minimum value of a convertible bond is given by its straight bond value or its conversion value, whichever is greater.

6. Many other corporate securities have option features. Bonds with call provisions, bonds with put provisions, and bonds backed by a loan guarantee are just a few examples.

Chapter Review and Self-Test Problems

14.1 Value of a Call Option Stock in the Nantucket Corporation is currently selling for $25 per share. In one year, the price will be either $20 or $30. T-bills with one year to maturity are paying 10 percent. What is the value of a call option with a $20 exercise price? A $26 exercise price?

14.2 Convertible Bonds Old Cycle Corporation (OCC), publisher of *Ancient Iron* magazine, has a convertible bond issue that is currently selling in the market for $950. Each bond can be exchanged for 100 shares of stock at the holder's option.

The bond has a 7 percent coupon, payable annually, and it will mature in 10 years. OCC's debt is BBB-rated. Debt with this rating is priced to yield 12 percent. Stock in OCC is trading at $7 per share.

What is the conversion ratio on this bond? The conversion price? The conversion premium? What is the floor value of the bond? What is its option value?

Answers to Chapter Review and Self-Test Problems

14.1 With a $20 exercise price, the option can't finish out of the money (it can finish "at the money" if the stock price is $20). We can replicate the value of the stock by investing the present value of $20 in T-bills and buying one call option. Buying the T-bill will cost $20/1.1 = $18.18.

If the stock ends up at $20, the call option will be worth zero and the T-bill will pay $20. If the stock ends up at $30, the T-bill will again pay $20, and the option will be worth $30 − 20 = $10, so the package will be worth $30. Because the T-bill–call option combination exactly duplicates the payoff on the stock, it has to be worth $20 or arbitrage is possible. Using the notation from the chapter, we can calculate the value of the call option:

$$\begin{aligned} S_0 &= C_0 + E/(1 + R_f) \\ \$25 &= C_0 + \$18.18 \\ C_0 &= \$6.82 \end{aligned}$$

With the $26 exercise price, we start by investing the present value of the lower stock price in T-bills. This guarantees us $20 when the stock price is $20. If the stock price is $30, then the option is worth $30 − 26 = $4. We have $20 from our T-bill, so we need $10 from the options in order to match the stock. Because each option is worth $4 in this case, we need to buy $10/4 = 2.5 call options. Notice that the difference in the possible stock prices (ΔS) is $10 and the difference in the possible option prices (ΔC) is $4, so $\Delta S/\Delta C = 2.5$.

To complete the calculation, we note that the present value of the $20 plus 2.5 call options has to be $20 to prevent arbitrage, so:

$$\$25 = 2.5 \times C_0 + \$20/1.1$$
$$C_0 = \$6.82/2.5$$
$$= \$2.73$$

14.2 Because each bond can be exchanged for 100 shares, the conversion ratio is 100. The conversion price is the face value of the bond ($1,000) divided by the conversion ratio, or $1,000/100 = $10. The conversion premium is the percentage difference between the current price and the conversion price, or ($10 − 7)/7 = 43%.

The floor value of the bond is the greater of its straight bond value or its conversion value. Its conversion value is what the bond is worth if it is immediately converted: 100 × $7 = $700. The straight bond value is what the bond would be worth if it were not convertible. The annual coupon is $70, and the bond matures in 10 years. At a 12 percent required return, the straight bond value is:

$$\text{Straight bond value} = \$70 \times (1 - 1/1.12^{10})/.12 + 1{,}000/1.12^{10}$$
$$= \$395.52 + 321.97$$
$$= \$717.49$$

This exceeds the conversion value, so the floor value of the bond is $717.49. Finally, the option value is the value of the convertible in excess of its floor value. Because the bond is selling for $950, the option value is:

$$\text{Option value} = \$950 - 717.49$$
$$= \$232.51$$

Concepts Review and Critical Thinking Questions

1. **Options** What is a call option? A put option? Under what circumstances might you want to buy each? Which one has greater *potential* profit? Why?
2. **Options** Complete the following sentence for each of these investors:
   a. A buyer of call options
   b. A buyer of put options
   c. A seller (writer) of call options
   d. A seller (writer) of put options

   "The (buyer/seller) of a (put/call) option (pays/receives) money for the (right/obligation) to (buy/sell) a specified asset at a fixed price for a fixed length of time."
3. **Intrinsic Value** What is the intrinsic value of a call option? How do we interpret this value?
4. **Put Options** What is the value of a put option at maturity? Based on your answer, what is the intrinsic value of a put option?
5. **Option Pricing** You notice that shares of stock in the Patel Corporation are going for $50 per share. Call options with an exercise price of $35 per share are selling for $10. What's wrong here? Describe how you can take advantage of this mispricing if the option expires today.
6. **Options and Stock Risk** If the risk of a stock increases, what is likely to happen to the price of call options on the stock? To the price of put options? Why?
7. **Option Rise** True or false: The unsystematic risk of a share of stock is irrelevant in valuing the stock because it can be diversified away; therefore, it is also irrelevant for valuing a call option on the stock. Explain.

