University of Rome Tor Vergata

DEPT. MANAGEMENT & LAW

BACHELOR DEGREE IN BUSINESS ADMINISTRATION & ECONOMICS

COURSE

Cost Analysis for Business Decisions

Analysis of Cost, Volume, and Pricing to Increase Profitability

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Learning Objective

Determine the sales volume necessary to break even or to earn a desired profit.

LO1

Basics of Cost-Volume-Profit Analysis

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Racing Bicycle Company
Contribution Income Statement
For the Month of June

Sales (500 bicycles)	$250,000
Less: Variables expenses	150,000
Contribution margin	100,000
Less: Fixed expenses	80,000
Net income	$ 20,000

Contribution Margin (CM) is the amount remaining from sales revenue after variable expenses have been deducted.

Basics of Cost-Volume-Profit Analysis

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H10

	A	B	C	D	E	F
1						
2			Racing Bicycle Company			
3			Contribution Income Statement			
4			For the Month of June			
5			Sales (500 bicycles)	$250,000		
6			Less: Variables expenses	150,000		
7			Contribution margin	100,000		
8			Less: Fixed expenses	80,000		
9			Net income	$ 20,000		
10						
11						

CM is used first to cover fixed expenses. Any remaining CM contributes to net operating income.

The Contribution Approach

Sales, variable expenses, and contribution margin can also be expressed on a per unit basis. If Racing sells an additional bicycle, $200 additional CM will be generated to cover fixed expenses and profit.

Racing Bicycle Company
Contribution Income Statement
For the Month of June

	Total	Per Unit
Sales (500 bicycles)	$ 250,000	$ 500
Less: Variables expenses	150,000	300
Contribution margin	100,000	$ 200
Less: Fixed expenses	80,000	
Net income	$ 20,000	

The Contribution Approach

Each month, Racing must generate at least $80,000 in total CM to break even.

Racing Bicycle Company
Contribution Income Statement
For the Month of June

	Total	Per Unit
Sales (500 bicycles)	$250,000	$ 500
Less: Variables expenses	150,000	300
Contribution margin	100,000	$ 200
Less: Fixed expenses	80,000	
Net income	$ 20,000	

The Contribution Approach

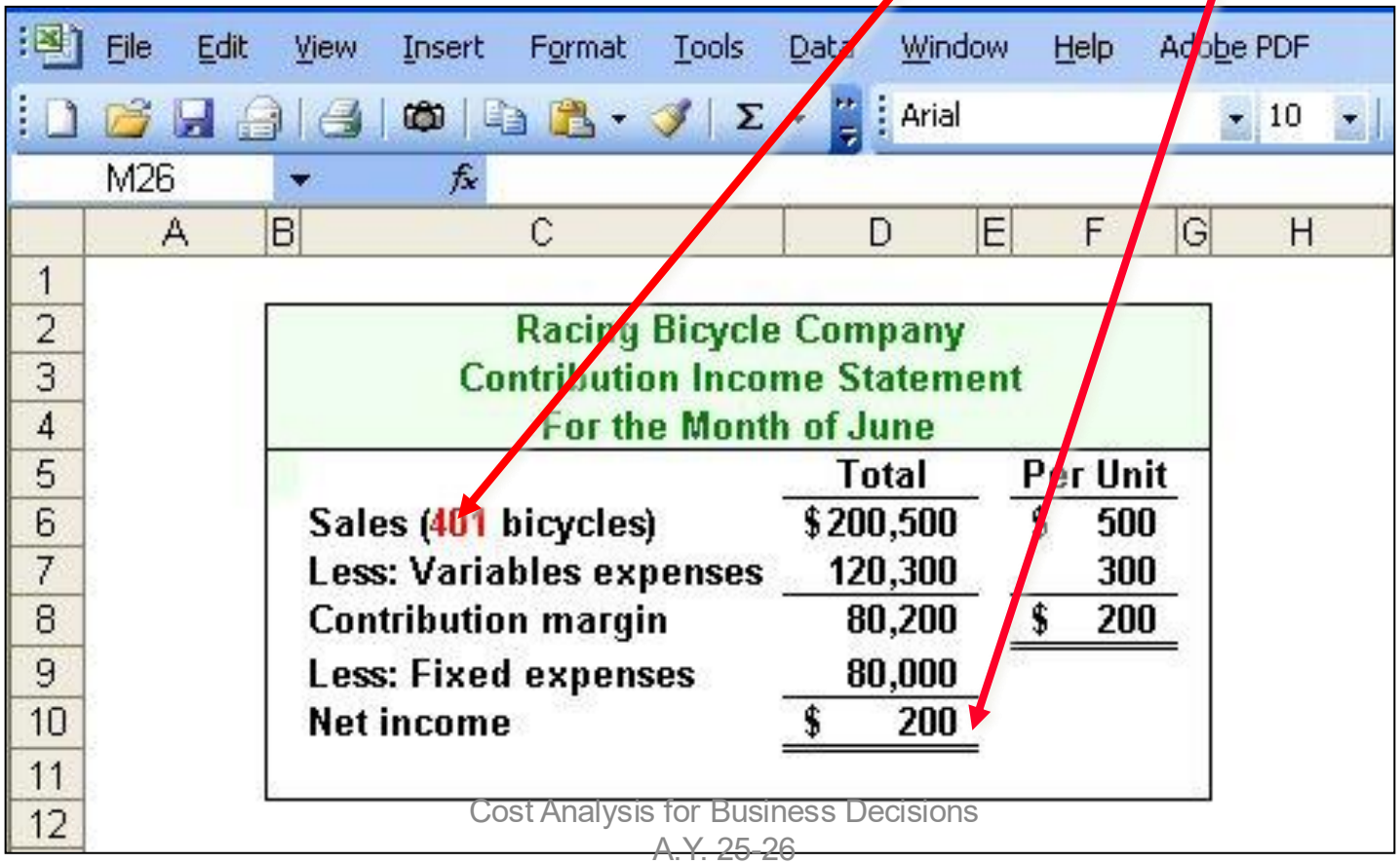
If Racing sells **400 units** in a month, it will be operating at the *break-even point*.

