CHAPTER 4

Mathematics of Merchandising

LEARNING OBJECTIVES

After completing this chapter, you will be able to:

- Calculate the net price of an item after single or multiple trade discounts

- Calculate a single discount rate that is equivalent to a series of discounts

- Understand the ordinary dating notation for the terms of payment of an invoice

- Calculate the amount of the cash discount for which a payment qualifies

- Solve merchandise pricing problems involving markup and markdown

MATHEMATICS TOUCHES ALMOST EVERY STAGE of product distribution and merchandising. Consider a retailer who buys goods from her suppliers, marks up the price, and sells the goods to her customers. The cost of the goods to the retailer is usually determined by deducting a "trade discount" from the supplier's "list price." The invoice she receives may offer a "cash discount" for prompt payment of the invoice. The amount of "markup" the retailer adds to the cost price must cover part of her overhead costs, and also generate a suitable profit. For a sale or special promotion, the retailer may offer a discount or "markdown" from the regular selling price.

In this chapter, we will learn the terminology and procedures for these calculations. We will also explore the mathematical relationships among pricing variables. This will help us understand how a change in one variable affects the other variables.

4.1   TRADE DISCOUNTS

Goods move from a manufacturer to the ultimate consumer through the *distribution chain* or *merchandising chain*. In the chain illustrated in Figure 4.1, a product is first sold by a *manufacturer* to one or more *distributors*. The agreement between a manufacturer and a distributor usually gives the distributor the *exclusive* right to distribute the product in a fairly large geographic region, but prohibits the distributor from handling competing products. Typically, a distributor also has marketing responsibilities in the region. The distributor then resells the goods to a number of *wholesalers*. A wholesaler carries a wider range of products within a general category or theme. The majority of a wholesaler's product lines are complementary, but some will be competing. All are for resale to *retailers* within a smaller geographic area. Retailers sell mainly to the ultimate consumers of the goods.

■ **FIGURE 4.1** | The Distribution Chain
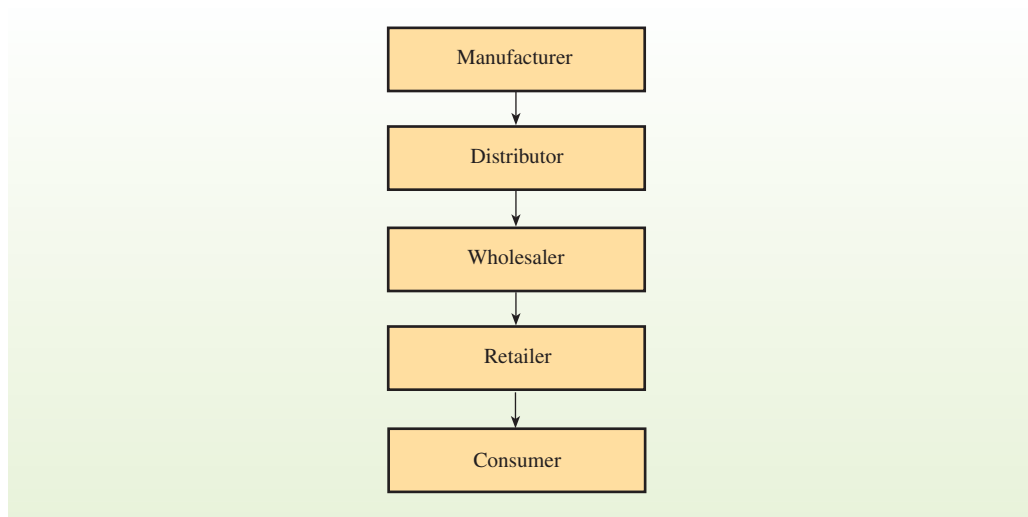
In many cases, one or more of the intermediate links may be absent. Large national retailers and *buying groups* of smaller retailers may have enough buying power to purchase directly from manufacturers.

To understand how prices are usually established within the merchandising chain, imagine that you are a wholesaler buying from a distributor. The distributor is likely to have a catalogue of **list prices.** List prices are commonly chosen to approximate the ultimate retail selling price. (No doubt you have noticed terms such as "manufacturer's suggested retail price," "suggested list price," or "recommended selling price" on the packaging or in advertisements

for certain products.) The distributor will offer you a percent discount from the list price[1] called the **trade discount** rate. The word "trade" signifies that the discount applies only to a transaction within the "trade," that is, within the merchandising chain (but not including the consumer). There may be some negotiating room for setting the rate of trade discount.

> ## TRAP   Watch for Imprecise Language in "Everyday" Usage
>
> In everyday usage, "trade discount" can refer to either the *percent* amount or the *dollar* amount of the discount. The intended meaning is sometimes obvious from the units quoted (% or $). Where there is a possibility of confusion, we will use "*rate* of trade discount" or "trade discount *rate*" for the trade discount quoted as a percentage of the list price. The "*amount* of the trade discount" will refer to the trade discount measured in dollars. For example, if a trade discount *rate* of 35% applies to a $200 list price item, the *amount* of the trade discount is 0.35 ($200) = $70.

The resulting price after deducting the amount of the trade discount from the list price is called the **net price.** That is,

$$\text{Net price} = \text{List price} - \text{Amount of trade discount}$$
$$= \text{List price} - (\text{Rate of trade discount} \times \text{List price})$$

The following symbols will be used to convert the preceding word equation to an algebraic equation.

$$N = \text{Net price}$$
$$L = \text{List price}$$
$$d = \text{Rate of trade discount}$$

Replacing the quantities in the word equation by these symbols, we obtain

$$N = L - dL$$

Since L is a common factor on the right side, we can write the basic discounting formula as:

NET PRICE AFTER A DISCOUNT

$$N = L(1 - d) \tag{4-1}$$

Multiple Discounts (or Series Discounts)   In the past, it was common for a seller/vendor in the merchandising chain to offer more than one discount. For example, in addition to the basic trade discount offered to all customers, the seller might also offer small discounts for large volume purchases, for special promotions and co-operative advertising, and for early orders of seasonal items.

If a purchaser qualifies for more than one discount, the understanding is that the discounts should be compounded rather than added. This means that we use a formula similar to formula (4-1) but with a $(1 - d)$ factor for each discount. If there are three discounts, d_1, d_2, and d_3, then the net price is

NET PRICE AFTER THREE DISCOUNTS

$$N = L(1 - d_1)(1 - d_2)(1 - d_3) \tag{4-2}$$

The granting of separate multiple discounts has been largely abandoned. It is now much more typical for buyers and sellers to negotiate a single discount rate that can be adjusted

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[1] The use of trade discounts in conjunction with fixed list prices makes it easier for the seller to set different prices for various categories of customers. For example, a manufacturer might offer one discount rate to a distributor in one part of the country, another discount rate to "big-box" retailers, and yet another rate to smaller buying groups. Every customer sees the same "up front" list price. Price flexibility is achieved in the setting of the trade discount rate.

over time as the business relationship evolves. Rather than offering a volume discount on individual orders, vendors increasingly pay end-of-year discounts (in the 2% to 5% range) based on the cumulative volume of a customer's purchases during the year.

Single Discount Rate Equivalent to Multiple Discounts   An **equivalent discount rate** is the single discount rate that gives the same net price as the combined effect of the multiple discounts. Suppose, for example, that the net amount after applying three discounts to a list price of $100 is $74. Then the dollar amount of the discount is $100 − $74 = $26, and the equivalent discount rate is

$$\frac{\$26}{\$100} \times 100\% = 26\%$$

This example suggests the most straightforward approach for calculating an equivalent discount rate. First, determine the net price after applying the given multiple discounts to a list price of $100. Then calculate the dollar amount of the discount—the percent equivalent discount rate is *numerically* equal to the amount of the discount. See Example 4.1E.

> ## TRAP   Do Not Add Series Discounts
>
> The single rate that is equivalent to two or more discounts *cannot* be obtained by adding the individual discounts. The equivalent discount rate will always be smaller than the sum of the discounts. This happens because the second and third individual discounts are applied to amounts smaller than the list price, whereas the equivalent rate is applied to the full list price.

Other Applications   Although formula (4-1) was derived in the context of trade discounts, it may be used in any discount or "% off" calculation. Indeed, formula (4-1) applies to any situation in which an amount (L) is reduced by d percent. Such applications include the calculation of the "sale" price after a percentage markdown, sales revenue net of commission, security prices after a percentage loss in value, and budget amounts after a percentage cut.

Similarly, formula (4-2) may be employed in any situation where a beginning amount, L, undergoes a series of compound percent decreases. N represents the amount left after the decreases. For example, suppose a product's sales are forecast to decline from the past year's sales of $200,000 by 10%, 20%, and 15% in successive years. Then sales in the third year are forecast to be

$$N = \$200{,}000(1-0.10)(1-0.20)(1-0.15) = \$200{,}000(0.90)(0.80)(0.85) = \$122{,}400$$

Note that the three decreases result in an overall sales reduction of 38.8%. This is less than the sum (10% + 20% + 15% = 45%) of the three percentage decreases.

EXAMPLE 4.1A | CALCULATING THE DISCOUNT AMOUNT AND NET PRICE

A wholesaler lists an item at $117 less 20%. What is the amount of the discount and the net price to a retailer?

SOLUTION
Given: $L = \$117$, $d = 0.20$.

$$\text{Amount of discount} = dL = (0.20)(\$117) = \$23.40$$
$$\text{Net price} = \text{List price} - \text{Amount of discount}$$
$$= \$117 - \$23.40$$
$$= \$93.60$$

EXAMPLE 4.1B | CALCULATING THE LIST PRICE

After a trade discount of 30%, a garage is able to purchase windshield wiper blades for a net price of $19.46. What is the list price of the blades?

SOLUTION

Given: $d = 0.30$, $N = \$19.46$.

If formula (4–1) is rearranged to isolate L, we obtain

$$L = \frac{N}{1 - d} = \frac{\$19.46}{1 - 0.30} = \frac{\$19.46}{0.70} = \$27.80$$

The list price of the blades is $27.80.

EXAMPLE 4.1C | CALCULATING THE TRADE DISCOUNT RATE

A clothing store is able to purchase men's leather coats at a net price of $173.40 after a discount of $115.60. What rate of trade discount was obtained?

SOLUTION

Given: Net price $= \$173.40$, Amount of discount $= \$115.60$

The trade discount rate is

$$d = \frac{\text{Amount of discount}}{\text{List price}}$$

We must calculate the "List price" before we can obtain d.

$$\begin{aligned}
\text{List price} &= \text{Net price} + \text{Amount of discount} \\
&= \$173.40 + \$115.60 \\
&= \$289.00
\end{aligned}$$

Hence,

$$d = \frac{\$115.60}{\$289.00} = 0.40$$

The trade discount rate is 40%.

EXAMPLE 4.1D | CALCULATING THE NET PRICE AFTER MULTIPLE DISCOUNTS

WGW Manufacturing and Ace Clothing both produce basic work shirts that are very similar in quality and popularity. Both manufacturers quote a list price of $29.90 for the shirt. WGW offers a regular trade discount of 25% plus an additional volume discount of 10% on orders of at least 1000 shirts. Ace offers a standard discount of 30% and a further 5% discount on orders exceeding 500 shirts. Which source will give the lower net price on an order for 1000 shirts?

SOLUTION

Given: For WGW, $L = \$29.90$, $d_1 = 25\%$, $d_2 = 10\%$
   For Ace, $L = \$29.90$, $d_1 = 30\%$, $d_2 = 5\%$

The net price per shirt from WGW is

$$\begin{aligned}
N = L(1 - d_1)(1 - d_2) &= \$29.90(1 - 0.25)(1 - 0.10) \\
&= \$29.90(0.75)(0.90) \\
&= \$20.18
\end{aligned}$$

The net price per shirt from Ace Clothing is

$$N = L(1 - d_1)(1 - d_2) = \$29.90(1 - 0.30)(1 - 0.05)$$
$$= \$29.90(0.70)(0.95)$$
$$= \$19.88$$

Therefore, Ace's net price is 30 cents per shirt lower. (Note that the sum of the two discount rates in each case is 35%. However, they do not have the same effect.)

EXAMPLE 4.1E | CALCULATING AN EQUIVALENT DISCOUNT RATE

What single discount rate is equivalent to multiple discounts of 20% and 10%?

SOLUTION

Let us apply the two discounts to a beginning value of $100.

$$N = L(1 - d_1)(1 - d_2) = \$100(1 - 0.20)(1 - 0.10) = \$100(0.80)(0.90) = \$72.00$$

The amount of the discount is $100 − $72.00 = $28.00. Therefore, a single discount rate of 28.0% is equivalent to multiple discount rates of 20% and 10%.

EXAMPLE 4.1F | CALCULATING ONE OF A SERIES OF DISCOUNTS

A provincial government recently tabled a budget in which agricultural subsidies will be reduced by 10% in each of the next three years. Subsidies in the current fiscal year total $11,000,000. What will be the amount of the reduction in the third year?

