Chapter 5

MyFinanceLab Solutions

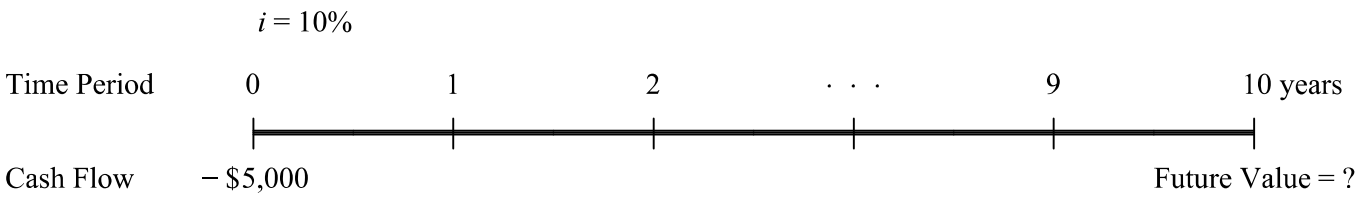
Problem 5-1

(Related to Checkpoint 5.2) (Future value) To what amount will $5,000 invested for 10 years at 10% compounded annually accumulate?

To what amount will $5,000 invested for 10 years at 10% compounded annually accumulate?

STEP 1: Picture the problem

We can set up a timeline to identify the cash flows from the investment as follows:



STEP 2: Decide on a solution strategy

This is a simple future value problem with a single cash flow. We know the present value, interest rate, and number of years; we are looking for the future value. We can find the future value using the mathematical formulas, a financial calculator, or an Excel spreadsheet.

STEP 3: Solve

Using the Mathematical Formulas.

Substitute $PV = \$5{,}000$, $i = 10\%$, and $n = 10$ years into the following equation to compute the future value:

$$\begin{pmatrix}\text{Future Value}\\ \text{in year } n\\ (FV_n)\end{pmatrix} = \begin{pmatrix}\text{Present}\\ \text{Value } (PV)\end{pmatrix}\left(1 + \begin{pmatrix}\text{Annual}\\ \text{Interest Rate } (i)\end{pmatrix}\right)^{\begin{matrix}\text{Number of}\\ \text{Years } (n)\end{matrix}}$$

$$FV_{10} = \$5{,}000(1 + 0.10)^{10}$$

Problem 5-1 (cont.)

$$= \$5{,}000(2.59374)$$

$$= \$12{,}968.71$$

At the end of 10 years, the investment will accumulate to the amount of $12,968.71.

Using a Financial Calculator.

Enter	10	10	− 5,000	0	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for					12,968.71

Using an Excel Spreadsheet.

= FV(rate,nper,pmt,pv) or with values entered = FV(0.10,10,0, − 5000)

STEP 4: Analyze

Notice that you input the present value with a negative sign because present value represents a cash outflow. In effect, the money leaves you when it is first invested. In this problem you invest $5,000 at 10% compound rate and found that it will grow to $12,968.71 after 10 years. Put another way, given a compound rate of 10%, your $5,000 today will be worth $12,968.71 in 10 years.

Problem 5-2

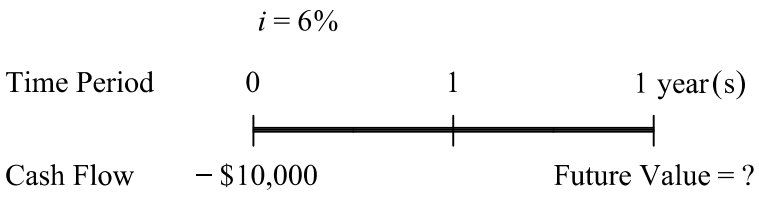
(Future value) Leslie Mosallam, who recently sold her Porsche, placed $10,000 in a savings account paying annual compound interest of 6%.

a. Calculate the amount of money that will accumulate if Leslie leaves the money in the bank for 1, 5, and 15 year(s).
b. Suppose Leslie moves her money into an account that pays 8% or one that pays 10%. Rework part (**a**) using 8% and 10%.
c. What conclusions can you draw about the relationship between interest rates, time, and future sums from the calculations you just did?

a. What is the amount of money that will accumulate if Leslie leaves the money in the bank for 1 year(s)?

STEP 1: Picture the problem

We can set up a timeline to identify the cash flows from the investment as follows:



STEP 2: Decide on a solution strategy

This is a simple future value problem with a single cash flow. We know the present value, interest rate, and number of years; we are looking for the future value. We can find the future value using the mathematical formulas, a financial calculator, or an Excel spreadsheet.

STEP 3: Solve

Using the Mathematical Formulas.

Substitute $PV = \$10{,}000$, $i = 6\%$, and $n = 1$ year(s) into the following equation to compute the future value:

Problem 5-2 (cont.)

$$\text{Future Value in year } n \ (FV_n) = \text{Present Value } (PV)\left(1 + \text{Annual Interest Rate } (i)\right)^{\text{Number of Years } (n)}$$

$$FV_1 = \$10{,}000(1 + 0.06)^1$$
$$= \$10{,}000(1.06000)$$
$$= \$10{,}600.00$$

At the end of 1 year(s), the investment will accumulate to the amount of $10,600.00.

Using a Financial Calculator.

Enter	1	6	− 10,000	0	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for					10,600.00

Using an Excel Spreadsheet.

= FV(rate,nper,pmt,pv) or with values entered = FV(0.06,1,0, − 10000)

STEP 4: Analyze

Notice that you input the present value with a negative sign because present value represents a cash outflow. In effect, the money leaves you when it is first invested. In this problem Leslie invests $10,000 at 6% and found that it will grow to $10,600.00 after 1 year(s). Put another way, given a compound rate of 6%, a(n) $10,000 investment today will be worth $10,600.00 in 1 year(s).

In order to calculate the accumulated value of the investment for 5 and 15 years, follow any of the alternative methods used above.

Problem 5-2 (cont.)

If Leslie leaves $10,000 in the bank account for 5 years at 6% compounded annually, the amount of money that will accumulate is computed as follows:

$$FV_5 = \$10{,}000(1 + 0.06)^5$$
$$= \$10{,}000(1.33823)$$
$$= \$13{,}382.26$$

If Leslie leaves $10,000 in the bank account for 15 years at 6% compounded annually, the amount of money that will accumulate is computed as follows:

$$FV_{15} = \$10{,}000(1 + 0.06)^{15}$$
$$= \$10{,}000(2.39656)$$
$$= \$23{,}965.58$$

b. Suppose Leslie moves her money into an account that pays 8% or one that pays 10%. Rework part (**a**) using the mathematical formulas, a financial calculator, or an Excel spreadsheet to calculate the accumulated value of the investment when the account pays either 8% or 10%.

Account paying 8 percent

If Leslie moves $10,000 into an account that pays 8% compounded annually for 1 year(s), the amount of money that will accumulate is computed as follows:

$$FV_1 = \$10{,}000(1 + 0.08)^1 = \$10{,}800.00$$

Thus, $10,000 invested for 1 year(s) at 8% compounded annually will accumulate to the amount of $10,800.00.

If Leslie moves $10,000 into an account that pays 8% compounded annually for 5 years, the amount of money that will accumulate is computed as follows:

$$FV_5 = \$10{,}000(1 + 0.08)^5 = \$14{,}693.28$$

Thus, $10,000 invested for 5 years at 8% compounded annually will accumulate to the amount of $14,693.28.

Problem 5-2 (cont.)

If Leslie moves $10,000 into an account that pays 8% compounded annually for 15 years, the amount of money that will accumulate is computed as follows:

$$FV_{15} = \$10{,}000(1 + 0.08)^{15} = \$31{,}721.69$$

Thus, $10,000 invested for 15 years at 8% compounded annually will accumulate to the amount of $31,721.69.

Account paying 10 percent

If Leslie moves $10,000 into an account that pays 10% compounded annually for 1 year(s), the amount of money that will accumulate is computed as follows:

$$FV_{1} = \$10{,}000(1 + 0.10)^{1} = \$11{,}000.00$$

Thus, $10,000 invested for 1 year(s) at 10% compounded annually will accumulate to the amount of $11,000.00.

If Leslie moves $10,000 into an account that pays 10% compounded annually for 5 years, the amount of money that will accumulate is computed as follows:

$$FV_{5} = \$10{,}000(1 + 0.10)^{5} = \$16{,}105.10$$

Thus, $10,000 invested for 5 years at 10% compounded annually will accumulate to the amount of $16,105.10.

If Leslie moves $10,000 into an account that pays 10% compounded annually for 15 years, the amount of money that will accumulate is computed as follows:

$$FV_{15} = \$10{,}000(1 + 0.10)^{15} = \$41{,}772.48$$

Thus, $10,000 invested for 15 years at 10% compounded annually will accumulate to the amount of $41,772.48.

c. What conclusions can you draw about the relationship between interest rates, time, and future sums from the calculations you just did?

There is a positive relationship between both the interest rate used to compound a present sum and the number of years for which the compounding continues and the future value of that sum.

Problem 5-3

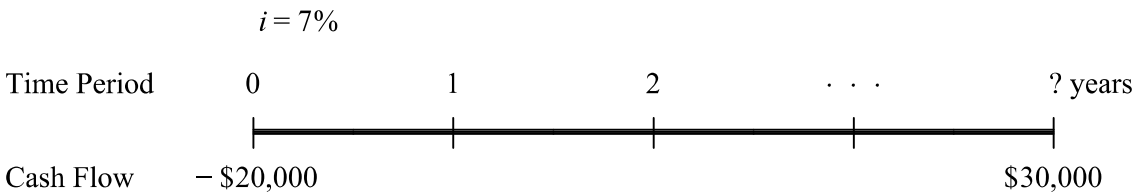
(Related to the Business of Life: Saving for Your First House) **(Future value)** You are hoping to buy a house in the future and recently received an inheritance of $20,000. You intend to use your inheritance as a down payment on your house.

a. If you put your inheritance in an account that earns 7% interest compounded annually, how many years will it be before your inheritance grows to $30,000?
b. If you let your money grow for 10.25 years at 7%, how much will you have?
c. How long will it take your money to grow to $30,000 if you move it into an account that pays 3% compounded annually? How long will it take your money to grow to $30,000 if you move it into an account that pays 11%?
d. What does all this tell you about the relationship among interest rates, time, and future sums?

a. If you put your inheritance in an account that earns 7% interest compounded annually, how many years will it be before your inheritance grows to $30,000?

STEP 1: Picture the problem

In this case we are solving for the number of periods:



STEP 2: Decide on a solution strategy

In this problem we know the interest rate, the present value, and the future value, and we want to know how many years it will take for $20,000 to grow to $30,000 at 7% per year. We are solving for *n*, and we can calculate it using either the future value equation or present value equation. Solving for *n* mathematically is tough. One way is to solve for *n* using a trial-and-error approach. That is, you could substitute different values of *n* into the equation—either increasing the value of *n* to make the right-hand side of the equation larger, or decreasing the value of *n* to make it smaller, until the two sides of the equation are equal—but that will be a bit tedious. Using the time value of money features on a financial calculator or in Excel is much easier and faster.

STEP 3: Solve

Using a Financial Calculator.

Problem 5-3 (cont.)

Enter		7	− 20,000	0	30,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for	6.0				

Using an Excel Spreadsheet.

= NPER(rate,pmt,pv,fv) or with values entered = NPER(0.07,0, − 20000,30000)

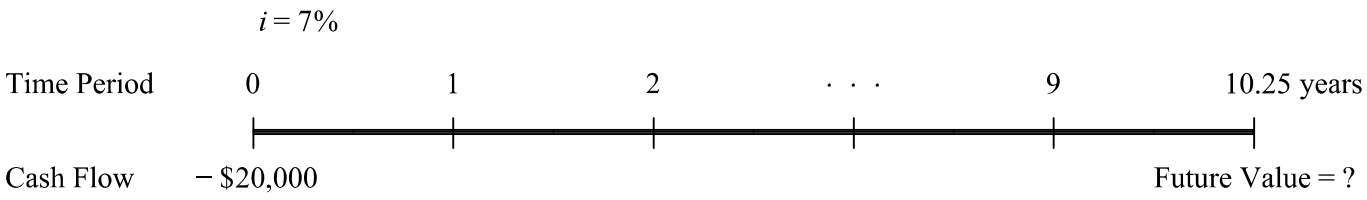
STEP 4. Analyze

It will take about 6.0 years for $20,000 to grow to $30,000 at 7% compound interest. This is the kind of calculation that both individuals and businesses make in trying to plan for major expenditures.

b. If you let your money grow for 10.25 years at 7%, how much will you have?

STEP 1: Picture the problem

We can set up a timeline to identify the cash flows from the investment as follows:



STEP 2: Decide on a solution strategy

This is a simple future value problem with a single cash flow. We know the present value, interest rate, and number of years; we are looking for the future value. We can find the future value using the mathematical formulas, a financial calculator, or an Excel spreadsheet.

Problem 5-3 (cont.)

STEP 3: Solve

Using the Mathematical Formulas.

Substitute $PV = \$20{,}000$, $i = 7\%$, and $n = 10.25$ years into the following equation to compute the future value:

$$\begin{pmatrix}\text{Future Value}\\ \text{in year } n\\ (FV_n)\end{pmatrix} = \begin{pmatrix}\text{Present}\\ \text{Value } (PV)\end{pmatrix}\left(1 + \begin{pmatrix}\text{Annual}\\ \text{Interest Rate } (i)\end{pmatrix}\right)^{\begin{matrix}\text{Number of}\\ \text{Years } (n)\end{matrix}}$$

$$\begin{aligned} FV_{10.25} &= \$20{,}000(1 + 0.07)^{10.25} \\ &= \$20{,}000(2.00071) \\ &= \$40{,}014.16 \end{aligned}$$

At the end of 10.25 years, the investment will accumulate to the amount of $40,014.16.

Using a Financial Calculator.

Enter	10.25	7	− 20,000	0	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for					40,014.16

Using an Excel Spreadsheet.

= FV(rate,nper,pmt,pv) or with values entered = FV(0.07,10.25,0, − 20000)

Problem 5-3 (cont.)

STEP 4: Analyze

Notice that you input the present value with a negative sign because present value represents a cash outflow. In effect, the money leaves you when it is first invested. In this problem you invest $20,000 at 7% and found that it will grow to $40,014.16 after 10.25 years. Put another way, given a compound rate of 7%, a $20,000 investment today will be worth $40,014.16 in 10.25 years.

Repeat the steps in part **a** to calculate the number of investment periods in part **c**.

c. The number of years it will take for your money to grow to $30,000 if you move it into an account that pays 3% compounded annually is computed as follows:

Using a Financial Calculator.

Enter		3	− 20,000	0	30,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for	13.7				

The number of years it will take for your money to grow to $30,000 if you move it into an account that pays 11% compounded annually is computed as follows:

Using a Financial Calculator.

Enter		11	− 20,000	0	30,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for	3.9				

d. What does all this tell you about the relationship among interest rates, time, and future sums?

There is a positive relationship between both the interest rate used to compound a present sum and the number of years for which the compounding continues

Problem 5-3 (cont.)

and the future value of that sum.

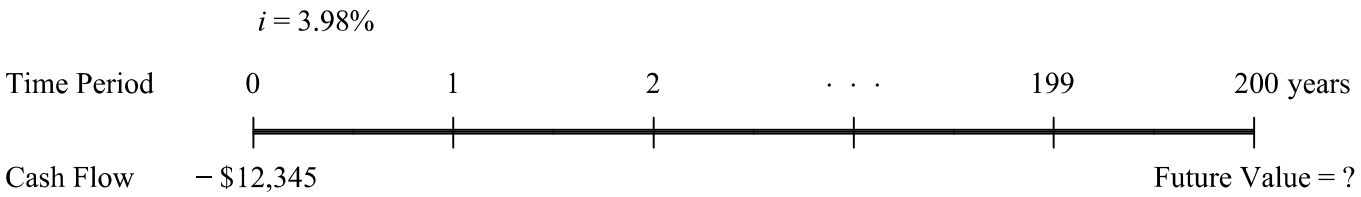
Problem 5-4

(Related to Checkpoint 5.2) **(Future value)** Bob Terwilliger received $12,345 for his services as financial consultant to the mayor's office of his hometown of Springfield. Bob says that his consulting work was his civic duty and that he should not receive any compensation. So, he has invested his paycheck into an account paying 3.98% annual interest and left the account in his will to the city of Springfield on the condition that the city could not collect any money from the account for 200 years. How much money will the city receive in 200 years from Bob's generosity?

a. Bob has invested his paycheck into an account paying 3.98% annual interest and left the account in his will to the city of Springfield. How much money will the city receive in 200 years from Bob's generosity?

STEP 1: Picture the problem

We can set up a timeline to identify the cash flows from the investment as follows:



STEP 2: Decide on a solution strategy

This is a simple future value problem with a single cash flow. We know the present value, interest rate, and number of years; we are looking for the future value. We can find the future value using the mathematical formulas, a financial calculator, or an Excel spreadsheet.

STEP 3: Solve

Using the Mathematical Formulas.

Substitute $PV = \$12{,}345$, $i = 3.98\%$, and $n = 200$ years into the following equation to compute the future value:

Problem 5-4 (cont.)

$$\text{Future Value in year } n \ (FV_n) = \text{Present Value } (PV)\left(1 + \text{Annual Interest Rate } (i)\right)^{\text{Number of Years } (n)}$$

$$FV_{200} = \$12{,}345(1 + 0.0398)^{200}$$
$$= \$12{,}345(2{,}454.49764)$$
$$= \$30{,}300{,}773$$

At the end of 200 years, the city of Springfield will receive $30,300,773 from Bob's generosity.

Using a Financial Calculator.

Enter	200	3.98	− 12,345	0	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for					30,300,773

Using an Excel Spreadsheet.

= FV(rate,nper,pmt,pv) or with values entered = FV(0.0398,200,0, − 12345)

STEP 4: Analyze

Notice that you input the present value with a negative sign because present value represents a cash outflow. In effect, the money leaves you when it is first invested. In this problem Bob invests $12,345 at 3.98% and found that it will grow to $30,300,773 after 200 years. Put another way, given a compound rate of 3.98%, Bob's $12,345 today will be worth $30,300,773 in 200 years.

