

## Hewlett-Packard 12C Calculator

Your calculator can be your best friend on the CFA exam. This powerful machine can solve problems quickly. It can handle time value of money, statistics, and bond math. Best of all you can check your work as you go along.

Each question on the exam has one correct answer and three distractors. In questions with quantitative answers these distractors are specifically selected to reflect typical candidate mistakes. Under exam pressure many candidates have fallen prey to the thought: “My calculator and the exam agree – that must be the right answer.” You will find one correct and three incorrect – but plausible – answers for every question. Understanding how to use the calculator to check your answers can be one of your comparative advantages.

While your calculator can be your best friend, it can also be a distraction. Many times quantitative questions can be answered without any calculations. The unthinking candidates will plough ahead and make unnecessary calculations, wasting valuable time. If you think the question through, many times you can deduce the answer with little or no calculation. Recently the exam has emphasized thinking and understanding over routine calculations.

Here’s a quick example:



The range, mean absolute deviation, and variance of the population [10, 15, 20, 30] are, respectively, closest to:

- A. 20 19.0 55.0
- B. 20 6.3 9.3
- C. 30 12.2 55.0
- D. 30 12.2 9.3


Think this one through. The four possible ranges are actually only two: 20 and 30. A quick inspection of the numbers reveals the range is 20 (30 minus 10). You might be able to tell that the variance (the average sum of *squared* deviations) has to be larger than 9.3 and the answer is A. If your intuition fails, you can quickly calculate the variance with your calculator – we will show you how in this guide. The mean absolute deviation is irrelevant and would have been a big waste of time.

Candidates who are already in the investment profession are used to solving quantitative problems with Bloomberg<sup>®</sup> or Excel<sup>®</sup>. Switching to calculators takes practice but we promise you practice will give you a comparative advantage.

This guide is specifically designed to help you work quantitative problems on the CFA exam. The calculator can do other things, too. You’ll find the full array of capabilities in the instruction manual that came with the calculator. Unless you’re just curious, we suggest you focus on solving CFA problems first.


To begin, look at the face of the calculator. Every key (except the arithmetic function keys in the far right column and the five keys on the bottom left row) has two or three functions: each key's primary function is noted in white on the key itself, while each key's secondary function is noted in gold above the key or in blue on the lower face of the key. To use the function on the key, simply press the key. To access the gold function above each key, first press the gold  key, which we will call the "gold shift" key, and then press the desired function key. (Note that the gold shift key is near the lower left corner of the calculator keyboard.) To access the blue function on the bottom of each key, first press the blue  key, which we will call the "blue shift" key, and then press the desired function. (The blue shift key is located just to the right of the gold shift key.)

### ***Turning the Calculator On and Off***

To turn on the calculator, press .

Note that the ON key is on the lower left corner of the keyboard—the face of the key has a white "ON". Also, we will designate keys throughout this tutorial by the use of small boxes, as above. To conserve the battery, the calculator turns itself off about 10 minutes after your last keystroke.

To turn the calculator off, press  again.





Also, note that pressing the gold shift key places a little "f" symbol in the lower left corner of the display. Pressing the blue shift key places a little "g" at the bottom of the display. Press the  key and the symbol goes away. The shift keys are toggle keys that switch back and forth between the "regular" and the "gold" or "blue" functions. They are like the shift key. After you press the "gold" (or "blue") key, look only at gold (or blue) writing. The blue text is especially hard to see. Try tilting the calculator away from you.

Note that your calculator has a continuous memory, so turning it off does not affect any data stored in the calculator.

### ***Clearing the Calculator***

Clearing the calculator is very important, since unwanted data in memory can result in improper calculations, and hence wrong answers. It is best to get into the habit of automatically clearing memory before starting a calculation. Occasionally, you may purposely want to save data, but, in general, you will be entering all new data, so starting with a clear memory is the safest approach.

There are four different levels of clearing data:


- |   |   |
|---|---|
|  | clears all memory and the display.                  |
|  | clears the entire display, but not the memory.      |
|  | clears the financial register, but not the display. |
|  | clears the statistics register and the display.     |

Note that the keys above are designated as CLEAR keys on the face of the calculator.

### *Changing the Display*

Enter 5555.5555.

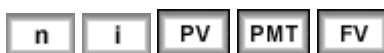
To change decimals from 2 to 4, press . 5,555.5555 is displayed.

To change from 4 places to 2, press . 5,555.56 is displayed. (Rounding is automatic.)