SOLUTION

The third 10% reduction will apply to the amount left after the first two reductions. The subsidies paid in the second year will be

$$N = L(1 - d_1)(1 - d_2) = \$11,000,000(1 - 0.10)(1 - 0.10)$$
$$= \$11,000,000(0.90)(0.90)$$
$$= \$8,910,000$$

Reduction in the third year $= d_3 \times \$8,910,000 = 0.10(\$8,910,000) = \$891,000$

EXERCISE 4.1

Answers to the odd-numbered problems are at the end of the book.

Calculate the missing values in Problems 1 through 14.

Problem	List price ($)	Discount rate (%)	Discount amount ($)	Net price ($)
1.	249.00	$33\frac{1}{3}$	?	?
2.	995.00	$16\frac{2}{3}$	?	?
3.	127.98	?	?	106.65
4.	49.95	?	?	34.97
5.	?	35	612.50	?
6.	?	40	7.99	?
7.	?	?	12.33	15.07
8.	?	?	258.75	891.25
•9.	?	12.5	?	2849.00
•10.	?	$16\frac{2}{3}$	?	413.05
11.	99.00	$30, 16\frac{2}{3}$	?	?
12.	595.00	$20, 12\frac{1}{2}, 8\frac{1}{3}$	?	?
13.	?	$25, 10, 7\frac{1}{2}$	?	93.03
14.	?	$20, 10, 8\frac{1}{3}$	?	989.00

15. The distributor of Nikita power tools is offering a trade discount of 38% to hardware stores. What will the stores' cost be to purchase a rotary saw listed at $135?

16. SuperSave stores can purchase Annapolis Gold apple juice for $11.50 per case less a trade discount of 30%. They can also obtain No-Name apple juice at a discount of 22% from the suggested retail price of $10.50 per case. Which juice will have the lower net cost per case? How much lower?

17. A 37.5% trade discount on a camera represents a discount of $223.14 from the suggested retail price. What is the net price to the buyer?

18. The net price of a product after a trade discount of 15% is $845.75. What is the amount of the discount?

19. The net price on an item listed for $369 is $287.82. What trade discount rate is being given?

20. Green Thumb Nursery sells spreading junipers to the gardening departments of local grocery and building supply stores. The net price per tree is $27.06 after a trade discount of $22.14. What rate of trade discount is the nursery giving to retailers?

21. Niagara Dairies gives convenience stores a discount of 24% on butter listed at $72.00 per case. What rate of discount will Silverwood Milk Products have to give on its list price of $74.50 per case to match Niagara's price to convenience stores?

22. A grocery store is offering an in-store special of 15% off the sticker price of all cheese. What will a customer pay for a package of cheese listed at $8.60?

23. The net proceeds to the vendor of a house after payment of a 5.5% real estate commission were $160,555.50. What price did the house sell for?

24. A merchant pays a 3.5% fee to the Bank of Montreal on all MasterCard sales.

    a. What amount will she pay on sales of $17,564 for a month?

    b. What were her gross sales for a month in which the bank charged total fees of $732.88?

25. Cynthia and Byron sell mutual funds for Syndicated Investors. Purchasers of mutual funds from agents of Syndicated Investors pay a front-end commission of 5.5%. The commission is paid on the total amount paid to Syndicated Investors, not on just the net amount actually invested in mutual funds.

    a. Mr. and Mrs. Stevens placed $5500 through Cynthia. What amount was actually invested in mutual funds after the commission was paid?

    b. If the net amount invested in mutual funds as a result of Byron's sale to Mrs. Stocker was $6426, what amount of commission was paid on the sale?

26. a. Mirabai's income tax rate on additional income is 42%. She has just received a wage increase of $1.25 per hour. What is her after-tax increase in hourly pay?

    b. Shira's tax rate on additional income is 47%. How much extra must he earn to keep an additional $1000 after tax?

27. The evening news reports that the S&P/TSX Composite Index dropped 1.3% on the day to close at 9561 points. How many points did the index fall on the day?

28. At its current price of $0.80 per share, Golden Egg Resources stock is down 73% from its price one year ago. What was that price?

•29. a. In a budget speech the federal government announced a $264 million cut in defense spending. This represents 5.4% of the previous year's defense budget. What is the new budgeted amount rounded to the nearest $0.1 million?

    b. The number of military personnel is to be reduced by 2.1% to 58,600. How many people are to be cut from the military?

30. A manufacturer of snowmobiles sells through distributors in some regions of the country, through wholesalers in other regions, and directly to retailers in its home province. The manufacturer gives a 25% trade discount to retailers, an additional 10% discount to wholesalers, and a further 7.5% discount to distributors. What net price does the manufacturer receive from each buying level on a snowmobile listed at $5800?

•31. A retailer is offered a regular discount of 25%, a further discount of 7.5% if she places an order exceeding $10,000 (at list prices), and another 5% discount for participating in a joint promotion with the distributor.

   a. If the retailer is eligible for all three trade discounts, what will be the net price of an order totalling $11,500?

   b. What is the dollar amount of the saving from the quantity discount (assuming that she does not participate in the joint promotion)?

   c. What is the dollar amount of the discount received for participating in the joint promotion?

32. An invoice shows a net price of $176.72 after trade discounts of 30%, 10%, and 2% have been deducted.

   a. What was the list price of the goods?

   b. What single rate of trade discount would be equivalent to the discount series?

•33. A wholesaler lists an item for $48.75 less 20%. What additional "special promotion" discount must be offered to retailers to get the net price down to $36.66?

•34. The representative for a European ski manufacturer offers Snow 'n Surf Sporting Goods a regular discount of 25%, a volume discount of 10% for an order of at least 100 pairs of skis, and an early booking discount of 5% for orders placed before July 1.

   a. If Snow 'n Surf is eligible for all three trade discounts on skis listed at a suggested retail price of $890, what is the net price per pair of skis?

   b. Assuming that Snow 'n Surf qualifies for the volume discount, what is the dollar amount of the early-order discount per pair of skis?

   c. The net price after all three trade discounts on a less expensive model of skis is $410.40. What is the suggested retail price?

   d. What single trade discount rate would be equivalent to the three trade discounts?

•35. In addition to the basic trade discount of 20%, an outboard engine manufacturer gives a boat dealer an additional discount of 12.5% for providing follow-up warranty service, and a 5% discount for co-operative advertising and boat-show promotions.

   a. After the basic discount, what further price reduction (in dollars) does the 12.5% discount represent on an engine with a list price of $3000?

   b. After the first two discounts, what price reduction does the 5% discount give on the $3000 engine?

•36. Ever-rest sells its mattresses for $960 less 25%. Posture-Perfect mattresses are listed at $880 less 20% and 5%. What second trade discount would Ever-rest need to offer to match Posture-Perfect's net price?

4.2 CASH DISCOUNTS AND TERMS OF PAYMENT

Other than the final sale to the consumer, transactions within the merchandising chain commonly involve "trade credit." Under this arrangement, the vendor does not require payment for goods during a "credit period" that can range from 15 days to a few weeks. No interest is charged during this interval. Following a transaction, the vendor sends the buyer an invoice, such as the sample shown in Figure 4.2. The invoice presents details of the "terms of pay-

ment," items purchased, unit prices, applicable trade discount rates, 15% Harmonized Sales Tax (HST), shipping cost, and the amount due.

■ **FIGURE 4.2** | A Sample Sales Invoice

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ATLANTIC ATHLETIC WHOLESALE LTD.
177 Main Avenue
Halifax, Nova Scotia B3M 1B4

Sold to:
  McGarrigle Sports   **Date:** July 17, 2005   **Invoice No:**   3498
  725 Kings Road   **Terms:**   2/10, n30   **Via:**   Beatty Trucking
  Sydney, N.S. B1S 1C2

Quantity	Product number	Description	Unit list price	Discount	Net amount
5	W-32	Universal Gymnasium	$2300	30%	$8050.00
150	S-4	Soccer balls	$56.00	25%, 15%	5355.00
1000	H-8a	Hockey pucks	$2.20	35%, 10%, 7%	1196.91

Invoice total:	$14,601.91
HST:	2190.29
Shipping charges:	546.00
Total amount due:	$17,338.20

1.5% per month on overdue accounts

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Terms of Payment   The sample invoice includes the entry "Terms: 2/10, n30." This is code or shorthand for the **terms of payment** which embody the following information.

■ The length of the **credit period.** The credit period is the length of time for which trade credit is granted. The invoice amount is due at the end of the credit period. Normally, interest is not charged for the credit period. It is common practice to charge a penalty on overdue amounts. The "1.5% per month" indicated on the sample invoice means that any portion of the invoice amount that goes overdue (anywhere from one day to one month) is liable for a 1.5% penalty. How strictly a vendor enforces the penalty is a judgment call.

■ The **cash discount** rate offered (if any) and the length of the **discount period.** A cash discount is a deduction allowed for prompt payment[2] of the invoice amount (or any portion thereof). The time period within which a payment qualifies for the cash discount is called the discount period.

■ The date on which both the credit period and the discount period begin.

The most common system for presenting the terms of payment is known as **ordinary dating** or *invoice dating*. (Two other systems are presented in this chapter's appendix.) With

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[2] It is generally advisable for the purchaser to take advantage of a cash discount. Forgoing the discount is usually equivalent to paying a high interest rate for trade credit during the remainder of the credit period. Therefore, failure of a customer to take advantage of a cash discount provides an early warning signal that the customer may, at least temporarily, be in a weak financial condition.

In recent years, there has been a trend away from offering cash discounts. Vendors find that many customers pay after the discount period but still deduct the cash discount from their remittance. Enforcement of the discount period cutoff gives rise to too many hassles with customers.

ordinary dating, both the credit period and the discount period are measured from the invoice date (day "0"). For example, if an invoice dated July 3 has a 30-day credit period, then July 4 is counted as "day 1," July 5 as "day 2," and so on. August 2 will be "Day 30," the final day of the credit period. A payment received on August 2 falls within the credit period, but a payment received on August 3 is liable for the overdue-account penalty.

A shorthand notation is normally used on an invoice to present the terms of payment. Figure 4.3 illustrates the ordinary dating notation in the particular case of a 2% cash discount offered during a 10-day discount period, and a 30-day credit period. The abbreviation "2/10, n/30" is read as "two ten, net thirty."

■ **FIGURE 4.3** | Interpreting the Terms of Payment in Ordinary Dating
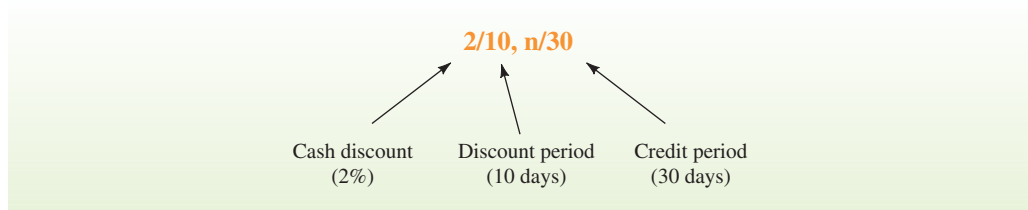
In Figure 4.4 the invoice date, discount period, and credit period for the example 2/10, n/30 are plotted on a time axis. The 2% cash discount is credited on *either partial payments or full payment* made *on or before* the last day of the discount period. The balance is due by the end of the 30-day credit period.

■ **FIGURE 4.4** | Discount and Credit Periods for the Ordinary Dating Case 2/10, n/30
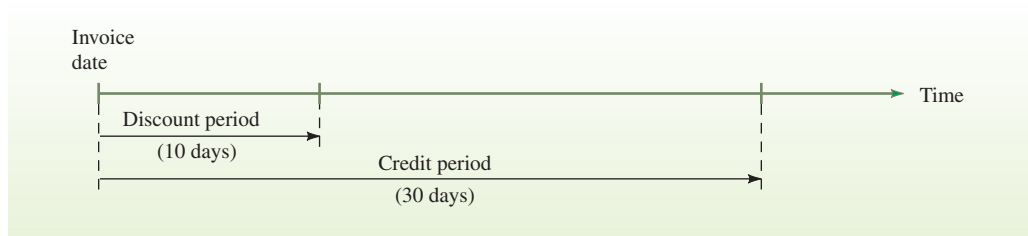
A variation of the ordinary dating notation is "2/10, 1/30, n/60." In this case, a reduced cash discount of 1% is offered on payments made any time from the eleventh to the thirtieth day after the invoice date.

The following are common practices with ordinary dating (and with the two other notations described in the appendix).

■ If the last day of the discount period or the credit period falls on a non-business day, the period is extended to the next business day.

■ If no cash discount is offered, only the "net" figure for the credit period is given (for example, n/15 or n/30).

■ If a net figure for the credit period is not stated, it is understood that the credit period ends 20 days after the end of the discount period. For example, "2/10" by itself implies "2/10, n/30".

Formula (4-1), $N = L(1 - d)$, may be used to calculate the amount required to settle an invoice if the cash discount is taken. Substitute the invoice amount for L and the cash dis-

count rate for *d*. The value calculated for *N* is the full payment that will settle the invoice within the discount period.

