

***A Guide to Financial Applications on***

***the TI-83/84 Plus Graphing Calculator***

Lawrence P. Schrenk

Version 1.0

© 2012 by Lawrence P. Schrenk

**Preface**

This *Guide* is intended for introductory finance students who plan to use a graphing calculator, such as a TI-83. Unfortunately, the nearly 1,000 pages manual that accompanies such a calculator typically contains only abut 25 pages on the financial functions, and students are little better served by the various ‘how to’ books that have been published about graphing calculators. This *Guide* is intended to fill that niche.

The symbol, 🢂, alerts the reader to special warnings, hints or common errors.

TI-83 and TI-84 are registered trademarks of Texas Instrument, Inc.

**Acknowledgements**

I wish to thank the students of Business Finance and Financial Management for their comments on an early version of the *Guide*.

**Author Information**

Larry Schrenk teaches finance at the Kogod School of Business, American University, Washington, DC. His courses include personal finance, personal wealth management, business finance, financial management, derivatives and international finance. His research interests are in executive compensation, corporate governance, real option valuation and capital structure. He has consulted for Fortune 500 firms, developing real option valuation models in energy and biotechnology. Professor Schrenk’s web pages are located at: <http://auapps.american.edu/~schrenk/>.

Comments or corrections should be sent to [schrenk@american.edu](mailto:schrenk@american.edu).

**Table of Contents**

Chapter 1–The Basics of a Graphing Calculator

[Chapter 2–Single Dollar Problems: Future Value and Present Value](#Topic_3)

▪ [Future Value Problems](#FV)

▪ [Present Value Problems](#PV)

[Chapter 3–Single Dollar Problems: Interest Rate and Time](#Topic_4)

▪ [Interest Rate Problems](#Rate)

▪ [Time Problems](#Time)

▪ [Why Enter Negative Values](#Negative)

Chapter 4–Mixed Cash Flows

[Chapter 5–Annuities: Future Value and Present Value](#Topic_7)

▪ [Future Value Annuity Problems](#FV_Annuity)

▪ [Present Value Annuity Problems](#PV_Annuity)

▪ Annuities Due

[Chapter 6–Annuities: Interest Rate, Time and Payment](#Topic_9)

▪ [Interest Rate Annuity Problems](#Rate_Annuity)

▪ [Time Annuity Problems](#Time_Annuity)

▪ [Payment Annuity Problems](#Payment_Annuity)

▪ [Time Value of Money Decision Flowchart](#Flowchart)

[Chapter 7–Non-Annual Compounding and Discounting](#Topic_12)

[Chapter 8–Interest Rates](#Topic_14)

Chapter 9–Bonds

* Price of a Bond
* Yield to Maturity (YTM) of a Bond

Chapter 10–Amortization

Chapter 11–Net Present Value (NPV)

Chapter 12–Internal Rate of Return (IRR)

Chapter 13–Application D: dbd (Days between Dates)

Abbreviations

Index

**Chapter 1–The Basics of a Graphing Calculator**

This chapter will introduce you to the most elementary features of a graphing calculator that are necessary for doing financial calculations. It will begin by showing you how to access the financial functions, how to input data, and how to solve a simple problem. It will also briefly outline the financial applications available on the calculator.

**Accessing the Basic Financial Applications**

To access the finance applications, turn on the calculator, and press [APPS] [ENTER].[[1]](#footnote-1) You should see the main financial screen below:

CALC VARS

1: TVM Solver...

2: tvm\_Pmt

3: tvm\_I%

4: tvm\_PV

5: tvm\_N

6: tvm\_FV

7↓npv(

These applications and are the basic financial applications. You open an application by entering its number/letter or moving the cursor to the line and pressing [ENTER].

‘TVM’ and ‘tvm’ stand for ‘time value of money’, and Applications 1-6 will solve questions involving the value of money over time, e.g., if I invest $100 and receive a 5% return, how much money will I have after 6 years? These and the other applications are summarized later in this chapter and described in detail in other chapters.

**A Sample Problem**

We will illustrate the TVM Solver with a simple example: if I invest $100 today and receive a 5% return, how much money will I have after 6 years?

Open the TVM Solver by either entering ‘1’ or moving the cursor to that line and pressing [ENTER]. You should see the screen below:[[2]](#footnote-2)

N=0.00

I%=0.00

PV=0.00

PMT=0.00

FV=0.00

P/Y=1.00

C/Y=1.00

PMT: END BEGIN

Don’t worry if you see different numbers assigned to individual variables. We will substitute the correct values as we solve the problem. The table below explains the variable abbreviations used on this screen:

|  |  |
| --- | --- |
| **Variable** | **Explanation** |
| N | *Number of Periods* the money is invested–for now we will assume each period is one year. |
| I% | *Annual Interest Rate* that applies to our investment. |
| PV | *Present Value* of the investment |
| PMT | *Payment* made each period over the life of the investment |
| FV | *Future Value* of the investment |
| P/Y | *Payment Periods per Year*, i.e., are we investing weekly, monthly, etc.–for now we will assume each period is one year. |
| C/Y | *Compounding Periods per Year*, i.e., is our investment being compounded weekly, monthly, annually, etc.–for now we will assume it is compounded annually. |
| PMT:END BEGIN | *Payment Time*, i.e., are payments made at the end or the beginning of each period. |

Most of these variables are only used in more advanced problems, so you should not be concerned if they now seem confusing; they will be explained in later chapters.

How do you solve the sample problem: if I invest $100 today and receive a 5% return, how much money will I have after 6 years? The present value (PV) of our investment is $100.00, since that is the amount we are investing today. We will invest it for 6 years/periods (N) at an annual interest rate of 5% (I%).

N = 6 I% = 5 PMT = 100

Move the cursor to the relevant line, input the number, and press [ENTER]. Then move the cursor to the next relevant line, until N = 6.00, PV = -100.00 and I% = 5.00. [[3]](#footnote-3) Your screen should now look as follows:

N=6.00

I%=5.00

PV=-100.00

PMT=0.00

FV=0.00

P/Y=1.00

C/Y=1.00

PMT:END BEGIN

If any of the variables have different values than above, change them to conform to this list. Also, be sure that in the last line END is highlighted, not BEGIN.

🢂 Note that the present value is a *negative* 100. We will discuss the need for this in a later chapter. @@@link

🢂 Be careful to enter I% as an ‘integer’, that is 5% as 5, *not* 0.05 and 12.45% as 12.45, *not* 0.1245.

To solve the problem, put the cursor on the variable for which you want the solution: here we want to know the future value (FV) of our investment, so put the cursor on FV=0.00. Then press [ALPHA] [ENTER].[[4]](#footnote-4) Your screen should now look as follows:

N=6.00

I%=5.00

PV=-100.00

PMT=0.00

FV=134.01 *(answer)*[[5]](#footnote-5)

P/Y=1.00

C/Y=1.00

PMT:END BEGIN

You have solved your first financial problem! The solution to the problem appears on the line of the corresponding variable, here FV. The solution is $134.01, that is, after 6 years I will have $134.01, if I invest $100 today and receive a 5% return. Since the concern is to find a value in the future, this type of problem is known as a future value of money problem.