Racing Bicycle Company
Contribution Income Statement
For the Month of June

	Total	Per Unit
Sales (400 bicycles)	$ 200,000	$ 500
Less: Variables expenses	120,000	300
Contribution margin	80,000	$ 200
Less: Fixed expenses	80,000	
Net income	$ -	

The Contribution Approach

If Racing sells one more bike (401 bikes), net operating income will increase by *$200*.



Racing Bicycle Company
Contribution Income Statement
For the Month of June

	Total	Per Unit
Sales (401 bicycles)	$200,500	$ 500
Less: Variables expenses	120,300	300
Contribution margin	80,200	$ 200
Less: Fixed expenses	80,000	
Net income	$ 200	

The Contribution Approach

We do not need to prepare an income statement to estimate profits at a particular sales volume. Simply multiply the number of units sold above break-even by the contribution margin per unit.

CVP Relationships in Graphic Form

The relationship among revenue, cost, profit and volume can be expressed graphically by preparing a CVP graph. Racing developed contribution margin income statements at 300, 400, and 500 units sold. We will use this information to prepare the CVP graph.

	Income 300 units	Income 400 units	Income 500 units
Sales	$ 150,000	$ 200,000	$ 250,000
Less: variable expenses	90,000	120,000	150,000
Contribution margin	$ 60,000	$ 80,000	$ 100,000
Less: fixed expenses	80,000	80,000	80,000
Net operating income	$ (20,000)	$ -	$ 20,000