Partial Payments A **partial payment** is any payment smaller than the initial amount required to fully satisfy the invoice. Unless otherwise indicated on the invoice, partial payments made within the discount period are eligible for the cash discount. The basic discount formula (4-1) may be used to calculate the amount credited to the customer's account. But you must be careful how you use it. See the Trap box below. In general,

$$\text{Amount credited, } L = \frac{\text{Amount paid, } N}{1 - d}$$

TRAP This One Catches the Majority of Students!

A very common error is to calculate the cash discount allowed on a *partial* payment as ($d \times$ payment). To understand why this is incorrect, think about how you calculate the cash discount when you pay an invoice *in full*. Suppose you receive an invoice for $1000 and you are eligible for a 2% cash discount. Therefore a payment of

$$N = L(1 - d) = \$1000(1 - 0.02) = \$980$$

will settle the account if you pay within the discount period. The vendor will credit your account for $1000 consisting of the $980 payment and a $20 cash discount. Notice that the $20 discount is 2% of the amount credited ($L = \$1000$), not 2% of the amount paid ($N = \$980$). Similarly, if you make a partial payment of $N = \$500$ within the discount period, the cash discount will be 2% of the amount credited (L) which is initially unknown. Do not take 2% of $500 to obtain the cash discount in this case (just as you did not take 2% of $980 in the former case). The total amount credited will be

$$L = \frac{N}{1 - d} = \frac{\$500}{1 - 0.02} = \$510.20$$

The cash discount allowed on the $500 payment is therefore $10.20 (which is 2% of the $510.20 credited).

■ **EXAMPLE 4.2A** | INVOICE SETTLEMENT WITH ORDINARY DATING

An invoice for $1079.80 with terms 2/10, n/30 is dated November 25. It was received in the mail on November 27. What payment will settle the invoice if payment is made on:

a. December 1?   **b.** December 5?   **c.** December 7?

SOLUTION

a., b. The last day of the discount period is the tenth day after the invoice date (November 25). November has 30 days. Therefore, payments made on or before December 5 are eligible for the 2% cash discount. The payment required to settle the invoice is:

$$N = L(1 - d) = \$1079.80(1 - 0.02) = \$1058.20$$

c. After December 5, the full amount must be paid to settle the invoice. The payment required is $1079.80.

■ **EXAMPLE 4.2B** | PARTIAL PAYMENTS WITH ORDINARY DATING

Roland Electric received an invoice for $3845 dated March 25 with terms 3/10, 1/20, n/60. Roland paid $1500 on April 4, $500 on April 12, and $500 on April 30. What balance was still owed after April 30?

SOLUTION

The 3% discount applies to any payment made on or before April 4 (March 25 + 10 days.) The 1% discount applies to any payment made in the period April 5 to April 14, inclusive. Therefore, the $1500 payment qualifies for the 3% discount, and the first $500 payment qualifies for the 1% discount. Use

$$\text{Amount credited} = \frac{\text{Amount paid}}{1 - d}$$

to obtain the amount credited for each of the first two payments. The total of the credits for the first three payments is

$$\frac{\$1500}{1 - 0.03} + \frac{\$500}{1 - 0.01} + \$500 = \$1546.39 + \$505.05 + \$500$$

$$= \$2551.44$$

$$\text{Balance owed} = \$3845 - \$2551.44 = \$1293.56$$

POINT of INTEREST

When Late-Payment Penalties Really Are "Criminal"

In October of 1998, the Supreme Court of Canada reached a ruling that meant certain late-payment penalties used by several utilities were in violation of Section 347 of the Criminal Code. This section makes it a criminal offence to charge interest at a rate exceeding an annual rate of 60%. For purposes of Section 347, "interest" is a broad term that includes charges or expenses "in the form of a penalty."

   The particular case (Garland vs. Consumers Gas Co.) before the Supreme Court was a class action brought by Gordon Garland on behalf of over 500,000 Ontario customers of Consumers Gas Co. (now Enbridge Gas Distribution Inc.). Consumers Gas billed its customers on a monthly basis. The monthly statement specified a "due date" for the payment of current charges. The due date for residential customers was 16 days after the statement date. Customers who failed to pay by the due date were charged a late-payment penalty (LPP) of 5% of the current amount billed. The LPP was an all-or-noth-

ing penalty—it was the same whether the customer paid 1 day or 20 days beyond the due date.

   After you peel away the actuaries, Garland's argument before the Court was essentially this. If a customer paid 10 days after the due date, the customer was, in effect, charged 5% interest for a term of just 10 days. This was like being charged an annual interest rate of $5\% \times \frac{365}{10} = 182.5\%$, which exceeds the upper limit of 60% set by the Criminal Code.

   In a subsequent unanimous ruling in April of 2004, the Supreme Court ordered Enbridge to refund excessive LPPs collected between 1994 and the date in 2002 when Enbridge reduced its late payment charge to 2% per month. After interest is added, the refunds may cost Enbridge in excess of $100 million.

   In the years following the 1998 ruling, many other utilities reduced their LPPs or established more commercial-type credit policies. For example, in 1999 Bonnyville Gas Company in Alberta changed from a

5% penalty after a 21-day grace period to a 3.5% penalty after a 28-day grace period. This reduced penalty corresponds to an effective annual rate of 56.6%. (In Chapter 9 you will learn how to make this effective rate calculation.) This change put Bonnyville marginally below the 60% threshold for a criminal rate.

Unlike Bonnyville Gas Company, the management of the 407 Express Toll Route (407 ETR) seemed unaware of the significance of the 1998 Supreme Court decision regarding Garland vs. Consumers Gas Co. (The 407 ETR is a privately operated open-access toll-highway spanning a 108-kilometer distance through the Greater Toronto Area.) A situation that verged on the bizarre resulted in Richard Prendiville of Waterloo, Ontario launching a Class Action against the 407 ETR in December 2001.

The ETR had a policy of charging a $30 penalty on accounts overdue more than 90 days. That's pretty outrageous by itself, but read on. On October 14, 2000, Prendiville received an invoice for $12.02. He didn't get around to paying the bill and consequent-ly received another invoice in December for $12.26. The additional $0.24 represented two month's interest at 1% per month. Prendiville remitted the $12.26 in early January, but apparently not early enough to avoid another month's interest of $0.12. On February 14, he received an invoice for the $0.12 balance, but with a $30 late-payment penalty tacked on! He regarded the $30 penalty on an overdue 12¢ as a tad excessive and, unfortunately for the 407 ETR, Prendiville is a lawyer!

In his Statement of Claim, Prendiville pointed out that a $30 charge on a 12¢ balance for one month is equivalent to an annual interest rate of 300,000%. ($30 is 250 × $0.12. Therefore, the penalty is equivalent to an interest rate of 250 × 100% = 25,000% per month or 300,000% per year.) This rate violated the 60% limit set by Section 347 of the Criminal Code.

An out-of-court settlement was reached in April of 2003. As part of the settlement, 407 ETR agreed to credit $36 to the accounts of up to 840,000 customers who had been charged the $30 LPP.

EXERCISE 4.2

Answers to the odd-numbered problems are at the end of the book.

For Problems 1 through 4, determine the payment required to settle the invoice on the indicated payment date.

Problem	Invoice amount ($)	Credit terms	Invoice date	Payment date
1.	2365.00	2/10, n/30	Sept 25	Oct 5
2.	2365.00	$1\frac{1}{2}$/15, n/45	Oct 25	Nov 10
3.	815.49	2/10, 1/20, n/60	June 27	July 7
4.	5445.00	3/10, $1\frac{1}{2}$/20, n/60	March 23	April 13

Calculate the missing values in Problems 5 through 8. Assume in each case that the payment is made within the discount period.

Problem	Invoice amount ($)	Credit terms	Payment ($)	Amount credited ($)	Balance owed ($)
5.	2365.00	2/10, n/30	?	1365.00	?
6.	5445.00	3/10, n/90	3000.00	?	?
7.	3765.25	$1\frac{1}{3}$/15, n/45	?	?	2042.28
8.	775.50	$1\frac{1}{4}$/15, n/60	?	?	293.98

9. On May 25, Morris Hardware received an invoice from Precision Tools Inc. for $5076.64. The invoice was dated May 22 and offered terms of 2/10, 1/20, n/30. What payment will settle the invoice on:

    a. June 1?   **b.** June 2?   **c.** June 5?

10. White's Photography received an e-invoice from Fuji Canada dated February 27 of a leap year. The amount of the invoice is $2896.77 with terms $2\frac{1}{2}$/10, 1/30, n/60.

    a. What is the last date on which White's is eligible for the $2\frac{1}{2}$% discount?

    b. What amount will be required on that date to settle the invoice?

    c. Instead of the payment in (b), what amount must be paid on March 29 to settle the invoice?

11. In Problem 9, what will be the balance owed by Morris Hardware after a payment of $2000 on May 27? (Ignore the payment mentioned in Problem 9.)

12. In Problem 10, what will be the balance owed by White's Photography after a payment of $1500 on March 4? (Ignore the payments mentioned in Problem 10.)

13. **a.** In Problem 9, what will be the balance owed by Morris Hardware on June 5 after making payments of $1000 on each of May 26 and June 4? (Ignore the payment mentioned in Problem 9.)

    b. On what date will this balance be due?

14. **a.** In Problem 10, what will be the balance owed by White's Photography after making a payment of $1000 on March 5 and another payment of $500 on March 25? (Ignore the payments mentioned in Problem 10.)

    b. On what date will this balance be due?

15. What total amount must be paid on July 4 to settle invoices dated June 20 for $485, June 24 for $367, and June 30 for $722, all with terms $1\frac{1}{2}$/10, n/30?

16. The Simcoe School Board has three invoices from Johnston Transport, all with terms 2/10, 1/20, n/60. Invoice 277, dated October 22, is for $14,200; Invoice 327, dated November 2, is for $8600; and Invoice 341, dated November 3, is for $11,500. What total payment to Johnston on November 12 will settle all three invoices?

•**17.** Ballard Jewellers received an invoice dated August 22 from Safeguard Security Systems for $2856.57 with terms $2\frac{1}{2}$/10, 1/20, n/45. Ballard made payments of $900 on September 1, $850 on September 10, and $700 on September 30. What amount was still owed on October 1?

•**18.** Peak Roofing sent Jensen Builders an invoice dated July 12 for $5400 with terms 3/10, $1\frac{1}{2}$/20, n/45. Jensen made a payment of $2000 on July 20, and a second payment on August 1 that reduced the balance owed to $1000. What was the size of the second payment?

•**19.** On August 6, A&B Construction has three outstanding invoices payable to Excel Builder's Supply. Invoice 535, dated July 16, is for $3228.56; Invoice 598, dated July 24, is for $2945.31; and Invoice 678, dated August 3, is for $6217.69. All invoices have terms 4/10, 2/20, n/60. If A&B makes a $10,000 payment to Excel on August 6, what further payment on August 15 will settle the account? Note that Excel applies payments to the oldest invoices first.

••**20.** Sutton Trucking made two equal payments, on June 25 and July 15, on an invoice for $6350 dated June 15 with terms 3/10, 1/30, n/60. The payments reduced the balance owed on the invoice to $1043.33. What was the amount of each payment?

••**21.** An invoice for $2956.60, dated February 2, has terms 2/15, 1/30, n/90. What three equal payments on February 17, March 2, and May 2 will settle the account?

4.3   ## MARKUP

The **markup** or **gross profit** is the amount added to the unit cost of an item to arrive at its selling price. Thus,

$$\text{Selling price} = \text{Unit cost} + \text{Markup}$$

The markup on each unit must be large enough to cover a portion of the overall operating expenses (such as wages, rent, and utilities) and also make a suitable contribution to the overall operating profit. Expressing this idea as a word equation,

$$\text{Markup} = \text{Overhead expenses per unit} + \text{Operating profit[3] per unit}$$

Let us define the following symbols:

$S =$ Unit selling price
$C =$ Unit cost
$M =$ Markup
$E =$ Overhead or operating expenses per unit
$P =$ Operating profit per unit

The algebraic versions of the preceding word equations are

SELLING PRICE $$S = C + M \qquad \text{(4-3)}$$

MARKUP $$M = E + P \qquad \text{(4-4)[4]}$$

If we replace M in formula (4-3) by $E + P$, we obtain

SELLING PRICE $$S = C + E + P \qquad \text{(4-5)}$$

Figure 4.5 is a pictorial representation of these relationships. It shows that S may be viewed as being composed of C and M, or of C, E, and P. The boundary between E and P is shown as a dashed line because an *accurate* breakdown of M into its components may be done only at the *end* of an accounting period. Suppose, for example, that sales volume during a month is lower than normal. Then each unit's E must include a larger share of the fixed rent expense than it would in a month of higher sales. For a future operating period, a merchandiser can only estimate E based on his sales forecast and his experience in previous periods. (Managers prefer to think of each product line's E in terms of its percentage of C or its percentage of S.) Any forward-looking P calculated using an estimated E is also an approximation.