Problem 5-5

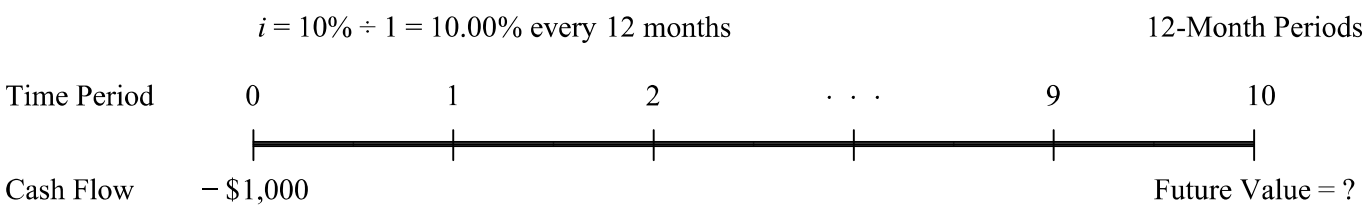
(Related to Checkpoint 5.3) (Compound interest with non-annual periods) Calculate the amount of money that will be in each of the following accounts at the end of the given deposit period:

Account Holder	Amount Deposited	Annual Interest Rate	Compounding Periods Per Year (M)	Compounding Periods (Years)
Theodore Logan III	$ 1,000	10 %	1	10
Vernell Coles	95,000	12	12	1
Thomas Elliot	8,000	12	6	2
Wayne Robinson	120,000	8	4	2
Eugene Chung	30,000	10	2	4
Kelly Cravens	15,000	12	3	3

The Theodore Logan III account has $1,000 that earns an annual rate of 10% compounded every 12 months for 10 years. What is the amount of money that will be in the account at the end of the given deposit period?

STEP 1: Picture the problem

If you earn an annual rate of 10% compounded every 12 months for 10 years, you really earn 10.00% every 12 months or 10 12-month periods. Expressed as a timeline, this problem would look like the following:



STEP 2: Decide on a solution strategy

In this instance we are simply solving for the future value of $1,000. The only twist is that interest is calculated on a 12-month basis. Thus, if you earn 10% compounded every 12 months for 10 years, you really earn 10.00% every 12 months for 10 12-month periods. We can calculate the future value of the $1,000 investment using the future value equation.

Problem 5-5 (cont.)

STEP 3: Solve

Using the Mathematical Formulas.

Substitute number of years *(n)* = 10, number of compounding periods per year *(m)* = 1, annual interest rate *(i)* = 10%, and *PV* = $1,000 into the following equation to compute the future value:

$$\text{Future Value in year } n \ (FV_n) = \text{Present Value } (PV)\left(1 + \frac{\text{Annual Interest Rate } (i)}{\text{Compounding Periods per Year } (m)}\right)^{m \times (\text{Number of Years } (n))}$$

$$FV_{10} = \$1{,}000\left(1 + \frac{0.10}{1}\right)^{1 \times 10}$$

$$= \$1{,}000 \times 2.59374$$

$$= \$2{,}593.74$$

Theodore Logan III will have $2,593.74 at the end of 10 years.

Using a Financial Calculator.

Enter	10	10.00	− 1,000	0	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for					2,593.74

Using an Excel Spreadsheet.

Problem 5-5 (cont.)

= FV(rate,nper,pmt,pv) or with values entered = FV(0.1,10,0, − 1000)

STEP 4: Analyze

The more often interest is compounded per year—that is, the larger m is, resulting in a larger value of nper—the larger the future value will be. That's because you are earning interest more often on the interest you've previously earned. In this problem Theodore Logan III deposited $1,000 into a bank account earning an annual rate of 10% compounded every 12 months for 10 years. The amount of money in the account at the end of the given deposit period is $2,593.74.

Repeat the steps above to calculate the amount of money in the other accounts at the end of the deposit periods. First identify all the parameters for each account and then substitute the values into the future value equation. Remember that you can also solve this problem using a financial calculator or an Excel spreadsheet.

Vernell Coles account

Since $PV = \$95{,}000$, $i = 12\%$, $m = 12$, and $n = 1$, the amount of money in this account after 1 years is computed as follows:

$$FV_{12} = \$95{,}000\left(1 + \frac{0.12}{12}\right)^{12 \times 1}$$

$$= \$95{,}000 \times 1.12683$$

$$= \$107{,}048.38$$

Thomas Elliot account

Since $PV = \$8{,}000$, $i = 12\%$, $m = 6$, and $n = 2$, the amount of money in this account after 2 years is computed as follows:

$$FV_{12} = \$8{,}000\left(1 + \frac{0.12}{6}\right)^{6 \times 2}$$

$$= \$8{,}000 \times 1.26824$$

$$= \$10{,}145.93$$

Problem 5-5 (cont.)

Wayne Robinson account

Since $PV = \$120{,}000$, $i = 8\%$, $m = 4$, and $n = 2$, the amount of money in this account after 2 years is computed as follows:

$$FV_8 = \$120{,}000\left(1 + \frac{0.08}{4}\right)^{4 \times 2}$$
$$= \$120{,}000 \times 1.17166$$
$$= \$140{,}599.13$$

Eugene Chung account

Since $PV = \$30{,}000$, $i = 10\%$, $m = 2$, and $n = 4$, the amount of money in this account after 4 years is computed as follows:

$$FV_8 = \$30{,}000\left(1 + \frac{0.10}{2}\right)^{2 \times 4}$$
$$= \$30{,}000 \times 1.47746$$
$$= \$44{,}323.66$$

Kelly Cravens account

Since $PV = \$15{,}000$, $i = 12\%$, $m = 3$, and $n = 3$, the amount of money in this account after 3 years is computed as follows:

$$FV_9 = \$15{,}000\left(1 + \frac{0.12}{3}\right)^{3 \times 3}$$
$$= \$15{,}000 \times 1.42331$$
$$= \$21{,}349.68$$

Problem 5-6

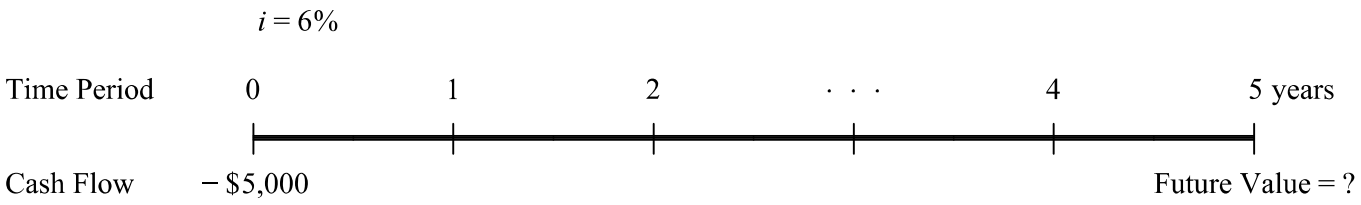
(Compound interest with non-annual periods) You just received a bonus of $5,000.

a. (Related to Checkpoint 5.2) Calculate the future value of $5,000, given that it will be held in the bank for 5 years and earn an annual interest rate of 6%.
b. Recalculate part (a) using a compounding period that is (1) semiannual and (2) bimonthly.
c. Recalculate parts (a) and (b) using an annual interest rate of 12%.
d. Recalculate part (a) using a time horizon of 12 years at an annual interest rate of 6%.
e. What conclusions can you draw when you compare the answers in parts (c) and (d) with the answers in parts (a) and (b)?

a. What is the future value of $5,000 in a bank account for 5 years at an annual interest rate of 6 percent?

STEP 1: Picture the problem

We can set up a timeline to identify the cash flows from the investment as follows:



STEP 2: Decide on a solution strategy

This is a simple future value problem with a single cash flow. We know the present value, interest rate, and number of years; we are looking for the future value. We can find the future value using the mathematical formulas, a financial calculator, or an Excel spreadsheet.

STEP 3: Solve

Using the Mathematical Formulas.

Substitute $PV = \$5{,}000$, $i = 6\%$, and $n = 5$ years into the following equation to compute the future value:

Problem 5-6 (cont.)

$$\text{Future Value in year } n \ (FV_n) = \text{Present Value } (PV)\left(1 + \text{Annual Interest Rate } (i)\right)^{\text{Number of Years } (n)}$$

$$FV_5 = \$5{,}000(1 + 0.06)^5$$
$$= \$5{,}000(1.33823)$$
$$= \$6{,}691.15$$

At the end of 5 years, the investment will accumulate to $6,691.15.

Using a Financial Calculator.

Enter	5	6	− 5,000	0	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for					6,691.15

Using an Excel Spreadsheet.

= FV(rate,nper,pmt,pv) or with values entered = FV(0.06,5,0, − 5000)

STEP 4: Analyze

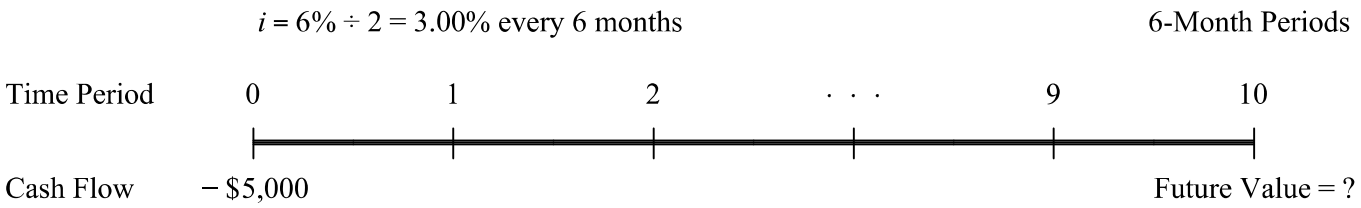
Notice that you input the present value with a negative sign because present value represents a cash outflow. In effect, the money leaves you when it is first invested. In this problem you invest $5,000 at 6% and found that it will grow to $6,691.15 after 5 years. Put another way, given a compound rate of 6%, your $5,000 today will be worth $6,691.15 in 5 years.

b. What is the future value of $5,000 in a bank account for 5 years at 6 percent compounded semiannually?

Problem 5-6 (cont.)

STEP 1: Picture the problem

If you earn an annual rate of 6% compounded semiannually for 5 years, you really earn 3.00% every 6 months or 10 6-month periods. Expressed as a timeline, this problem would look like the following:



STEP 2: Decide on a solution strategy

In this instance we are simply solving for the future value of $5,000. The only twist is that interest is calculated on a semiannual basis. Thus, if you earn 6% compounded semiannually for 5 years, you really earn 3.00% every 6 months for 10 6-month periods. We can calculate the future value of the $5,000 investment using the future value equation.

STEP 3: Solve

Using the Mathematical Formulas.

Substitute number of years *(n)* = 5, number of compounding periods per year *(m)* = 2, annual interest rate *(i)* = 6%, and PV = $5,000 into the following equation to compute the future value:

$$\begin{matrix}\text{Future Value} \\ \text{in year } n \\ (FV_n)\end{matrix} = \text{Present Value } (PV)\left(1 + \text{Annual Interest Rate } (i)\right)^{\text{Number of Years } (n)}$$

Problem 5-6 (cont.)

$$FV_{10} = \$5{,}000\left(1 + \frac{0.06}{2}\right)^{2 \times 5}$$

$$= \$5{,}000(1.34392)$$

$$= \$6{,}719.60$$

The future value of $5,000 in a bank account for 5 years at 6 percent compounded semiannually is $6,719.60.

Using a Financial Calculator.

Enter	10	3.00	− 5,000	0	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for					6,719.60

Using an Excel Spreadsheet.

= FV(rate,nper,pmt,pv) or with values entered = FV(0.03,10,0, − 5000)

STEP 4: Analyze

The more often interest is compounded per year—that is, the larger *m* is, resulting in a larger value of nper—the larger the future value will be. That's because you are earning interest more often on the interest you've previously earned. In this problem you invest $5,000 into a bank account earning an annual rate of 6% compounded semiannually for 5 years. The amount of money in the account at the end of the given deposit period is $6,719.60.

Repeat the steps above to calculate the amount of money in the accounts at different interest rates and different deposit periods. First identify all the parameters for each account and then substitute the values into the future value equation. Remember that you can also solve this problem using a financial calculator or an Excel spreadsheet.

The future value of $5,000 in a bank account for 5 years at 6 percent compounded bimonthly is computed as follows:

Problem 5-6 (cont.)

$$FV_{30} = \$5{,}000\left(1 + \frac{0.06}{6}\right)^{6 \times 5} = \$6{,}739.25$$

c. Recalculate parts (a) and (b) using an annual interest rate of 12%.

The future value of $5,000 in a bank account for 5 years at an annual interest rate of 12 percent is computed as follows:

$$FV_5 = \$5{,}000(1 + 0.12)^5 = \$8{,}811.70$$

The future value of $5,000 in a bank account for 5 years at 12 percent compounded semiannually is computed as follows:

$$FV_{10} = \$5{,}000\left(1 + \frac{0.12}{2}\right)^{2 \times 5} = \$8{,}954.25$$

The future value of $5,000 in a bank account for 5 years at 12 percent compounded bimonthly is computed as follows:

$$FV_{30} = \$5{,}000\left(1 + \frac{0.12}{6}\right)^{6 \times 5} = \$9{,}056.80$$

d. Recalculate part (a) using a time horizon of 12 years at an annual interest rate of 6%.

The future value of $5,000 in a bank account for 12 years at an annual interest rate of 6 percent is computed as follows:

$$FV_{12} = \$5{,}000(1 + 0.06)^{12} = \$10{,}061.00$$

e. What conclusions can you draw when you compare the answers in parts (c) and (d) with the answers in parts (a) and (b)?

An increase in the stated interest rate will increase the future value of a given sum. Likewise, an increase in the length of the holding period will increase the future value of a given sum.

Problem 5-7

(Related to Checkpoint 5.3) (Compound interest with non-annual periods) Your grandmother just gave you $6,000.

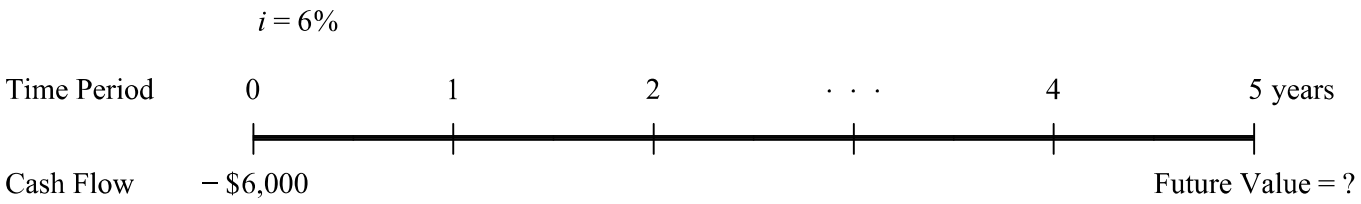
a. Calculate the future value of $6,000, given that it will be invested for 5 years at an annual interest rate of 6%.
b. Recalculate part (a) using a compounding period that is (1) semiannual and (2) bimonthly.
c. Now let's look at what might happen if you can invest the money at a rate of 12% rather than 6% rate; recalculate parts (a) and (b) for an annual interest rate of 12%.
d. Now let's see what might happen if you invest the money for 12 years rather than 5 years; recalculate part (a) using a time horizon of 12 years (annual interest rate is still 6%).
e. With respect to the changes in the stated interest rate and length of time the money is invested in parts (c) and (d), what conclusions can you draw?

---

a. What is the future value of $6,000 invested for 5 years at an annual interest rate of 6 percent?

STEP 1: Picture the problem

We can set up a timeline to identify the cash flows from the investment as follows:



STEP 2: Decide on a solution strategy

This is a simple future value problem with a single cash flow. We know the present value, interest rate, and number of years; we are looking for the future value. We can find the future value using the mathematical formulas, a financial calculator, or an Excel spreadsheet.

STEP 3: Solve

Using the Mathematical Formulas.

Substitute $PV = \$6{,}000$, $i = 6\%$, and $n = 5$ years into the following equation to compute the future value:

Problem 5-7 (cont.)

$$\text{Future Value in year } n \ (FV_n) = \text{Present Value } (PV)\left(1 + \text{Annual Interest Rate } (i)\right)^{\text{Number of Years } (n)}$$

$$FV_5 = \$6{,}000(1 + 0.06)^5$$
$$= \$6{,}000(1.33823)$$
$$= \$8{,}029.38$$

At the end of 5 years, the investment will accumulate to $8,029.38.

Using a Financial Calculator.

Enter	5	6	− 6,000	0	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for					8,029.38

Using an Excel Spreadsheet.

= FV(rate,nper,pmt,pv) or with values entered = FV(0.06,5,0, − 6000)

STEP 4: Analyze

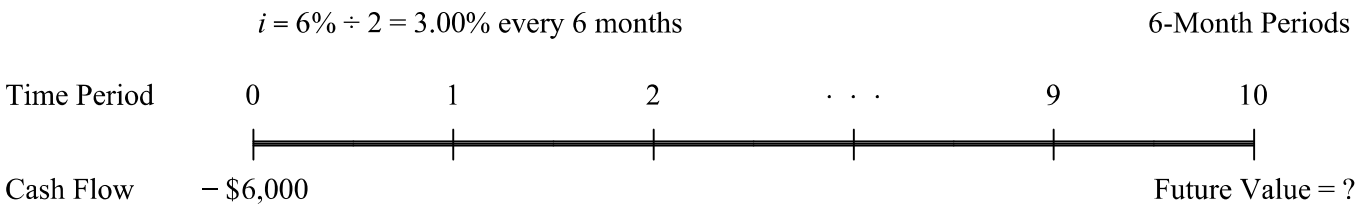
Notice that you input the present value with a negative sign because present value represents a cash outflow. In effect, the money leaves you when it is first invested. In this problem you invest $6,000 at 6% and found that it will grow to $8,029.38 after 5 years. Put another way, given a compound rate of 6%, your $6,000 today will be worth $8,029.38 in 5 years.