Learning Objective

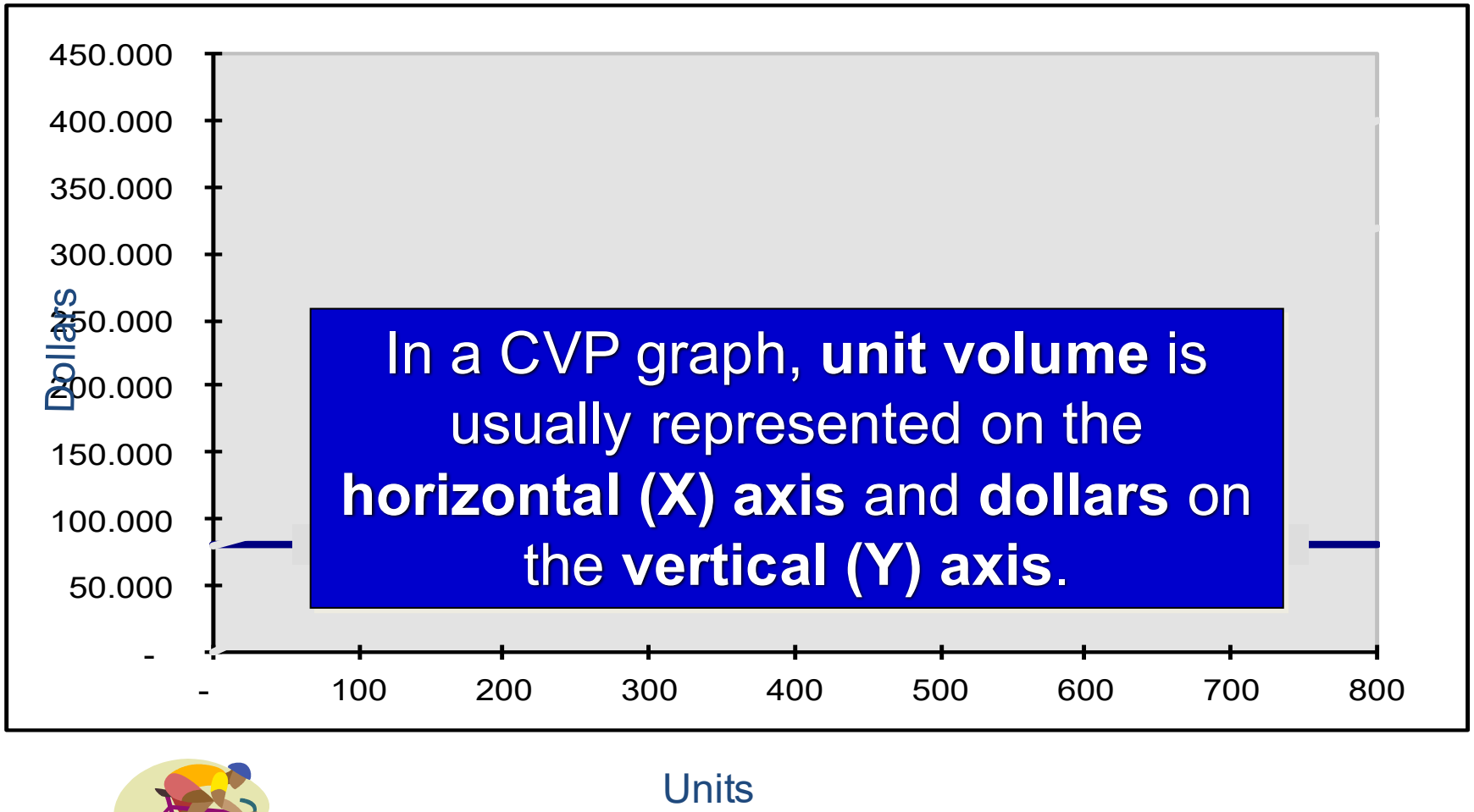
Draw and interpret a cost-volume-profit graph.