8. **Option Pricing** Suppose a certain stock currently sells for $30 per share. If a put option and a call option are available with $30 exercise prices, which do you think will sell for more, the put or the call? Explain.
9. **Option Price and Internet Rates** Suppose the interest rate on T-bills suddenly and unexpectedly rises. All other things being the same, what is the impact on call option values? On put option values?
10. **Contingent Liabilities** When you take out an ordinary student loan, it is usually the case that whoever holds that loan is given a guarantee by the U.S. government, meaning that the government will make up any payments you skip. This is just one example of the many loan guarantees made by the U.S. government. Such guarantees don't show up in calculations of government spending or in official deficit figures. Why not? Should they show up?
11. **Option to Abandon** What is the option to abandon? Explain why we underestimate NPV if we ignore this option.
12. **Option to Expand** What is the option to expand? Explain why we underestimate NPV if we ignore this option.
13. **Capital Budgeting Options** In Chapter 10, we discussed GM's launch of its new Cadillac Escalade. Suppose sales of the new Cadillac go extremely well and GM is forced to expand output to meet demand. GM's action in this case would be an example of exploiting what kind of option?
14. **Option to Suspend** Natural resource extraction facilities (e.g., oil wells or gold mines) provide a good example of the value of the option to suspend operations. Why?
15. **Employee Stock Options** You own stock in the Hendrix Guitar Company. The company has implemented a plan to award employee stock options. As a shareholder, does the plan benefit you? If so, what are the benefits?

Questions and Problems

Basic
(Questions 1–13)

1. **Calculating Option Values** T-bills currently yield 6 percent. Stock in Christina Manufacturing is currently selling for $50 per share. There is no possibility that the stock will be worth less than $45 per share in one year.
   a. What is the value of a call option with a $40 exercise price? What is the intrinsic value?
   b. What is the value of a call option with a $30 exercise price? What is the intrinsic value?
   c. What is the value of a put option with a $40 exercise price? What is the intrinsic value?
2. **Understanding Option Quotes** Use the option quote information shown here to answer the questions that follow.

Option and NY Close	Strike Price	Expiration	Calls		Puts	
			Vol.	Last	Vol.	Last
RWJ						
83	80	Mar	230	2.80	160	0.80
83	80	Apr	170	6	127	1.40
83	80	Jul	139	8.05	43	3.90
83	80	Oct	60	10.20	11	3.65

Basic
(*continued*)

a. Are the call options in the money? What is the intrinsic value of an RWJ Corp. call option?
b. Are the put options in the money? What is the intrinsic value of an RWJ Corp. put option?
c. Two of the options are clearly mispriced. Which ones? At a minimum, what should the mispriced options sell for? Explain how you could profit from the mispricing in each case.

3. Calculating Payoffs Use the option quote information shown here to answer the questions that follow.

Option and NY Close	Strike Price	Expiration	Calls		Puts	
			Vol.	Last	Vol.	Last
Macrosoft						
125	120	Feb	85	8.10	40	.55
125	120	Mar	61	9.60	22	1.50
125	120	May	22	11.45	11	2.75
125	120	Aug	3	13.90	3	4.60

a. Suppose you buy 10 contracts of the February 120 call option. How much will you pay, ignoring commissions?
b. In part (*a*), suppose that Macrosoft stock is selling for $140 per share on the expiration date. How much is your options investment worth? What if the terminal stock price is $125? Explain.
c. Suppose you buy 10 contracts of the August 120 put option. What is your maximum gain? On the expiration date, Macrosoft is selling for $114 per share. How much is your options investment worth? What is your net gain?
d. In part (*c*), suppose you *sell* 10 of the August 120 put contracts. What is your net gain or loss if Macrosoft is selling for $113 at expiration? For $132? What is the break-even price, that is, the terminal stock price that results in a zero profit?

4. Calculating Option Values The price of Paula Corp. stock will be either $70 or $90 at the end of the year. Call options are available with one year to expiration. T-bills currently yield 4 percent.
a. Suppose the current price of Paula stock is $75. What is the value of the call option if the exercise price is $65 per share?
b. Suppose the exercise price is $85 in part (*a*). What is the value of the call option now?

5. Calculating Option Values The price of Tara, Inc., stock will be either $80 or $100 at the end of the year. Call options are available with one year to expiration. T-bills currently yield 5 percent.
a. Suppose the current price of Tara stock is $90. What is the value of the call option if the exercise price is $65 per share?
b. Suppose the exercise price is $90 in part (*a*). What is the value of the call option now?