For most problems involving the time value of money, you can use either the TVM Solver (Application 1) or specific financial applications (Applications 2-6). The only difference is that the TVM Solver displays a list of variable on the screen, while the individual applications require you to express the inputs in an equation-like format, e.g. tvm\_I%[(N,PV,PMT,FV,P/Y,C/Y)]. Beginners should start with the TVM Solver. Later chapters will show how to use both types of applications.

**Summary of the Financial Applications**

The applications available on a graphing calculator are summarized in the table below:

|  |  |  |
| --- | --- | --- |
| **Application** | **Description** | **Chapter in *Guide*** |
| 1: TVM Solver... | TVM Solver | 1, 2, 3, 4, 5, 6, 7 @ link |
| 2: tvm\_Pmt | Calculates the payment on an annuity. | 6 |
| 3: tvm\_I% | Calculates the interest rate. | 3, 6 |
| 4: tvm\_PV | Calculates the PV. | 2, 5 |
| 5: tvm\_N | Calculates the number of periods. | 3, 6 |
| 6: tvm\_FV | Calculates the FV. | 2,5 |
| 7: npv( | Calculates the net present value. | 4, 11 |
| 8: irr( | Calculates the internal rate of return. | 12 |
| 9: bal( | Calculates the balance on an amortization schedule. | 10 |
| 0: Prn( | Calculates the principal on an amortization schedule. | 10 |
| A: Int( | Calculates the interest on an amortization schedule. | 10 |
| B: ►Nom( | Calculates the nominal rate. | 8 |
| C: ►Eff( | Calculates the effective rate. | 8 |
| D: dbd( | Calculates the days between two dates. | 13 |
| E: Pmt\_End | Updates the TVM Solver to calculate an ordinary annuity. | -- |
| F: Pmt\_Bgn | Updates the TVM Solver to calculate an annuity due. | -- |

If these explanations contain terms or concepts unknown to you, they will be explained in later Chapters.

**Chapter 2–Single Dollar Problems: Present and Future Value**

We begin with single dollar problems: those in which we are comparing monetary values at two different times–now versus some time in the future. In this chapter we will focus on problems that involve only present and future values. Examples of these would be the following questions:

* Future Value: If I invest $100 today and receive a 5% return, how much money will I have after 6 years? (Yes, our example from the previous Chapter)
* Present Value: How much do I need to invest today, if I want to have $200 in 6 years and receive a 5% return?

But first a small bit of theory…

**The Time Value of Money:** Everyone prefers getting $100 today to getting $100 in five years. But before we do any calculations, we should consider why this is so. We can isolate three separate motives for the time value of money, that is, three distinct reasons why you would prefer $100 today to $100 in five years:

1. *Inflation*: Prices go up, so if I wait five years I can buy less with the $100.
2. *Opportunity Cost*: By delaying the payment, I loose the opportunity to spend the $100 for the next five years.
3. *Risk:* In five years, you may not have the money to pay me, so waiting involves a risk of not getting $100.

The interest rate is how fast money grows (annually) over time. We get a return (or interest rate) on an investment to compensate us for waiting and accepting these three costs.

*Terminology*: In different contexts, the rate money grows over time may be called the ‘interest rate’, the ‘rate of return on an investment’ (often shortened to ‘rate of return’ or just ‘return’), the ‘compounding rate’ or the ‘discounting rate’.

**Time Lines**: When you are dealing with payments over time, the easiest way to visualize them is to draw a time line such as the one below.

**0 1 2 3 4 … N**

**Today**

**Time**

Today is 0. A year from now is 1, two years from now is 2, etc.

🢂 Until you are comfortable with these problems, always start by drawing a timeline.

**Future Value Problems**

Problem: How much will you have in your bank account 5 years from now, if you deposit $100 today, earn 10% interest per year and make no additional deposits. In this time line, X represents the amount in my account in five years:

**0 1 2 3 4 5**

**Today**

**Time**

***X***

**100**

This is a *future value* problem because I am asking the future value of a single dollar amount today. The amount deposited today is called the *present value*, and the process of going from the present value to the future value is called *compounding*. Future value problems often have the general pattern:

How much *future value (FV)* will I have after *N years*, if I deposit the *present value (PV)* today and get an *interest**rate of* *I%* per year?

We will use a graphing calculator to solve these problems, but you should see the step by step calculations to understand what is going on.

*Year 1*: If start with $100.00, how much will I have after one year?

$100.00 × 1.10 = $110.00

I multiply the $100 by 1 because I still have my $100 deposit and by 10% because that is the interest I receive for one year. We combine these in one calculation by multiplying the $100 by 1.10.

*Year 2*: I start the year with $110.00 in my account. How much will I have after one more year?

$110.00 × 1.10 = $121.00

As in the first year, I multiply the starting amount by 1.10.

*Year 3*: I start the year with $121.00 in my account. How much will I have after another year?

$121.00 × 1.10 = $133.10

You see that pattern: multiple each year by 1.10. I don’t need to do this in three different steps; instead, I can find the amount in year 3 from the original deposit:

$100.00 × 1.10 × 1.10 × 1.10 = $100.00 × 1.103 = $133.10

This is what our graphing calculator will do, but instead of worrying about formulae (yes, this one is easy and you could easily do it with a regular calculator, but the formulae get more complicated later), we just need to enter the data:

N = 3 I% = 10 PV = $100.00

into a graphing calculator.

**Future Value on your Calculator:** Now let’s use your calculator.

Problem: How much do you have after 4 years if you deposit $200 today and the interest rate is 12%?

N = 4 I% = 12 PV = 200

Enter the appropriate values (remembering to press [ENTER] after each), move the cursor to the FV line, and then press [ALPHA] [ENTER]. Your screen should look like this:

N=4.00

I%=12.00

PV=-200.00

PMT=0.00

FV=314.70 *(answer)*

P/Y=1.00

C/Y=1.00

PMT:END BEGIN

In 4 years, your bank account will have $314.70.

🢂 Enter 12% as 12 (don’t enter it as the decimal 0.12, because the calculator will think the interest rate is 0.12%).

🢂 The present value must be entered as a negative value. (If you want to know why, see [Why Enter Negative Values?](#Negative) Otherwise, just do it.)

**Future Value Practice Problems:**

1. How much is $350.00 worth in 5 years if the interest rate is 9%?

N=5.00

I%=9.00

PV=-350.00

PMT=0.00

FV=538.52 *(answer)*

P/Y=1.00

C/Y=1.00

PMT:END BEGIN

1. How much is $400.00 worth in 15 years if the interest rate is 11%?

N=15.00

I%=11.00

PV=-400.00

PMT=0.00

FV=1913.84 *(answer)*

P/Y=1.00

C/Y=1.00

PMT:END BEGIN

1. How much is $1.00 worth in 100 years if the interest rate is 15%?

N=100.00

I%=15.00

PV=-1.00

PMT=0.00

FV=1174313.45 *(answer)*

P/Y=1.00

C/Y=1.00

PMT:END BEGIN

**Application 6: tvm\_FV**

You can also use Application 6 to find the future value. The format for this application is:[[6]](#footnote-6)

tvm\_FV(I%,N,PV,PMT, P/Y,C/Y)

Problem: How much do you have after 7 years if you deposit $500 today and the interest rate is 10%?