LO2

Preparing a Cost-Volume-Profit Graph

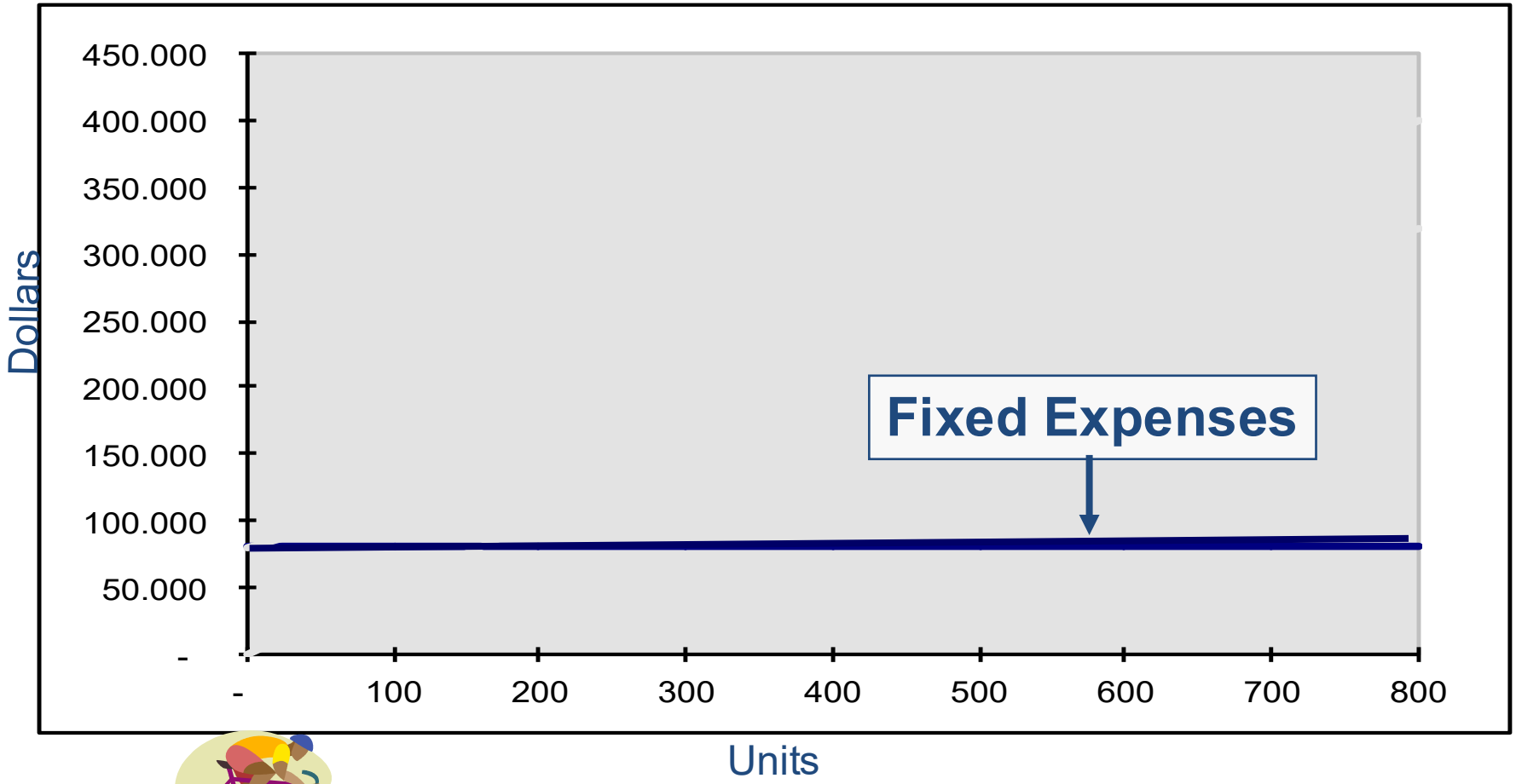
1. Draw and label the axes.
   - Horizontal axis – activity (in units)
   - Vertical axis - dollars
2. Draw the fixed cost line.
   - A horizontal line
3. Draw the total cost line.
   - A diagonal line that begins at the fixed cost line and vertical axis
4. Draw the sales line.
   - A diagonal line that begins at the origin