Set your display to 4 places which is especially convenient when dealing with interest rates and rates of return that are entered as decimals.



### *Time Value of Money (TVM)*

The TVM keys are located on the top row of the keyboard.





In general, TVM problems involve four variables—three are known and the fourth is unknown. (Note that the fifth TVM key is used for bond valuation.)

### **Lump Sums**

To begin, we consider TVM calculations with single (lump) sums. Be sure to either clear all, , , which sets all TVM variables to 0. If you know any three variables, you can find the value of the fourth.

*Example 1:*

The FV of \$100 after 3 years if the interest rate is 26 percent is closest to? First, clear by pressing . If you pressed  the TVM variables will be cleared but this is a good habit, nevertheless.

Next, enter the following data:

You Enter		Calculator Response
3	<b>n</b>	3.0000
26	<b>i</b>	26.0000
100	<b>PV</b>	100.0000
0	<b>PMT</b>	0.0000
0	<b>FV</b>	0.0000

To determine the FV simply press **FV** and the FV of -\$200.0376 is displayed.

You may find it helpful to use the same keypad sequence: **n**, **i**, **PV**, **PMT**, and **FV**, for every time value of money problem. That way, you won't forget a step. You can enter a zero for the value you are going to compute – the calculator knows the difference between entering a zero and being asked to compute an answer.

The HP is programmed so that if the PV is positive (+) then the FV is displayed as negative (-) and vice versa, because the HP assumes that one is an inflow and the other is an outflow. When entering both PV and FV, one must be entered as negative and the other as positive.

Before you clear your calculator you can check to be sure you have the right inputs. Press

**RCL** **n** to see that the number of periods was really 3, **RCL** **i** to see that the interest rate was 26, and so on. If you find that you have entered the wrong number, don't start over. You can correct the number of years, for example, by entering the correct number, pressing **n**, and recalculating the future value.

*Example 2:*

The PV of \$500 due in 5 years if the interest rate is 10 percent is closest to? Clear first and then enter the following data:

You Enter		Calculator Response
5	<b>n</b>	5.0000
10	<b>i</b>	10.0000
0	<b>PV</b>	0.0000

0	<b>PMT</b>	<b>0.0000</b>
500	<b>FV</b>	<b>500.0000</b>

Pressing the **PV** key reveals that the present value of \$500 to be received in 5 years at a 10 percent rate is -\$310.46.

*Example 3:*

The exam often asks a question about compound growth rates as they are a primary tool of the financial analyst. Remember that interest rates and growth rates are the same thing and you can use the calculator to solve for either one.

If \$310.46 grows to \$500 in 5 years, the compound growth rate is closest to? Clear first and then enter:

5	<b>n</b>	<b>5.0000</b>
0	<b>i</b>	<b>0.0000</b>
310.46	<b>PV</b>	<b>310.4600</b>
0	<b>PMT</b>	<b>0.0000</b>
500	<b>FV</b>	<b>500.0000</b>

Press **i** to see the answer. Did you see Error 5? Of course you did. Use this example to remember that either the PV or the FV **must** be negative. Try again:

5	<b>n</b>	<b>5.0000</b>
0	<b>i</b>	<b>0.0000</b>
-310.461	<b>PV</b>	<b>310.4600</b>
0	<b>PMT</b>	<b>0.0000</b>
500	<b>FV</b>	<b>500.0000</b>

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1 Press 310.46 then the minus key to make the value negative.

Press **i** to see that the answer is indeed 10.0000%.

Unless otherwise instructed, assume the present value is negative.

If you see Error 5 you now know your present value is probably positive when it should be negative. Instead of re-entering all the numbers press **CLX** to clear the error then **RCL** **PV**. When the calculator responds with 310.4600 press **CHS** to change the sign and **PV** to store and re-compute by pressing **i**.

*Example 4:*

Assume a bond can be purchased today for \$200. It will return \$1,000 after 14 years. The bond pays no interest during its life. The rate of return you would earn if you bought the bond is closest to? Clear first then enter:

	You Enter	Calculator Responds
14	<b>n</b>	<b>14.0000</b>
0	<b>i</b>	<b>0.0000</b>
200	<b>CHS</b> <b>PV</b>	<b>-200.0000</b>
0	<b>PMT</b>	<b>0.0000</b>
1000	<b>FV</b>	<b>1000.0000</b>

Press the **i** key and the HP calculates the rate of return to be 12.1828 percent.