N = 7 I% = 10 PV = 500

Press [APPS] [ENTER] ‘6’. Your screen should look like this:

tvm\_FV

Enter the variables for the equation using the format above:

tvm\_FV(10,7,-500,0,1,1)

Press [ENTER]. Your screen should look like this:

tvm\_FV(10,7,-500,0,1,1)

983.58

In 7 years, your bank account will have $983.58.

🢂 Note that the rules for negative values are the same for this application as for the TVM Solver.

**Present Value Problems**

I might also ask the reverse question: How much must you deposit today to have $100.00 in a bank account 5 years from now, if you earn 5% per year and make no additional deposits?

In this timeline, X is the amount I need to deposit today:

**0 1 2 3 4 5**

**Today**

**Time**

**100**

**X**

This is a **present value** problem because I am asking the present (or current) value of a single dollar amount at some time in the future. The process of going from the future value back to the present value is called **discounting**. A present value problem typically has one of the two general patterns:

How much *present value (PV)* must you deposit today to have the *future**value (FV)* after *N years* if you get an *interest rate* of *I%* per year?

What is the *present value (PV)* today of the *future value (FV)* in *N years* if you get an *interest rate* of *I%* per year?

These are actually identical questions–only the phrasing is different. In both you must find the present value of money coming in the future (given N and I%).

**Present Value on your Calculator:** How much is $200 received in 4 years worth now, if the interest rate is 12%?

N = 4 I% = 12 FV = 200

Enter the appropriate values (remembering to press [ENTER] after each), move the cursor to the PV line, and then press [ALPHA] [ENTER]. Your screen should look like this:

N=4.00

I%=12.00

PV=127.10 *(answer)*

PMT=0.00

FV=-200.00

P/Y=1.00

C/Y=1.00

PMT:END BEGIN

The value today is $127.10. Or, using different phrasing, you need to put $127.10 in the bank to have $200.00 in four years.

🢂 Here the future value must be entered as a negative value. (If you want to know why, see [Why Enter Negative Values?](#Negative) Otherwise, just do it.).

**Present Value Practice Problems:**

1. How much is $350.00 received in 5 years worth if the interest rate is 9%?

N=5.00

I%=9.00

PV=227.48 *(answer)*

PMT=0.00

FV=-350.00

P/Y=1.00

C/Y=1.00

PMT:END BEGIN

1. How much is $400.00 received in 15 years worth if the interest rate is 11%?

N=15.00

I%=11.00

PV=83.60 *(answer)*

PMT=0.00

FV=-400.00

P/Y=1.00

C/Y=1.00

PMT:END BEGIN

1. How much is $1,000,000 received in 100 years worth if the interest rate is 15%?

N=100.00

I%=15.00

PV=0.85

PMT=0.00 *(answer)*

FV=-1000000.00

P/Y=1.00

C/Y=1.00

PMT:END BEGIN

**Application 4: tvm\_PV**

You can also use Application 4 to find the present value. The format for this application is:

tvm\_PV(I%,N,PMT, FV,P/Y,C/Y)

Problem: What is the present value of $500 coming in year 11 if the rate is 5%?

N = 11 I% = 5 PV = 500

Press [APPS] [ENTER] ‘4’. Your screen should look like this:

tvm\_PV

Enter the variables for the equation using the format above:

tvm\_PV(5,7,0,-500,1,1)

Press [ENTER]. Your screen should look like this:

tvm\_PV(5,7,0,-500,1,1)

356.49

The present value is $356.49.

🢂 Note that the rules for negative values are the same for this application as for the TVM Solver.

*Now go practice!*

**Chapter 3–Single Dollar Problems: Time and Interest Rate**

In the last Chapter you were introduced to present and future value problems. These problems have four variables:

* Present Value (PV)
* Future Value (FV)
* Interest Rate (I%)
* Years (N)[[7]](#footnote-7)

If you are given any three of these variables, you can use your graphing calculator to find the fourth (unknown) value. In Chapter 2, we did problems in which FV or PV was the unknown; in this Chapter we will do problems in which I% or N is the unknown. The good news is that the calculator works the same for these new problems: put in three of the numbers and it will give you the fourth. The two new types of problems are interest rate and time problems.

**Interest Rate Problems**

Interest rate problems ask what interest rate is needed to meet a financial objective and often have the general pattern:

What *I% interest rate* do you need, If you want the *present value (PV)* to grow into the *future value (FV)* in *N years*?

**Interest Rate Problems on your Calculator**:

You want to buy a $30,000 car in 4 years. If you have $20,000 today, what interest rate do you need? What is I%?

N = 4 PV = 20,000 FV = 30,000

Enter the appropriate values (remembering to press [ENTER] after each), move the cursor to the I% line, and then press [ALPHA] [ENTER]. Your screen should look like this:

N=4.00

I%=10.67 *(answer)*

PV=-20000.00

PMT=0.00

FV=30000.00

P/Y=1.00

C/Y=1.00

PMT:END BEGIN

You would need to get a return, i.e., an interest rate, of 10.67%.

🢂 Here either the future or present value must be entered as a negative value–but not both. It does not matter which one you make negative, but you will get a wrong answer or error should you make both or neither negative. (If you want to know why, see [Why Enter Negative Values?](#Negative) Otherwise, just do it.).

**Interest Rate Practice Problem:**

You now have $30.00 in an account in which 6 years ago you put $25.00. What interest rate have you been receiving?

N=6.00

I%=3.09 *(answer)*

PV=-25.00

PMT=0.00

FV=30.00

P/Y=1.00

C/Y=1.00

PMT:END BEGIN

You have been receiving an interest rate of 3.09%.

**Application 3: tvm\_I%**

You can also use Application 3 to find the interest rate. The format for this application is:

tvm\_I%(N,PV,PMT, FV,P/Y,C/Y)

Problem: What interest rate do you need for $200 to grow to $300 in 2 years?

N = 2 PV = 200 FV=300

Press [APPS] [ENTER] ‘3’. Your screen should look like this:

tvm\_I%

Enter the variables for the equation using the format above:

tvm\_I%(2,200,0,-300,1,1)

Press [ENTER]. Your screen should look like this:

tvm\_I%(2,200,0,-300,1,1)

22.47

You would need an interest rate of 22.47%.

🢂 Note that the rules for negative values are the same for this application as for the TVM Solver.

**Time Problems**

Time problems ask how long it will take to meet a financial objective and often have the following general pattern:

How many *N years* will it take the *present value (PV)* to grow into the*future value (FV)* if you get an *I% interest rate*?

**Time Problems on your Calculator**:

You want to buy a $30,000 car. If you have $20,000 today and can get an interest rate of 12%, how long must you wait, i.e., what is N?

I% = 12 PV = 20,000 FV = 30,000

Enter the appropriate values (remembering to press [ENTER] after each), move the cursor to the N line, and then press [ALPHA] [ENTER]. Your screen should look like this:

N=3.58 *(answer)*

I%=12.00

PV=-20000.00

PMT=0.00

FV=30000.00

P/Y=1.00

C/Y=1.00

PMT:END BEGIN

You would need to wait 3.58 years.