CVP Graph

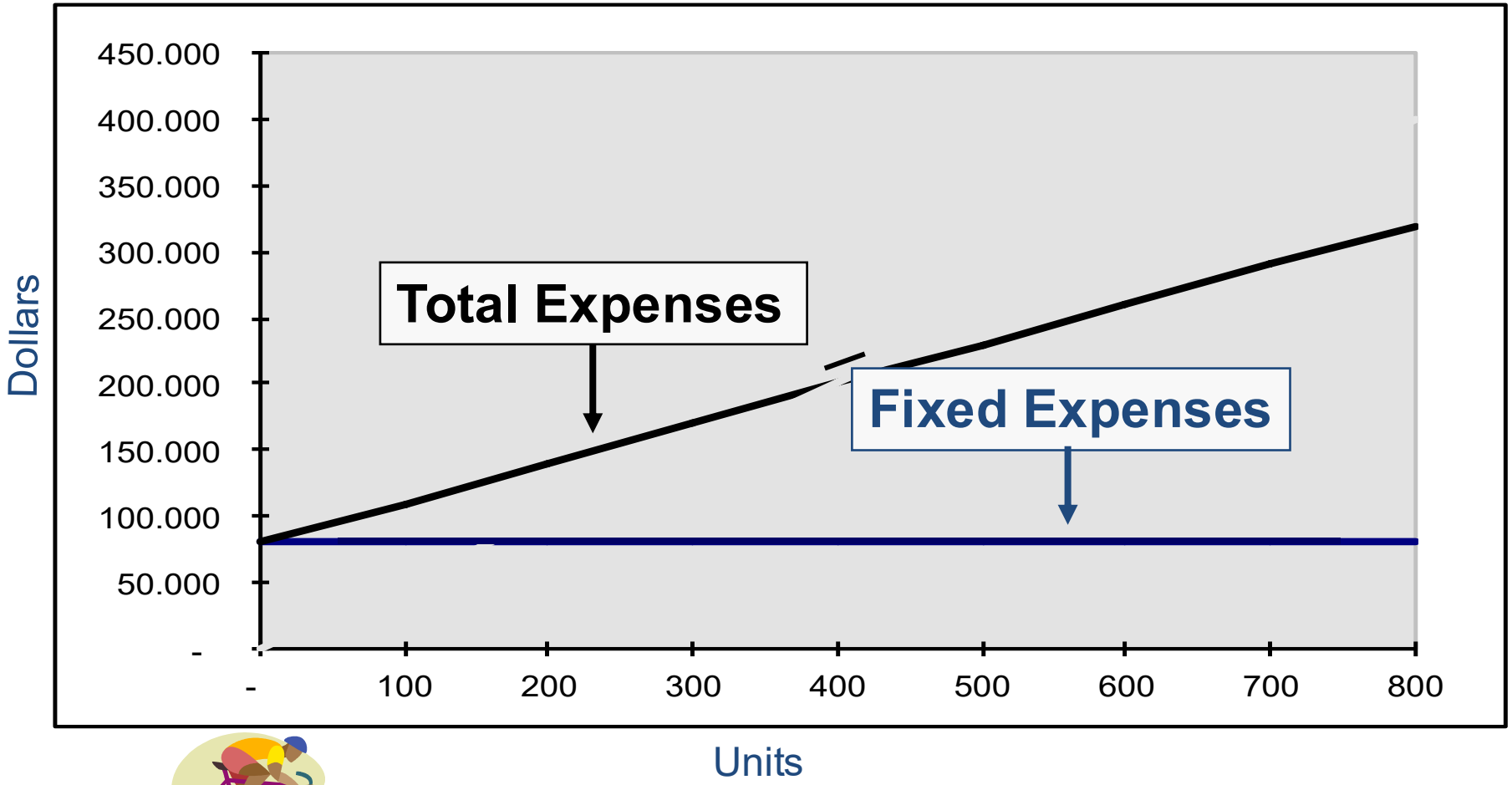


In a CVP graph, **unit volume** is usually represented on the **horizontal (X) axis** and **dollars** on the **vertical (Y) axis**.