Problem 5-7 (cont.)

b. What is the future value of $6,000 invested for 5 years at 6 percent compounded semiannually?

STEP 1: Picture the problem

If you earn an annual rate of 6% compounded semiannually for 5 years, you really earn 3.00% every 6 months or 10 6-month periods. Expressed as a timeline, this problem would look like the following:



STEP 2: Decide on a solution strategy

In this instance we are simply solving for the future value of $6,000. The only twist is that interest is calculated on a semiannual basis. Thus, if you earn 6% compounded semiannually for 5 years, you really earn 3.00% every 6 months for 10 6-month periods. We can calculate the future value of the $6,000 investment using the future value equation.

STEP 3: Solve

Using the Mathematical Formulas.

Substitute number of years *(n)* = 5, number of compounding periods per year *(m)* = 2, annual interest rate *(i)* = 6%, and PV = $6,000 into the following equation to compute the future value:

$$\begin{matrix}\text{Future Value} \\ \text{in year } n \\ (FV_n)\end{matrix} = \begin{matrix}\text{Present} \\ \text{Value } (PV)\end{matrix}\left(1 + \begin{matrix}\text{Annual} \\ \text{Interest Rate } (i)\end{matrix}\right)^{\begin{matrix}\text{Number of} \\ \text{Years } (n)\end{matrix}}$$

Problem 5-7 (cont.)

$$FV_{10} = \$6{,}000\left(1 + \frac{0.06}{2}\right)^{2 \times 5}$$

$$= \$6{,}000(1.34392)$$

$$= \$8{,}063.52$$

The future value of $6,000 invested for 5 years at 6 percent compounded semiannually is $8,063.52.

Using a Financial Calculator.

Enter	10	3.00	− 6,000	0	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for					8,063.52

Using an Excel Spreadsheet.

= FV(rate,nper,pmt,pv) or with values entered = FV(0.03,10,0, − 6000)

STEP 4: Analyze

The more often interest is compounded per year—that is, the larger *m* is, resulting in a larger value of nper—the larger the future value will be. That's because you are earning interest more often on the interest you've previously earned. In this problem you invest $6,000 into a bank account earning an annual rate of 6% compounded semiannually for 5 years. The amount of money in the account at the end of the given deposit period is $8,063.52.

Repeat the steps above to calculate the amount of money in the account at different interest rates and different deposit periods. First identify all the parameters for each account and then substitute the values into the future value equation. Remember that you can also solve this problem using a financial calculator or an Excel spreadsheet.

The future value of $6,000 invested for 5 years at 6 percent compounded bimonthly is computed as follows:

Problem 5-7 (cont.)

$$FV_{30} = \$6{,}000\left(1 + \frac{0.06}{6}\right)^{6 \times 5} = \$8{,}087.10$$

c. Now let's look at what might happen if you can invest the money at a 12% rate rather than 6% rate; recalculate parts (a) and (b) for an annual interest rate of 12%.

The future value of $6,000 invested for 5 years at an annual interest rate of 12 percent is computed as follows:

$$FV_5 = \$6{,}000(1 + 0.12)^5 = \$10{,}574.04$$

The future value of $6,000 invested for 5 years at 12 percent compounded semiannually is computed as follows:

$$FV_{10} = \$6{,}000\left(1 + \frac{0.12}{2}\right)^{2 \times 5} = \$10{,}745.10$$

The future value of $6,000 invested for 5 years at 12 percent compounded bimonthly is computed as follows:

$$FV_{30} = \$6{,}000\left(1 + \frac{0.12}{6}\right)^{6 \times 5} = \$10{,}868.16$$

d. Now let's see what might happen if you invest the money for 12 years rather than 5 years; recalculate part (a) using a time horizon of 12 years (annual interest rate is still 6%).

The future value of $6,000 invested for 12 years at an annual interest rate of 6 percent is computed as follows:

$$FV_{12} = \$6{,}000(1 + 0.06)^{12} = \$12{,}073.20$$

e. With respect to the changes in the stated interest rate and length of time the money is invested in parts (c) and (d), what conclusions can you draw?

An increase in the stated interest rate will increase the future value of a given sum. Likewise, an increase in the length of the holding period will increase the future value of a given sum.

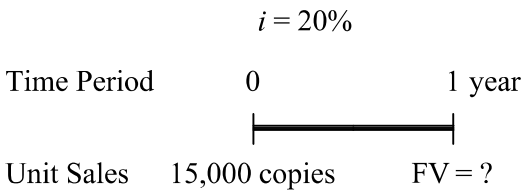
Problem 5-8

(Related to Checkpoint 5.2) (Future value) A new finance book sold 15,000 copies following the first year of its release, and was expected to increase by 20% per year. What sales are expected during years two, three, and four? Graph this sales trend and explain how compound growth affects the shape of the sales trend.

a. If the 15,000 copies of book sales following the first year of its release were expected to increase by 20 percent per year, what are the expected sales of the new finance book during year two?

STEP 1: Picture the problem

We can set up a timeline to identify the book sales as follows:



STEP 2: Decide on a solution strategy

This is a simple future value problem with a single cash flow. The sales of the new finance book during the first year of its release is the present value, the expected sales growth rate is the interest rate, and the number of years is equal to 1; we are looking for the expected sales in one year, which is the future value. We can find the future value using the mathematical formulas, a financial calculator, or an Excel spreadsheet.

STEP 3: Solve

Using the Mathematical Formulas.

Substitute $PV = 15{,}000$, $i = 20\%$, and $n = 1$ year into the following equation to compute the future value:

Problem 5-8 (cont.)

$$\text{Future Value in year } n \ (FV_n) = \text{Present Value } (PV)\left(1 + \text{Annual Interest Rate } (i)\right)^{\text{Number of Years } (n)}$$

$$FV_1 = 15{,}000(1 + 0.20)^1$$
$$= 15{,}000(1.20000)$$
$$= 18{,}000 \text{ copies}$$

The sales of the new finance book during year 2 are expected to be 18,000 copies.

Using a Financial Calculator.

Enter	1	20	− 15,000	0	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for					18,000

Using an Excel Spreadsheet.

= FV(rate,nper,pmt,pv) or with values entered = FV(0.20,1,0, − 15000)

STEP 4: Analyze

The concept of compounding applies to almost anything that grows. In this problem, 15,000 copies of the current sales of the new finance book were expected to grow at 20% per year. Given a compound rate of 20%, the sales will grow to 18,000 copies in one year.

Use the mathematical formulas, a financial calculator, or an Excel spreadsheet to compute the expected sales of the new finance book in parts **b** and **c.**

Problem 5-8 (cont.)

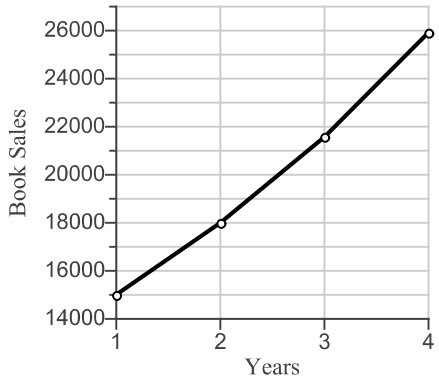
b. If the 15,000 copies of book sales following the first year of its release were expected to increase by 20 percent per year, the expected sales of the new finance book during year three are found to be:

$$FV_2 = 15{,}000(1 + 0.20)^2 = 21{,}600 \text{ copies}$$

c. If the 15,000 copies of book sales following the first year of its release were expected to increase by 20 percent per year, the expected sales of the new finance book during year four are found to be:

$$FV_3 = 15{,}000(1 + 0.20)^3 = 25{,}920 \text{ copies}$$

d. The following graph shows the sales trend for years two, three, and four following the first year of its release.



The sales trend graph is not linear, because this is a compound growth trend. Just as compound interest occurs when interest paid on the investment during the first period is added to the principal of the second period, compound growth in sales occurs when new sales during the first period are added to the original sales and new sales are based on the new sum. Book sales growth was compounded; thus, the first year the growth was 20% of 15,000 books, the second year 20% of 18,000 books, and the third year 20% of 21,600 books.

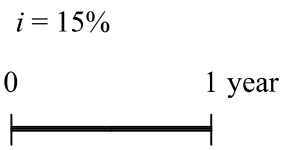
Problem 5-9

(Future value) You have just introduced "must have" headphones for the iPod. Sales of the new product are expected to be 10,000 units this year and are expected to increase by 15% per year in the future. What are expected sales during each of the next three years? Graph this sales trend and explain why the number of additional units sold increases every year.

a. If the 10,000 units of sales this year were expected to increase by 15 percent per year, what are the expected sales of the new headphone next year?

STEP 1: Picture the problem

We can set up a timeline to identify the headphone sales as follows:



STEP 2: Decide on a solution strategy

This is a simple future value problem with a single cash flow. The sales of the new headphone this year is the present value, the expected sales growth rate is the interest rate, and the number of years is equal to 1; we are looking for the expected sales in one year, which is the future value. We can find the future value using the mathematical formulas, a financial calculator, or an Excel spreadsheet.

STEP 3: Solve

Using the Mathematical Formulas.

Substitute $PV = 10{,}000$, $i = 15\%$, and $n = 1$ year into the following equation to compute the future value:

Problem 5-9 (cont.)

$$\text{Future Value in year } n \ (FV_n) = \text{Present Value } (PV)\left(1 + \text{Annual Interest Rate } (i)\right)^{\text{Number of Years } (n)}$$

$$FV_1 = 10{,}000(1 + 0.15)^1$$
$$= 10{,}000(1.150)$$
$$= 11{,}500 \text{ units}$$

The sales of the new headphone next year are expected to be 11,500 units.

Using a Financial Calculator.

Enter	1	15	− 10,000	0	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for					11,500

Using an Excel Spreadsheet.

= FV(rate,nper,pmt,pv) or with values entered = FV(0.15,1,0, − 10000)

STEP 4: Analyze

The concept of compounding applies to almost anything that grows. In this problem, 10,000 units of the current sales of the new headphone were expected to grow at 15% per year. Given a compound rate of 15%, the sales will grow to 11,500 units in one year.

Use the mathematical formulas, a financial calculator, or an Excel spreadsheet to compute the expected sales of the new headphone in parts **b** and **c.**

Problem 5-9 (cont.)

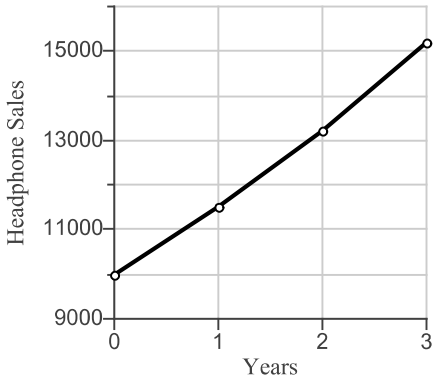
b. If the 10,000 units of sales this year were expected to increase by 15 percent per year, the expected sales of the new headphone in two years are found to be:

$$FV_2 = 10{,}000(1 + 0.15)^2 = 13{,}225 \text{ units}$$

c. If the 10,000 units of sales this year were expected to increase by 15 percent per year, the expected sales of the new headphone in three years are found to be:

$$FV_3 = 10{,}000(1 + 0.15)^3 = 15{,}209 \text{ units}$$

d. The following graph shows the sales trend for the next three years.



The sales trend graph is not linear, because this is a compound growth trend. Just as compound interest occurs when interest paid on the investment during the first period is added to the principal of the second period, compound growth in sales occurs when new sales during the first period are added to the original sales and new sales are based on the new sum. Headphone sales growth was compounded; thus, the first year the growth was 15% of 10,000 units, the second year 15% of 11,500 units, and the third year 15% of 13,225 units.

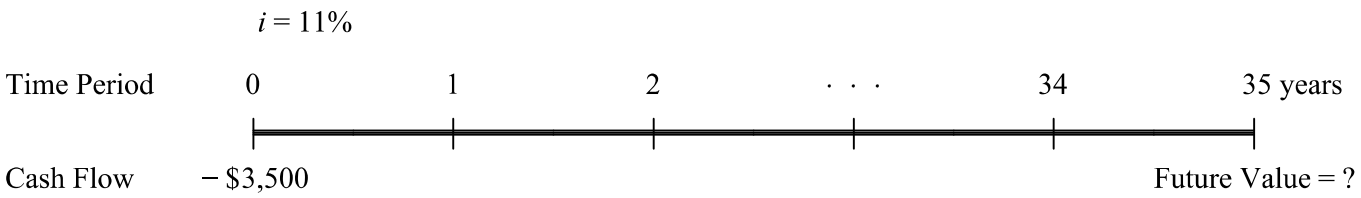
Problem 5-10

(Future value) If you deposit $3,500 today into an account earning an annual rate of return of 11%, what would your account be worth in 35 years (assuming no further deposits)? In 40 years?

If you deposit $3,500 today into an account earning an annual rate of return of 11%, what would your account be worth in 35 years?

STEP 1: Picture the problem

We can set up a timeline to identify the cash flows from the investment as follows:



STEP 2: Decide on a solution strategy

This is a simple future value problem with a single cash flow. We know the present value, interest rate, and number of years; we are looking for the future value. We can find the future value using the mathematical formulas, a financial calculator, or an Excel spreadsheet.

STEP 3: Solve

Using the Mathematical Formulas.

Substitute $PV = \$3{,}500$, $i = 11\%$, and $n = 35$ years into the following equation to compute the future value:

$$\begin{array}{c}\text{Future Value} \\ \text{in year } n \\ (FV_n)\end{array} = \begin{array}{c}\text{Present} \\ \text{Value } (PV)\end{array}\left(1 + \begin{array}{c}\text{Annual} \\ \text{Interest Rate } (i)\end{array}\right)^{\begin{array}{c}\text{Number of} \\ \text{Years } (n)\end{array}}$$

Problem 5-10 (cont.)

$$FV_{35} = \$3{,}500(1 + 0.11)^{35}$$
$$= \$3{,}500(38.57485)$$
$$= \$135{,}011.98$$

At the end of 35 years, the investment will accumulate to $135,011.98.

Using a Financial Calculator.

Enter	35	11	− 3,500	0	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for					135,011.98

Using an Excel Spreadsheet.

= FV(rate,nper,pmt,pv) or with values entered = FV(0.11,35,0, − 3500)

STEP 4: Analyze

Notice that you input the present value with a negative sign because present value represents a cash outflow. In effect, the money leaves you when it is first invested. In this problem you invest $3,500 at 11% and found that it will grow to $135,011.98 after 35 years. Put another way, given a compound rate of 11%, your $3,500 today will be worth $135,011.98 in 35 years.

Use the mathematical formulas, a financial calculator, or an Excel spreadsheet to compute the future value of the investment for the new time period.

If you deposit $3,500 today into an account earning an annual rate of return of 11%, the amount of money in your account in 40 years is computed as follows:

$$FV_{40} = \$3{,}500(1 + 0.11)^{40}$$
$$= \$3{,}500(65.00087)$$

Problem 5-10 (cont.)

= $227,503.04

Thus, $3,500 invested for 40 years at 11% compounded annually will accumulate to the amount of $227,503.04.

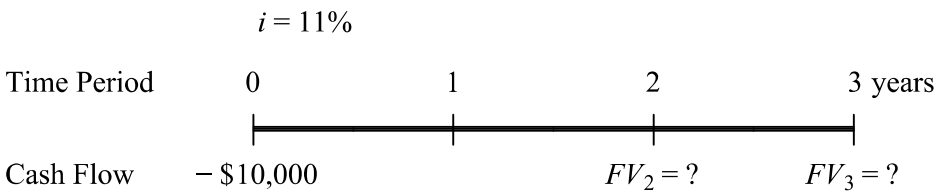
Problem 5-11

(Simple and compound interest) If you deposit $10,000 today into an account earning an annual rate of return of 11%, in the third year how much interest would be earned? How much of the total is simple interest and how much results from compounding of interest?

If you deposit $10,000 today into an account earning an annual rate of return of 11%, in the third year how much interest would be earned?

STEP 1: Picture the problem

The amount of interest that you can earn during the third year of your investment is the difference between the investment values at the beginning and the end of year three. Expressed as a timeline, this problem would look like the following:



STEP 2: Decide on a solution strategy

This is a simple future value problem with a single cash flow. We know the present value, interest rate, and number of years; we are looking for the future values. We can find the future value using the mathematical formulas, a financial calculator, or an Excel spreadsheet. Then, simply subtract the future value at the end of year 2 from the future value at the end of year 3 to find the total amount of interest earned in the third year.

STEP 3: Solve

Using the Mathematical Formulas.

Substitute $PV = \$10{,}000$, $i = 11\%$, and $n = 2$ years into the following equation to compute the future value:

Problem 5-11 (cont.)

$$\text{Future Value in year } n \ (FV_n) = \text{Present Value } (PV)\left(1 + \text{Annual Interest Rate } (i)\right)^{\text{Number of Years } (n)}$$

$$FV_2 = \$10{,}000(1 + 0.11)^2$$
$$= \$10{,}000(1.2321)$$
$$= \$12{,}321.00$$

At the end of 2 years, the investment will accumulate to the amount of $12,321.00.

Using a Financial Calculator.

Enter	2	11	− 10,000	0	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for					12,321.00

Using an Excel Spreadsheet.

= FV(rate,nper,pmt,pv) or with values entered = FV(0.11,2,0, − 10000)

STEP 4: Analyze

Notice that you input the present value with a negative sign because present value represents a cash outflow. In effect, the money leaves you when it is first invested. In this problem you invest $10,000 at 11% and found that it will grow to $12,321.00 after 2 years. Put another way, given a compound rate of 11%, a $10,000 investment today will be worth $12,321.00 in 2 years.

The future value of your account at the end of year 3 should be:

Problem 5-11 (cont.)

$$FV_3 = \$10{,}000(1 + 0.11)^3 = \$13{,}676.31$$

If you deposit $10,000 today into an account earning an annual rate of return of 11%, the amount of interest that you can earn during the third year of your investment is the difference between the investment values at the beginning and the end of year three, or $FV_3 - FV_2 = \$13{,}676.31 - \$12{,}321.00 = \$1{,}355.31$.