In time problems you can change the fraction of a year (here 0.58) into the approximate number of months. Multiply it by 12 (since there are 12 months in a year):

12 × 0.58 = 6.96 ≈ 7

You would need to wait 3 years 7 months.

🢂 Here either the future or present value must be entered as a negative value–but not both. It does not matter which one you make negative, but you will get a wrong answer or error should you make both or neither negative. (If you want to know why, see [Why Enter Negative Values?](#Negative) Otherwise, just do it.).

**Time Practice Problem:**

Your account grew from $50,000 to $75,000 with an interest rate of 10%. How long did you have the account?

N=4.25 *(answer)*

I%=10.00

PV=-50000

PMT=0.00

FV=75000

P/Y=1.00

C/Y=1.00

PMT:END BEGIN

You have had the account for 4.25 years, or 4 years 3 months.

**Application 5: tvm\_N**

You can also use Application 5 to find the number of periods. The format for this application is:

tvm\_N(I%,PV,PMT, FV,P/Y,C/Y)

Problem: How long does it take $100 to grow to $500 is the interest rate is 15%?

I% = 15 PV = 100 FV=500

Press [APPS] [ENTER] ‘5’. Your screen should look like this:

tvm\_N

Enter the variables for the equation using the format above:

tvm\_N(15,100,0,-500,1,1)

Press [ENTER]. Your screen should look like this:

tvm\_N(15,100,0,-500,1,1)

11.52

You would need 11.52 years, or 11 years 6 months.

🢂 Note that the rules for negative values are the same for this application as for the TVM Solver.

**Why Enter Negative Values?**

Why do you need to make some of the dollar values negative? Take the simplest problem: How much do we have after 1 year if you deposit PV and the interest rate is 10%?

You would set up and solve the following problem:

FV = PV × 1.10

Your calculator, however, sets up the same problem in a different way. It moves the FV to the other side of the equal sign and solves:

FV + PV × 1.10 = 0

Obviously, the problem is insoluble with FV and PV either both positive or both negative. If you don’t enter the present value as negative, the answer will have the wrong sign, i.e., you would get FV as a negative. In interest rate and time problems, you will get an error message (not just a sign change), if you do not enter one and only one dollar value as negative.

An alternate way to thing about this is to regard cash flows in different directions as having different signs. I put the PV *into* the investment and get the FV *out of* the investment. Therefore, PV and FV have different signs. Later we will do problems that have three dollar value inputs, but the same principle will apply: *all cash flows in one direction have a different sign than cash flows in the other direction*.

**Chapter 4–Mixed Cash Flows**

While some financial problems involve single dollar problems, many more have multiple cash flows over time: stocks pay a stream of dividends, debt a stream of interest payments. How much is it worth, i.e., what is the present value, to receive a certain sum next year than a sum the year after, etc. If these amounts are the same every year, this is an *annuity*–the subject of Chapter @. If, however, they are different amounts, then you have a *mixed cash flow*. An example of a mixed cash flow would be:[[8]](#footnote-8)

|  |  |  |
| --- | --- | --- |
| **Year 1** | **Year 2** | **Year 3** |
| $100.00 | -$150.00 | $200.00 |

By the principle of *additivity*, we could break this up into three separate, single dollar problems. We could then find the present value of each and add the three present values to find the present value of the entire mixed cash flow. Happily, your graphing calculator has an application that allows us to find the present value of a mixed cash flow.

Return to the main financial applications screen by pressing [APPS] [ENTER]. You should see the screen below:

CALC VARS

1: TVM Solver...

2: tvm\_Pmt

3: tvm\_I%

4: tvm\_PV

5: tvm\_N

6: tvm\_FV

7↓npv(

For mixed cash flows we will be using the NPV application (Application 7). ‘NPV’ stands for ‘Net Present Value’. We will be using the NPV application, but we will *not* be calculating the net present value–that calculation will come in Chapter @. The format for this application is:[[9]](#footnote-9)

npv(rate,CF0,{CF1,CF2,CF3...},{Freq1,Freq2,Freq3...})

**Frequencies**

If your cash flows contain ‘runs’ of the same number, you might want to use frequency lists to indicate this–though this is entirely optional and any problem can be calculated without the use of frequency lists. A frequency list is a list of the number of time each cash flow occurs. If you had the following cash flows, you could either list them all individually in the application or use frequencies lists (assume the interest rate is 5% and CF0 = 0).

|  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- |
| **Year** | 1 | 2 | 3 | 4 | 5 | 6 |
| **Cash Flow** | 100 | 100 | 200 | 200 | 200 | 300 |

*Individually*, we would use the following input–omitting frequencies altogether, since they are optional:

npv(5,0,{100,100,200,200,200,300})

*Using a frequency list*, we would use the alternate input:

npv(5,0,{100,200,300},{2,3,1})

The frequency list indicates that the first cash flow ($100) occurs 2 times, the second cash flow ($200) occurs 3 times and the last cash flow ($300) only 1 time.

**Returning to the calculation of mixed cash flows...**

Entering the frequencies list is optional, so without using a frequency list the format is:

npv(rate,CF0,{CF1,CF2,CF3...})

Problem: Given a project generates the following cash flows and the appropriate discount rate is 7%, what is the project’s present value?

|  |  |  |  |
| --- | --- | --- | --- |
| **Year** | 1 | 2 | 3 |
| **Cash Flow** | 500 | -200 | 800 |

Rate = 7 CF0 = 0[[10]](#footnote-10) CF1 = 500 CF2 = -200 CF3 = 800

Press [APPS] [ENTER] ‘7’. Your screen should look like this:

npv(

Enter the variables for the equation using the format above:

npv(7,0,{500,-200,800})

Press [ENTER]. Your screen should look like this:

npv(7,0,{500,-200,800})

-54.36

The present value is $945.64.

🢂 Be very careful to enter the format correctly. Do not omit any commas and do not substitute parentheses ‘( )’ or brackets ‘[ ]’ for the braces ‘{ }’.

🢂 Remember we are using the npv application to find the present value of a mixed cash flow, *not* the net present value (npv)

**Chapter 5–Annuities: Future and Present Value**

An *annuity* is a finite series of constant payments occurring at regular intervals. For example, I promise to pay you $10 every year for the next 25 years. There are three crucial features of any annuity:

* It is a *finite* series: it does not go on forever. There is a final payment; in the example, the last payment will be made in year 25.
* The payments are *level*: every payment is the same amount, e.g., $10.
* The payments come at *regular intervals*: yearly, monthly, weekly, etc. In our example, the payments come every year.

An annuity is the typical way we save money: if I want to go on vacation, I would save $100 per week for a year, and this is an annuity. Timing like this is far more plausible than the earlier savings behavior when we put all the money in an investment today and just wait for it to grow. To have $1,000,000 at your retirement in 50 years (at 3% interest), you would need to deposit $228,107.08 today. I don’t think that is a very practical way for you to fund your retirement–unless, of course, you just happen to have an extra $228,107.08 under your mattress. You are far more likely to save a certain amount every pay period for many, many years; that is, your savings behavior is likely an annuity.