■ **FIGURE 4.5** | Markup Diagram

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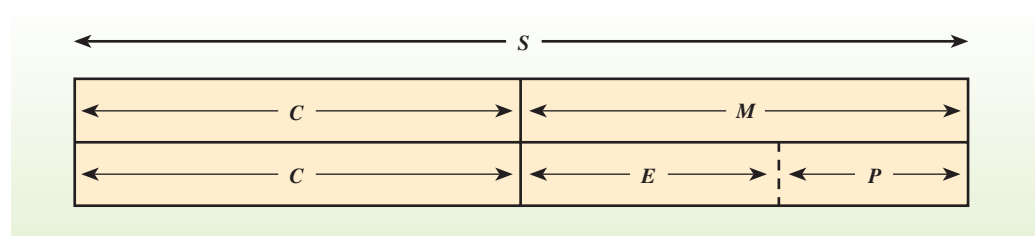
[3] In accounting, the "operating profit" on a Statement of Earnings is the profit from normal business operations. Unusual revenues from the sale of capital assets or other nonrecurring events are not included. The "operating profit" in our discussion of markup corresponds to the operating profit from a Statement of Earnings, but calculated on a per-unit basis.
[4] In applications of formulas (4-3), (4-4), and (4-5) in this chapter, we will assume that E and P are constant over the range of sales being considered. In practice, economies of scale usually result in the operating expenses per unit decreasing as the sales volume rises.

Part B on the textbook's CD-ROM presents an alternative to the Markup Diagram as an aid for solving problems in Sections 4.3, 4.4, and 4.5. Part B demonstrates the use of a Table Model in alternative solutions to Examples 4.3A, 4.3C, 4.3D, 4.3E, 4.4B, 4.5A, and 4.5B.

If a retailer is prepared to break even ($P = 0$) in order to clear out old stock, then the reduced price in a clearance sale needs to cover only the unit cost and the unit overhead expense. That is,

$$S(\text{break even}) = C + E \quad \text{and} \quad M(\text{break even}) = E$$

Merchandisers prefer to think of an item's markup in terms of its percentage of cost and its percentage of selling price. In the "real world," the terminology in this respect is inconsistent and confusing. We will use[5]

$$\text{Rate of markup} = \frac{M}{C} \times 100\%$$

and

$$\text{Gross profit margin} = \frac{M}{S} \times 100\%$$

When pricing merchandise, retailers usually first decide upon the rate of markup for each product line. Then they calculate the corresponding dollar amount of the markup for each product and add it to the unit cost.

THE CONNECTION BETWEEN THE NET PRICE, *N*, AND THE UNIT COST, *C*

In Section 4.1, we calculated the net price, N, after one or more trade discounts. In this section we use C to represent an item's unit cost. In most cases that we will encounter, C will equal the value of N calculated for one unit.

There are two common situations in which C will differ from N. Since *cash discounts* for prompt payment are credited toward N, any cash discounts taken on the purchase of an item will make C less than N. Any *shipping charges* included in the invoice amount are added to the net price *after* trade discounts. Therefore, shipping charges on purchases will make C greater than N. Unless a cash discount or shipping charges apply in a problem, assume that the net price (per unit) after trade discounts will also be the unit cost.

■ **EXAMPLE 4.3A** | CALCULATING THE MARKUP AND SELLING PRICE THAT WILL GIVE A DESIRED OPERATING PROFIT

Coastal Marine is importing a new line of inflatable boats at a unit cost of $1860. Coastal estimates that operating expenses per unit will be 30% of cost.

a. What should the markup and selling price be if Coastal Marine's desired unit operating profit is 25% of cost?

b. What are Coastal Marine's rate of markup and gross profit margin on the inflatable boats?

SOLUTION

a. Given: $C = \$1860$, $E = 0.30C$, $P = 0.25C$

First we sketch a markup diagram. It helps us organize the given information. It will also help us solve for the unknown quantities because the mathematical relationships, $M = E + P$ and $S = C + M = C + E + P$, are embedded in the geometry of the diagram.

$S =$

| $C =$ | $E =$ | $P =$ |

$M =$

---
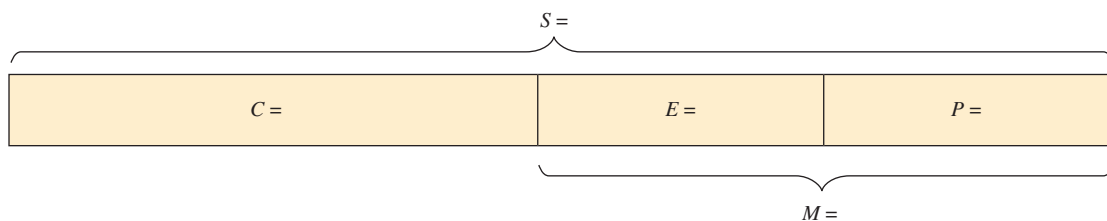
[5] These are also the terms and definitions employed in the Texas Instruments BA-II Plus Guidebook and Owner's Manual.

Next enter the given information. The diagram now looks like this:

$$S =$$

C = \$1860	E = 0.30C	P = 0.25C

$$M =$$
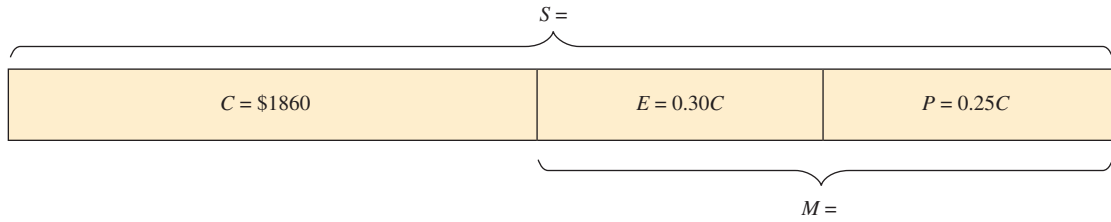
We can directly calculate E and P. That is,

$$E = 0.30C = 0.30(\$1860) = \$558$$

and

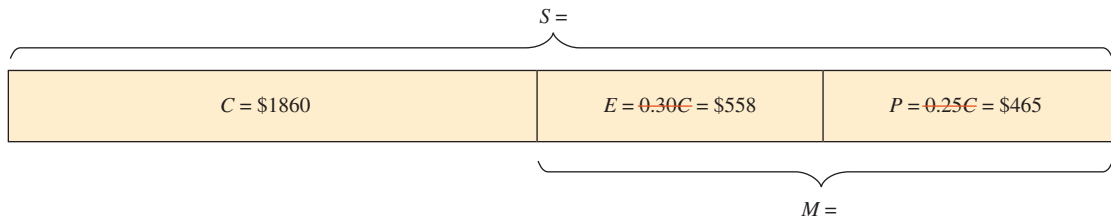$$P = 0.25C = 0.25(\$1860) = \$465$$

After you obtain the numerical value for a variable, enter it on the diagram. Then you can keep track of the variables that are known, and more readily identify the variable that may be calculated next. The diagram now looks like this:

$$S =$$

C = \$1860	E = ~~0.30C~~ = \$558	P = ~~0.25C~~ = \$465

$$M =$$

From the diagram, it is evident that

$$M = \$558 + \$465 = \$1023$$

and that

$$S = \$1860 + \$1023 = \$2883$$

Coastal Marine should apply a markup of \$1023, resulting in a selling price of \$2883.

b. Rate of markup $= \dfrac{M}{C} \times 100\% = \dfrac{\$1023}{\$1860} \times 100\% = 55.0\%$

Gross profit margin $= \dfrac{M}{S} \times 100\% = \dfrac{\$1023}{\$2883} \times 100\% = 35.5\%$

EXAMPLE 4.3B | CALCULATING THE UNIT OPERATING PROFIT

Kabir is the proprietor of Fredericton Cycle. He wants to estimate the unit operating profit on a new line of bicycles he may add to his inventory. His unit cost for these bicycles will be \$385. Kabir does financial projections based on operating expenses of 35% of cost. If he matches the competition's retail price of \$649 on these bicycles, what will be his unit operating profit?

SOLUTION

Enter the given information on a markup diagram.

$$S = \$649$$

C = \$385	E = ~~0.35C~~ = \$134.75	P =

$$M =$$

$$E = 0.35C = 0.35(\$385) = \$134.75$$
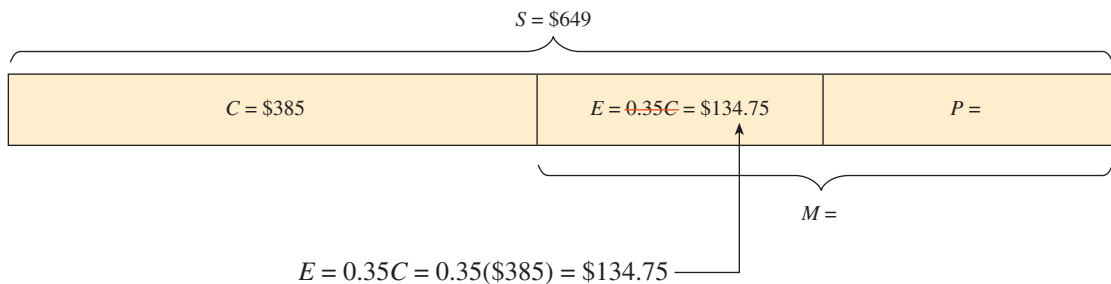
From the diagram, it is then apparent that

$$\$649 = \$385 + \$134.75 + P$$

Therefore,

$$P = \$649 - \$385 - \$134.75 = \$129.25$$

Kabir's estimated operating profit will be $129.25 per bicycle.

EXAMPLE 4.3C | CALCULATING THE SELLING PRICE THAT PRODUCES A DESIRED GROSS PROFIT MARGIN

The cost of a gas barbecue to a retailer is $245. If the retailer wants a gross profit margin of 30%, determine the amount of the markup and the selling price.

SOLUTION

Enter the given information on a markup diagram. Since the gross profit margin is 30%, then

$$\frac{M}{S} = 0.30 \qquad \text{and} \qquad M = 0.30S$$

$S =$

C = $245	E =	P =

$M = 0.30S$
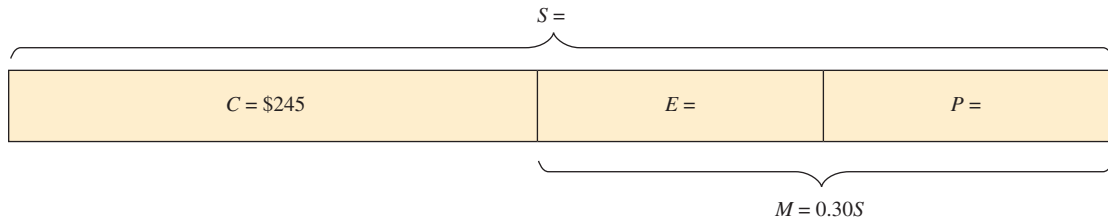
This problem is less straightforward than the preceding examples. If you can express a relationship (among some of the quantities portrayed on the diagram) in terms of a single unknown variable, then you can solve for that variable.

In the diagram, observe that

$$S = \$245 + 0.30S$$

Now solve this equation for *S*.

$$S - 0.30S = \$245$$
$$0.70S = \$245$$
$$S = \frac{\$245}{0.70} = \$350$$

Hence,

$$M = 0.30S = 0.30(\$350) = \$105$$

After a markup of $105 the selling price is $350.

EXAMPLE 4.3D | USING RELATIONSHIPS AMONG PRICING VARIABLES

Cal-Tire retails its regular tires at $120 each and its high-performance tires at $175 each. Cal-Tire purchases the tires from the factory for $80 and $122, respectively. Overhead expenses are 20% of the selling price. For each line of tires, determine:

a. The amount of markup.   **b.** The rate of markup.

c. The gross profit margin.   **d.** The operating profit per tire.

SOLUTION

Enter the given information for each tire on a markup diagram.

Regular tire:

$S = \$120$

$C = \$80$	$E = 0.20S$	$P =$

$M =$

High-performance tire:

$S = \$175$

$C = \$122$	$E = 0.20S$	$P =$

$M =$
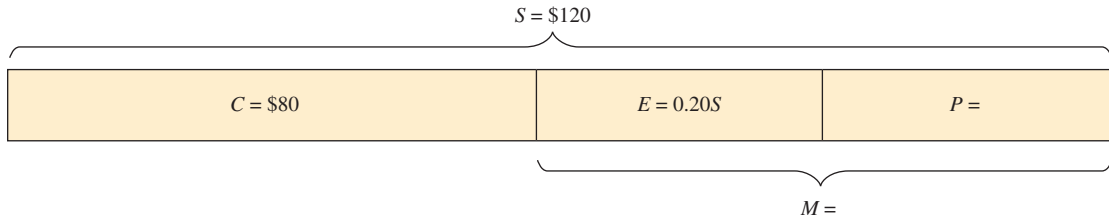
Regular tire:	**High-performance tire:**
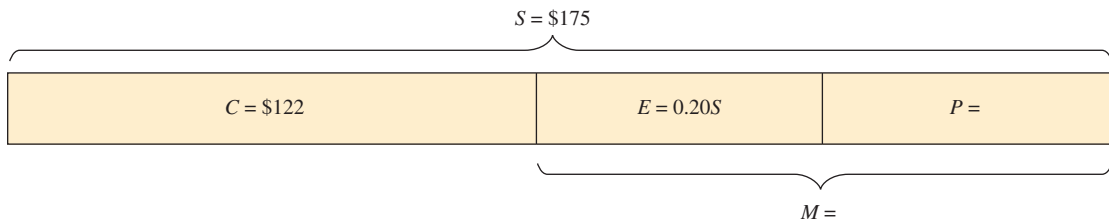
a. From the upper diagram,　　　　　　　　　From the lower diagram,

$M = \$120 - \$80 = \$40$　　　　　　　　　$M = \$175 - \$122 = \$53$

The markup is $40.00.　　　　　　　　　The markup is $53.00.

