y's return)
$S_Y$	= 37.03	(sample standard deviation of Y, Stock Y's return)
$\sigma_Y$	= 33.12	(population standard deviation of Y, Stock Y's return)

Since we are working with sample data, the relevant standard deviations here are the sample standard deviations,  $S_X$  and  $S_Y$ . The population standard deviations ( $\sigma_X$  and  $\sigma_Y$ ) are not applicable and mean nothing in this example, so focus only on the sample standard deviations.

### ***Linear Regression***

Regression analysis shows the relationship between two variables, in this case the returns on the Market and on Stock Y, and the regression is given in the form of  $Y = a + bX$ . The  $b$  term in this equation is the *beta coefficient*, which is used in the CAPM to show the relationship between returns on an individual stock and returns on the market. We can use the data you just entered in the calculator to find Stock Y's beta. These same procedures can be used for any simple linear regression.

### ***Example 20: Determining the regression parameters***

You presumably kept the data in the calculator and stopped with  $\sigma_Y$  displayed. If you cleared the data, you must re-enter it and then scroll down to  $\sigma_Y$ . You can now use the **↓** key to scroll to the next term after  $\sigma_Y$ , which is the Y-intercept,  $a = -7.74$ , and then to the next term, the beta (or slope) coefficient,  $b = 1.98$ .

$a$  = the Y-intercept = **-7.74%**.

$b$  = the beta coefficient = **1.98**.

Therefore, the regression line is:

**Stock Y's return = -7.74% + 1.98 (Market return).**



Based on this equation, if the broad stock market has a return of 10% next year, then Stock Y should have a return of 12.06%:

$$\text{Stock Y's return} = -7.74\% + 1.98(\text{Market return}) = -7.74\% + 19.80\% = 12.06\%.$$

Here Y is the dependent variable and X is the independent variable, so we are saying that Stock X's returns depend on what happens to the broad stock market. We are also interested in the strength of the relationship between the X and Y variables, and this is measured by the correlation coefficient, which can be seen by scrolling down one more time by using the  $\square\downarrow$  key. The correlation coefficient is seen to be  $r = 0.94$ , indicating a strong relationship.

$$r = \text{the correlation coefficient} = 0.94.$$

In a simple regression (which means that the dependent variable is presumed to be determined by just one independent variable), the  $R^2$  of the regression, which is just the correlation coefficient squared, tells us the percentage of the variation in Stock Y's returns that are caused by swings in the Market's returns:

$$R^2 = (r)^2 = (0.94)^2 = 0.88.$$

Finally, note that the TI BAII Plus cannot do multiple regressions, where there are two or more independent variables.