The amount of simple interest per year is equal to the original amount of investment times the annual interest rate, or $\$10{,}000 \times 0.11 = \$1{,}100.00$ per year.

The amount of interest from compounding in the third year is the total amount of interest earned over the third year minus the amount of simple annual interest; that is, $\$1{,}355.31 - \$1{,}100.00 = \$255.31$.

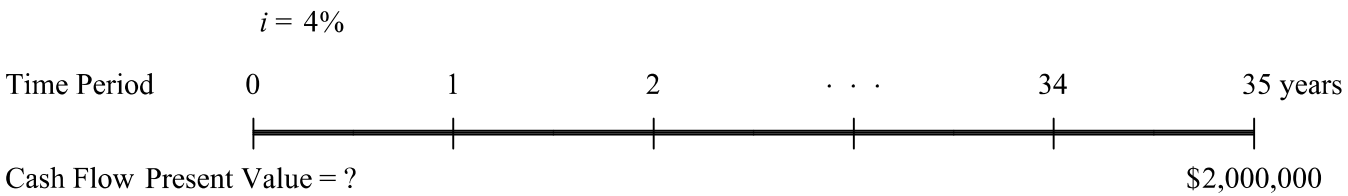
Problem 5-12

(Related to Checkpoint 5.4) (Present value) Sarah Wiggum would like to make a single investment and have $2.0 million at the time of her retirement in 35 years. She has found a mutual fund that will earn 4% annually. How much will Sarah have to invest today? If Sarah earned an annual return of 14%, how soon could she then retire?

If Sarah can earn 4% annually for the next 35 years, how much will she have to invest today?

STEP 1: Picture the problem

Expressed as a timeline, this problem would look like the following:



STEP 2: Decide on a solution strategy

This is a simple present value problem with a single cash flow. We know the future value, interest rate, and number of years; we are looking for the present value. We can find the present value using the mathematical formulas, a financial calculator, or an Excel spreadsheet.

STEP 3: Solve

Using the Mathematical Formulas.

Substitute $FV_n = \$2{,}000{,}000$, $i = 4\%$, and $n = 35$ years into the following equation to compute the present value:

$$\text{Present Value } (PV) = \text{Future Value in year } n \ (FV_n) \left[\frac{1}{\left(1 + \text{Annual Interest Rate } (i)\right)^{\text{Number of Years } (n)}} \right]$$

Problem 5-12 (cont.)

$$PV = \$2{,}000{,}000\left(\frac{1}{(1+0.04)^{35}}\right)$$

$$= \$2{,}000{,}000(0.253415)$$

$$= \$506{,}831$$

Sarah has to invest $506,831 today at 4% in order to have $2,000,000 when she retires in 35 years.

Using a Financial Calculator.

Enter	35	4		0	2,000,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			− 506,831		

Using an Excel Spreadsheet.

= PV(rate,nper,pmt,fv) or with values entered = PV(0.04,35,0,2000000)

STEP 4: Analyze

Notice that regardless of which method we use to calculate the future value—computing the formula by hand, with a calculator, or with Excel—we always arrive at the same answer. In this problem, given a discount rate of 4%, Sarah needs to invest $506,831 today in order to receive $2,000,000 in 35 years.

If Sarah were a finance major and learned how to earn an annual return of 14%, how soon could she then retire?

STEP 1: Picture the problem

In this case we are solving for the number of periods:

$$i = 14\%$$

Problem 5-12 (cont.)

STEP 2: Decide on a solution strategy

In this problem we know the interest rate, the present value, and the future value, and we want to know how many years it will take for $506,831 to grow to $2,000,000 at 14% per year. We are solving for *n*, and we can calculate it using either the future value equation or present value equation. Solving for *n* mathematically is tough. One way is to solve for *n* using a trial-and-error approach. That is, you could substitute different values of *n* into the equation—either increasing the value of *n* to make the right-hand side of the equation larger, or decreasing the value of *n* to make it smaller, until the two sides of the equation are equal—but that will be a bit tedious. Using the time value of money features on a financial calculator or in Excel is much easier and faster.

STEP 3: Solve

Using a Financial Calculator.

Enter		14	− 506,831	0	2,000,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for	10.5				

Using an Excel Spreadsheet.

= NPER(rate,pmt,pv,fv) or with values entered = NPER(0.14,0,− 506,831,2,000,000)

STEP 4. Analyze

If Sarah invests $506,831 today at 14% compounded annually, it will take about 10.5 years for $506,831 to grow to $2,000,000. This is the kind of calculation that both individuals and businesses make in trying to plan for major expenditures.

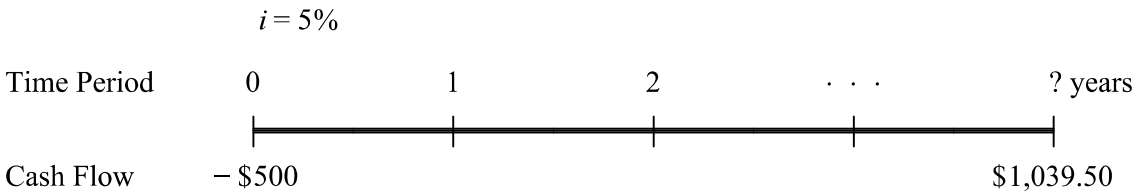
Problem 5-13

(Related to Checkpoint 5.5) (Solving for *n*) How many years will it take for $500 to grow to $1,039.50 if it's invested at 5% compounded annually?

How many years will it take for $500 to grow to $1,039.50 at 5% compounded annually?

STEP 1: Picture the problem

In this case we are solving for the number of periods:



STEP 2: Decide on a solution strategy

In this problem we know the interest rate, the present value, and the future value, and we want to know how many years it will take for $500 to grow to $1,039.50 at 5% per year. We are solving for *n*, and we can calculate it using either the future value equation or present value equation. Solving for *n* mathematically is tough. One way is to solve for *n* using a trial-and-error approach. That is, you could substitute different values of *n* into the equation—either increasing the value of *n* to make the right-hand side of the equation larger, or decreasing the value of *n* to make it smaller, until the two sides of the equation are equal—but that will be a bit tedious. Using the time value of money features on a financial calculator or in Excel is much easier and faster.

STEP 3: Solve

Using a Financial Calculator.

Enter		5	− 500	0	1,039.50
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for	15				

Problem 5-13 (cont.)

Using an Excel Spreadsheet.

= NPER(rate,pmt,pv,fv) or with values entered = NPER(0.05,0, − 500,1039.50)

STEP 4: Analyze

It will take about 15 years for $500 to grow to $1,039.50 at 5% compound interest. This is the kind of calculation that both individuals and businesses make in trying to plan for major expenditures.

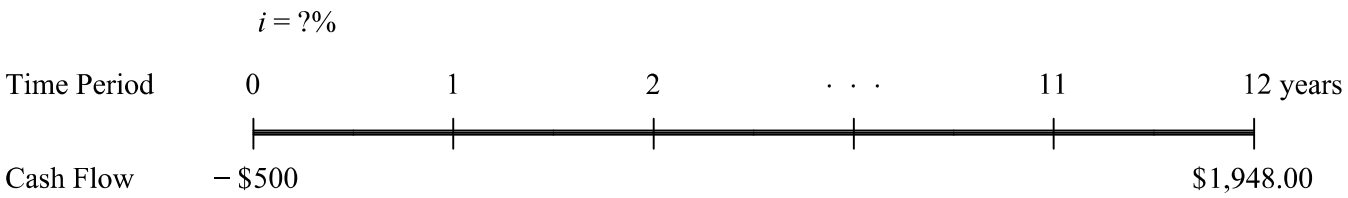
Problem 5-14

(Related to Checkpoint 5.6) **(Solving for *i*)** At what annual interest rate, compounded annually, would $500 have to be invested for it to grow to $1,948.00 in 12 years?

At what annual interest rate, compounded annually, must $500 be invested for it to grow to $1,948.00 in 12 years?

STEP 1: Picture the problem

We can visualize the problem using a timeline as follows:



STEP 2: Decide on a solution strategy

In this problem we know the number of years, the present value, and the future value, and we are solving for the interest rate. We are solving for i, and we can calculate it using either the future value equation or present value equation. Solving for i mathematically is tough. One way is to solve for i using a trial-and-error approach. That is, you could substitute different values of i into the equation—either increasing the value of i to make the right-hand side of the equation larger, or decreasing the value of i to make it smaller, until the two sides of the equation are equal—but that will be a bit tedious. Using the time value of money features on a financial calculator or in Excel is much easier and faster.

STEP 3: Solve

Using the Mathematical Formulas.

Substitute FV_n = $1,948.00, PV = $500, and n = 12 years into the following equation to solve for i:

Problem 5-14 (cont.)

$$\text{Future Value in year } n \ (FV_n) = \text{Present Value } (PV)\left(1 + \text{Annual Interest Rate } (i)\right)^{\text{Number of Years } (n)}$$

$$\$1{,}948.00 = \$500(1 + i)^{12}$$

$$3.8960 = (1 + i)^{12}$$

We then take the 12^{th} root of this equation to find the value of $(1 + i)$. Since taking the 12^{th} root is the same as taking something to the 1/12 (or 0.083333) power, this can be done if you have a financial calculator with a "y^n" key. In this case, you (1) enter 3.8960, (2) press the "y^n" key, (3) enter 0.083333, and (4) press the " = " key. The answer should be 1.1200, indicating that $(1 + i) = 1.1200$, and $i = 12\%$.

Using a Financial Calculator.

Enter	12		− 500	0	1,948.00
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for		12			

Using an Excel Spreadsheet.

= RATE(nper,pmt,pv,fv) or with values entered = RATE(12,0, − 500,1,948.00)

STEP 4: Analyze

You can increase your future value by growing your money at a higher interest rate or by letting your money grow for a longer period of time. For most of you, when it comes to planning for your retirement, a larger n is a real positive for you. Also, if you can earn a slightly higher return on your retirement savings, or any savings for that matter, it can make a big difference. For this problem, the annually compounded interest rate at which $500 must be invested for it to grow to $1,948.00 in 12 years is 12%.

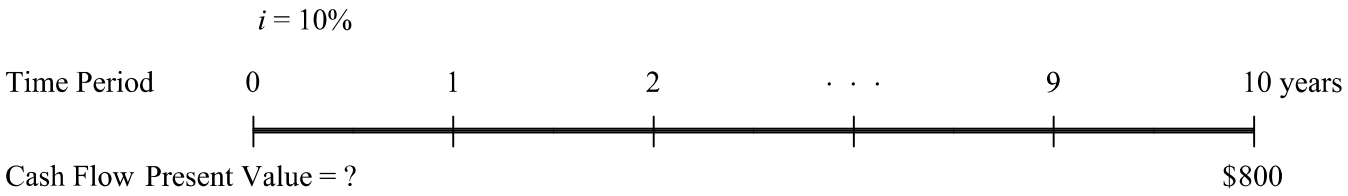
Problem 5-15

(Related to Checkpoint 5.4) (Present value) What is the present value of $800 to be received 10 years from now discounted back to the present at 10%?

What is the present value of $800 to be received 10 years from now discounted back to the present at 10%?

STEP 1: Picture the problem

Expressed as a timeline, this problem would look like the following:



STEP 2: Decide on a solution strategy

This is a simple present value problem with a single cash flow. We know the future value, interest rate, and number of years; we are looking for the present value. We can find the present value using the mathematical formulas, a financial calculator, or an Excel spreadsheet.

STEP 3: Solve

Using the Mathematical Formulas.

Substitute $FV_{10} = \$800$, $i = 10\%$, and $n = 10$ years into the following equation to compute the present value:

$$\text{Present Value } (PV) = \text{Future Value in year } n \ (FV_n) \left[\frac{1}{\left(1 + \text{Annual Interest Rate } (i)\right)^{\text{Number of Years } (n)}} \right]$$

Problem 5-15 (cont.)

$$PV = \$800\left[\frac{1}{(1+0.10)^{10}}\right]$$

$$= \$800[0.38554]$$

$$= \$308.43$$

The present value of the $800 to be received in 10 years is $308.43.

Using a Financial Calculator.

Enter	10	10		0	800
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			− 308.43		

Using an Excel Spreadsheet.

= PV(rate,nper,pmt,fv) or with values entered = PV(0.10,10,0,800)

STEP 4: Analyze

Once you've found the present value of any future cash flow, that present value is in today's dollars and can be compared to other present values. The underlying point of this exercise is to make cash flows that occur in different time periods comparable so that we can make good decisions. Also notice that regardless of which method we use to calculate the future value—computing the formula by hand, with a calculator, or with Excel—we always arrive at the same answer. In this problem, given a discount rate of 10%, $800 to be received in 10 years is worth $308.43 today.

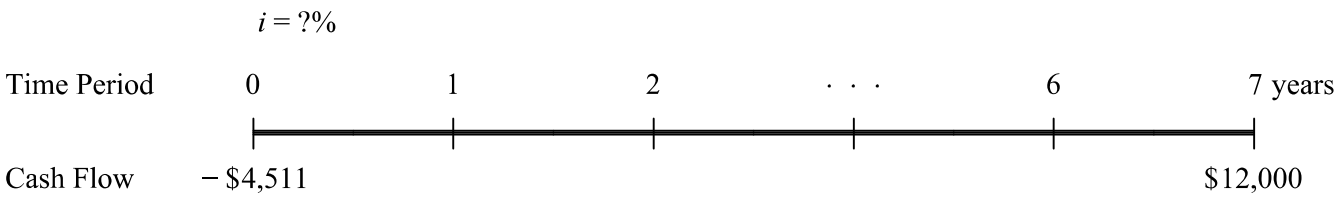
Problem 5-16

(Related to Checkpoint 5.6) (Solving for *i*) Kirk Van Houten, who has been married for 23 years, would like to buy his wife an expensive diamond ring with a platinum setting on their 30-year wedding anniversary. Assume that the cost of the ring will be $12,000 in 7 years. Kirk currently has $4,511 to invest. What annual rate of return must Kirk earn on his investment to accumulate enough money to pay for the ring?

What annual rate of return must Kirk earn on his investment to accumulate enough money to pay for the ring?

STEP 1: Picture the problem

We can visualize the problem using a timeline as follows:



STEP 2: Decide on a solution strategy

In this problem we know the number of years, the present value, and the future value, and we are solving for the interest rate. We are solving for i, and we can calculate it using either the future value equation or present value equation. Solving for i mathematically is tough. One way is to solve for i using a trial-and-error approach. That is, you could substitute different values of i into the equation—either increasing the value of i to make the right-hand side of the equation larger, or decreasing the value of i to make it smaller, until the two sides of the equation are equal—but that will be a bit tedious. Using the time value of money features on a financial calculator or in Excel is much easier and faster.

STEP 3: Solve

Using the Mathematical Formulas.

Substitute $FV_n = \$12{,}000$, $PV = \$4{,}511$, and $n = 7$ years into the following equation to solve for i:

Problem 5-16 (cont.)

$$\text{Future Value in year } n \ (FV_n) = \text{Present Value } (PV)\left(1 + \text{Annual Interest Rate } (i)\right)^{\text{Number of Years } (n)}$$

$$\$12{,}000 = \$4{,}511(1 + i)^7$$

$$2.6602 = (1 + i)^7$$

We then take the 7^{th} root of this equation to find the value of $(1 + i)$. Since taking the 7^{th} root is the same as taking something to the 1/7 (or 0.14286) power, this can be done if you have a financial calculator with a "y^n" key. In this case, you (1) enter 2.6602, (2) press the "y^n" key, (3) enter 0.14286, and (4) press the " = " key. The answer should be 1.15001, indicating that $(1 + i) = 1.15001$, and $i = 15\%$.

Using a Financial Calculator.

Enter	7		−4,511	0	12,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for		15			

Using an Excel Spreadsheet.

= RATE(nper,pmt,pv,fv) or with values entered = RATE(7,0, − 4511,12000)

STEP 4: Analyze

For this problem, the annual interest rate Kirk must earn on his $4,511 investment to accumulate $12,000 in 7 years is 15%. This is a very high annual rate of return to achieve over a 7-year period and Kirk will not reach his goal if he achieves less than an 15% rate of return. Also, Kirk will be responsible for paying taxes on the growth each year as his investment grows. Since there is no flexibility in the maturity date of Kirk's objective—the 30th wedding anniversary will be in exactly 7 years—if he fails to achieve his expected rate of return he may have to settle for a less expensive anniversary gift.

Problem 5-17

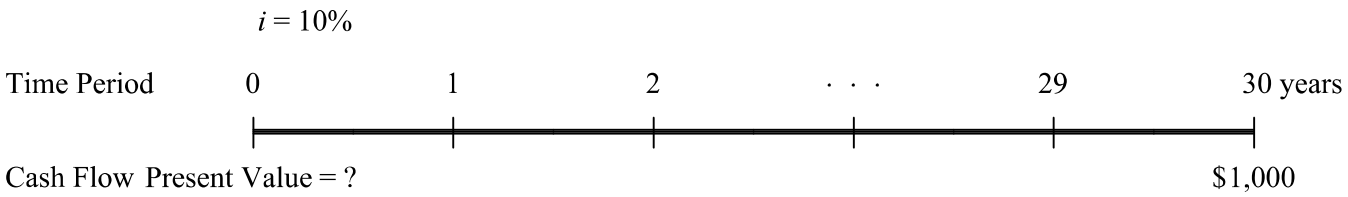
(Solving for *i*) You are considering investing in a security that will pay you $1,000 in 30 years.

a. If the appropriate discount rate is 10%, what is the present value of this investment?
b. Assume these investments sell for $365 in return for which you receive $1,000 in 30 years. What is the rate of return investors earn on this investment if they buy it for $365?

a. If the appropriate discount rate is 10%, what is the present value of this investment?

STEP 1: Picture the problem

Expressed as a timeline, this problem would look like the following:



STEP 2: Decide on a solution strategy

This is a simple present value problem with a single cash flow. We know the future value, interest rate, and number of years; we are looking for the present value. We can find the present value using the mathematical formulas, a financial calculator, or an Excel spreadsheet.

STEP 3: Solve

Using the Mathematical Formulas.