6. Using the Pricing Equation A one-year call option *contract* on Cheesy Poofs Co. stock sells for $1,400. In one year, the stock will be worth $40 or $60 per share. The exercise price on the call option is $55. What is the current value of the stock if the risk-free rate is 5 percent?

Basic (*continued*)

7. **Equity as an Option** Rackin Pinion Corporation's assets are currently worth $1,100. In one year, they will be worth either $1,000 or $1,300. The risk-free interest rate is 5 percent. Suppose Rackin Pinion has an outstanding debt issue with a face value of $1,000.
   a. What is the value of the equity?
   b. What is the value of the debt? The interest rate on the debt?
   c. Would the value of the equity go up or down if the risk-free rate were 20 percent? Why? What does your answer illustrate?

8. **Equity as an Option** Volunteer Industries has a bond issue with a face value of $1,000 that is coming due in one year. The value of Volunteer's assets is currently $1,200. Phil Fulmer, the CEO, believes that the assets in the firm will be worth either $800 or $1,400 in a year. The going rate on one-year T-bills is 4 percent.
   a. What is the value of Volunteer's equity? The value of the debt?
   b. Suppose Volunteer can reconfigure its existing assets in such a way that the value in a year will be $500 or $1,700. If the current value of the assets is unchanged, will the stockholders favor such a move? Why or why not?

9. **Calculating Conversion Value** A $1,000 par convertible debenture has a conversion price for common stock of $125 per share. With the common stock selling at $90, what is the conversion value of the bond?

10. **Convertible Bonds** The following facts apply to a convertible bond making semiannual payments:

Conversion price	$50/share
Coupon rate	8%
Par value	$1,000
Yield on nonconvertible debentures of same quality	9%
Maturity	20 years
Market price of stock	$55/share

   a. What is the minimum price at which the convertible should sell?
   b. What accounts for the premium of the market price of a convertible bond over the total market value of the common stock into which it can be converted?

11. **Calculating Values for Convertibles** You have been hired to value a new 30-year callable, convertible bond. The bond has an 8 percent coupon, payable annually, and its face value is $1,000. The conversion price is $70 and the stock currently sells for $50.
   a. What is the minimum value of the bond? Comparable nonconvertible bonds are priced to yield 10 percent.
   b. What is the conversion premium for this bond?

12. **Calculating Warrant Values** A bond with 30 detachable warrants has just been offered for sale at $1,000. The bond matures in 15 years and has an annual coupon of $110. Each warrant gives the owner the right to purchase two shares of stock in the company at $15 per share. Ordinary bonds (with no warrants) of similar quality are priced to yield 12 percent. What is the value of one warrant?

13. **Option to Wait** Your company is deciding whether to invest in a new machine. The new machine will increase cash flow by $180,000 per year. You believe the technology used in the machine has a 10-year life, in other words, no matter when you purchase the machine, it will be obsolete 10 years from today.

Basic (*continued*)

The machine is currently priced at $1,000,000. The cost of the machine will decline by $100,000 per year until it reaches $500,000, where it will remain. If your required return is 12 percent, should you purchase the machine? If so, when should you purchase it?

Intermediate (Questions 14–19)

14. Abandonment Value We are examining a new project. We expect to sell 6,000 units per year at $65 net cash flow apiece for the next 10 years. In other words, the annual operating cash flow is projected to be $65 × 6,000 = $390,000. The relevant discount rate is 16 percent, and the initial investment required is $1,750,000.

a. What is the base-case NPV?

b. After the first year, the project can be dismantled and sold for $1,250,000. If expected sales are revised based on the first year's performance, when would it make sense to abandon the investment? In other words, at what level of expected sales would it make sense to abandon the project?

c. Explain how the $1,250,000 abandonment value can be viewed as the opportunity cost of keeping the project in one year.

15. Abandonment In the previous problem, suppose you think it is likely that expected sales will be revised upwards to 8,000 units if the first year is a success and revised downwards to 4,000 units if the first year is not a success.

a. If success and failure are equally likely, what is the NPV of the project? Consider the possibility of abandonment in answering.

b. What is the value of the option to abandon?

16. Abandonment and Expansion In the previous problem, suppose the scale of the project can be doubled in one year in the sense that twice as many units can be produced and sold. Naturally, expansion would only be desirable if the project is a success. This implies that if the project is a success, projected sales after expansion will be 16,000. Again assuming that success and failure are equally likely, what is the NPV of the project? Note that abandonment is still an option if the project is a failure. What is the value of the option to expand?

17. Intuition and Option Value Suppose a share of stock sells for $60. The risk-free rate is 5 percent, and the stock price in one year will be either $70 or $80.

a. What is the value of a call option with a $70 exercise price?

b. What's wrong here? What would you do?

18. Intuition and Convertibles Which of the following two sets of relationships, at time of issuance of convertible bonds, is more typical? Why?