**Future Value Annuity Problems**

Saving money at regular intervals is a *future value annuity problem*, because I want to know how much I will have *in the future* if I save $100 per week for a year. For the moment we will only consider annuities that are annual; in Chapter @ we will do problems in which we save weekly or monthly. Also, we shall begin with regular annuities (also known as annuities in arrears) in which the first payment beings next period, so my example would be more explicit if I promised to pay you $10 every year for the next 25 years beginning next year.[[11]](#footnote-11)

The timeline for a future value annuity looks like this:

**0 1 2 3 4 5**

**Today**

**Time**

**100*0***

**100**

**100**

**100**

**100**

To do annuities, we are going to need a new variable on our calculators, so we can enter the amount of the level payment. Appropriately, this variable is labeled PMT which stands for payment.

Future value annuity problems often have the following general pattern:

How much *future value (FV)* will you have, if you make *payments (PMT)* for *N years* and get *I% interest rate* per year?

🢂 Observe that you do not see present value mentioned in this question.[[12]](#footnote-12)

**Future Value Annuity Problems on your Calculator**: The mechanics of doing these on a calculator is simple, since you are just entering a value for PMT, instead of one for PV.

How much do you have after 3 years if you save $200 per year beginning next year and the interest rate is 12%?

N = 3 I% = 12 PMT = 200

Enter the appropriate values (remembering to press [ENTER] after each), move the cursor to the FV line, and then press [ALPHA] [ENTER]. Your screen should look like this:

N=3.00

I%=12.00

PV=0.00

PMT=-200.00

FV=674.88 *(answer)*

P/Y=1.00

C/Y=1.00

PMT:END BEGIN

In 3 years, your account will have $674.88.

🢂 As in earlier problems, there is one dollar input (PMT) and we made it negative.

🢂 We do not enter anything for the present value, so the present value remains at its default value of 0.

**Future Value Annuity Practice Problems:**

1. How much will you have if you save $100.00 per year for 25 years at 8%?

N=25.00

I%=8.00

PV=0.00

PMT=-100.00

FV=7310.59 *(answer)*

P/Y=1.00

C/Y=1.00

PMT:END BEGIN

1. How much will you have if you save $1000.00 per year for 5 years at 7%?

N=5.00

I%=7.00

PV=0.00

PMT=-1000.00

FV=5750.74 *(answer)*

P/Y=1.00

C/Y=1.00

PMT:END BEGIN

1. How much will you have if you save $1.00 per year for 50 years at 10%?

N=50.00

I%=10.00

PV=0.00

PMT=-1.00

FV=1163.91 *(answer)*

P/Y=1.00

C/Y=1.00

PMT:END BEGIN

You may also use Application 6 to do this, see @@@.

**Present Value Annuity Problems**

Present value annuity problems are easy to calculate, but hard to understand at a more abstract level. Instead of asking how much a regular series of payments will be worth in the future, we are now asking how much a regular series of payments will be worth *today*. Think of this as a borrowing problem: how much could I borrow if I promised to make a series of regular payments into the future. For example, how much would a bank lend me if I promised to pay $200 per year for 3 years and the interest rate was 12%?

*Future**value* annuity problems are often *savings/investing* problems.

*Present**value* annuity problems are often *borrowing* problems.

Present value annuity problems often have the following general pattern:

How much *present value (PV)* can you borrow, if you make *payments (PMT)* for *N years* and get *I% interest rate* per year?

**Present Value Annuity Problems on your Calculator**: You are now entering a value for PMT, instead of one for FV.

How much could you borrow if you promised to pay $200 per year for 3 years and the interest rate was 12%?

N = 3 I% = 12 PMT = 200

Enter the appropriate values (remembering to press [ENTER] after each), move the cursor to the PV line, and then press [ALPHA] [ENTER]. Your screen should look like this:

N=3.00

I%=12.00

PV=480.37 *(answer)*

PMT=-200.00

FV=0.00

P/Y=1.00

C/Y=1.00

PMT:END BEGIN

You will be able to borrow $480.37.

🢂 As in earlier problems, there is one dollar input (PMT) and we made it negative.

🢂 We do not enter anything for the future value, so the future value remains at its default value of 0.

**Present Value Annuity Practice Problems:**

1. What is the present value of $100.00 per year for 25 years at 8%?

N=25.00

I%=8.00

PV=1067.48 *(answer)*

PMT=-100.00

FV=0.00

P/Y=1.00

C/Y=1.00

PMT:END BEGIN

1. What is the present value of $1000.00 per year for 5 years at 7%?

N=5.00

I%=7.00

PV=4100.20 *(answer)*

PMT=-1000.00

FV=0.00

P/Y=1.00

C/Y=1.00

PMT:END BEGIN

1. What is the present value of $1.00 per year for 50 years at 10%?

N=50.00

I%=10.00

PV=9.91 *(answer)*

PMT=-1.00

FV=0.00

P/Y=1.00

C/Y=1.00

PMT:END BEGIN

🢂 The main difficulty in doing any annuity problem is figuring out whether it is a future value or a present value problem. Practice determining this and the calculation will be simple.

You may also use Application 4 to do this, see @@@.

**Annuities Due**

All the annuities that we have now considered are regular annuities, or more formally annuities in arrears. In each we assumed that the first payment came *next* period. *Annuities due* are annuities in which the first payment is immediate. Annuities due are otherwise identical to regular annuities. They can be either present or future value annuities, and all the problems posed in the next chapter of regular annuities can also be posed of annuities due. Once you have mastered the calculation of regular annuities, annuities due are fortunately extremely easy: you need only change the PMT: END BEGIN line from END to BEGIN.

How much do you have after 3 years if you save $200 per year beginning *today* and the interest rate is 12%?

N = 3 I% = 12 PMT = 200 PMT: BEGIN

Enter the appropriate values (remembering to press [ENTER] after each), move the cursor to the FV line, and then press [ALPHA] [ENTER]. Your screen should look like this:

N=3.00

I%=12.00

PV=0.00

PMT=-200.00

FV=$755.87 *(answer)*

P/Y=1.00

C/Y=1.00

PMT:END BEGIN

In 3 years, your account will have$755.87.

**Chapter 6–Annuities: Interest Rate, Time and Payment**

Just as we did in Chapter @@@ for single dollar problems, in the case of annuities, we can also ask (besides PV and FV questions):

*What is the interest rate (I%)?* (Interest Rate Annuity Problem)

*How long will it take (N)?* (Time Annuity Problem)

But with annuities we can also ask:

*How much are my payments (PMT)?* (Payment Annuity Problem)

Unfortunately, I can ask each of these three questions with respect to *both* future value annuity problems *and* present value annuity problems. This means that before you can start calculating interest rate, time, or payment annuity problems, you still need to determine whether it is a future value or present value annuity problem.

🢂 This is complicated, so I organize the steps into a decision [flow chart](#Flowchart) a bit later.

For now, a set of examples should help:

This is the time question applied to a *future value* annuity problem (a savings problem):

If I save *payment (PMT)* every year, how many *N years* will it take to save the *future value (PV)* if I get an *I% interest rate*?