Substitute FV_n = $1,000, i = 10%, and n = 30 years into the following equation to compute the present value:

Problem 5-17 (cont.)

$$\text{Present Value } (PV) = \text{Future Value in year } n \ (FV_n) \left[\frac{1}{\left(1 + \text{Annual Interest Rate } (i)\right)^{\text{Number of Years } (n)}} \right]$$

$$PV = \$1{,}000\left(\frac{1}{(1+0.10)^{30}}\right)$$

$$= \$1{,}000\,(0.05731)$$

$$= \$57.31$$

The present value of the security if it offers $1,000 in 30 years is $57.31.

Using a Financial Calculator.

Enter	30	10		0	1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			− 57.31		

Using an Excel Spreadsheet.

= PV(rate,nper,pmt,fv) or with values entered = PV(0.10,30,0,1000)

STEP 4: Analyze

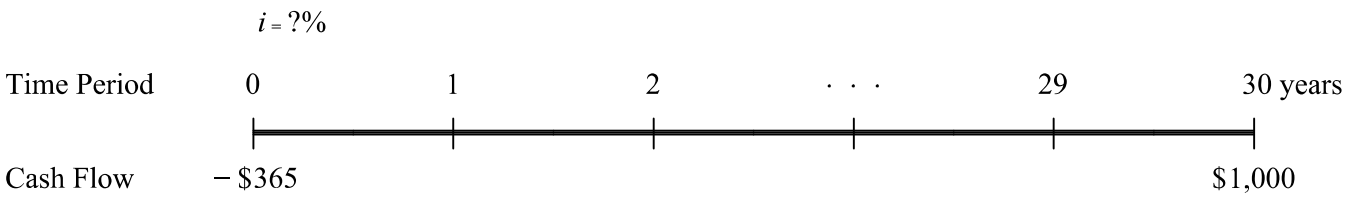
Once you've found the present value of any future cash flow, that present value is in today's dollars and can be compared to other present values. The underlying point of this exercise is to make cash flows that occur in different time periods comparable so that we can make good decisions. Also notice that regardless of which method we use to calculate the future value—computing the formula by hand, with a calculator, or with Excel—we always arrive at the same answer. In this problem, given a discount rate of 10%, a security that offers $1,000 in 30 years is worth $57.31 today.

Problem 5-17 (cont.)

b. Assume these investments sell for $365 in return for which you receive $1,000 in 30 years. What is the rate of return investors earn on this investment if they buy it for $365?

STEP 1: Picture the problem

We can visualize the problem using a timeline as follows:



STEP 2: Decide on a solution strategy

In this problem we know the number of years, the present value, and the future value, and we are solving for the interest rate. We are solving for i, and we can calculate it using either the future value equation or present value equation. Solving for i mathematically is tough. One way is to solve for i using a trial-and-error approach. That is, you could substitute different values of i into the equation—either increasing the value of i to make the right-hand side of the equation larger, or decreasing the value of i to make it smaller, until the two sides of the equation are equal—but that would be a bit tedious. Using the time value of money features on a financial calculator or in Excel is much easier and faster.

STEP 3: Solve

Using the Mathematical Formulas.

Substitute $FV_n = \$1{,}000$, $PV = \$365$, and $n = 30$ years into the following equation to solve for i:

Problem 5-17 (cont.)

$$\text{Future Value in year } n \ (FV_n) = \text{Present Value } (PV)\left(1 + \text{Annual Interest Rate } (i)\right)^{\text{Number of Years } (n)}$$

$$\$1{,}000 = \$365(1 + i)^{30}$$

$$2.73973 = (1 + i)^{30}$$

We then take the 30th root of this equation to find the value of $(1 + i)$. Since taking the 30th root is the same as taking something to the 1/30 (or 0.033333) power, this can be done if you have a financial calculator with a "y^n" key. In this case, you (1) enter 2.73973, (2) press the "y^n" key, (3) enter 0.033333, and (4) press the " = " key. The answer should be 1.03417, indicating that $(1 + i) = 1.03417$, and $i = 3.42\%$.

Using a Financial Calculator.

Enter	30		− 365	0	1,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for		3.42			

Using an Excel Spreadsheet.

= RATE(nper,pmt,pv,fv) or with values entered = RATE(30,0, − 365,1000)

STEP 4: Analyze

You can increase your future value by growing your money at a higher interest rate or by letting your money grow for a longer period of time. For most of you, when it comes to planning for your retirement, a larger n is a real positive for you. Also, if you can earn a slightly higher return on your retirement savings, or any savings for that matter, it can make a big difference. For this problem, if a security sells for $365 today in return for which investors receive $1,000 in 30 years, the rate of return investors can earn on this security is 3.42%.

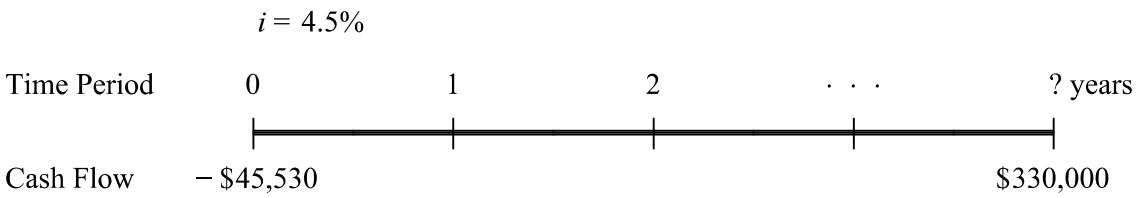
Problem 5-18

(Related to Checkpoint 5.5) (Solving for *n*) Jack asked Jill to marry him, and she has accepted under one condition: Jack must buy her a new $330,000 Rolls-Royce Phantom. Jack currently has $45,530 that he may invest. He has found a mutual fund with an expected annual return of 4.5% in which he will place the money. How long will it take Jack to win Jill's hand in marriage? Ignore taxes and inflation.

How long will it take Jack to win Jill's hand in marriage?

STEP 1: Picture the problem

In this case we are solving for the number of periods:



STEP 2: Decide on a solution strategy

In this problem we know the interest rate, the present value, and the future value, and we want to know how many years it will take for $45,530 to grow to $330,000 at 4.5% per year. We are solving for *n*, and we can calculate it using either the future value equation or present value equation. Solving for *n* mathematically is tough. One way is to solve for *n* using a trial-and-error approach. That is, you could substitute different values of *n* into the equation—either increasing the value of *n* to make the right-hand side of the equation larger, or decreasing the value of *n* to make it smaller, until the two sides of the equation are equal—but that would be a bit tedious. Using the time value of money features on a financial calculator or in Excel is much easier and faster.

STEP 3: Solve

Using a Financial Calculator.

Problem 5-18 (cont.)

Enter		4.5	− 45,530	0	330,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for	45				

Using an Excel Spreadsheet.

= NPER(rate,pmt,pv,fv) or with values entered = NPER(0.045,0, − 45530,330000)

STEP 4: Analyze

It will take about 45 years for $45,530 to grow to $330,000 at 4.5% compound interest. This is the kind of calculation that both individuals and businesses make in trying to plan for major expenditures.

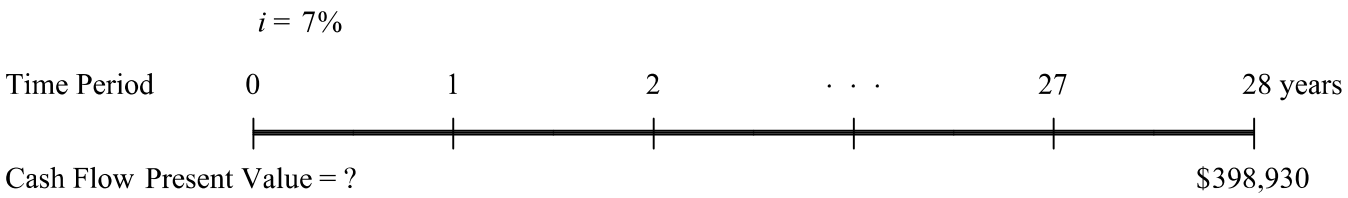
Problem 5-19

(Related to Checkpoint 5.4) (Present value) Ronen Consulting has just realized an accounting error that has resulted in an unfunded liability of $398,930 due in 28 years. In other words, they will need $398,930 in 28 years. Toni Flanders, the company's CEO, is scrambling to discount the liability to the present to assist in valuing the firm's stock. If the appropriate discount rate is 7%, what is the present value of the liability?

If the appropriate discount rate is 7%, what is the present value of the $398,930 liability due in 28 years?

STEP 1: Picture the problem

Expressed as a timeline, this problem would look like the following:



STEP 2: Decide on a solution strategy

This is a simple present value problem with a single cash flow. We know the future value, interest rate, and number of years; we are looking for the present value. We can find the present value using the mathematical formulas, a financial calculator, or an Excel spreadsheet.

STEP 3: Solve

Using the Mathematical Formulas.

Substitute FV_n = $398,930, i = 7%, and n = 28 years into the following equation to compute the present value:

$$\text{Present Value } (PV) = \text{Future Value in year } n \ (FV_n) \left[\frac{1}{\left(1 + \text{Annual Interest Rate } (i)\right)^{\text{Number of Years } (n)}} \right]$$

Problem 5-19 (cont.)

$$PV = \$398{,}930\left[\frac{1}{(1+0.07)^{28}}\right]$$

$$= \$398{,}930[0.15040]$$

$$= \$60{,}000$$

The present value of the $398,930 liability due in 28 years is $60,000.

Using a Financial Calculator.

Enter	28	7		0	398,930
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			− 60,000		

Using an Excel Spreadsheet.

= PV(rate,nper,pmt,fv) or with values entered = PV(0.07,28,0,398930)

STEP 4: Analyze

Once you've found the present value of any future cash flow, that present value is in today's dollars and can be compared to other present values. The underlying point of this exercise is to make cash flows that occur in different time periods comparable so that we can make good decisions. Also notice that regardless of which method we use to calculate the future value—computing the formula by hand, with a calculator, or with Excel—we always arrive at the same answer. In this problem, given a discount rate of 7%, the present value of the $398,930 liability due in 28 years is $60,000.

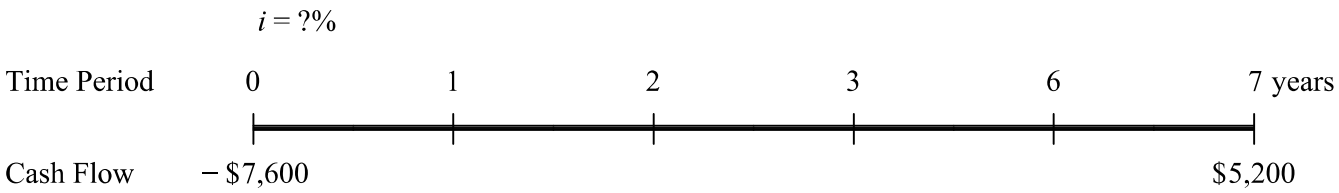
Problem 5-20

(Related to Checkpoint 5.6) (Solving for *i*) Lance Murdock purchased a wooden statue of a Conquistador for $7,600 to put in his home office 7 years ago. Lance has recently married, and his home office is being converted into a sewing room. His new wife, who has far better taste than Lance, thinks the Conquistador is hideous and must go immediately. Lance decided to sell it on e-Bay and only received $5,200 for it, and so he took a loss on the investment. What was his rate of return, that is, the value of *i*?

What was Lance Murdock's rate of return, that is, the value of *i*?

STEP 1: Picture the problem

We can visualize the problem using a timeline as follows:



STEP 2: Decide on a solution strategy

In this problem we know the number of years, the present value, and the future value, and we are solving for the interest rate. We are solving for *i*, and we can calculate it using either the future value equation or present value equation. Solving for *i* mathematically is tough. One way is to solve for *i* using a trial-and-error approach. That is, you could substitute different values of *i* into the equation—either increasing the value of *i* to make the right-hand side of the equation larger, or decreasing the value of *i* to make it smaller, until the two sides of the equation are equal—but that would be a bit tedious. Using the time value of money features on a financial calculator or in Excel is much easier and faster.

STEP 3: Solve

Using the Mathematical Formulas.

Substitute $FV_n = \$5{,}200$, $PV = \$7{,}600$, and $n = 7$ years into the following equation to solve for *i*:

Problem 5-20 (cont.)

$$\text{Future Value in year } n \ (FV_n) = \text{Present Value } (PV)\left(1 + \text{Annual Interest Rate } (i)\right)^{\text{Number of Years } (n)}$$

$$\$5{,}200 = \$7{,}600(1 + i)^7$$

$$0.68421 = (1 + i)^7$$

We then take the 7^{th} root of this equation to find the value of $(1 + i)$. Since taking the 7^{th} root is the same as taking something to the 1/7 (or 0.14286) power, this can be done if you have a financial calculator with a "y^n" key. In this case, you (1) enter 0.68421, (2) press the "y^n" key, (3) enter 0.14286, and (4) press the " = " key. The answer should be 0.94723, indicating that $(1 + i) = 0.94723$, and $i = -0.0528 = -5.28\%$.

Using a Financial Calculator.

Enter	7		− 7,600	0	5,200
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for		− 5.28			

Using an Excel Spreadsheet.

= RATE(nper,pmt,pv,fv) or with values entered = RATE(7,0, − 7600,5200)

STEP 4: Analyze

Investors can earn a negative return on investments. Compounding of losses can increase a loss just as easily as compounding of a positive return can increase one's gains. For this problem, the annual rate of return Lance Murdock earned on his investment over the 7 years is − 5.28%.

Problem 5-21

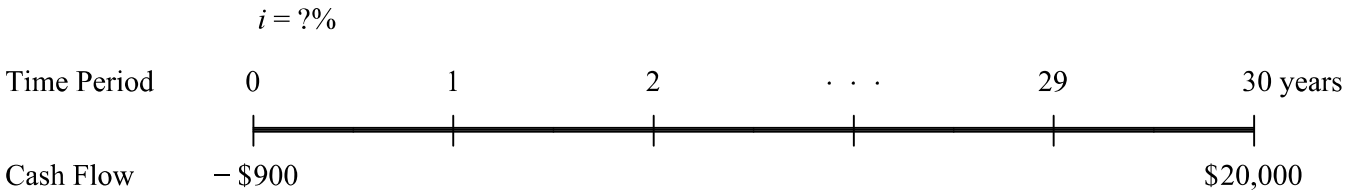
(Solving for *i*) Springfield Learning sold zero coupon bonds (bonds that don't pay any interest, instead the bondholder gets just one payment, coming when the bond matures, from the issuer) and received $900 for each bond that will pay $20,000 when it matures in 30 years.

a. At what rate is Springfield Learning borrowing the money from investors?
b. If Nancy Muntz purchased a bond at the offering for $900 and sold it 10 years later for the market price of $3,500, what annual rate of return did she earn?
c. If Barney Gumble purchased Muntz's bond at the market price ($3,500) and held it 20 years until maturity, what annual rate of return would he have earned?

Springfield Learning sold zero coupon bonds and received $900 for each bond that will pay $20,000 when it matures in 30 years. At what rate is Springfield Learning borrowing the money from investors?

STEP 1: Picture the problem

We can visualize the problem using a timeline as follows:



STEP 2: Decide on a solution strategy

In this problem we know the number of years, the present value, and the future value, and we are solving for the interest rate. We are solving for *i*, and we can calculate it using either the future value equation or present value equation. Solving for *i* mathematically is tough. One way is to solve for *i* using a trial-and-error approach. That is, you could substitute different values of *i* into the equation—either increasing the value of *i* to make the right-hand side of the equation larger, or decreasing the value of *i* to make it smaller, until the two sides of the equation are equal—but that would be a bit tedious. Using the time value of money features on a financial calculator or in Excel is much easier and faster.

STEP 3: Solve

Using the Mathematical Formulas.

Problem 5-21 (cont.)

Substitute $FV_n = \$20{,}000$, $PV = \$900$, and $n = 30$ years into the following equation to solve for i:

$$\text{Future Value in year } n \ (FV_n) = \text{Present Value } (PV)\left(1 + \text{Annual Interest Rate } (i)\right)^{\text{Number of Years } (n)}$$

$$\$20{,}000 = \$900(1 + i)^{30}$$

$$22.22222 = (1 + i)^{30}$$

We then take the 30th root of this equation to find the value of $(1 + i)$. Since taking the 30th root is the same as taking something to the 1/30 (or 0.03333) power, this can be done if you have a financial calculator with a "y^n" key. In this case, you (1) enter 22.22222, (2) press the "y^n" key, (3) enter 0.03333, and (4) press the " = " key. The answer should be 1.10889, indicating that $(1 + i) = 1.10889$, and $i = 0.1089 = 10.89\%$.

Using a Financial Calculator.

Enter	30		− 900	0	20,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for		10.89			

Using an Excel Spreadsheet.

= RATE(nper,pmt,pv,fv) or with values entered = RATE(30,0, − 900,20000)

STEP 4: Analyze

You can increase your future value by growing your money at a higher interest rate or by letting your money grow for a longer period of time. For most of you, when it comes to planning for your retirement, a larger n is a real positive for you. Also, if you can earn a slightly higher return on your retirement savings, or

Problem 5-21 (cont.)

any savings for that matter, it can make a big difference. For this problem, the annual interest rate at which Springfield Learning is borrowing the money from investors is 10.89%.

Follow the same steps to find the corresponding annual rates for the bond investments in parts **b** and **c**.

b. If Nancy Muntz purchased a bond at the offering for $900 and sold it 10 years later for the market price of $3,500, the annual rate of return she earned is computed as follows:

Using a Financial Calculator.

Enter	10		− 900	0	3,500
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for		14.55			

c. If Barney Gumble purchased Muntz's bond at the market price ($3,500) and held it 20 years until maturity, the annual rate of return he would have earned is computed as follows:

Using a Financial Calculator.