Remember that the HP is programmed so that if the PV is + then the FV is displayed as - and vice versa because the HP assumes that one is an inflow and other is an outflow. Also note that the negative sign is placed on the 200 PV entry by pressing the key marked “CHS” for change sign.

Now suppose you learn that the bond will actually cost \$300. What rate of return will you earn?

**Override** the -200 by entering 300 **CHS** **PV**, then press **i** to get 8.9804 percent. If you pay more for the bond, you earn less on it.

What if you are asked to find the price if yields on comparable bonds are 10%? Override the 8.9804 percent that is now stored as the yield by entering 10 **i** and then press **PV**. You should see -263.3313. Don't be alarmed that the price is negative – that's just the calculator's way of saying either the PV or the FV has to be negative.

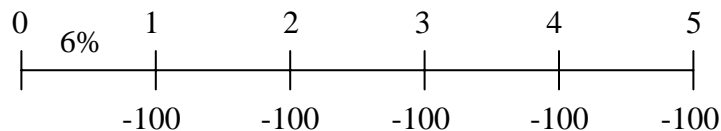
The important thing to remember is that you can do “what if” analyses with the calculator.

Now, press **ON** to turn off the calculator. Then turn on the calculator **ON**. The display still shows -263.3313. The memory is not erased. What was on the screen when you turned the calculator off returns when you turn it back on. Now press **CLX**. What was on the screen is gone, but press **RCL** **n** to get  $N = 14.0000$ . The other memory registers also retain information unless you press **f** **FIN**.

## Ordinary Annuities

*Example 1:*

The FV of an annuity of \$100 paid at the end of each year for 5 years if the interest rate equals 6 percent is closest to?



Now, enter the following data:

5 **n**  
 6 **i**  
 0 **PV**  
 100 **CHS** **PMT**  
 0 **FV**

Now press the **FV** key, and an FV of \$563.7093 is displayed. Because the payment is negative, the answer is future value is positive. If you didn't change the sign on the payment and saw an answer of -\$563.7093, you will know the answer is actually \$563.7093.

*Example 2:*

The PV of the same annuity is closest to?

Leave data in calculator, but enter 0 as the FV to override, then press **PV** to get a PV of \$421.2364.

## Annuities Due

Each payment of an annuity due occurs at the beginning of the period instead of at the end, as with a regular annuity. In essence, each payment is shifted back one period. To analyze an annuity due press **g** **BEG**. The word “BEGIN” appears on the screen. Now the HP analyzes the cash flows based on beginning of period payments. Change back to end mode by pressing **g** **END**.

## Interest Conversion

The following equation is used to convert a nominal rate to an effective rate.

$$\text{EAR} = \left[ 1 + \frac{k_{\text{Nom}}}{m} \right]^m - 1.$$

Given:  $k_{\text{Nom}} = 10\%$  and  $m = 12$  payments/year,

$$\text{EAR} = \left[ 1 + \frac{0.10}{12} \right]^{12} - 1 = (1.0083)^{12} - 1 = 1.1047 - 1 = 0.1047 = 10.47\%.$$

However, it's much easier to convert the nominal rate using the calculator.

First, clear the financial register, **f** **FIN**.

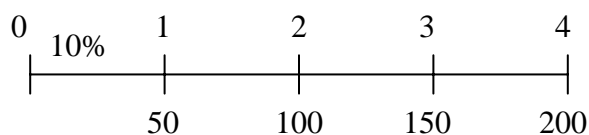
10 **ENTER**  
12 **n** **÷** **i**  
**CHS** **PMT** **FV**      10.4713% shows on the screen.

## Cash Flow Operations

We can also find the PV, FV, and IRR (rate of return) of a series of unequal cash flows.

*Example 1: Uneven Cash Flows*

Assume the following cash flows:



The PV of these CFs is closest to?

First, clear the HP's financial register, **f** **FIN** and screen, **CLX**.