While this is the time question applied to a *present value* annuity problem (a borrowing problem):

If I make a *payment (PMT)* every year on a loan, how many *N years* will it take me to pay back a loan of *present value (PV)* if I have an *I% interest rate*?

🢂 Before anything else, determine whether an annuity is a future value or present value problem. You will get an opportunity to practice this skill doing the graphing calculator problems assigned in various topics.

**Interest Rate Annuity Problems**

Interest rate annuity problems ask you to find the interest rate to achieve a financial objective: For example, what interest rate do you need to have $2,000 in 3 years if you save $600 per year?

*First, is this a future value or present value annuity problem?* Look for key phrases in the problem: ‘save per year’ implies a savings problem and ‘in 3 years’ points to the future, so both suggest it is a future value annuity problem.

*Second, what result is the problem seeking? Which variable is unknown?* It is asking for the interest rate.

N = 3 PMT = 600 FV = 2000

Enter the appropriate values (remembering to press [ENTER] after each), move the cursor to the I% line, and then press [ALPHA] [ENTER]. Your screen should look like this:

N=3.00

I%=10.73 *(answer)*

PV=0.00

PMT=-600.00

FV=2000.00

P/Y=1.00

C/Y=1.00

PMT:END BEGIN

You need an interest rate of 10.73% to reach your goal.

🢂 Here either the future value or the payment must be entered as a negative value–but not both. It does not matter which one you make negative, but you will get a wrong answer or error should you make both or neither negative. (If you want to know why, see [Why Enter Negative Values?](#Negative) Otherwise, just do it.).

You may also use Application 3 to do this, see @@@.

**Time Annuity Problems**

Time annuity problems ask you hoe long it will take to achieve a financial objective: For example, how long do you have to save $600 per year to get $2,000 if the interest rate is 5%?

*First, is this a future value or present value annuity problem?* Look for key phrases in the problem: ‘save per year’ implies a savings problem, so it is a future value annuity problem.

*Second, what result is the problem seeking? Which variable is unknown?* It is asking for the time.

I% = 5 PMT = 600 FV = 2000

Enter the appropriate values (remembering to press [ENTER] after each), move the cursor to the N line, and then press [ALPHA] [ENTER]. Your screen should look like this:

N=3.16 *(answer)*

I%=5.00

PV=0.00

PMT=-600.00

FV=2000.00

P/Y=1.00

C/Y=1.00

PMT:END BEGIN

You would need to save for 3.16 years, or 3 years 2 months.

🢂 Here either the future value or the payment must be entered as a negative value–but not both. It does not matter which one you make negative, but you will get a wrong answer or error should you make both or neither negative. (If you want to know why, see [Why Enter Negative Values?](#Negative) Otherwise, just do it.).

You may also use Application 5 to do this, see @@@.

**Payment Annuity Problems**

Payment annuity problems ask you to find the constant payment that achieves a financial objective. The payment might be the amount you need to save or the amount to repay a loan, depending on whether it is a future value or present value annuity problem.

For example, how much do you have to save per year to have $2,000 in 3 years if the interest rate is 12%?

*First, is this a future value or present value annuity problem?* Look for key phrases in the problem: ‘save per year’ implies a savings problem and ‘in 3 years’ points to the future, so both suggest it is a future value annuity problem.

*Second, what result is the problem seeking? Which variable is unknown? ‘*how much do you have to save per year’ is asking for the payment (PMT) variable.

N = 3 I% = 12 FV = 2000

Enter the appropriate values (remembering to press [ENTER] after each), move the cursor to the PMT line, and then press [ALPHA] [ENTER]. Your screen should look like this:

N=3.00

I%=12.00

PV=0.00

PMT=592.70 *(answer)*

FV=-2000.00

P/Y=1.00

C/Y=1.00

PMT:END BEGIN

You would need to make payments of $592.70.

🢂 Here the future value must be entered as a negative value.

**Application 2: tvm\_Pmt**

You can also use Application 2 to find the number of periods. The format for this application is:

tvm\_Pmt(N,I%,PV, FV,P/Y,C/Y)

Problem: What are the payments on a 5 year loan of $25,000 if the loan carries an interest rate of 8%?

N = 5 I% = 8 PV = 25,000

Press [APPS] [ENTER] ‘2’. Your screen should look like this:

tvm\_Pmt

Enter the variables for the equation using the format above:

tvm\_Pmt(5,8,-25000,0,1,1)

Press [ENTER]. Your screen should look like this:

tvm\_Pmt(5,8,-25000,0,1,1)

6261.41

Your payments would be $6261.41.

🢂 Note that the rules for negative values are the same for this application as for the TVM Solver.

**Decision Flowchart for Time Value of Money Problems**

This flowchart should help you organize your approach to solving time value of money problems. Start at ‘Problem’ and work your way down the chart until you have identified the type of problem.

*Problem Types*: Single Dollar, Mixed Cash Flow, Future Value Annuity, Present Value Annuity, Perpetuity[[13]](#footnote-13)

Step 1: Is it a one time cash flow or a multiple cash flow problem?

Step 2: If it is a one time cash flow, it is a *single dollar problem*. **DONE**

If it is a multiple cash flow problem, are all the payments the same or different?

Step 3: If all the payments are the same, are they finite or infinite?

If the payments the different, it is a *mixed cash flow*. **DONE**

Step 4: If all the payments are the same and infinite, it is a *perpetuity*. **DONE**

If all the payments are the same and finite, it is an annuity–but is it like a savings problem or like a borrowing problem?

Step 5: If it is like a savings problem, it is *future value annuity*. **DONE**

If it is like a borrowing problem, it is *present value annuity*. **DONE**

🢂 Once you have some experience with your graphing calculator, your main task will be to figure out the type of question being asked. Calculating is the easy part!

**Chapter 7–Non-Annual Compounding and Discounting**

While saving annually for the down payment on a home is better than having to put the present value in the bank today, most likely we will save for things monthly, biweekly or weekly depending on the frequency of our paycheck. So far every financial problem has used one year as the basic unit, so we now need to adjust our calculators so that we can do non-annual calculations. This is to change the value for *payments per year* (P/Y). To make this change, move the cursor to the P/Y line, enter the correct number, and press [ENTER]. Note that the C/Y line will automatically change to the same number. The number you enter is the number of payment periods in a calendar year, for example:

Semi-Annual 2

Quarter 4

Month 12

Week 52

Before you try a problem, you need one other change. The N key stands for ‘Number’. But it is the number of *periods* (or payments), not the number of years that must be entered. When you are doing annual problems, as we have, these are the same, but not in non-annual problems. For example:

A monthly annuity for two years has 24 periods: 2 × 12 = 24

A weekly annuity for one year has 52 periods: 1 × 52 = 52

A quarterly annuity for 4 years has 16 periods: 4 × 4 = 16

How much do you have after 3 years if you save $200 *per month* beginning next month and the interest rate is 12%?