Enter	20		− 3,500	0	20,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for		9.11			

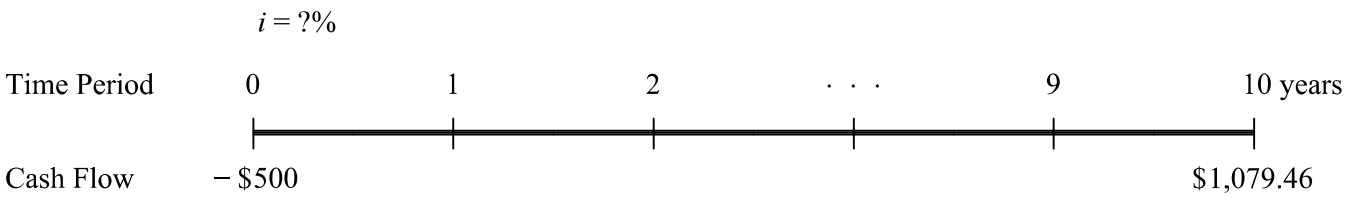
Problem 5-22

(Solving for *i*) If you were offered $1,079.46 10 years from now in return for an investment of $500 currently, what annual rate of interest would you earn if you took the offer?

If you were offered $1,079.46 10 years from now in return for an investment of $500 currently, what annual rate of interest would you earn if you took the offer?

STEP 1: Picture the problem

We can visualize the problem using a timeline as follows:



STEP 2: Decide on a solution strategy

In this problem we know the number of years, the present value, and the future value, and we are solving for the interest rate. We are solving for i, and we can calculate it using either the future value equation or present value equation. Solving for i mathematically is tough. One way is to solve for i using a trial-and-error approach. That is, you could substitute different values of i into the equation—either increasing the value of i to make the right-hand side of the equation larger, or decreasing the value of i to make it smaller, until the two sides of the equation are equal—but that would be a bit tedious. Using the time value of money features on a financial calculator or in Excel is much easier and faster.

STEP 3: Solve

Using the Mathematical Formulas.

Substitute FV_n = $1,079.46, PV = $500, and n = 10 years into the following equation to solve for i:

Problem 5-22 (cont.)

$$\text{Future Value in year } n \ (FV_n) = \text{Present Value } (PV)\left(1 + \text{Annual Interest Rate } (i)\right)^{\text{Number of Years } (n)}$$

$$\$1{,}079.46 = \$500(1 + i)^{10}$$

$$2.15892 = (1 + i)^{10}$$

We then take the 10^{th} root of this equation to find the value of $(1 + i)$. Since taking the 10^{th} root is the same as taking something to the 1/10 (or 0.10000) power, this can be done if you have a financial calculator with a "y^n" key. In this case, you (1) enter 2.15892, (2) press the "y^n" key, (3) enter 0.10000, and (4) press the " = " key. The answer should be 1.0799998, indicating that $(1 + i) = 1.0799998$, and $i = 8\%$.

Using a Financial Calculator.

Enter	10		− 500	0	1,079.46
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for		8			

Using an Excel Spreadsheet.

= RATE(nper,pmt,pv,fv) or with values entered = RATE(10,0, − 500,1079.46)

STEP 4: Analyze

Investors must be able to determine if an investment sounds reasonable or if it has an acceptable rate of return. By solving for i, we can see that this investment promises an annual rate of return of 8%, which is a good rate of return if the risk is acceptable.

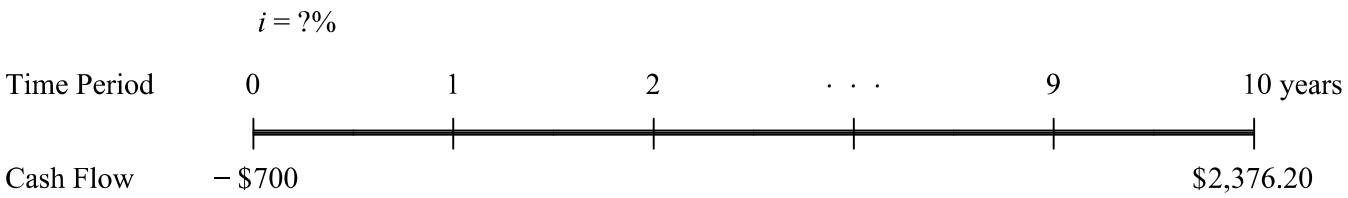
Problem 5-23

(Solving for *i*) An insurance agent just offered you a new insurance product that will provide you with $2,376.20 10 years from now if you invest $700 today. What annual rate of interest would you earn if you invested in this product?

What annual rate of interest would you earn if you invest $700 today in a new insurance product that will provide you with $2,376.20 10 years from now?

STEP 1: Picture the problem

We can visualize the problem using a timeline as follows:



STEP 2: Decide on a solution strategy

In this problem we know the number of years, the present value, and the future value, and we are solving for the interest rate. We are solving for i, and we can calculate it using either the future value equation or present value equation. Solving for i mathematically is tough. One way is to solve for i using a trial-and-error approach. That is, you could substitute different values of i into the equation—either increasing the value of i to make the right-hand side of the equation larger, or decreasing the value of i to make it smaller, until the two sides of the equation are equal—but that would be a bit tedious. Using the time value of money features on a financial calculator or in Excel is much easier and faster.

STEP 3: Solve

Using the Mathematical Formulas.

Substitute FV_n = $2,376.20, PV = $700, and n = 10 years into the following equation to solve for i:

Problem 5-23 (cont.)

$$\text{Future Value in year } n \ (FV_n) = \text{Present Value } (PV)\left(1 + \text{Annual Interest Rate } (i)\right)^{\text{Number of Years } (n)}$$

$$\$2{,}376.20 = \$700(1 + i)^{10}$$

$$3.39457 = (1 + i)^{10}$$

We then take the 10^{th} root of this equation to find the value of $(1 + i)$. Since taking the 10^{th} root is the same as taking something to the 1/10 (or 0.10000) power, this can be done if you have a financial calculator with a "y^n" key. In this case, you (1) enter 3.39457, (2) press the "y^n" key, (3) enter 0.10000, and (4) press the " = " key. The answer should be 1.130000, indicating that $(1 + i) = 1.130000$, and $i = 13\%$.

Using a Financial Calculator.

Enter	10		− 700	0	2,376.20
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for		13			

Using an Excel Spreadsheet.

= RATE(nper,pmt,pv,fv) or with values entered = RATE(10,0, − 700,2376.20)

STEP 4: Analyze

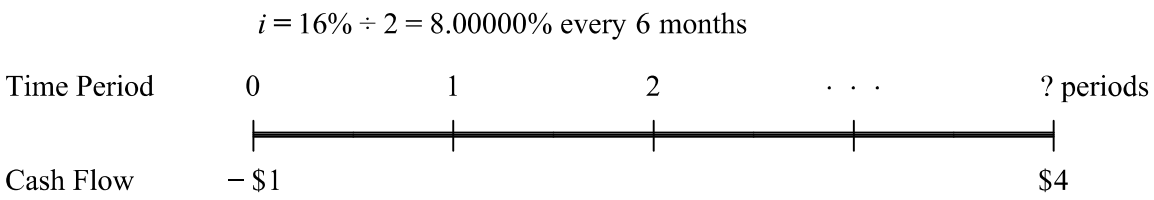
Investors must be able to determine if an investment sounds reasonable or if it has an acceptable rate of return. By solving for i, we can see that this investment promises an annual rate of return of 13%, which is a good rate of return especially if it is a guaranteed rate.

Problem 5-24

(Solving for *n* with non-annual periods) Approximately how many years would it take for an investment to grow fourfold if it were invested at 16% compounded semiannually? Assume that you invest $1 today.

STEP 1: Picture the problem

If you earn an annual rate of 16% compounded semiannually, you really earn 8.00000% every 6 months. Expressed as a timeline, this problem would look like the following:



STEP 2: Decide on a solution strategy

In this problem we know the interest rate, the present value, and the future value, and we want to know how many years it will take for an investment to grow fourfold at 16% compounded semiannually. The only twist is that interest is calculated on a semiannual basis. Thus, if you earn 16% compounded semiannually, you really earn 8.00000% every 6 months. We are solving for *n*, and we can calculate it using either the future value equation or present value equation. Solving for *n* mathematically is tough. One way is to solve for *n* using a trial-and-error approach. That is, you could substitute different values of *n* into the equation—either increasing the value of *n* to make the right-hand side of the equation larger, or decreasing the value of *n* to make it smaller, until the two sides of the equation are equal—but that would be a bit tedious. Using the time value of money features on a financial calculator or in Excel is much easier and faster.

STEP 3: Solve

Using a Financial Calculator.

Problem 5-24 (cont.)

Enter		8.00000	− 1	0	4
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for	18				

Note that the N computed from the calculator is the total investment periods (18 weeks for this problem). Since the interest rate is compounded semiannually and there are 2 6 monthss per year, the number of years it would take to triple the investment is $\frac{18}{2} = 9.0$ years.

Using an Excel Spreadsheet.

= NPER(rate,pmt,pv,fv) or with values entered = NPER(0.08,0, − 1,4)

STEP 4: Analyze

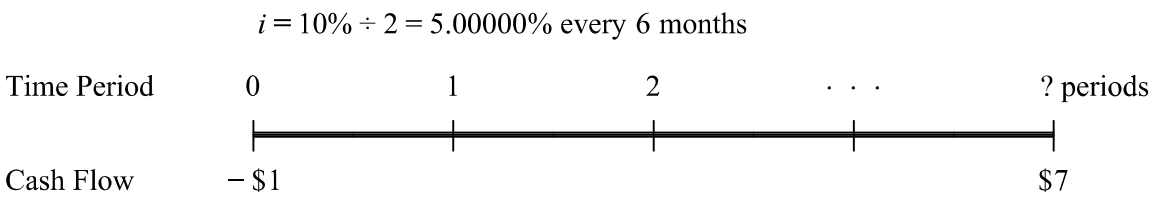
It will take about 9.0 years for an investment to grow fourfold at 16% compounded semiannually. You can use any number for the present value as long as the future value is triple the present value.

Problem 5-25

(Solving for *n* with non-annual periods) Approximately how many years would it take for an investment to grow sevenfold if it were invested at 10% compounded semiannually? Assume that you invest $1 today.

STEP 1: Picture the problem

If you earn an annual rate of 10% compounded semiannually, you really earn 5.00000% every 6 months. Expressed as a timeline, this problem would look like the following:



STEP 2: Decide on a solution strategy

In this problem we know the interest rate, the present value, and the future value, and we want to know how many years it will take for an investment to grow sevenfold at 10% compounded semiannually. The only twist is that interest is calculated on a semiannual basis. Thus, if you earn 10% compounded semiannually, you really earn 5.00000% every 6 months. We are solving for n, and we can calculate it using either the future value equation or present value equation. Solving for n mathematically is tough. One way is to solve for n using a trial-and-error approach. That is, you could substitute different values of n into the equation—either increasing the value of n to make the right-hand side of the equation larger, or decreasing the value of n to make it smaller, until the two sides of the equation are equal—but that would be a bit tedious. Using the time value of money features on a financial calculator or in Excel is much easier and faster.

STEP 3: Solve

Using a Financial Calculator.

Problem 5-25 (cont.)

Enter		5.00000	− 1	0	7
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for	40				

Note that the N computed from the calculator is the total investment periods (40 weeks for this problem). Since the interest rate is compounded semiannually and there are 2 6 monthss per year, the number of years it would take to triple the investment is $\frac{40}{2}$ = 19.9 years.

Using an Excel Spreadsheet.

= NPER(rate,pmt,pv,fv) or with values entered = NPER(0.05,0, − 1,7)

STEP 4: Analyze

It will take about 19.9 years for an investment to grow sevenfold at 10% compounded semiannually. You can use any number for the present value as long as the future value is triple the present value.

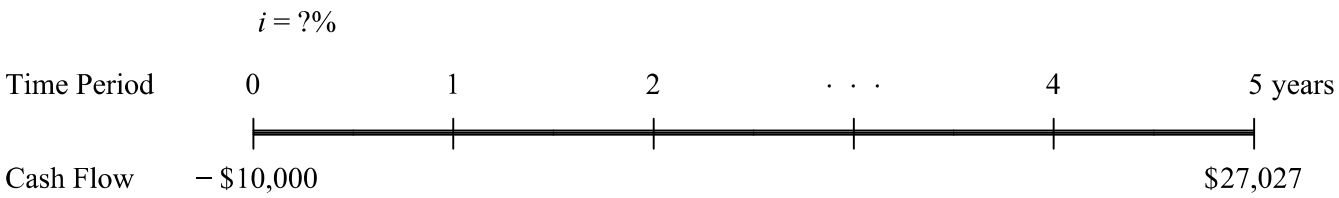
Problem 5-26

(Related to Checkpoint 5.6) (Solving for *i*) You lend a friend $10,000, for which your friend will repay you $27,027 at the end of 5 years. What interest rate are you charging your "friend"?

If you lend a friend $10,000, for which your friend will repay you $27,027 at the end of 5 years, what interest rate are you charging your "friend"?

STEP 1: Picture the problem

We can visualize the problem using a timeline as follows:



STEP 2: Decide on a solution strategy

In this problem we know the number of years, the present value, and the future value, and we are solving for the interest rate. We are solving for i, and we can calculate it using either the future value equation or present value equation. Solving for i mathematically is tough. One way is to solve for i using a trial-and-error approach. That is, you could substitute different values of i into the equation—either increasing the value of i to make the right-hand side of the equation larger, or decreasing the value of i to make it smaller, until the two sides of the equation are equal—but that would be a bit tedious. Using the time value of money features on a financial calculator or in Excel is much easier and faster.

STEP 3: Solve

Using the Mathematical Formulas.

Substitute $FV_n = \$27{,}027$, $PV = \$10{,}000$, and $n = 5$ years into the following equation to solve for i:

Problem 5-26 (cont.)

$$\text{Future Value in year } n \ (FV_n) = \text{Present Value } (PV)\left(1 + \text{Annual Interest Rate } (i)\right)^{\text{Number of Years } (n)}$$

$$\$27{,}027 = \$10{,}000(1 + i)^5$$

$$2.70271 = (1 + i)^5$$

We then take the 5th root of this equation to find the value of $(1 + i)$. Since taking the 5th root is the same as taking something to the 1/5 (or 0.20000) power, this can be done if you have a financial calculator with a "y^n" key. In this case, you (1) enter 2.70270, (2) press the "y^n" key, (3) enter 0.20000, and (4) press the " = " key. The answer should be 1.219999, indicating that $(1 + i) = 1.219999$, and $i = 22\%$.

Using a Financial Calculator.

Enter	5		− 10,000	0	27,027
	N	I/Y	PV	PMT	FV
Solve for		22			

Using an Excel Spreadsheet.

= RATE(nper,pmt,pv,fv) or with values entered = RATE(5,0, − 10000,27027)

STEP 4: Analyze

Investors must be able to determine if an investment sounds reasonable or if it has an acceptable rate of return. By solving for i, we can see that this investment promises an annual rate of return of 22%, which is a good rate of return especially if it is a guaranteed rate.

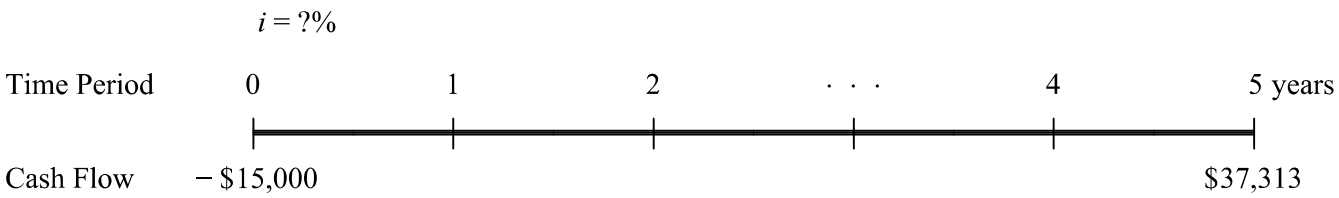
Problem 5-27

(Solving for *i*) You've run out of money for college, and your college roommate has an idea for you. He offers to lend you $15,000, for which you will repay him $37,313 at the end of 5 years. If you took this loan, what interest rate would you be paying on it?

Your friend offers to lend you $15,000, for which you will repay him $37,313 at the end of 5 years. If you took this loan, what interest rate would you be paying on it?

STEP 1: Picture the problem

We can visualize the problem using a timeline as follows:



STEP 2: Decide on a solution strategy

In this problem we know the number of years, the present value, and the future value, and we are solving for the interest rate. We are solving for i, and we can calculate it using either the future value equation or present value equation. Solving for i mathematically is tough. One way is to solve for i using a trial-and-error approach. That is, you could substitute different values of i into the equation—either increasing the value of i to make the right-hand side of the equation larger, or decreasing the value of i to make it smaller, until the two sides of the equation are equal—but that would be a bit tedious. Using the time value of money features on a financial calculator or in Excel is much easier and faster.

STEP 3: Solve

Using the Mathematical Formulas.

Substitute FV_n = $37,313, PV = $15,000, and n = 5 years into the following equation to solve for i:

Problem 5-27 (cont.)

$$\text{Future Value in year } n \ (FV_n) = \text{Present Value } (PV)\left(1 + \text{Annual Interest Rate } (i)\right)^{\text{Number of Years } (n)}$$

$$\$37{,}313 = \$15{,}000(1 + i)^5$$

$$2.48753 = (1 + i)^5$$

We then take the 5th root of this equation to find the value of $(1 + i)$. Since taking the 5th root is the same as taking something to the 1/5 (or 0.20000) power, this can be done if you have a financial calculator with a "y^n" key. In this case, you (1) enter 2.48753, (2) press the "y^n" key, (3) enter 0.20000, and (4) press the " = " key. The answer should be 1.199924, indicating that $(1 + i) = 1.199924$, and $i = 19.99\%$.

Using a Financial Calculator.

Enter	5		− 15,000	0	37,313
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for		19.99			

Using an Excel Spreadsheet.

= RATE(nper,pmt,pv,fv) or with values entered = RATE(5,0, − 15000,37313)

STEP 4: Analyze

Borrowers must be able to determine if the loan interest rate is reasonable or if it is the lower than any alternative source of funds. By solving for i, we can see that the annual interest rate you are paying for the $15,000 5-year loan would be 19.99%. You can now compare that rate with any other loans you are considering.