Enter these markup amounts on their respective diagrams.

b. Rate of markup $= \dfrac{M}{C} \times 100\%$　　　　　Rate of markup $= \dfrac{M}{C} \times 100\%$

$\qquad = \dfrac{\$40}{\$80} \times 100\%$　　　　　　　　$\qquad = \dfrac{\$53}{\$122} \times 100\%$

$\qquad = 50.0\%$　　　　　　　　　　$\qquad = 43.4\%$

c. Gross profit margin $= \dfrac{M}{S} \times 100\%$　　　Gross profit margin $= \dfrac{M}{S} \times 100\%$

$\qquad = \dfrac{\$40}{\$120} \times 100\%$　　　　　　　$\qquad = \dfrac{\$53}{\$175} \times 100\%$

$\qquad = 33.3\%$　　　　　　　　　　$\qquad = 30.3\%$

d. $E = 0.20S = 0.20(\$120) = \$24.00$　　　　$E = 0.20S = 0.20(\$175) = \$35.00$

After entering these amounts on their respective diagrams, it is apparent that

$P = M - E = \$40.00 - \$24.00 = \$16.00$　　and　　$P = \$53.00 - \$35.00 = \$18.00$

■ **EXAMPLE 4.3E** | CALCULATING THE MARKUP AND SELLING PRICE THAT WILL GIVE A DESIRED OPERATING PROFIT

A sporting goods store sets the selling price of baseball gloves to include expected overhead expenses of 25% of the selling price and a desired profit of 20% of the selling price. Determine the selling price and the rate of markup for a glove that costs the store $56.50.

SOLUTION

Given: $E = 0.25S$, $P = 0.20S$, $C = \$56.50$

Enter the given information on a markup diagram.

$S =$		
$C = \$56.50$	$E = 0.25S$	$P = 0.20S$

$M =$
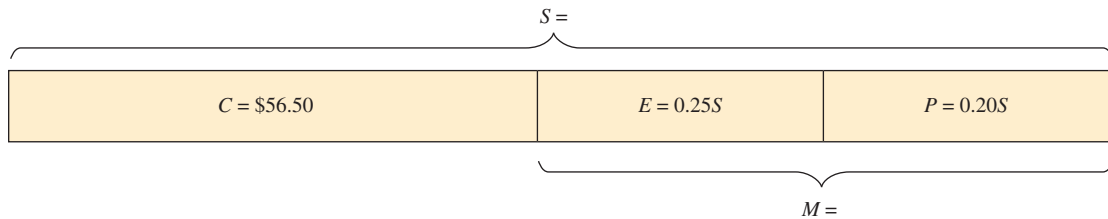
There is no simple one-step calculation that enables us to obtain any of the unknown variables. So we should look for a relationship that involves a single unknown. The diagram helps us see that

$$S = \$56.50 + 0.25S + 0.20S$$

Solve for S by first collecting terms in S on the left side.

$$S - 0.25S - 0.20S = \$56.50$$

$$0.55S = \$56.50$$

$$S = \frac{\$56.50}{0.55} = \$102.73$$

Enter this value on the diagram. Then we notice that

$$M = S - C = \$102.73 - \$56.50 = \$46.23$$

Hence,

$$\text{Rate of markup} = \frac{M}{C} \times 100\% = \frac{\$46.23}{\$56.50} \times 100\% = 81.8\%$$

After a markup of 81.8%, the selling price of the glove is $102.73.

Concept Questions

1. Which will be the larger number: the rate of markup or the gross profit margin? Explain.

2. Is it possible for the gross profit margin to exceed 100%? Explain.

3. Is it possible for the rate of markup to exceed 100%? Explain.

4. Under what unusual circumstance will the rate of markup equal the gross profit margin?

5. Does a retailer break even if an item is sold "at cost"?

6. What sort of items in a grocery store will tend to have the highest markup rates?

EXERCISE 4.3

Answers to the odd-numbered problems are at the end of the book.

For Problems 1 through 6, determine:
a. The amount of markup.
b. The amount of operating (overhead) expenses.
c. The operating profit or loss.
d. The rate of markup.
e. The gross profit margin.

Problem	Cost, C ($)	Selling price, S ($)	Operating expenses, E
1.	30.00	50.00	40% of cost
2.	64.00	96.00	25% of selling price
3.	55.65	79.50	30% of selling price
4.	17.50	29.75	50% of cost
5.	53.90	77.00	35% of selling price
6.	23.00	29.90	45% of cost

Calculate the missing values in Problems 7 through 12.

Problem	Cost, C ($)	Markup, M ($)	Selling price, S ($)	Rate of markup	Gross profit margin
7.	152.50	47.45	?	?	?
8.	51.30	?	79.90	?	?
9.	?	435.00	1990.00	?	?
10.	?	?	19.90	?	50%
11.	8.89	?	?	90%	?
•12.	6.60	?	?	?	40%

13. Omega Restaurant buys Merlot wine at $10.95 per bottle, and sells it to customers at $24.95 per bottle. Calculate Omega's rate of markup and gross profit margin on the wine.

14. Super Value Foods buys bulk peanuts for $54.50 per 20-kilogram bag and sells the peanuts for $0.42 per 100 grams. What are Super Value's gross profit margin and rate of markup on the peanuts?

15. Café Desserts buys cheesecake from General Bakeries at $19 per complete cheesecake. Each cake is then cut into twelve slices and sold to customers at $4.50 per slice. Calculate the rate of markup and gross profit margin on the cheesecake.

16. The Annapolis Rotary Club sells hot dogs for $1.95 each at the annual Annapolis Fall Fair. The Rotary Club buys wieners at $3.95 per package of 10 wieners, and hot dog buns at $2.90 per dozen. It costs $78 for enough condiments for 1000 hot dogs. What are the Rotary Club's gross profit margin and rate of markup on the hot dogs?

17. Computer Warehouse buys a printer for $380 less trade discounts of 20% and 10%. If the operating expenses are $57 per printer:
   a. What should be the selling price to generate a profit of $33 per printer?
   b. What is the rate of markup?
   c. What is the gross profit margin?
   d. What would be the break-even selling price for an inventory clearance sale?

18. Damsels clothing store orders a line of jeans at a suggested retail price of $58 less trade discounts of 30% and 7%. The manager intends to sell the jeans at the suggested retail price. If overhead expenses are 25% of the selling price:

    a. What will be the unit operating profit?

    b. What is the rate of markup?

    c. What is the gross profit margin?

    d. What would be the break-even selling price for an inventory clearance sale?

19. The rate of markup on a toaster selling at $54.95 is 45%.

    a. What was the cost of the toaster to the retailer?

    b. What is the gross profit margin?

20. Cuddly Pets purchased a litter of six puppies from a reputable breeder for $77 each. If the gross profit margin is 45%,

    a. What is the selling price of each puppy?

    b. What is the rate of markup?

•21. If the gross profit margin on lettuce in a grocery store is 60%, what is the rate of markup?

•22. The rate of markup on fresh peaches in a grocery store is 125% because of the large losses from spoilage and bruising while the peaches are in storage and on display. What is the gross profit margin?

•23. Workers World bought 250 pairs of rubber boots at $15 per pair. The manager applies a 90% rate of markup when pricing footwear. What is the unit operating profit if overhead expenses work out on average to be 20% of the selling price?

•24. A florist buys potted poinsettias from a nursery at $15 each less series discounts of 40% and 10%. The florist prices her stock to allow for overhead of 55% of cost and an operating profit of 20% of the selling price. At what price should she sell the poinsettias?

•25. Beaver Building Supply obtains 4-ft by 8-ft sheets of half-inch plywood from Macmillan Forest Products at $36 per sheet less discounts of 30% and 5%. The trade price is to be set to cover Beaver's overhead of 20% of the selling price and to provide an operating profit of 12% of the selling price. What should be the retail price per sheet?

•26. Village Foods employs a 35% rate of markup for all dairy products. The store's overhead averages out to 20% of sales each month. What is the operating profit on a 4-litre pail of ice cream for which the wholesale cost is $4.65?

•27. Prestige Clothiers' regular prices for menswear are set to provide a gross profit margin of 40%. Overhead expenses are 30% of cost on average. What is the operating profit on a suit that sells for $495?

•28. Digital Devices sets its retail prices on computers, monitors, and printers to generate a gross profit margin of 30%. Overhead expenses normally work out to be 30% of cost. What is the operating profit on a monitor that costs $345?

MARKDOWN

A **markdown** is a reduction in the selling price of an item. Retailers use markdowns for many reasons: to reduce excess inventory, to clear out damaged or discontinued items, or to increase sales volume during special "sale" events. Sometimes retailers will mark down a few popular items to the break-even point, or even below it, just to attract additional customers who they hope will also purchase other items. Grocery stores do this on a regular basis.

$$\text{Amount of markdown} = \text{Regular selling price} - \text{Reduced selling price}$$

Introducing the symbols

$$D = \text{Amount of markdown}$$
$$S = \text{(Regular) selling price}$$
$$S(\text{reduced}) = \text{Reduced selling price (or Sale Price)}$$

the word equation becomes

$$D = S - S(\text{reduced})$$

The rate of markdown is the markdown calculated as a percentage of the regular selling price. That is,

$$\text{Rate of markdown} = \frac{D}{S} \times 100\%$$

If the regular selling price and rate of markdown are given, you can calculate the reduced selling price using the basic discounting formula $N = L(1 - d)$ restated as

$$S(\text{reduced}) = S(1 - \text{Rate of markdown})$$

■ **EXAMPLE 4.4A** | CALCULATING THE REDUCED SELLING PRICE

Toby's Cycle Shop advertises a 20% markdown on an Alpine mountain bike regularly priced at $445. Cycle City's regular selling price for the same model of bike is $429.

a. What is the reduced price at Toby's?

b. What rate of markdown would Cycle City have to offer to match Toby's reduced price?

SOLUTION

a. The reduced or marked-down price may be calculated using formula (4-1) restated as

$$S(\text{reduced}) = S(1 - \text{Rate of markdown})$$
$$= \$445(1 - 0.20)$$
$$= \$356$$

The reduced price is $356.

b. In order to match Toby's reduced price, Cycle City must mark down its price by

$$D = S - S(\text{reduced}) = \$429 - \$356 = \$73$$

The necessary rate of markdown is

$$\frac{D}{S} \times 100\% = \frac{\$73}{\$429} \times 100\% = 17.0\%$$

A markdown of 17.0% will enable Cycle City to match Toby's reduced price.

◼ **EXAMPLE 4.4B** | CALCULATING THE RATE OF MARKDOWN

An item costing $150 was marked up by 40% of the selling price. During the store's Tenth Anniversary Sale, the selling price was reduced to $175. What was the regular selling price, and what was the rate of markdown during the sale?

SOLUTION

For all but the easiest markdown problems, it pays to draw an expanded version of the markup diagram we employed in Section 4.3. Enter all known values on the diagram as follows.

$S =$

$C = \$150$	$M = 0.40S$	
$C = \$150$	$M(\text{reduced}) =$	$D =$
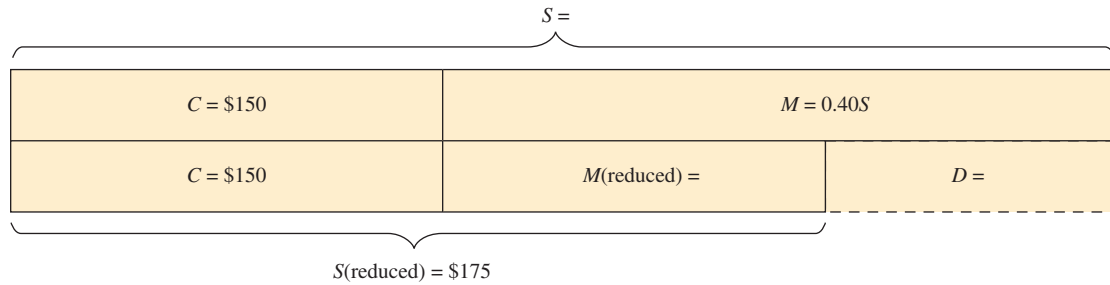
$S(\text{reduced}) = \$175$

From the diagram, we note that

$$S = \$150 + 0.40S$$

Hence,

$$0.60S = \$150$$

and

$$S = \frac{\$150}{0.6} = \$250.00$$

Enter this value on the diagram. It then becomes obvious that

$$D = S - S(\text{reduced}) = \$250 - \$175 = \$75.00$$

Therefore,

$$\text{Rate of markdown} = \frac{D}{S} \times 100\% = \frac{\$75}{\$250} \times 100\% = 30.0\%$$

The regular selling price was $250.00 and the rate of markdown was 30.0%.