You Enter	Calculator Responds
0 <input type="button" value="g"/> <input 1px="" 5px;="" black;="" border:="" center;"="" padding:="" solid="" text-align:="" type="button" value="CF&lt;sub&gt;0&lt;/sub&gt;&lt;/input&gt;&lt;sup&gt;2&lt;/sup&gt;&lt;br/&gt;Sets CF&lt;sub&gt;0&lt;/sub&gt; equal to 0.&lt;/td&gt; &lt;td style="/> 0.0000	
50 <input type="button" value="g"/> <input 1px="" 5px;="" black;="" border:="" center;"="" padding:="" solid="" text-align:="" type="button" value="CF&lt;sub&gt;i&lt;/sub&gt;&lt;/input&gt;&lt;br/&gt;Sets CF&lt;sub&gt;1&lt;/sub&gt; equal to 50.&lt;/td&gt; &lt;td style="/> 50.0000	
100 <input type="button" value="g"/> <input 1px="" 5px;="" black;="" border:="" center;"="" padding:="" solid="" text-align:="" type="button" value="CF&lt;sub&gt;i&lt;/sub&gt;&lt;/input&gt;&lt;br/&gt;Sets CF&lt;sub&gt;2&lt;/sub&gt; equal to 100.&lt;/td&gt; &lt;td style="/> 100.0000	
150 <input type="button" value="g"/> <input 1px="" 5px;="" black;="" border:="" center;"="" padding:="" solid="" text-align:="" type="button" value="CF&lt;sub&gt;i&lt;/sub&gt;&lt;/input&gt;&lt;br/&gt;Sets CF&lt;sub&gt;3&lt;/sub&gt; equal to 150.&lt;/td&gt; &lt;td style="/> 150.0000	
200 <input type="button" value="g"/> <input 1px="" 5px;="" black;="" border:="" center;"="" padding:="" solid="" text-align:="" type="button" value="CF&lt;sub&gt;i&lt;/sub&gt;&lt;/input&gt;&lt;br/&gt;Sets CF&lt;sub&gt;4&lt;/sub&gt; equal to 200.&lt;/td&gt; &lt;td style="/> 200.0000	

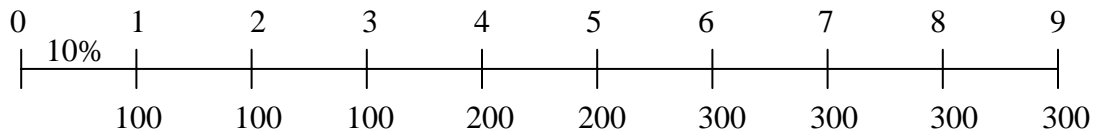
The CFs from the time line are entered. Now enter the interest rate.

10 <input type="button" value="i"/>	10.0000
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At this point the HP knows the cash flows, the number of periods, and the interest rate. To find the PV, press   to get  $PV = NPV = \$377.3991$ .<sup>3</sup>

### Example 2: Embedded Annuities

We have these cash flows, which contain embedded annuities:



The PV is closest to?

Clear the HP,   and screen, .

You Enter	Calculator Responds
0 <input type="button" value="g"/> <input 1px="" 5px;="" black;="" border:="" center;"="" padding:="" solid="" text-align:="" type="button" value="CF&lt;sub&gt;0&lt;/sub&gt;&lt;/input&gt;&lt;/td&gt; &lt;td style="/> 0.0000	

<sup>2</sup>These keys are hard to see.  is on the same key as .

100	<input type="button" value="g"/>	<input type="button" value="CF&lt;sub&gt;j&lt;/sub&gt;"/>	<input type="text" value="100.0000"/>
3	<input type="button" value="g"/>	<input type="button" value="N&lt;sub&gt;j&lt;/sub&gt;"/>	<input type="text" value="3.0000"/>
200	<input type="button" value="g"/>	<input type="button" value="CF&lt;sub&gt;j&lt;/sub&gt;"/>	<input type="text" value="200.0000"/>
2	<input type="button" value="g"/>	<input type="button" value="N&lt;sub&gt;j&lt;/sub&gt;"/>	<input type="text" value="2.0000"/>
300	<input type="button" value="g"/>	<input type="button" value="CF&lt;sub&gt;j&lt;/sub&gt;"/>	<input type="text" value="300.0000"/>
4	<input type="button" value="g"/>	<input type="button" value="N&lt;sub&gt;j&lt;/sub&gt;"/>	<input type="text" value="4.0000"/>

Now the HP knows the cash flows. Thus, enter the interest rate:

10

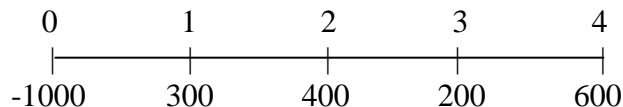
Now press   to get  $PV = NPV = \$1,099.9433$ .

To check your entries:

- 0 to see  $CF_0$ .
- 1 to see first CF entry, 100.00 in this example.
- 1     to see how many times  $CF_1$  is repeated. The display shows that the first CF occurs three consecutive times.
- 3     shows that the third CF was repeated four times.