Problem 5-28

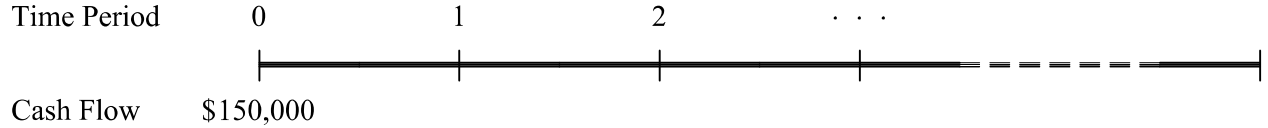
(Related to Checkpoint 5.4) (Present-value comparison) You are offered $150,000 today or $300,000 in 13 years. Assuming that you can earn 11% on your money, which should you choose?

Assuming that you can earn 11% on your money, which should you choose: $150,000 today or $300,000 in 13 years?

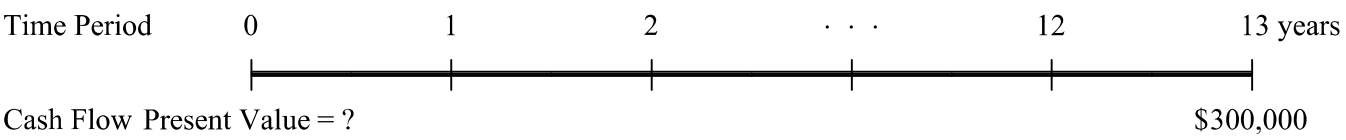
STEP 1: Picture the problem

An investment is more attractive if it has higher present value at a given interest rate. We can set up timelines to identify the cash flows for the two options as follows:

Option 1: $i = 11\%$



Option 2: $i = 11\%$



STEP 2: Decide on a solution strategy

This is a simple present value problem with a single cash flow. We know the future value, interest rate, and number of years; we are looking for the present value. We can find the present value using the mathematical formulas, a financial calculator, or an Excel spreadsheet. You should choose the option with higher present value.

STEP 3: Solve

If you are offered $300,000 in 13 years and you can earn 11% on your money, the present value of $300,000 is computed as follows:

Problem 5-28 (cont.)

Using the Mathematical Formulas.

Substitute $FV_n = \$300{,}000$, $i = 11\%$, and $n = 13$ years into the following equation to compute the present value:

$$\text{Present Value } (PV) = \text{Future Value in year } n \ (FV_n) \left[\frac{1}{\left(1 + \text{Annual Interest Rate } (i)\right)^{\text{Number of Years } (n)}} \right]$$

$$PV = \$300{,}000\left(\frac{1}{(1+0.11)^{13}}\right)$$

$$= \$300{,}000\,(0.25751)$$

$$= \$77{,}254$$

Using a Financial Calculator.

Enter	13	11		0	300,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			− 77,254		

Using an Excel Spreadsheet.

= PV(rate,nper,pmt,fv) or with values entered = PV(0.11,13,0,300000)

STEP 4: Analyze

In this problem, you should choose \$150,000 today because at a 11% discount rate 300,000 present value is less than than \$150,000.

Problem 5-29

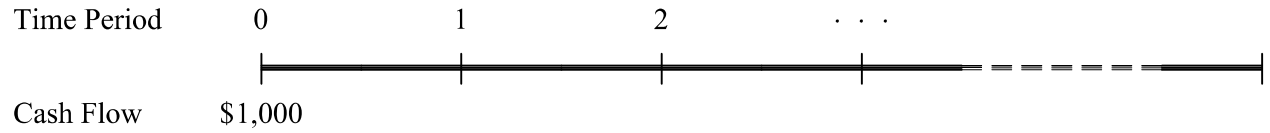
(Present value comparison) Much to your surprise, you were selected to appear on the TV show "The Price is Right." As a result of your prowess in identifying how many rolls of toilet paper a typical American family keeps on hand, you win the opportunity to choose one of the following: $1,000 today, $10,000 in 12 years, or $25,000 in 25 years. Assuming that you can earn 11% on your money, which should you choose?

Assuming that you can earn 11% on your money, which should you choose: $1,000 today, $10,000 in 12 years, or $25,000 in 25 years?

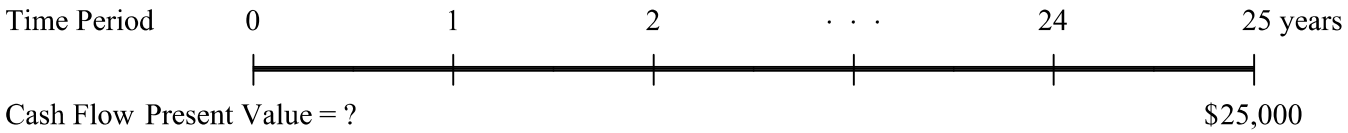
STEP 1: Picture the problem

An investment is more attractive if it has higher present value at a given interest rate. We can set up timelines to identify the cash flows for the three options as follows:

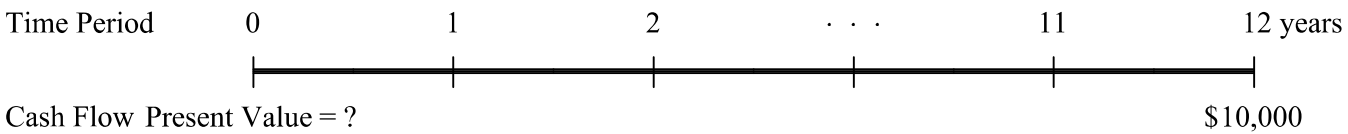
Option 1: $i = 11\%$



Option 2: $i = 11\%$



Option 3: $i = 11\%$



Problem 5-29 (cont.)

STEP 2: Decide on a solution strategy

This is a simple present value problem with a single cash flow. We know the future value, interest rate, and number of years; we are looking for the present value. We can find the present value using the mathematical formulas, a financial calculator, or an Excel spreadsheet. You should choose the option with the highest present value.

If you are offered $10,000 in 12 years and you can earn 11% on your money, the present value of $10,000 is computed as follows:

STEP 3: Solve

Using the Mathematical Formulas.

Substitute $FV_n = \$10{,}000$, $i = 11\%$, and $n = 12$ years into the following equation to compute the present value:

$$\text{Present Value } (PV) = \text{Future Value in year } n \ (FV_n) \left[\frac{1}{\left(1 + \text{Annual Interest Rate } (i)\right)^{\text{Number of Years } (n)}} \right]$$

$$PV = \$10{,}000\left(\frac{1}{(1+0.11)^{12}}\right)$$

$$= \$10{,}000\,(0.28584)$$

$$= \$2{,}858.41$$

Using a Financial Calculator.

Problem 5-29 (cont.)

Enter	12	11		0	10,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			−2,858.41		

Using an Excel Spreadsheet.

= PV(rate,nper,pmt,fv) or with values entered = PV(0.11,12,0,10000)

If you are offered $25,000 in 25 years and you can earn 11% on your money, the present value of $25,000 is computed as follows:

STEP 3: Solve

Using the Mathematical Formulas.

Substitute $FV_n = \$25{,}000$, $i = 11\%$, and $n = 25$ years into the following equation to compute the present value:

$$\text{Present Value } (PV) = \text{Future Value in year } n \ (FV_n) \left[\frac{1}{\left(1 + \text{Annual Interest Rate } (i)\right)^{\text{Number of Years } (n)}} \right]$$

$$PV = \$25{,}000\left(\frac{1}{(1+0.11)^{25}}\right)$$

$$= \$25{,}000\,(0.07361)$$

$$= \$1{,}840.20$$

Using a Financial Calculator.

Problem 5-29 (cont.)

Enter	25	11		0	25,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for			− 1,840.20		

Using an Excel Spreadsheet.

= PV(rate,nper,pmt,fv) or with values entered = PV(0.11,25,0,25000)

STEP 4: Analyze

In this problem, you should choose $10,000 in 12 years because its present value is the highest when the interest rate is 11%.

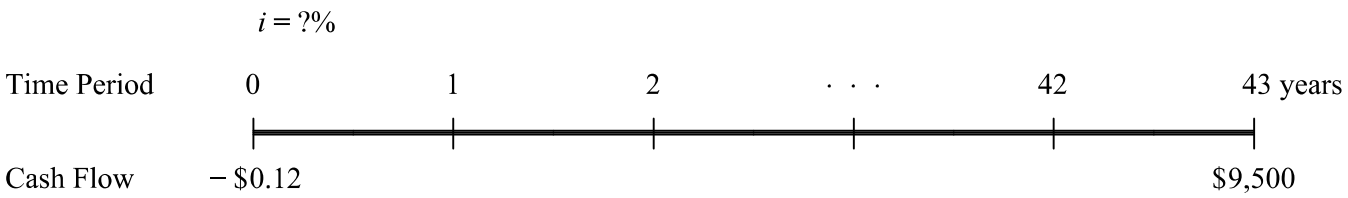
Problem 5-30

(Related to Checkpoint 5.6) (Solving for *i*—financial calculator needed) In September 1963, the first issue of the comic book *X-MEN* was issued. The original price for the issue was $0.12. By September 2006, 43 years later, the value of this comic book had risen to $9,500. What annual rate of interest would you have earned if you had bought the comic in 1963 and sold it in 2006?

What annual rate of interest would you have earned if you had bought the comic in 1963 and sold it in 2006?

STEP 1: Picture the problem

We can visualize the problem using a timeline as follows:



STEP 2: Decide on a solution strategy

In this problem we know the number of years, the present value, and the future value, and we are solving for the interest rate. We are solving for i, and we can calculate it using either the future value equation or present value equation. Solving for i mathematically is tough. One way is to solve for i using a trial-and-error approach. That is, you could substitute different values of i into the equation—either increasing the value of i to make the right-hand side of the equation larger, or decreasing the value of i to make it smaller, until the two sides of the equation are equal—but that would be a bit tedious. Using the time value of money features on a financial calculator or in Excel is much easier and faster.

STEP 3: Solve

Using the Mathematical Formulas.

Substitute FV_n = $9,500, PV = $0.12, and n = 43 years into the following equation to solve for i:

Problem 5-30 (cont.)

$$\text{Future Value in year } n \ (FV_n) = \text{Present Value } (PV)\left(1 + \text{Annual Interest Rate } (i)\right)^{\text{Number of Years } (n)}$$

$$\$9{,}500 = \$0.12(1 + i)^{43}$$

$$79{,}166.67 = (1 + i)^{43}$$

We then take the 43^{th} root of this equation to find the value of $(1 + i)$. Since taking the 43^{th} root is the same as taking something to the 1/43 (or 0.023256) power, this can be done if you have a financial calculator with a "y^n" key. In this case, you (1) enter 79,166.67, (2) press the "y^n" key, (3) enter 0.023256, and (4) press the " = " key. The answer should be 1.29993, indicating that $(1 + i) = 1.29993$, and $i = 29.99\%$.

Using a Financial Calculator.

Enter	43		− 0.12	0	9,500
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for		29.99			

Using an Excel Spreadsheet.

= RATE(nper,pmt,pv,fv) or with values entered = RATE(43,0, − 0.12,9500)

STEP 4: Analyze

You can increase your future value by growing your money at a higher interest rate or by letting your money grow for a longer period of time. For most of you, when it comes to planning for retirement, a larger n is a real positive for you. Also, if you can earn a slightly higher return on your retirement savings, or any savings for that matter, it can make a big difference. For this problem, the annual rate of interest you would have earned if you had bought the comic for $0.12 in 1963 and sold it for $9,500 in 2006 is 29.99%. In this problem you can also see the power of compounding. An initial investment of just a few cents,

Problem 5-30 (cont.)

compounded at a very good rate of return for a lengthy period of time, can provide a return of thousands of dollars.

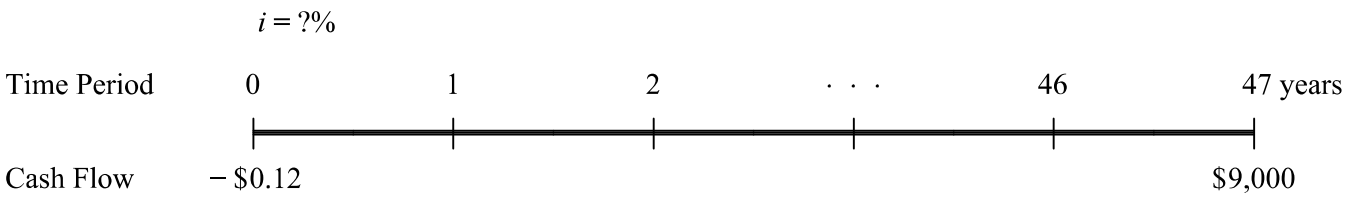
Problem 5-31

(Solving for *i*—financial calculator needed) In March 1963, Ironman was first introduced in issue number 39 of *Tales of Suspense*. The original price for that issue was $0.12. By March of 2010, 47 years later, the value of this comic book had risen to $9,000. What annual rate of interest would you have earned if you had bought the comic book in 1963 and sold it in 2010?

What annual rate of interest would you have earned if you had bought the comic book in 1963 and sold it in 2010?

STEP 1: Picture the problem

We can visualize the problem using a timeline as follows:



STEP 2: Decide on a solution strategy

In this problem we know the number of years, the present value, and the future value, and we are solving for the interest rate. We are solving for i, and we can calculate it using either the future value equation or present value equation. Solving for i mathematically is tough. One way is to solve for i using a trial-and-error approach. That is, you could substitute different values of i into the equation—either increasing the value of i to make the right-hand side of the equation larger, or decreasing the value of i to make it smaller, until the two sides of the equation are equal—but that would be a bit tedious. Using the time value of money features on a financial calculator or in Excel is much easier and faster.

STEP 3: Solve

Using the Mathematical Formulas.

Substitute $FV_n = \$9{,}000$, $PV = \$0.12$, and $n = 47$ years into the following equation to solve for i:

Problem 5-31 (cont.)

$$\text{Future Value in year } n \ (FV_n) = \text{Present Value } (PV)\left(1 + \text{Annual Interest Rate } (i)\right)^{\text{Number of Years } (n)}$$

$$\$9{,}000 = \$0.12(1 + i)^{47}$$

$$75{,}000.00 = (1 + i)^{47}$$

We then take the 47th root of this equation to find the value of $(1 + i)$. Since taking the 47th root is the same as taking something to the 1/47 (or 0.02128) power, this can be done if you have a financial calculator with a "y^n" key. In this case, you (1) enter 75,000.00, (2) press the "y^n" key, (3) enter 0.02128, and (4) press the " = " key. The answer should be 1.26982, indicating that $(1 + i) = 1.26982$, and $i = 26.98\%$.

Using a Financial Calculator.

Enter	47		− 0.12	0	9,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for		26.98			

Using an Excel Spreadsheet.

= RATE(nper,pmt,pv,fv) or with values entered = RATE(47,0, − 0.12,9000)

STEP 4: Analyze

You can increase your future value by growing your money at a higher interest rate or by letting your money grow for a longer period of time. For most of you, when it comes to planning for your retirement, a larger n is a real positive for you. Also, if you can earn a slightly higher return on your retirement savings, or any savings for that matter, it can make a big difference. For this problem, the annual rate of interest you would have earned if you had bought the comic book for $0.12 in 1963 and sold it for $9,000 in 2010 is 26.98%. In this problem you can also see the power of compounding. An initial investment of just a few

Problem 5-31 (cont.)

cents, compounded at a very good rate of return for a lengthy period of time, can provide a return of thousands of dollars.

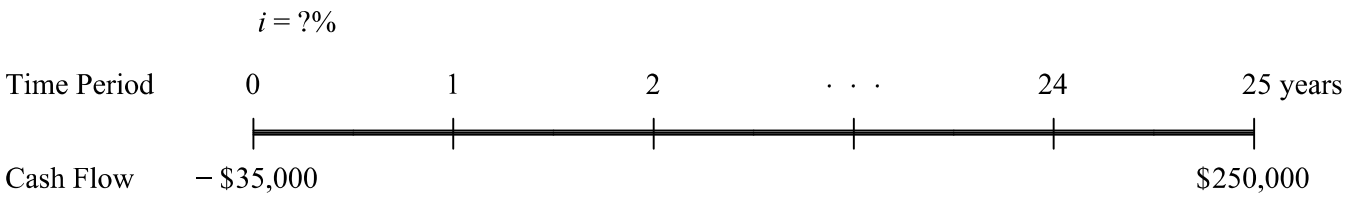
Problem 5-32

(Solving for *i*) A financial planner just offered you a new investment product that would require an initial investment on your part of $35,000, and would be worth $250,000 25 years from now. What annual rate of interest would you earn if you invested in this product?

If you invested $35,000 in a product that would be worth $250,000 in 25 years, what annual rate of interest would you earn?

STEP 1: Picture the problem

We can visualize the problem using a timeline as follows:



STEP 2: Decide on a solution strategy

In this problem we know the number of years, the present value, and the future value, and we are solving for the interest rate. We are solving for i, and we can calculate it using either the future value equation or present value equation. Solving for i mathematically is tough. One way is to solve for i using a trial-and-error approach. That is, you could substitute different values of i into the equation—either increasing the value of i to make the right-hand side of the equation larger, or decreasing the value of i to make it smaller, until the two sides of the equation are equal—but that would be a bit tedious. Using the time value of money features on a financial calculator or in Excel is much easier and faster.

STEP 3: Solve

Using the Mathematical Formulas.

Substitute FV_n = $250,000, PV = $35,000, and n = 25 years into the following equation to solve for i:

Problem 5-32 (cont.)

$$\text{Future Value in year } n \ (FV_n) = \text{Present Value } (PV)\left(1 + \text{Annual Interest Rate } (i)\right)^{\text{Number of Years } (n)}$$

$$\$250{,}000 = \$35{,}000(1 + i)^{25}$$

$$7.14286 = (1 + i)^{25}$$

We then take the 25th root of this equation to find the value of $(1 + i)$. Since taking the 25th root is the same as taking something to the 1/25 (or 0.04000) power, this can be done if you have a financial calculator with a "y^n" key. In this case, you (1) enter 7.14286, (2) press the "y^n" key, (3) enter 0.04000, and (4) press the " = " key. The answer should be 1.08182, indicating that $(1 + i) = 1.08182$, and $i = 8.18\%$.