Concept Questions

1. Suppose an item that originally had a 40% rate of markup is marked down 40%. Is its reduced selling price equal to C? Explain.

2. If an item is marked down by the same percentage as the gross profit margin, will the reduced operating profit be positive, negative, or zero? Explain.

EXERCISE 4.4   *Answers to the odd-numbered problems are at the end of the book.*

Calculate the missing values in Problems 1 through 6.

Problem	Cost ($)	Rate of markup (%)	Gross profit margin (%)	Selling price ($)	Markdown ($)	Rate of markdown %	Reduced price ($)
1.	185.00	50	?	?	60.00	?	?
2.	58.50	?	?	95.00	?	30	?
3.	24.99	?	?	49.98	?	?	24.99
4.	580.00	30	?	?	?	30	?
5.	19.25	?	35	?	?	25	?
6.	249.00	?	25	?	?	?	249.00

7. Patti's Lingerie marked up an article from its $37.50 cost to $59.98.

    a. What is the rate of markup?

    b. What is the gross profit margin?

    c. What rate of markdown can be advertised if, at a later date, the price is reduced to cost for a clearance sale?

8. **a.** Merchant A operates on a rate of markup of 45%. If she later marks the price of a few items down to their cost in order to attract additional customers to the store, what rate of markdown can she advertise?

    b. Merchant B operates on a gross profit margin of 45%. If he later marks the price of a few items down to their cost in order to attract additional customers to the store, what rate of markdown can he advertise?

9. The Ski Hut purchased Lampinen cross-country skis for $193.60 per pair and marked them up to give a gross profit margin of 45%. When the skis were discontinued, the Ski Hut marked down its remaining stock by 35%. What was the sale price after the markdown?

10. The sign on a rack of sport coats reads: "All prices marked down 30%!" What is the regular selling price of a coat marked at:

    a. $100?   **b.** $196.49?

11. Merchants C and D sell the same article at $69.95 and $64.95 respectively. They both advertise that they will match the price offered by any other store on any product that they stock.

    a. What discount rate must C give to match D's price marked down by 20% during a sale?

    b. What discount rate must D give to match C's price marked down by 20% during a sale?

•12. A pharmacy marks up its springtime shipment of sunglasses to provide for overhead expenses of 40% of cost and a profit of 70% of cost. At the end of the summer, what rate of markdown can the pharmacy apply to the remaining inventory of sunglasses and still break even on sales at this level?

*4.5   PUTTING IT ALL TOGETHER

The problems in this section bring together elements from two or more sections of the chapter. Consequently, their solution usually requires several steps and has a higher degree of difficulty. The more complex the problem, the more benefits you will derive from using a diagram of the sort illustrated in the following examples.

The unit cost, C, and the operating (or overhead) expenses per unit, E, do not change when a retailer marks down the price. Therefore, the reduced operating profit, P(reduced), after a markdown is

$$P(\text{reduced}) = S(\text{reduced}) - C - E$$

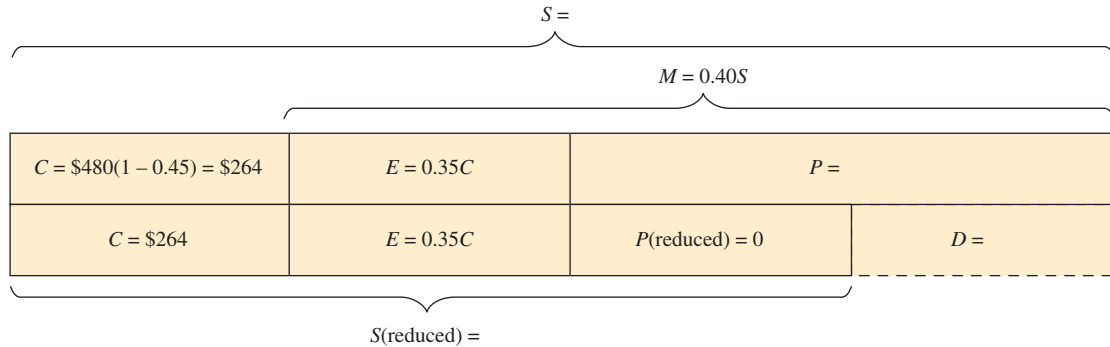A merchant breaks even on a particular item when P(reduced) = 0, that is, when

$$S(\text{reduced}) = S(\text{break even}) = C + E.$$

EXAMPLE 4.5A | USING RELATIONSHIPS AMONG PRICING VARIABLES

Stereo World purchased Pioneer XL Receivers at a discount of 45% from its supplier's suggested retail price of $480. Stereo World's normal gross profit margin is 40%. The manager wants to clear out the remaining XL units because the manufacturer has discontinued the XL model. What rate of markdown can Stereo World offer and still break even on each unit? On average, operating expenses are 35% of cost.

SOLUTION

The first sentence tells us that $C = \$480(1 - 0.45)$. The second sentence tells us that $M = 0.40S$. The fourth sentence tells us that $P(\text{reduced}) = 0$. The fifth and last sentence tells us that $E = 0.35C$. Enter this information on the following markup/markdown diagram.

$S =$			
	$M = 0.40S$		
$C = \$480(1 - 0.45) = \$264$	$E = 0.35C$	$P =$	
$C = \$264$	$E = 0.35C$	$P(\text{reduced}) = 0$	$D =$
	$S(\text{reduced}) =$		

We need to obtain both D and S in order to calculate the rate of markdown. From the upper part of the diagram, we can write an equation containing S as the only unknown.

$$S = \$264 + 0.40S$$

Therefore,

$$S = \frac{\$264}{0.6} = \$440.00$$

As you obtain numerical values, enter them on the diagram. You can directly calculate

$$E = 0.35C = 0.35(\$264) = \$92.40$$

Then observe on the diagram that there is enough information to obtain S(reduced).

$$S(\text{reduced}) = \$264 + \$92.40 + \$0 = \$356.40$$

With the value for $S(\text{reduced})$ entered on the diagram, notice that you can now calculate D.

$$D = S - S(\text{reduced}) = \$440 - \$356.40 = \$83.60$$

Therefore,

$$\text{Rate of markdown} = \frac{D}{S} \times 100\% = \frac{\$83.60}{\$440} \times 100\% = 19.0\%$$

Stereo World can offer a markdown of 19.0% and still break even.

EXAMPLE 4.5B | USING RELATIONSHIPS AMONG PRICING VARIABLES

Standard Appliances obtains Frigid-Air refrigerators for $1460 less 30% and 5%. Standard's overhead works out to 18% of the regular selling price of $1495. A scratched demonstrator unit from their floor display was cleared out for $1195.

**a.** What is the regular rate of markup?

b. What was the rate of markdown on the demonstrator unit?

c. What was the operating profit or loss on the demonstrator unit?

d. What rate of markup was actually realized?

SOLUTION

Standard Appliances' cost for one refrigerator was

$$C = N = L(1 - d_1)(1 - d_2)$$
$$= \$1460(1 - 0.30)(1 - 0.05)$$
$$= \$970.90$$

Enter this value and the other given information on a markup/markdown diagram.

$S = \$1495$

$M =$

| $C = \$970.90$ | $E = 0.18S$ | $P =$ | |
| $C = \$970.90$ | $E = 0.18S$ | $P(\text{reduced}) =$ | $D =$ |
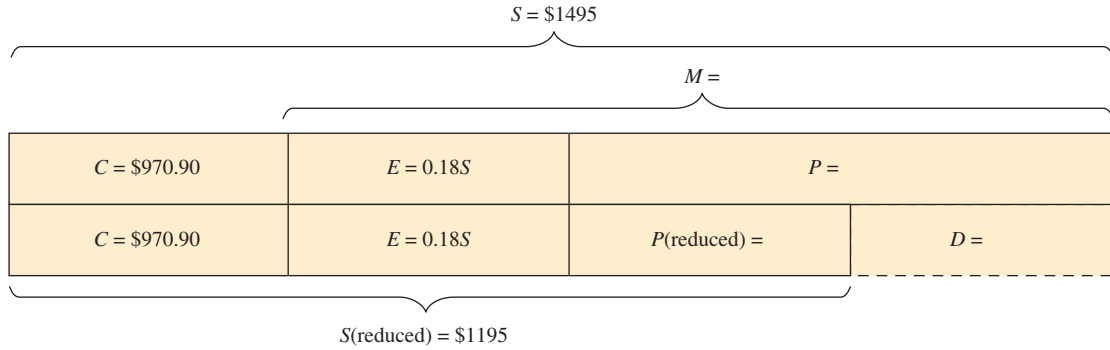
$S(\text{reduced}) = \$1195$

a. From the upper part of the diagram, we see that

$$M = \$1495 - \$970.90 = \$524.10$$

Hence, $\qquad$ Rate of markup $= \dfrac{M}{C} \times 100\% = \dfrac{\$524.10}{\$970.90} \times 100\% = 54.0\%$

b. On the diagram, we note that both S and $S(\text{reduced})$ are known. Therefore,

$$D = \$1495 - \$1195 = \$300$$

and $\qquad$ Rate of markdown $= \dfrac{D}{S} \times 100\% = \dfrac{\$300}{\$1495} \times 100\% = 20.1\%$

c. Now we want $P(\text{reduced})$. First calculate E.

$$E = 0.18S = 0.18(\$1495) = \$269.10$$

Therefore, $\qquad$ $P(\text{reduced}) = \$1195.00 - \$970.90 - \$269.10 = -\$45.00$

The negative sign means that the store suffered a loss of $45.00 on the demonstrator unit.

d. The actual markup at the reduced price was

$$M(\text{reduced}) = E + P(\text{reduced}) = \$269.10 + (-\$45.00) = \$224.10$$

The rate of markup actually realized was

$$\dfrac{M(\text{reduced})}{C} \times 100\% = \dfrac{\$224.10}{\$970.90} \times 100\% = 23.1\%$$

Sales, Sales, and More Sales! Some merchants seem to have a sale of some sort going on almost all the time. A few "SALE!" signs around the premises help to induce curious shoppers to investigate potential bargains. Once in the store, the shopper may make other purchases. Some retailers initially price certain lines of merchandise at a level that provides "room" for a substantial planned markdown in a future sale event. Some merchandise may sell at the high "regular" price, but the merchant fully expects the bulk of the sales volume to

occur at the reduced price.[6] In such cases, the merchant may regard the ultimate marked-down price as the primary selling price that provides the "normal" unit operating profit.

EXAMPLE 4.5C | USING RELATIONSHIPS AMONG PRICING VARIABLES

Fromme's Jewellers purchased sterling silver tea services for $960 each, less 35% and 15%. The "regular" selling price was set so that, in a "30% off" sale, overhead expenses represent 25% of the sale price and the operating profit is 15% of the sale price.
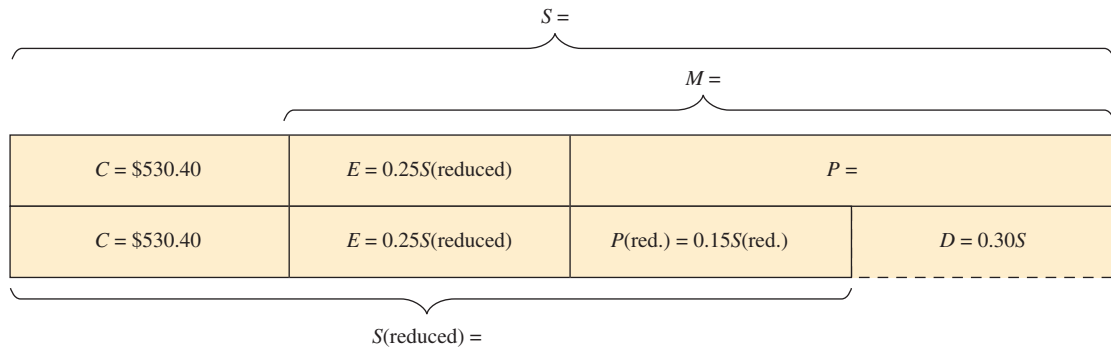
a. At what price will a tea service sell in a "30% off" sale?

b. What was the "regular" price before the markdown?

c. If the last set in inventory is cleared out at 50% off the regular price, what will the operating profit be on that set?

SOLUTION

Fromme's cost of a silver tea service was

$$C = N = L(1 - d_1)(1 - d_2)$$
$$= \$960(1 - 0.35)(1 - 0.15)$$
$$= \$530.40$$

Enter this value and the other given information on a markup/markdown diagram.