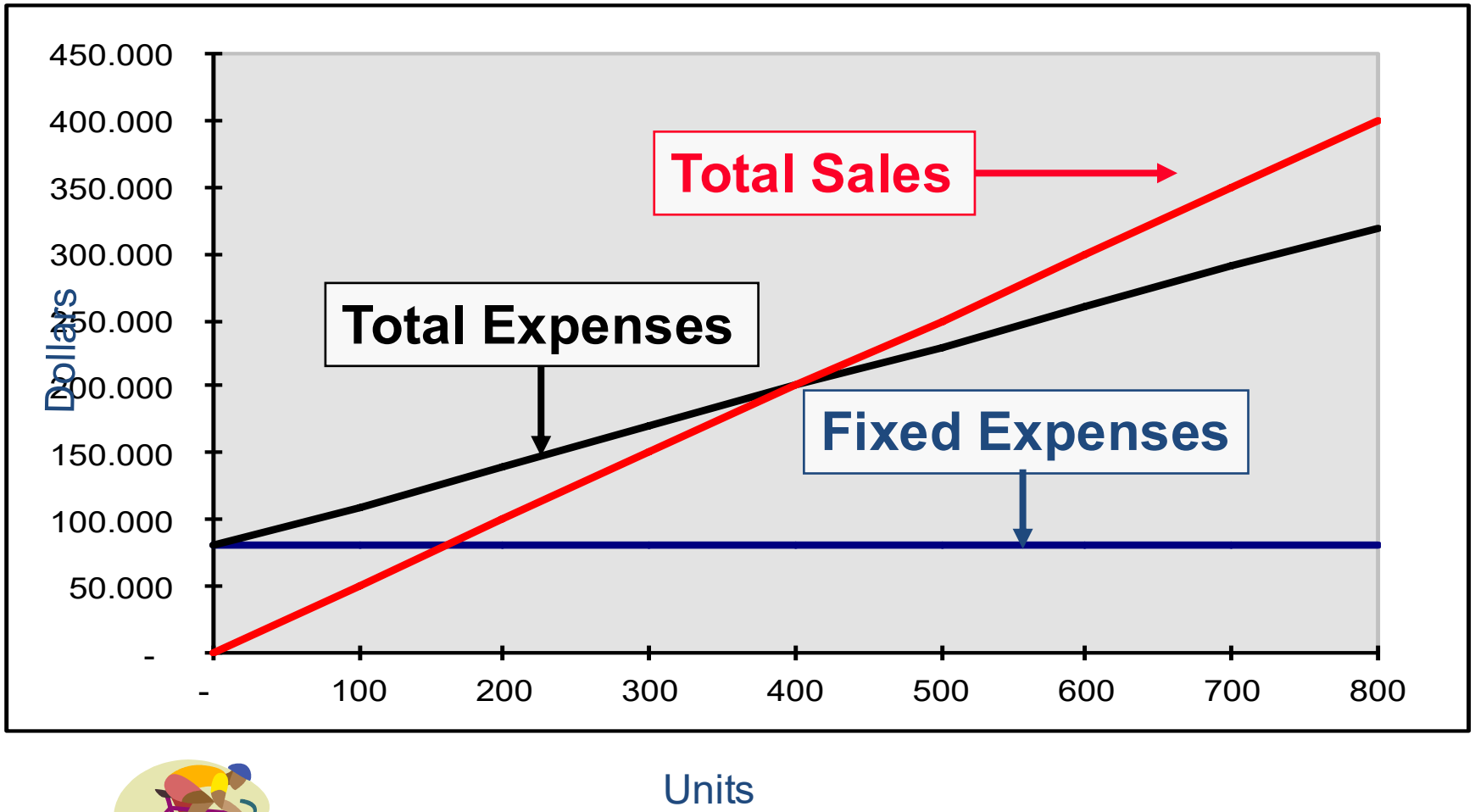
CVP Graph


450.000
400.000
350.000
300.000
250.000
200.000
150.000
100.000
50.000
-
Dollars
Fixed Expenses
-
100
200
300
400
500
600
700
800
Units