	A	B
Offering price of bond	$ 800	$1,000
Bond value (straight debt)	800	950
Conversion value	1,000	900

19. Convertible Calculations Alicia, Inc., has a $1,000 face value convertible bond issue that is currently selling in the market for $950. Each bond is exchangeable at any time for 25 shares of the company's stock. The convertible bond has a 7 percent coupon, payable semiannually. Similar nonconvertible bonds are priced to yield 9 percent. The bond matures in 10 years. Stock in Alicia sells for $37 per share.

a. What are the conversion ratio, conversion price, and conversion premium?

b. What is the straight bond value? The conversion value?

Intermediate (*continued*)

Challenge (Questions 20–22)

c. In part (*b*), what would the stock price have to be for the conversion value and the straight bond value to be equal?

d. What is the option value of the bond?

20. Pricing Convertibles You have been hired to value a new 25-year callable, convertible bond. The bond has a 6.20 percent coupon, payable annually. The conversion price is $140, and the stock currently sells for $41.12. The stock price is expected to grow at 12 percent per year. The bond is callable at $1,200, but, based on prior experience, it won't be called unless the conversion value is $1,300. The required return on this bond is 10 percent. What value would you assign?

21. Abandonment Decisions For some projects, it may be advantageous to terminate the project early. For example, if a project is losing money, you might be able to reduce your losses by scrapping out the assets and terminating the project, rather than continuing to lose money all the way through to the project's completion. Consider the following project of Hand Clapper, Inc. The company is considering a four-year project to manufacture clap-command garage door openers. This project requires an initial investment of $8 million that will be depreciated straight-line to zero over the project's life. An initial investment in net working capital of $2 million is required to support spare parts inventory; this cost is fully recoverable whenever the project ends. The company believes it can generate $7 million in pretax revenues with $3 million in total pretax operating costs. The tax rate is 38 percent and the discount rate is 16 percent. The market value of the equipment over the life of the project is as follows:

Year	Market Value (millions)
1	$6.50
2	6.00
3	3.00
4	0.00

a. Assuming Hand Clapper operates this project for four years, what is the NPV?

b. Now compute the project NPV assuming the project is abandoned after only one year, after two years, and after three years. What economic life for this project maximizes its value to the firm? What does this problem tell you about not considering abandonment possibilities when evaluating projects?

22. Replacement Decisions Suppose we are thinking about replacing an old computer with a new one. The old one cost us $300,000; the new one will cost $600,000. The new machine will be depreciated straight-line to zero over its five-year life. It will probably be worth about $75,000 after five years.

The old computer is being depreciated at a rate of $100,000 per year. It will be completely written off in three years. If we don't replace it now, we will have to replace it in two years. We can sell it now for $120,000; in two years, it will probably be worth half that. The new machine will save us $130,000 per year in operating costs. The tax rate is 38 percent and the discount rate is 14 percent.

a. Suppose we only consider whether or not we should replace the old computer now without worrying about what's going to happen in two years. What are the relevant cash flows? Should we replace it or not? Hint: Consider the net change in the firm's aftertax cash flows if we do the replacement.

Challenge (*continued*)

b. Suppose we recognize that if we don't replace the computer now, we will be replacing it in two years. Should we replace now or should we wait? Hint: What we effectively have here is a decision either to "invest" in the old computer (by not selling it) or to invest in the new one. Notice that the two investments have unequal lives.

What's On the Web?

14.1 Option Prices You want to find the option prices for ConAgra Foods (CAG). Go to finance.yahoo.com, get a stock quote, and follow the "Options" link. What is the option premium and strike price for the highest and lowest strike price options that are nearest to expiring? What are the option premium and strike price for the highest and lowest strike price options expiring next month?

14.2 Option Symbol Construction What is the option symbol for a call option on Cisco Systems (CSCO) with a strike price of $25 that expires in July. Go to www.cboe.com, follow the "Trading Tools" link, then the "Symbol Lookup" link. Find the basic ticker symbol for Cisco Systems options. Next, follow the "Strike Price Code" link. Find the codes for the expiration month and strike price and construct the ticker symbol. Now construct the ticker symbol for a put option with the same strike price and expiration.

14.3 Option Expiration Go to www.cboe.com, highlight the "Trading Tools" tab, then follow the "Expiration Calendar" link. On what day do equity options expire in the current month? On what day do they expire next month?

14.4 LEAPS. Go to www.cboe.com, highlight the "Products" tab, then follow the "LEAPS®" link. What are LEAPS? What are the two types of LEAPS? What are the benefits of equity LEAPS? What are the benefits of index LEAPS?

14.5 FLEX Options Go to www.cboe.com, highlight the "Institutional" tab, then follow the "FLEX Options" link. What is a FLEX option? When do FLEX options expire? What is the minimum size of a FLEX option?