$S =$

$M =$

| $C = \$530.40$ | $E = 0.25S$(reduced) | $P =$ | |
| $C = \$530.40$ | $E = 0.25S$(reduced) | P(red.) $= 0.15S$(red.) | $D = 0.30S$ |

S(reduced) $=$

a. From the lower part of the diagram, we notice that we can create an equation having S(reduced) as the only unknown.

$$S(\text{reduced}) = \$530.40 + 0.25S(\text{reduced}) + 0.15S(\text{reduced})$$

Hence

$$S(\text{reduced}) - 0.40S(\text{reduced}) = \$530.40$$

$$S(\text{reduced}) = \frac{\$530.40}{0.60} = \$884.00$$

The price in a "30% off" sale will be $884.00.

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[6] Mattresses are an example of a product line for which the majority of sales occur at a significant markdown from the "regular" price. The following footnote appeared in a display advertisement placed in a Victoria newspaper by one of Vancouver Island's largest furniture stores: "The reference to our 'regular selling price' is to a price at which goods are regularly offered for sale in our store and is not a representation that this is the price at which most of a product is actually sold."

b. We now want to calculate S. After entering $S(\text{reduced}) = \$884$ on the diagram, we observe that

$$S = S(\text{reduced}) + D = \$884 + 0.30S$$

Hence,

$$S - 0.30S = \$884$$

and

$$S = \frac{\$884}{0.70} = \$1262.85$$

The "regular" price of the tea service was $1262.85.

c. In this new scenario, $D = 0.50S$. [If necessary, construct a new diagram showing $D = 0.50S$ and indicating that both $S(\text{reduced})$ and $P(\text{reduced})$ are unknown.] C and E remain at

$$C = \$530.40 \quad \text{and} \quad E = 0.25(\$884) = \$221.00$$

Now

$$S(\text{reduced}) = S - D = S - 0.50S = 0.50S = 0.50(\$1262.85) = \$631.43$$

Then

$$P(\text{reduced}) = S(\text{reduced}) - C - E = \$631.43 - \$530.40 - \$221.00 = -\$119.97$$

Fromme's will lose $119.97 on the last tea set.

Misleading Price Representation

A few categories of consumer goods (expensive jewellery, for example) seem to be "ON SALE" so frequently or for so long that the consumer may wonder whether any significant volume of sales takes place at the "regular price."

Price representations usually fall under Section 74.01 of the federal Competition Act. In layman's terms, the section states that any materially misleading representation as to the price at which a product is ordinarily sold is prohibited. The courts have interpreted "ordinary price" to include words and phrases (such as "Compare to . . ." or "$x\%$ off") used to imply that the comparison price is the price at which the product is ordinarily sold.

Section 74.01 states that the quoted or implied ordinary selling price should be one of the following:

- The price at which the product ordinarily sells in the market area.

- The advertiser's own regular selling price, clearly identified by such words as "our regular price."

The comparison price should be sufficiently recent to have relevance. The "ordinary price" implied or quoted for comparison should be one at which the product has had significant sales, not merely a price at which it was offered for sale. The volume needed in order to be regarded as "significant" depends on the product and the market. However, the volume should have been large enough to justify a consumer believing that the markdown represented a genuine bargain or true savings. On the other hand, if the price of a product had been raised for a few weeks during which very few sales took place, then the merchant should not state or imply that the inflated price was the regular or ordinary selling price. Furthermore, the use of a "Manufacturer's Suggested Retail Price" or "Suggested List Price" can constitute deceptive pricing if this price is not the product's ordinary selling price.

Answers to the odd-numbered problems are at the end of the book.

Calculate the missing values in Problems 1 through 4.

Problem	Cost, C ($)	Overhead, E	Markup, M	Regular price, S ($)	Rate of markdown	Sale price, S(reduced) ($)	Reduced profit, P(reduced) ($)
1.	37.25	20% of C	60% of C	?	?	41.72	?
2.	7.92	70% of C	?% of C	19.80	20%	?	?
3.	98.00	18% of S	?% of S	147.00	$16\frac{2}{3}$%	?	?
4.	115.70	20% of S	35% of S	?	?	133.50	?

5. A retailer pays $81 to a wholesaler for an article. The retail price is set using a gross profit margin of 40%. To increase traffic to his store, the retailer marks the article down 20% during a sale. What is the sale price?

6. A bedroom suite costs Town & Country Furniture $2500 less 30% and 15%. The normal rate of markup is 90%. The suite is marked down 30% in a Mid-Summer sale. What is the sale price?

7. Comfort Shoes' normal gross profit margin is 45%. What rate of markdown can the store offer on a pair of shoes normally priced at $140, and still realize a 20% rate of markup at the sale price?

8. Just Dresses sets its regular prices based on overhead expenses at 50% of cost and an operating profit of 40% of cost. What will be the operating profit (as a percent of cost) for dresses sold at a 20% discount?

•9. Hi-Lites Inc. purchased a ceiling fixture for $480 less 40% and 25%, and marked it up by 120% of cost. In a clearance sale, Hi-Lites offered the fixture at 40% off.

   a. What was the sale price?

   b. At the sale price, what was the rate of markup?

   c. If overhead expenses were 55% of cost, what was the operating profit or loss at the sale price?

•10. Long Lake Nursery bought fertilizer in bulk in March at $18.60 less $33\frac{1}{3}$%, $12\frac{1}{2}$%, and 5% per 20 kilogram bag. The fertilizer is normally priced to give a gross profit margin of 55%. The fertilizer was marked down 45% for an inventory reduction sale in late July.

   a. What was the sale price?

   b. What was the (reduced) gross profit margin?

   c. What was the operating profit or loss at the reduced price if operating expenses were 30% of cost?

•11. Water Sports Ltd. pays $360 less 25% for a backyard above-ground pool kit. Overhead expenses are $16\frac{2}{3}$% of the regular selling price, and the operating profit is 15% of the selling price.

   a. What is the maximum rate of markdown the store can offer and still break even?

   b. What is the profit or loss per unit if Water Sports clears out its remaining stock at 20% off in a Hot August Bargains sale?

•12. A lawn mower retails for $349. The dealer's overhead is 25% of cost, and normal operating profit is $16\frac{2}{3}$% of cost.

   a. What is the largest amount of markdown that will allow the dealer to break even?

   b. What rate of markdown will price the lawn mower at cost?

•**13.** Rainbow Paints is discontinuing a line of paint that it purchased at $30 less 45% and 10% per 4-litre pail. The store's overhead is 50% of cost, and normal operating profit is 30% of cost. If the manager of the store is prepared to accept a loss of one-quarter of the overhead expenses, what markdown rate can the store offer in order to clear out the paint?

•**14.** United Furniture buys reclining rocking chairs at $550 less 40% and 10%. The price is marked up to allow for overhead of 50% of cost and profit of 35% of cost. The unit on display in the store acquired a stain. What rate of markdown from the regular price can the store offer on the display unit if it is to recover only half of the unit overhead costs?

•**15.** Fashion Master purchased men's sweaters for $72 less 40% and 15%. The normal gross profit margin is 40%, and overhead is 25% of the regular selling price. The sweaters were reduced to $45.90 for the store's Boxing Day Blowout.

   a. What was the rate of markdown for the sale?

   b. What was the profit or loss on each sweater at the sale price?

   c. At the sale price, what was the rate of markup?

•**16.** Mr. Vacuum obtains vacuum cleaners for $720 less $33\frac{1}{3}$% and 15%. A demonstration unit regularly priced at $750 was sold for $450. The shop's overhead is 22% of cost.

   a. What was the markdown rate on the vacuum cleaner?

   b. What was the profit or loss on the sale of the demonstrator?

   c. What rate of markup was realized at the reduced price?

•**17.** A discount furniture store bought a waterbed at the wholesale price of $665. The "regular price" of the waterbed is set so that, in a "20% off" sale, the gross profit margin is 30%.

   a. What is the price of the waterbed in a "20% off" sale?

   b. What is the "regular price" of the waterbed?

•**18.** A jewellery store purchased a diamond ring for $2500 less 40% and 5%. The store's average unit overhead expenses are 30% of cost. The "regular price" of the ring is established so that, if it is sold in a "20% off" sale, the unit operating profit at the reduced price will be 20% of cost.

   a. What is the reduced price of the ring in a "20% off" sale?

   b. What is the "regular price" of the ring?

   c. What is the operating profit if the ring happens to sell at the "regular price?"

•**19.** Sonic Boom obtained a stereo system for $2400 less 30% and 15%. The store's pricing is based on overhead expenses of 40% of cost. The "regular price" of the stereo system is set so that, if it is sold in a "20% off" sale, the store's operating profit will be 25% of cost.

   a. What is the "regular price?"

   b. In a Midnight Madness Special, the system was sold at a "$\frac{1}{3}$ off" special price. What was the profit or loss at the special price?

••**20.** Furniture Warehouse bought upright freezers for $1800 less $33\frac{1}{3}$% and 5%. The store's overhead works out to 30% of cost. The freezers are initially priced so that a profit of $16\frac{2}{3}$% of cost will be realized when a freezer is sold at a "15% off" price.

   a. What is the initial full rate of markup?

   b. During its Scratch-and-Save sale, customers qualify for an extra discount of either 5%, 7%, or 10%. This extra discount appears when the customer scratches a ticket at the time of a purchase. It is added to the basic 15% discount, making the combined discount 20%, 22%, or 25%, respectively. What is the store's profit or loss per freezer at each of these discounts?

KEY TERMS

Cash discount *p. 141*

Credit period *p. 141*

Discount period *p. 141*

Equivalent discount rate *p. 136*

Gross profit *p. 147*

Gross profit margin *p. 148*

List price *p. 134*

Markdown *p. 155*

Markup *p. 147*

Net price *p. 135*

Ordinary dating *p. 141*

Partial payment *p. 143*

Rate of markdown *p. 155*

Rate of markup *p. 148*

Terms of payment *p. 141*

Trade discount *p. 135*

SUMMARY OF NOTATION AND KEY FORMULAS

$$L = \text{List price}$$
$$d = \text{Rate of trade discount}$$
$$N = \text{Net price}$$

In the broader context of calculating the final amount after a percentage reduction to a beginning amount:

$$L = \text{Beginning amount}$$
$$d = \text{Decimal equivalent of percentage reduction}$$
$$N = \text{Final amount after the reduction}$$

The variables used in pricing and profit calculations are:

$$S = \text{Unit selling price}$$
$$C = \text{Unit cost}$$
$$M = \text{Amount of markup}$$
$$E = \text{Overhead or operating expenses per unit}$$
$$P = \text{Operating profit per unit}$$
$$D = \text{(Amount of) Markdown}$$
$$S(\text{reduced}) = \text{Reduced selling price}$$
$$P(\text{reduced}) = \text{Reduced operating profit per unit}$$

FORMULA (4-1) $N = L(1 - d)$ Finding the net amount or net price after applying a single rate of discount to the original amount or list price.

FORMULA (4-2) $N = L(1 - d_1)(1 - d_2)(1 - d_3)$ Finding the net price after a series of three compound discount rates.

FORMULA (4-3) $S = C + M$ Selling price is the sum of the unit cost and the markup.

FORMULA (4-4) $M = E + P$ Markup is the sum of the unit overhead expenses and the unit operating profit.

FORMULA (4-5) $S = C + E + P$ Selling price is the sum of the unit cost plus overhead expenses plus operating profit.

REVIEW PROBLEMS
Answers to the odd-numbered review problems are at the back of the book.

1. A 28% trade discount on a VCR represents a discount of $136.92 from the suggested retail price. What is the net price to the buyer?

2. The net price of an item after a discount of 22% is $155.61. What is the amount of the discount?

•3. Chicken Little Farms gives convenience stores a trade discount of 25% on eggs listed at $43.00 per case. What discount will Sunnyside Farms have to give on its list price of $44.50 per case to match Chicken Little's price to convenience stores?

4. The net proceeds to the vendor of a house after payment of a 4.5% real estate commission were $275,995. At what price did the house sell?

5. A merchant pays a 2.9% fee to the RBC Royal Bank on all Visa sales.
   a. What amount will he pay on sales of $28,476 for a month?
   b. What were his gross sales for a month in which the bank charged fees totalling $981.71?

•6. The evening news reports that the S&P 500 Index dropped 0.9% on the day to close at 1298 points. How many points did the index fall?

7. At its current price of $1.10 per share, the price of Apex Resources stock is down 78% from its price one year ago. What was that price?

8. An invoice shows a net price of $199.16 after trade discounts of 22%, 7%, and 5% are deducted.
   a. What was the list price of the goods?
   b. What single trade discount would be equivalent to the discount series?

9. A uranium mining town reported population declines of 3.2%, 5.2%, and 4.7% for the three successive five-year periods 1985–89, 1990–94, and 1995–99. If the population at the end of 1999 was 9320:
   a. How many people lived in the town at the beginning of 1985?
   b. What was the population loss in each of the five-year periods?