N = 3 × 12 = 36 I% = 12 PMT = -200 P/Y = 12

Determine that this is a *future value annuity problem*. Enter the appropriate values (remembering to press [ENTER] after each) [[14]](#footnote-14), move the cursor to the FV line, and then press [ALPHA] [ENTER]. Your screen should look like this:

N=36.00

I%=12.00

PV=0.00

PMT=-200.70

FV=8615.38 *(answer)*

P/Y=12.00

C/Y=12.00

PMT:END BEGIN

You will have $8,615.38.

**Non-Annual Practice Problems:**

1. How much will you have if you save $100.00 per month for 25 years at 8%?
2. Determine that this is a *future value annuity problem*, because it involves saving.
3. Determine P/Y is 12 (since the payments are ‘per month’).
4. Calculate number of periods: 25 years × 12 months = 300 periods.

Enter the appropriate values (remembering to press [ENTER] after each), move the cursor to the FV line, and then press [ALPHA] [ENTER]. Your screen should look like this:

N=300.00

I%=8.00

PV=0.00

PMT=-100.00

FV=95102.64 *(answer)*

P/Y=12.00

C/Y=12.00

PMT:END BEGIN

1. How much can you borrow if you pay $50.00 per week for 5 years at 7%?
2. Determine that this is a *present value annuity problem*, because it involves borrowing.
3. Set P/R to 52 (since the payments are ‘per week’).
4. Calculate number of periods: 5 years × 52 weeks = 260 periods.

Enter the appropriate values (remembering to press [ENTER] after each), move the cursor to the PV line, and then press [ALPHA] [ENTER]. Your screen should look like this:

N=260.00

I%=7.00

PV=10962.57 *(answer)*

PMT=-50.00

FV=0.00

P/Y=52.00

C/Y=52.00

PMT:END BEGIN

1. How much do you need to save per month to have $10,000 in 5 years at 10%?
2. Determine that this is a *future value annuity problem*, because it involves saving.
3. Set P/R to 12 (since the payments are ‘per month’).
4. Calculate number of periods: 5 years × 12 months = 60 periods.

Enter the appropriate values (remembering to press [ENTER] after each), move the cursor to the PV line, and then press [ALPHA] [ENTER]. Your screen should look like this:

N=60.00

I%=10.00

PV=0.00

PMT=129.14 *(answer)*

FV=-10000

P/Y=12.00

C/Y=12.00

PMT:END BEGIN

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
| **60** | **10** |  | **129.14** | **-10000** |

If you are having trouble with step 1, use the [flowchart](#Flowchart) link and practice.

🢂 A Suggestion: Before for every new calculation always check payment periods per year (P/Y) for the new problem. This precaution will ensure that incorrect variables from your last calculation do not cause an error in any new calculation.

**Chapter 8–Interest Rates**

You can use your calculator to convert between nominal and effective interest rate and vice versa.

**Effective to Nominal Interest Rate**

You use Application B to find the nominal rate from the effective rate. The format for this application is:

►Nom(effective rate,compounding periods)

Problem: If my efficient rate is 10% and compounding is quarterly, what is the corresponding nominal rate.

Efficient Rate = 10% Compounding Periods = 4

Press [APPS] [ENTER] scroll down to Application B and press [ENTER]. Your screen should look like this:

►Nom(

Enter the variables for the equation using the format above:

►Nom(10,4)

Press [ENTER]. Your screen should look like this:

►Nom(10,4)

9.65

The corresponding nominal rate is 9.65%.

**Nominal to Effective Interest Rate**

You use Application C to find the effective rate from the nominal rate. The format for this application is:

►NEff(nominal rate,compounding periods)

Problem: If my nominal rate is 15% and compounding is monthly, what is the corresponding efficient rate.

Nominal Rate = 15% Compounding Periods = 12

Press [APPS] [ENTER] scroll down to Application C and press [ENTER]. Your screen should look like this:

►Eff(

Enter the variables for the equation using the format above:

►Eff(15,12)

Press [ENTER]. Your screen should look like this:

►Eff(10,4)

16.08

The corresponding effective rate is 916.08%.

**Chapter 9–Bonds**

The cash flows from a bond can be distinguished into the coupon payments and the repayment of principal. The former constitute an annuity and the latter a single dollar payment. We could thus value a bond by finding the present value of the annuity comprised of the coupon payment and adding it to the present value of the single dollar principal. Fortunately, it is even easier than this, since we can use the TVM Solver (or the other individual applications) to do it in one calculation.

**Price (Present Value) of a Bond**

Problem: What is the price of a ten year semi-annual bond that has a coupon rate of 8% and a face value/principal of $1,000 if the appropriate interest rate is 10%?

Since this a semi-annual bond, P/Y = 2 and N = 10 × 2 = 20.

Since the coupon rate is 8% and the face value $1,000, the annual coupon is 0.08 × 1,000 = $80. But this is a semi-annual bond, so each semi-annual payment is $40.

N = 20 I% = 10 PMT = $40 FV = $1000 P/Y = 2

Enter the appropriate values into the TVM Solver, move the cursor to the PV line, and then press [ALPHA] [ENTER]. Your screen should look like this:

N=20.00

I%=10.00

PV=875.38 *(answer)*

PMT=-40.00

FV=-1000.00

P/Y=2.00

C/Y=2.00

PMT:END BEGIN

The bond is worth $875.38.

🢂 Note that we make both the payment and future value negative. When you purchase a bond you pay the price/present value (one direction) and receive the coupon/payments and principal/future value (the other direction). Present value is going in one direction and payments and future value the other, so the present value should have the sign opposite *both* the payment *and* the future value.

**Yield to Maturity (YTM) of a Bond**

The yield to maturity (YTM) is the expected return on a bond that is I% (given the price of the bond.

Problem: What is the TYM of a ten year semi-annual bond that has a coupon rate of 8% and a face value/principal of $1,000 if its price is $900?

Since this a semi-annual bond, P/Y = 2 and N = 10 × 2 = 20.

Since the coupon rate is 8% and the face value $1,000, the annual coupon is 0.08 × 1,000 = $80. But this is a semi-annual bond, so each semi-annual payment is $40.

N = 20 I% = 10 PMT = $40 FV = $1000 P/Y = 2

Enter the appropriate values into the TVM Solver, move the cursor to the I% line, and then press [ALPHA] [ENTER]. Your screen should look like this:

N=20.00

I%=9.58 *(answer)*

PV=900

PMT=-40.00

FV=-1000.00

P/Y=2.00

C/Y=2.00

PMT:END BEGIN

The yield to maturity of the bond is 9.58%.

🢂 Note that we make both the payment and future value negative, but the present value positive. When you purchase a bond you pay the price/present value (one direction) and receive the coupon/payments and principal/future value (the other direction). Present value is going in one direction and payments and future value the other, so the present value should have the sign opposite *both* the payment *and* the future value.

**Chapter 10–Amortization**

Amortization is the distribution of loan payments into multiple cash flows, as determined by an amortization schedule. Each repayment installment is the same amount and consists of both principal and interest. A greater amount of the payment is applied to interest at the beginning of the amortization schedule, while more money is applied to principal at the end.

A graph of an amortization schedule for a home loan follows:



A very simple amortization schedule would be:

Year

1

2

3

End Bal.