### Example 3: The Rate of Return of an Investment (IRR)<sup>4</sup>

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



The rate of return we will earn is closest to? Enter the following:

<sup>3</sup> For our purposes we consider the present value and the net present value (NPV) the same.

<sup>4</sup> If a negative CF occurs at the end of a project's life, the HP may give an error message, indicating that there are two IRRs. You are unlikely to encounter this situation on the exam.

Clear the HP, **f** **FIN** and screen, **CLX**

	You Enter	Calculator Responds
1000	<b>CHS</b> <b>g</b> <b>CF<sub>0</sub></b>	<b>-1000.0000</b>
300	<b>g</b> <b>CF<sub>j</sub></b>	<b>300.0000</b>
400	<b>g</b> <b>CF<sub>j</sub></b>	<b>400.0000</b>
200	<b>g</b> <b>CF<sub>j</sub></b>	<b>200.0000</b>
600	<b>g</b> <b>CF<sub>j</sub></b>	<b>600.0000</b>
	<b>f</b> <b>IRR</b>	<b>16.7053</b>

You can also determine the NPV of the investment. Leave data entered and then enter the opportunity cost interest rate, say 8 percent. To find NPV press:

8 **i** **f** **NPV**.

The NPV of \$220.4977 is displayed. Thus, the PV of the cash inflows exceeds the cost of the investment by \$220.4977.

### Statistical Calculations

The HP can also be used for several types of statistical calculations.

#### Mean and Standard Deviation

<u>Year</u>	<u>Sales</u>
1999	\$150
2000	95
2001	260

What is the mean (average) and standard deviation ( $\sigma$ ) of sales over the 3 years?

Use the  $\Sigma+$  key to enter data:

**f**  **$\Sigma$**  Clears the statistical register.

	You Enter	Calculator Responds
150	<b><math>\Sigma+</math></b>	<b>1.0000</b>

95	$\Sigma+$	2.0000
260	$\Sigma+$	3.0000

Determine the mean and standard deviation by pressing

$g$   $\bar{x}$  The mean equals \$168.3333.

$g$   $S$  The standard deviation is \$84.0139. S is the sample standard deviation.

If you want the population standard deviation follow these steps from this point:

$g$ $\bar{x}$	168.3333
$\Sigma+$	4.0000

Adds the mean as an extra observation.

$g$ $S$	68.5971
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Recalculates the population standard deviation.

Let's try that problem again with an additional set of sales figures:

Year	Product X Sales	Product Y Sales
1999	\$150	\$200
2000	95	175
2001	260	300

$f$   $\Sigma$  Clears the statistical register.

150	ENTER	150.0000
200	$\Sigma+$	1.0000
95	ENTER	95.0000
175	$\Sigma+$	2.0000
260	ENTER	260.0000
300	$\Sigma+$	3.0000

Note: The HP expects you to enter the dependent variable (typically denoted  $y$ ) first – using **ENTER** and then the independent or explanatory variable (usually denoted  $x$ ) second using  **$\Sigma+$** . Unless you are running a regression, it doesn't matter which order you use. The second variable you entered will be displayed first but it should be obvious from the context.

Determine the mean and standard deviation of the **second** variable by pressing

**g**  **$\bar{x}$**  The mean of Product Y equals \$225.0000.

**g** **S** The sample standard deviation of Product Y is \$66.1438.

To see the sample standard deviation of Product X press  **$x\geq y$**  and the calculator responds: 84.0139.  
For the mean of Product X press **g**  **$\bar{x}$**   **$x\geq y$**  to see 168.333.

To compute the correlation, press **g**  **$\hat{y}, r$**  and then  **$x\geq y$** . You should see 0.9897. Again, the order doesn't matter.

Correlation is a natural output of regression but you should not need to calculate a regression on the exam. The only potentially important statistic in this sequence is the correlation coefficient which, when squared, is the regression's  $R^2$ .

Although your calculator will perform a regression, as we have seen, the emphasis on the exam is most likely to be interpreting the results of a regression rather than computing one. Don't waste your time learning how to run regressions on your calculator for the exam.

## Bond Calculations

Unlike the TI, the HP has no special facility to handle bond pricing. Although bond calculations are fair game at Level I, we've already seen how to work these problems above. You are unlikely to encounter anything more complicated than these problems and your calculator can handle it quickly and efficiently.