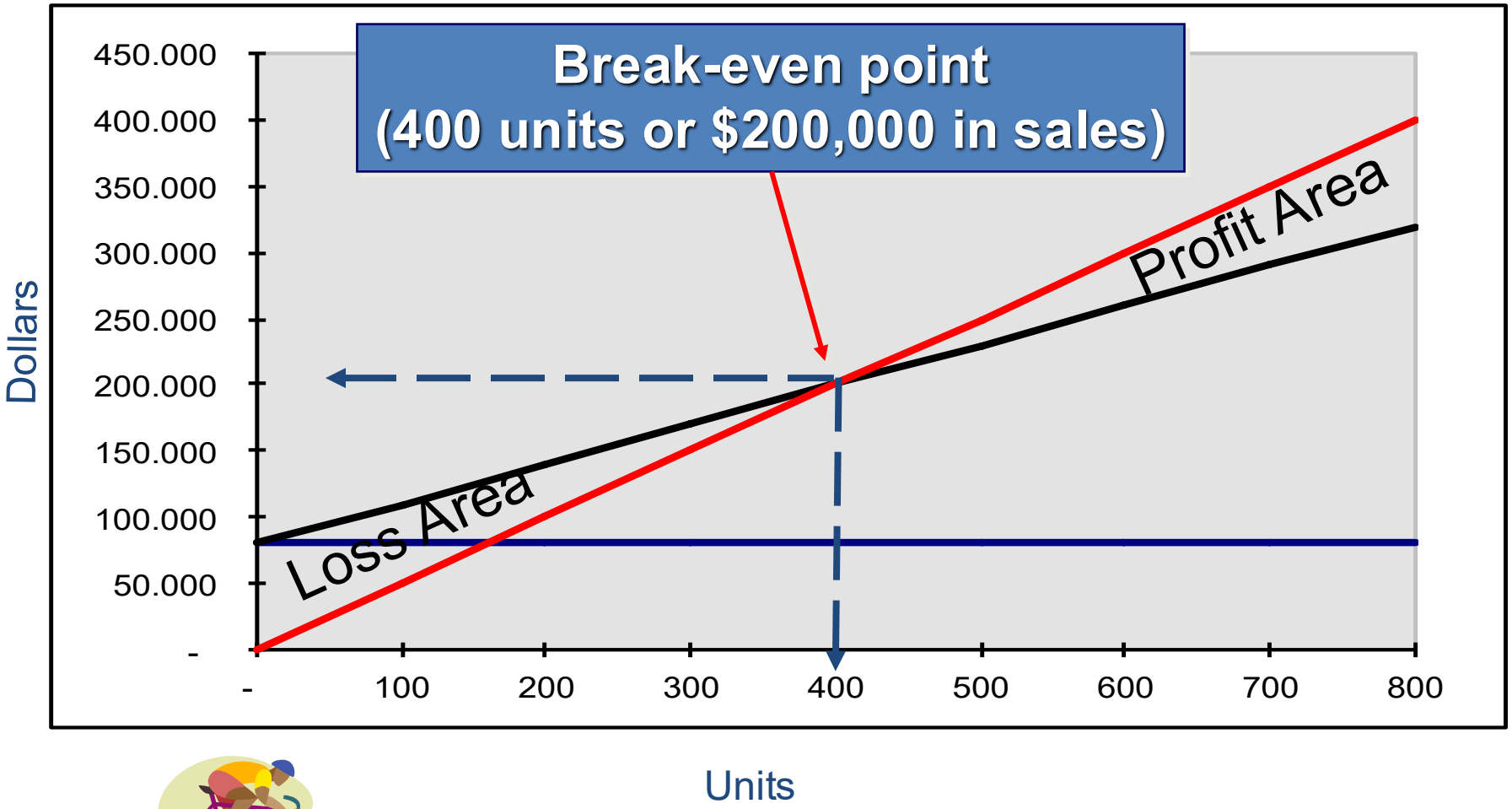
CVP Graph


450.000
400.000
350.000
300.000
250.000
200.000
150.000
100.000
50.000
-
Dollars
Total Expenses
Fixed Expenses
-
100
200
300
400
500
600
700
800
Units