691.97

359.29

0

Principal

308.03

332.68

359.29

Interest

80.00

55.36

28.74

Payment

388.03

388.03

388.03

Begin Bal.

1,000

691.97

359.29

Your calculator allows you to find the following value in an amortization schedule

• The balance in any period

• The principle repayment in any period

• The interest payment in any period

**Chapter 11–Net Present Value (NPV)**

Net present value (NPV) is the present value of a series of cash flows net of there cost, i.e., the investment required to obtain the cash flows. It is most typically used (in capital budgeting) to evaluate potential projects to be undertaken by the firm. We have already used this function to find the present value of mixed cash flows in Chapter link, so you should review that section on the construction of cash flow streams using ‘frequencies’. You use Application 7 to find the NPV, and format for this application is:

npv(rate,CF0,{CF1,CF2,CF3...},{Freq1,Freq2,Freq3...})

Entering the frequencies list is optional, so without them the format is:

npv(rate,CF0,{CF1,CF2,CF3...})

Problem: Given a project generates the following cash flows, has a required investment of $1,000 and the appropriate discount rate is 7%, what is the project’s NPV?

|  |  |  |  |
| --- | --- | --- | --- |
| **Year** | 1 | 2 | 3 |
| **Cash Flow** | 500 | -200 | 800 |

Rate = 7 CF0 = 1,000 CF1 = 500 CF2 = -200 CF3 = 800

Press [APPS] [ENTER] ‘7’. Your screen should look like this:

npv(

Enter the variables for the equation using the format above:

npv(7,-1000,{500,-200,800})

Press [ENTER]. Your screen should look like this:

npv(7,-1000,{500,-200,800})

-54.36

The NPV is -$54.36.

🢂 Note that the investment must be entered as a negative.

🢂 Be very careful to enter the pattern correctly. Do not omit any commas and do not substitute parentheses ‘( )’ or brackets ‘[ ]’ for the braces ‘{ }’.

**Chapter 12–Internal Rate of Return (IRR)**

Intrenal rate of return (IRR) is the return on a series of cash flows given their cost/investment. Ore technically, IRR is the rate that makes NPV = 0. Before trying to calculate IRR, you may want to review that section on the construction of cash flow streams using ‘frequencies’ in Chapter link. You use Application 8 to find the IRR, and format for this application is:

irr(CF0,{CF1,CF2,CF3...},{Freq1,Freq2,Freq3...})

Entering the frequencies list is optional, so without them the format is:

irr(CF0,{CF1,CF2,CF3...})

Problem: Given a project generates the following cash flows and has a required investment of $1,000, what is the project’s IRR?

|  |  |  |  |
| --- | --- | --- | --- |
| **Year** | 1 | 2 | 3 |
| **Cash Flow** | 500 | -200 | 800 |

Rate = 7 CF0 = 1,000 CF1 = 500 CF2 = -200 CF3 = 800

Press [APPS] [ENTER] ‘8’. Your screen should look like this:

irr(

Enter the variables for the equation using the format above:

irr(-1000,{500,-200,800})

Press [ENTER]. Your screen should look like this:

irr(-1000,{500,-200,800})

4.33

The IRR is 4.33%.

🢂 Note that the investment must be entered as a negative.

🢂 Be very careful to enter the pattern correctly. Do not omit any commas and do not substitute parentheses ‘( )’ or brackets ‘[ ]’ for the braces ‘{ }’.

**Chapter 13–Application D: dbd**

This application allows you to find the number of days between any two dates. The format for this application is:

dbd(date1,date2)

The date variable may be either of the two formats:

MM.DDYY

DDMM.YY

Problem: How many days are there between October 23, 2002 and December 15, 2005?

date1 = 10.2302 date2: = 12.1505

Press [APPS] [ENTER] and scroll down to D: dbd(. Press [ENTER]. Your screen should look like this:

dbd(

Enter the variables for the equation using the format above:

dbd(10.2302,12.1505)

Press [ENTER]. Your screen should look like this:

dbd(10.2302,12.1505)

1149

There are 1,149 days between the two dates.

🢂 Allowable dates are between 1950 and 2049 inclusive.

**Abbreviations**

[ALPHA] ALPHA button

[APPS] Apps button

[ENTER] ENTER button

[MODE] MODE button

bal Balance (amortization)

BEGIN Beginning of period payment

C/Y Compounding periods per year

CF Cash flow (used in mixed cash flow, NPV and IRR calculations)

dbd Days between dates (Application D)

Eff Effective interest rate

END End of period payment

Freq Frequency (used in mixed cash flow, NPV and IRR calculations)

FV Future value

I% Interest Rate (Annual)

Int Interest (amortization)

irr Internal rate of return

N Number of periods

Nom Nominal interest rate

npv Net present value

P/Y Payment periods per year

Pmt Payment (annuity)

Prn Principle (amortization)

PV Present value

Rate Interest Rate

TVM, tvm Time value of money

TYM Yield to Maturity (of a bond)

**Index**

NOTES:

* Single dollar non-annual compounding and discounting
* Amortization
* Interest Rates
* Alter the flow chart
* I/WE/YOU consistency in text and examples
* CreateSpace for Physical Book
* Links

1. The [APPS] button is in the upper left above the [SIN] button and the [ENTER] button is in the lower right corner. [↑](#footnote-ref-1)
2. You can change the number of decimal points displayed by your calculator press the [MODE] button, scroll down to FLOAT, select the number of digits and press [ENTER]. [↑](#footnote-ref-2)
3. You will find out later why you need to input the present value in this problem as negative. The negative button is labeled ‘(-)’ and is located in the lower right corner. [↑](#footnote-ref-3)
4. The [ALPHA] button is turquoise and located in the upper left corner. [↑](#footnote-ref-4)
5. I use ‘*(answer)*’ to indicate the line containing the answer to the problem. It will not appear on your screen. [↑](#footnote-ref-5)
6. The buttons for the parentheses marks are above the 8 and 9 buttons, and the comma button is above the 7 button. [↑](#footnote-ref-6)
7. Actually, N means number of periods which, in the problems for the first few Chapters, is the same as number of years. [↑](#footnote-ref-7)
8. Note: the value in year two is negative, but we treat it like any a positive number [↑](#footnote-ref-8)
9. The buttons for braces ‘{ }’ are second functions under the parentheses buttons. [↑](#footnote-ref-9)
10. When finding the present value of mixed cash flows, always set CF0 = 0. We will set it to other values when we use this application to find the net present value in Chapter @. [↑](#footnote-ref-10)
11. Below we will value annuities due, i.e., annuities in which the first payment is immediate. Assume that unless stated otherwise or it is clear from the wording of a problem that an annuity is a regular annuity. [↑](#footnote-ref-11)
12. Although we will not cover this here, you would enter as the present value the amount you had already saved. [↑](#footnote-ref-12)
13. A *perpetuity* is like an annuity except the cash flow is infinite. I include it in the chart for completeness, but do not discuss it in the text, since there is no financial application for the calculation of perpetuities. See any introductory financial textbook for further information. [↑](#footnote-ref-13)
14. Remember that setting P/Y to 12 will automatically change C/Y to 12. [↑](#footnote-ref-14)