Using a Financial Calculator.

Enter	25		− 35,000	0	250,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for		8.18			

Using an Excel Spreadsheet.

= RATE(nper,pmt,pv,fv) or with values entered = RATE(25,0, − 35000,250000)

STEP 4: Analyze

You can increase your future value by growing your money at a higher interest rate or by letting your money grow for a longer period of time. For most of you, when it comes to planning for your retirement, a larger n is a real positive for you. Also, if you can earn a slightly higher return on your retirement savings, or any savings for that matter, it can make a big difference. For this problem, the annual interest rate you would earn if you invested $35,000 in the new investment product for 25 years would be 8.18%.

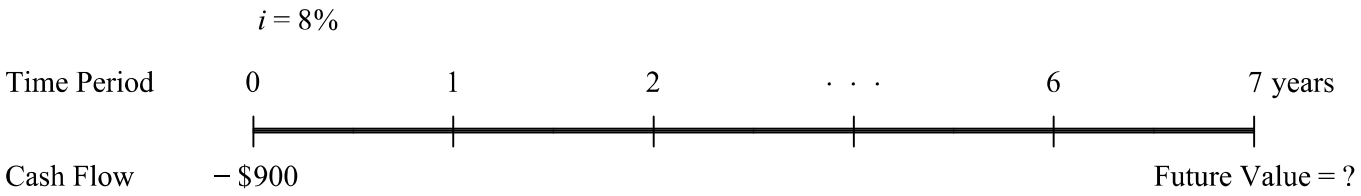
Problem 5-33

(Spreadsheet problem) If you invest $900 in a bank where it will earn 8% compounded annually, how much will it be worth at the end of 7 years?

If you invest $900 in a bank where it will earn 8% compounded annually, how much will it be worth at the end of 7 years?

STEP 1: Picture the problem

We can set up a timeline to identify the cash flows from the investment as follows:



STEP 2: Decide on a solution strategy

This is a simple future value problem with a single cash flow. We know the present value, interest rate, and number of years; we are looking for the future value. We can find the future value using the mathematical formulas, a financial calculator, or an Excel spreadsheet.

STEP 3: Solve

Using the Mathematical Formulas.

Substitute $PV = \$900$, $i = 8\%$, and $n = 7$ years into the following equation to compute the future value:

$$\begin{pmatrix}\text{Future Value}\\ \text{in year } n\\ (FV_n)\end{pmatrix} = \begin{pmatrix}\text{Present}\\ \text{Value } (PV)\end{pmatrix}\left(1 + \begin{pmatrix}\text{Annual}\\ \text{Interest Rate } (i)\end{pmatrix}\right)^{\begin{matrix}\text{Number of}\\ \text{Years } (n)\end{matrix}}$$

$$FV_7 = \$900(1 + 0.08)^7$$

Problem 5-33 (cont.)

$= \$900(1.71382)$

$= \$1{,}542.44$

At the end of 7 years, the investment will accumulate to the amount of $1,542.44.

Using a Financial Calculator.

Enter	7	8	− 900	0	
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for					1,542.44

Using an Excel Spreadsheet.

= FV(rate,nper,pmt,pv) or with values entered = FV(0.08,7,0, − 900)

STEP 4: Analyze

Notice that you input the present value with a negative sign because present value represents a cash outflow. In effect, the money leaves you when it is first invested. In this problem you invest $900 at 8% and found that it will grow to $1,542.44 after 7 years. Put another way, given a compound rate of 8%, your $900 today will be worth $1,542.44 in 7 years.

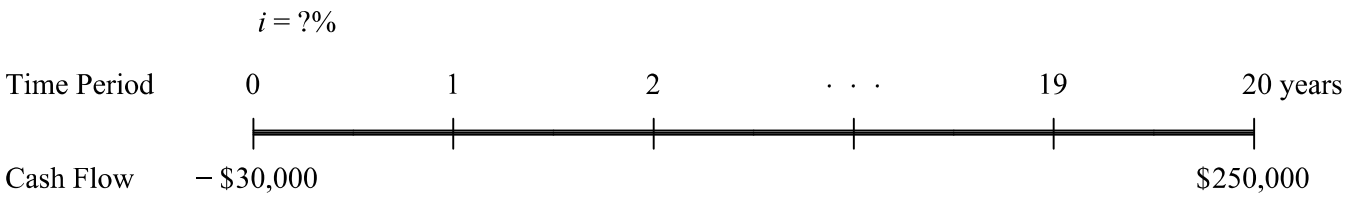
Problem 5-34

(Spreadsheet problem) In 20 years, you would like to have $250,000 to buy a vacation home. If you have only $30,000, at what rate must it be compounded annually for it to grow to $250,000 in 20 years?

If you have only $30,000, at what rate must it be compounded annually for it to grow to $250,000 in 20 years?

STEP 1: Picture the problem

We can visualize the problem using a timeline as follows:



STEP 2: Decide on a solution strategy

In this problem we know the number of years, the present value, and the future value, and we are solving for the interest rate. We are solving for i, and we can calculate it using either the future value equation or present value equation. Solving for i mathematically is tough. One way is to solve for i using a trial-and-error approach. That is, you could substitute different values of i into the equation—either increasing the value of i to make the right-hand side of the equation larger, or decreasing the value of i to make it smaller, until the two sides of the equation are equal—but that would be a bit tedious. Using the time value of money features on a financial calculator or in Excel is much easier and faster.

STEP 3: Solve

Using the Mathematical Formulas.

Substitute FV_n = $250,000, PV = $30,000, and n = 20 years into the following equation to solve for i:

Problem 5-34 (cont.)

$$\text{Future Value in year } n \ (FV_n) = \text{Present Value } (PV)\left(1 + \text{Annual Interest Rate } (i)\right)^{\text{Number of Years } (n)}$$

$$\$250{,}000 = \$30{,}000(1 + i)^{20}$$

$$8.3333 = (1 + i)^{20}$$

We then take the 20th root of this equation to find the value of $(1 + i)$. Since taking the 20th root is the same as taking something to the 1/20 (or 0.05000) power, this can be done if you have a financial calculator with a "y^n" key. In this case, you (1) enter 8.3333, (2) press the "y^n" key, (3) enter 0.05000, and (4) press the " = " key. The answer should be 1.11184, indicating that $(1 + i) = 1.11184$, and $i = 11.18\%$.

Using a Financial Calculator.

Enter	20		− 30,000	0	250,000
	N	**I/Y**	**PV**	**PMT**	**FV**
Solve for		11.18			

Using an Excel Spreadsheet.

= RATE(nper,pmt,pv,fv) or with values entered = RATE(20,0, − 30,000,250000)

STEP 4: Analyze

You can increase your future value by growing your money at a higher interest rate or by letting your money grow for a longer period of time. For most of you, when it comes to planning for your retirement, a larger n is a real positive for you. Also, if you can earn a slightly higher return on your retirement savings, or any savings for that matter, it can make a big difference. For this problem, the annual interest rate you need to earn in order for the $30,000 to grow to $250,000 in 20 years should be 11.18%.

Problem 5-35

(Related to Checkpoint 5.7) (Calculating an EAR) After examining the various personal loan rates available to you, you find that you can borrow funds from a finance company at 12% compounded monthly or from a bank at 13% compounded annually. Which alternative is more attractive?

You find that you can borrow funds from a finance company at 12% compounded monthly or from a bank at 13% compounded annually. Which alternative is more attractive?

STEP 1: Picture the problem

We can visualize the problem using a timeline as follows:

Finance company: If i = an annual rate of 12% compounded monthly, what is the EAR?
Bank: If i = an annual rate of 13% compounded annually, what is the EAR?

STEP 2: Decide on a solution strategy

We'll use the following equation to solve this problem:

$$\begin{matrix}\text{Effective}\\ \text{Annual Rate}\\ (EAR)\end{matrix} = \left(1 + \frac{\text{Quoted Annual Rate}}{\text{Compounding Periods per year } (m)}\right)^{m} - 1$$

STEP 3: Solve

You can borrow funds from a finance company at 12% compounded monthly. To calculate the EAR we can use the following equation, where the quoted annual rate is 12%, and m is 12. Substituting in these values, we get,

Problem 5-35 (cont.)

$$\text{Effective Annual Rate } (EAR) = \left(1 + \frac{\text{Quoted Annual Rate}}{\text{Compounding Periods per year } (m)}\right)^{m} - 1$$

$$EAR = \left(1 + \frac{0.12}{12}\right)^{12} - 1$$

$$EAR = 0.1268 = 12.68\%$$

You are correct if you believe that the EAR will be higher than the quoted rate. In reality, the EAR, or effective annual rate, is actually 12.68%. Recall that whenever interest is compounded more frequently, it accumulates faster.

You can borrow funds from a bank at 13% compounded annually. To calculate the EAR we can use the following equation, where the quoted annual rate is 13%, and *m* is 1. Substituting in these values, we get,

$$EAR = \left(1 + \frac{0.13}{1}\right)^{1} - 1$$

$$EAR = 0.1300 = 13.00\%$$

STEP 4: Analyze

When you invest in a certificate of deposit, or CD, at a bank, the rate they will quote you is the EAR—that's because it actually is the rate that you will earn on your money—and it's also higher than the simple APR. It's important to make sure when you compare different interest rates that they are truly comparable, and the EAR allows you to make them comparable. For example, if you're talking about borrowing money from the finance company at 12% compounded monthly, while the APR is 12%, the EAR is 12.68%. If you borrow money from the bank at 13% compounded annually, while the APR is 13%, the EAR is actually 13.00%. That's a pretty big difference when you're paying the interest.

The loan from the finance company at 12% compounded monthly is more attractive because its EAR is lower, meaning that you will be paying lower interest for the loan.

Problem 5-36

(Calculating an EAR) You have a choice of borrowing money from a finance company at 24% compounded monthly or borrowing money from a bank at 26% compounded annually. Which alternative is the most attractive?

You find that you can borrow funds from a finance company at 24% compounded monthly or from a bank at 26% compounded annually. Which alternative is more attractive?

STEP 1: Picture the problem

We can visualize the problem using a timeline as follows:

Finance company: If i = an annual rate of 24% compounded monthly, what is the EAR?
Bank: If i = an annual rate of 26% compounded annually, what is the EAR?

STEP 2: Decide on a solution strategy

We'll use the following equation to solve this problem:

$$\text{Effective Annual Rate } (EAR) = \left(1 + \frac{\text{Quoted Annual Rate}}{\text{Compounding Periods per year } (m)}\right)^{m} - 1$$

STEP 3: Solve

You can borrow funds from a finance company at 24% compounded monthly. To calculate the EAR we can use the following equation, where the quoted annual rate is 24%, and m is 12. Substituting in these values, we get,

Problem 5-36 (cont.)

$$\text{Effective Annual Rate } (EAR) = \left(1 + \frac{\text{Quoted Annual Rate}}{\text{Compounding Periods per year } (m)}\right)^{m} - 1$$

$$EAR = \left(1 + \frac{0.24}{12}\right)^{12} - 1$$

$$EAR = 0.2682 = 26.82\%$$

You are correct if you believe that the EAR will be higher than the quoted rate. In reality, the EAR, or effective annual rate, is actually 26.82%. Recall that whenever interest is compounded more frequently, it accumulates faster.

You can borrow funds from a bank at 26% compounded annually. To calculate the EAR we can use the following equation, where the quoted annual rate is 26%, and *m* is 1. Substituting in these values, we get,

$$EAR = \left(1 + \frac{0.26}{1}\right)^{1} - 1$$

$$EAR = 0.2600 = 26.00\%$$

STEP 4: Analyze

When you invest in a certificate of deposit, or CD, at a bank, the rate they will quote you is the EAR—that's because it actually is the rate that you will earn on your money—and it's also higher than the simple APR. It's important to make sure when you compare different interest rates that they are truly comparable, and the EAR allows you to make them comparable. For example, if you're talking about borrowing money from the finance company at 24% compounded monthly, while the APR is 24%, the EAR is 26.82%. If you borrow money from the bank at 26% compounded annually, while the APR is 26%, the EAR is actually 26.00%. That's a pretty big difference when you're paying the interest.

The loan from the bank at 26% compounded annually is more attractive because its EAR is lower, meaning that you will be paying lower interest for the loan.

Problem 5-37

(Calculating an EAR) Your grandmother asks for your help in choosing a certificate of deposit (CD) from a bank with a one-year maturity and a fixed interest rate. The first certificate of deposit, CD #1, pays 4.95% APR compounded daily, while the second certificate of deposit, CD #2, pays 5.00% APR compounded monthly. What is the effective annual rate (the EAR) of each CD, and which CD do you recommend to your grandmother?

The first certificate of deposit, CD #1, pays 4.95% APR compounded daily, while the second certificate of deposit, CD #2, pays 5.00% APR compounded monthly. Which CD do you recommend to your grandmother?

STEP 1: Picture the problem

We can visualize the problem using a timeline as follows:

CD #1: If i = an annual rate of 4.95% compounded daily, what is the EAR?
CD #2: If i = an annual rate of 5.00% compounded monthly, what is the EAR?

STEP 2: Decide on a solution strategy

We'll use the following equation to solve this problem:

$$\text{Effective Annual Rate } (EAR) = \left(1 + \frac{\text{Quoted Annual Rate}}{\text{Compounding Periods per year } (m)}\right)^{m} - 1$$

STEP 3: Solve

The first certificate of deposit, CD #1, pays 4.95% APR compounded daily. To calculate the EAR we can use the following equation, where the quoted annual rate is 4.95%, and m is 365. Substituting in these values, we get,

Problem 5-37 (cont.)

$$\text{Effective Annual Rate } (EAR) = \left(1 + \frac{\text{Quoted Annual Rate}}{\text{Compounding Periods per year } (m)}\right)^{m} - 1$$

$$EAR = \left(1 + \frac{0.0495}{365}\right)^{365} - 1$$

$$EAR = 0.0507 = 5.07\%$$

You will notice that the EAR is higher than the quoted APR. In reality, the EAR, or effective annual rate, is actually 5.07%. Recall that whenever interest is compounded more frequently, it accumulates faster.

The second certificate of deposit, CD #2, pays 5.00% APR compounded monthly. To calculate the EAR we can use the following equation, where the quoted annual rate is 5.00%, and *m* is 12. Substituting in these values, we get,

$$EAR = \left(1 + \frac{0.05}{12}\right)^{12} - 1$$

$$EAR = 0.0512 = 5.12\%$$

STEP 4: Analyze

When you invest in a certificate of deposit, or CD, at a bank,they will normally quote both the APR and the EAR. The EAR is actually the rate that you will earn on your money—and it's also higher than the simple APR. It's important to make sure when you compare different interest rates for two different products that the rates are truly comparable, and the EAR allows you to make them comparable. For example, if you're talking about depositing money into CD #1 that pays 4.95% compounded daily, while the APR is 4.95%, the EAR is 5.07%. If you deposit money into CD #2 that pays 5.00% compounded monthly, while the APR is 5.00%, the EAR is 5.12%. That's a pretty big difference when you're receiving the interest.

CD#1, which pays 4.95% compounded monthly, is more attractive than CD#2 because its EAR is higher, meaning that you will earn higher interest on the deposit. Had grandmother simply compared the APRs she would have incorrectly selected CD #2.

Problem 5-38

(Calculating an EAR) Based on effective interest rates, would you prefer to deposit your money into Springfield National Bank, which pays 8.0% interest compounded annually, or into Burns National Bank, which pays 7.8% compounded monthly? (Hint: Calculate the EAR on each account.)

Would you prefer to deposit your money into Springfield National Bank, which pays 8.0% interest compounded annually, or into Burns National Bank, which pays 7.8% compounded monthly?

STEP 1: Picture the problem

We can visualize the problem using a timeline as follows:

Springfield: If i = an annual rate of 8.0% compounded annually, what is the EAR?
Burns: If i = an annual rate of 7.8% compounded monthly, what is the EAR?

STEP 2: Decide on a solution strategy

We'll use the following equation to solve this problem:

$$\text{Effective Annual Rate } (EAR) = \left(1 + \frac{\text{Quoted Annual Rate}}{\text{Compounding Periods per year } (m)}\right)^{m} - 1$$

STEP 3: Solve

You can deposit your money into Springfield National Bank, which pays 8.0% interest compounded annually. To calculate the EAR we can use the following equation, where the quoted annual rate is 8.0%, and m is 1. Substituting in these values, we get,

Problem 5-38 (cont.)

$$\text{Effective Annual Rate } (EAR) = \left(1 + \frac{\text{Quoted Annual Rate}}{\text{Compounding Periods per year } (m)}\right)^{m} - 1$$

$$EAR = \left(1 + \frac{0.08}{1}\right)^{1} - 1$$

$$EAR = 0.0800 = 8.00\%$$

You were right in thinking the amount of interest you received seemed high. In reality, the EAR, or effective annual rate, is actually 8.00%. Recall that whenever interest is compounded more frequently, it accumulates faster.

You can deposit your money into Burns National Bank, which pays 7.8% interest compounded monthly. To calculate the EAR we can use the following equation, where the quoted annual rate is 7.8%, and m is 12. Substituting in these values, we get,

$$EAR = \left(1 + \frac{0.078}{12}\right)^{12} - 1$$

$$EAR = 0.0808 = 8.08\%$$

STEP 4: Analyze

When you invest in a certificate of deposit, or CD, at a bank, the rate they will quote you is the EAR—that's because it actually is the rate that you will earn on your money—and it's also higher than the simple APR. It's important to make sure when you compare different interest rates that they are truly comparable, and the EAR allows you to make them comparable. For example, if you're talking about depositing money into Springfield National Bank that pays 8.0% compounded annually, while the APR is 8.0%, the EAR is 8.00%. If you can deposit money into Burns National Bank that pays 7.8% compounded monthly, while the APR is 7.8%, the EAR is actually 8.08%. That's a pretty big difference when you're receiving the interest.

The deposit into Burns National Bank that pays 7.8% compounded monthly is more attractive than the deposit into Springfield National Bank because its EAR is higher, meaning that you will earn higher interest on the deposit. Had you simply compared the APRs you would have incorrectly selected the Springfield National Bank.