10. What total amount must be paid on May 4 to settle invoices dated April 20 for $650, April 24 for $790, and April 30 for $465, all with terms $1\frac{1}{2}$/10, n/30?

11. Omega Restaurant received an invoice dated July 22 from Industrial Kitchen Equipment for $3691, with terms 2/10, 1/20, n/45. Omega made payments of $1100 on August 1, $900 on August 10, and $800 on August 31. What amount was still owed on September 1?

12. Nelson Hardware ordered a shipment of gas barbecues at a suggested retail price of $459 less trade discounts of 25% and 10%. The manager intends to sell the barbecues at the suggested retail price. If overhead expenses are 20% of the selling price:
   a. What will be the unit operating profit?
   b. What is the rate of markup?
   c. What is the gross profit margin?
   d. What would be the break-even selling price for an inventory clearance sale?

•13. If a grocery store's gross profit margin on tomatoes is 55%, what is the rate of markup on the tomatoes?

•14. Sunrise Building Supply obtains 4-ft by 8-ft sheets of wallboard from Canadian Gypsum at $30 per sheet less 30% and 10%. The price is to be set to cover Sunrise's overhead of 20% of the selling price and to provide an operating profit of 18% of the selling price. What should be the retail price per sheet?

•15. Ski 'n Cycle purchased Elan 200 skis for $492 per pair and priced them to give a gross profit margin of 40%. When this model was discontinued, the store marked down its remaining stock by 30%. What was the sale price after the markdown?

•16. A pharmacy marked up its sunscreen to provide for overhead expenses of 40% of cost and a profit of 45% of cost. At the end of the summer, what rate of markdown can the pharmacy apply to the remaining inventory of sunscreen and still break even on sales at the reduced price?

•17. A snowblower retails for $489. The dealer's overhead is 20% of cost, and normal operating profit is $16\frac{2}{3}$% of cost.
   a. What is the largest amount of markdown that will allow the dealer to break even?
   b. What rate of markdown will price the snowblower at cost?

SELF-TEST EXERCISE

Answers to the self-test problems are at the back of the book.

1. Specialty Builders Supply has two sources for the same power saw. Source A sells the saw at $196.00 less 20%, and Source B offers it at $186.60 less $16\frac{2}{3}$%. Which source is less expensive, and by how much?

2. A trade discount of 22.5% from the suggested selling price for a line of personal computers translates to a $337.05 discount. What net price will a retailer pay?

3. Mr. and Mrs. Ogrodnik want to list their house at a price that will net them a minimum of $160,000 after a real estate commission of 5.5% of the selling price. Rounded to the nearest $100, what is the lowest offer they could accept on their home?

4. In addition to the regular trade discount of 25% and a volume purchase discount of $8\frac{1}{3}$% from the manufacturer, Appliance Warehouse is offered a further 5% discount for orders placed in January.
   a. What is the net price after all three trade discounts on refrigerators listed at $1195?
   b. What is the list price on an electric range whose net price works out to be $470.25?
   c. What single discount rate is equivalent to the three trade discounts?
   d. After the regular and volume discounts are both taken, what dollar amount of savings does the extra discount for January orders represent on a $1000 list price item?

5. In three successive years the price of the common shares of Bedrock Resources Ltd. fell 40%, 60%, and 70%, ending the third year at 50 cents.
   a. What was the share price at the beginning of the three-year skid?
   b. How much (in dollars and cents) did the share price drop in the second year?

6. Custom Kitchens received an invoice dated November 17 from Idea Cabinets Ltd. for $7260 with terms 3/15, $1\frac{1}{2}$/30, n/60. If Custom Kitchens made a payment of $4000 on December 2, what further payment on December 16 will settle the account?

7. A payment of $500 on an invoice for $887 reduced the balance owed to $378.09. What cash discount rate was allowed on the $500 payment?

8. What is the cost of an item that sells for $87.49 if:
   a. The rate of markup is 30%?
   b. The gross profit margin is 30%?

9. Bosley's Pet Foods buys dog kibble for $19.50 per bag less 40%. The store's overhead is $33\frac{1}{3}$% of the selling price, and the desired profit is 10% of the selling price.
   a. At what price per bag should the dog food be sold?
   b. At this price, what is the rate of markup?
   c. What is the break-even price?

•10. The Pro Shop at Sunny Lake Golf and Country Club prices its golf club sets to allow for overhead of $33\frac{1}{3}$% of cost and profit of 20% of cost.
   a. What is the regular selling price as a percentage of cost?
   b. What discount rate can the Pro Shop offer to club members if it will accept half of the normal profit on member purchases?

•11. Central Ski and Cycle purchased 50 pairs of ski boots for $360 per pair less $33\frac{1}{3}$% and 10%. The regular gross profit margin on the boots is 40%. The store's overhead is 22% of the selling price. During a January clearance sale, the price was reduced to $270 per pair.
   a. What was the rate of markdown for the sale?
   b. What was the profit or loss on each pair of boots at the sale price?
   c. At the sale price, what was the rate of markup?

| ***APPENDIX 4A** | # OTHER NOTATIONS FOR TERMS OF PAYMENT |

END-OF-MONTH (EOM) DATING

In end-of-month dating, the discount and credit periods both begin at the end of the month in the invoice date. Figure 4.6 plots the invoice date, the end-of-month date, the discount period, and the credit period on a time axis for the example 2/10 n/30, EOM. In this case the 2% cash discount may be taken in the first 10 days of the next month. If no credit period is explicitly stated, it is understood that the credit period ends 20 days after the discount period. Therefore, n/30 is implied in the notation 2/10, EOM.

■ **FIGURE 4.6** | Discount and Credit Periods for the EOM Dating Case 2/10, n/30, EOM
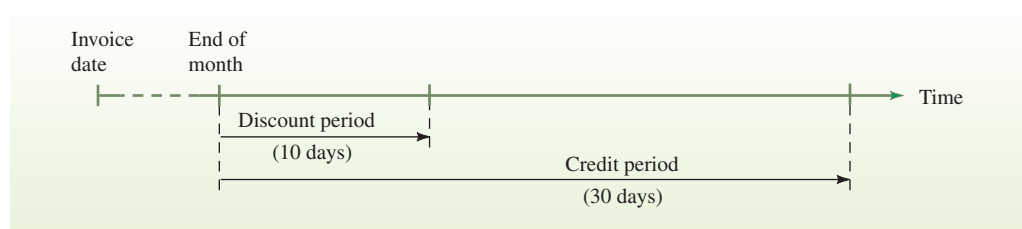
■ **EXAMPLE 4AA** | INVOICE SETTLEMENT WITH EOM DATING

An invoice for $650.48 with terms $1\frac{1}{2}$/10, EOM is dated November 25. What payment will settle the invoice on:

a. November 28?   **b.** December 6?   **c.** December 10?   **d.** December 11?

SOLUTION

a., b., c. The discount period ends at the end of the tenth day after the month's end. Therefore, payments made on or before December 10 qualify for the $1\frac{1}{2}$% cash discount. The payment required to settle the invoice is

$$N = L(1 - d) = \$650.48(1 - 0.015) = \$640.72$$

d. Payment of the full $650.48 is required.

RECEIPT-OF-GOODS (ROG) DATING

When the goods being purchased are to be shipped over a long distance with an uncertain delivery date, receipt-of-goods (ROG) dating is sometimes used. Payment terms quoted in the form "2/10, n/30, ROG" mean that the discount and credit periods start on the date of receipt of the goods. Figure 4.7 plots the invoice date, the date of receipt of the goods, the discount period, and the credit period on a time axis for the ROG dating example 2/10, n/30, ROG.

■ **FIGURE 4.7** | Discount and Credit Periods for the ROG Dating Case 2/10, n/30, ROG
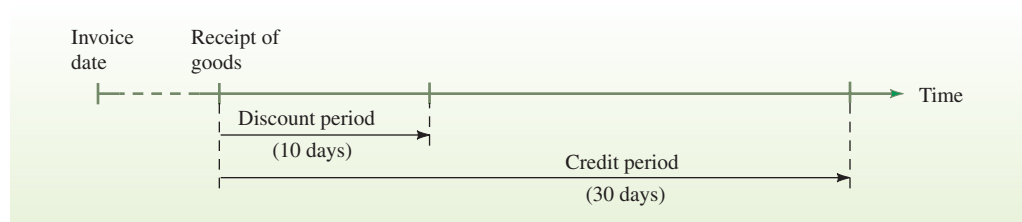
EXAMPLE 4AB | ROG DATING

An invoice dated November 25 for $5340 with terms 1/15, ROG was received on December 1. The merchandise was shipped from Vancouver on December 15 and was received by the purchaser in Goose Bay on January 8.

  a. What is the last day of the discount period?

  b. What is the last day of the credit period?

SOLUTION

  a. The last day of the discount period is the fifteenth day after the date of receipt of the goods. Therefore, January 23 is the last day of the discount period.

  b. When a net period is not stated, the understanding is that the credit period ends 20 days after the end of the discount period. This makes February 12 the last day of the credit period. Any unpaid balance is due on that date.

EXAMPLE 4AC | PARTIAL PAYMENTS WITH EOM DATING

Counter Culture Microbiological Labs received an invoice for $3000 dated October 20 with terms 2/10, EOM.

  a. What amount must Counter Culture pay on November 10 to reduce the balance owed by $1000?

  b. What will be the balance owed if Counter Culture instead pays $1000 on November 10?

SOLUTION

  a. November 10 is the last day of the discount period. Any partial payment within the discount period qualifies for the cash discount. Using the adaptation of formula (4-1),

$$\text{Amount paid, } N = \text{Amount credited, } L \times (1 - d)$$
$$= \$1000(1 - 0.02)$$
$$= \$980.00$$

  b.
$$\text{Amount paid} = \text{Amount credited} \times (1 - d)$$
$$\$1000 = \text{Amount credited} \times (1 - 0.02)$$
$$\text{Amount credited} = \frac{\$1000}{1 - 0.02} = \frac{\$1000}{0.98} = \$1020.41$$
$$\text{Balance owed} = \$3000 - \$1020.41 = \$1979.59$$

EXERCISE **4A**   *Answers to the odd-numbered problems are at the end of the book.*

For problems 1 through 4, determine the payment required to settle the invoice on the indicated payment date.

Problem	Invoice amount ($)	Credit terms	Invoice date	Date goods received	Payment date
1.	3765.25	$1\frac{1}{2}$/15, n/30, EOM	Dec 24	Jan 2	Jan 17
2.	775.50	2/10, EOM	Aug 4	July 30	Sept 5
3.	1450.61	2/10, ROG	May 23	May 28	June 8
4.	995.00	$1\frac{1}{2}$/15, n/60, ROG	Nov 19	Dec 2	Dec 16

Calculate the missing values in problems 5 through 8. Assume in each case that the payment is made within the discount period.

Problem	Invoice amount ($)	Credit terms	Payment ($)	Amount credited ($)	Balance owed ($)
5.	2365.00	$1\frac{1}{2}$/10, EOM	?	1421.32	?
6.	815.49	2/10, n/45, ROG	500.00	?	?
7.	1450.61	?/15, n/60, ROG	500.00	?	943.00
8.	995.00	?/10, EOM	700.00	?	285.54

9. An invoice for $2678.50 dated April 15 has terms $1\frac{1}{2}$/15, EOM.

   a. When does the discount period end?

   b. When does the credit period end?

   c. What payment on April 30 will reduce the outstanding balance by $800?

   d. If an additional payment of $800 is made on May 5, what will be the new balance?

   e. What further payment on May 10 will reduce the outstanding balance to $800?

10. An invoice for $13,600 dated May 18 has terms 2/10, ROG. The goods were shipped on May 21 and received on May 28.

    a. When does the discount period end?

    b. When does the credit period end?

    c. What payment on May 30 will reduce the outstanding balance by $5000?

    d. Instead of the payment in Part c, $5000 is paid on May 30. What will be the balance owed?

    e. Instead of the payment in Parts c and d, what payment on June 5 will reduce the outstanding balance to $5000?

11. Burlingame Carpets received a cheque for $8000 on December 10 from Sorenson Flooring as partial payment of Burlingame's invoice. The invoice, dated November 20, was for $14,772 with terms 2/10, 1/20, n/45, EOM.

    a. How much should Burlingame credit Sorenson's account?

    b. What is the balance still owed?

12. Lakeside Marine received an invoice from Osborne Boats dated March 26 with terms $1\frac{1}{2}$/15, n/45, ROG for four 19-foot Barracuda boats at $23,500 each, less 20%, 5%. The boats arrived on April 27. Lakeside made a payment of $60,000 on the account on May 10. How much does Lakeside still owe?

•13. McAfee Furniture received an invoice dated September 14 from Palisade Manufacturing with terms $2\frac{1}{2}$/10, EOM for the following items: four Prestige bedroom suites at $3900 each less 20%, 7%, and six Oak Traditional dining room suites at $4880 each less 25%, 5%. What amount paid on October 10 will cut the amount owed in half?