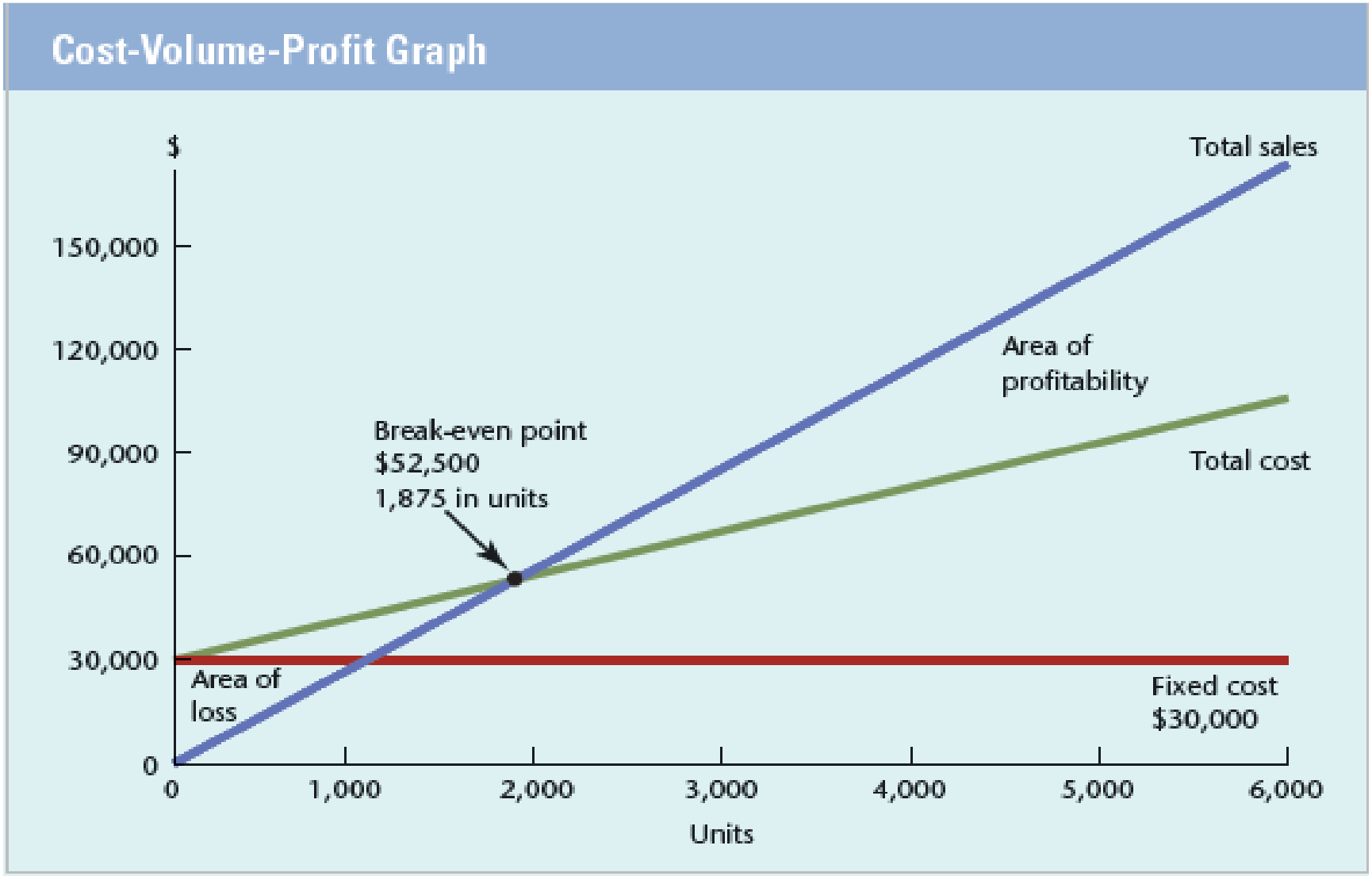
CVP Graph


450.000
400.000
350.000
300.000
250.000
200.000
150.000
100.000
50.000
-
Dollars
Total Sales
Total Expenses
Fixed Expenses
-
100
200
300
400
500
600
700
800
Units

CVP Graph


Break-even point
(400 units or $200,000 in sales)
Profit Area
Loss Area
Dollars
450.000
400.000
350.000
300.000
250.000
200.000
150.000
100.000
50.000
-
-
100
200
300
400
500
600
700
800
Units

Cost-Volume-Profit Graph



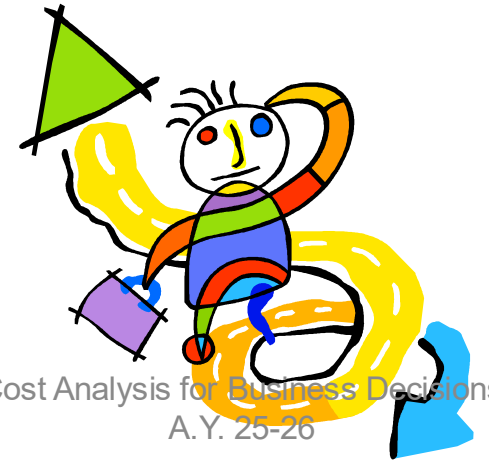
Learning Objective

Explain how a change in sales price, sales volume, variable cost, or fixed cost affects profitability.

LO3

Profitability Analysis:
Changes in Fixed Costs and Sales Volume

What is the profit impact if Racing can increase unit sales from 500 to 540 by increasing the monthly advertising budget by $10,000?



Changes in Fixed Costs and Sales Volume

$80,000 + $10,000 advertising = $90,000

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Racing Bicycle Company
Contribution Income Statement
For the Month of June

	Current Sales (500 bikes)	Projected Sales (540 bikes)
Sales revenue	$ 250,000	$ 270,000
Less: Variables expenses	150,000	162,000
Contribution margin	100,000	108,000
Less: Fixed expenses	80,000	90,000
Net income	$ 20,000	$ 18,000

Sales *increased* by $20,000, but net operating income *decreased* by $2,000.

Changes in Fixed Costs and Sales Volume

The Shortcut Solution

Increase in CM (40 units X $200)	**$ 8,000**
Increase in advertising expenses	**10,000**
Decrease in net operating income	**$ (2,000)**

Profitability Analysis:
Change in Variable Costs and Sales Volume

What is the profit impact if Racing can use higher quality raw materials, thus increasing variable costs per unit by $10, to generate an increase in unit sales from 500 to 580?

Change in Variable Costs and Sales Volume

580 units × $310 variable cost/unit = $179,800

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Racing Bicycle Company
Contribution Income Statement
For the Month of June

	Current Sales (500 bikes)	Projected Sales (580 bikes)
Sales revenue	$ 250,000	$ 290,000
Less: Variables expenses	150,000	179,800
Contribution margin	100,000	110,200
Less: Fixed expenses	80,000	80,000
Net income	$ 20,000	$ 30,200

Sales *increase* by $40,000, and net operating income *increases* by $10,200.

Profitability Analysis:
Change in Fixed Cost, Sales Price and Volume

What is the profit impact if Racing (1) cuts its selling price $20 per unit, (2) increases its advertising budget by $15,000 per month, and (3) increases sales from 500 to 650 units per month?

Change in Fixed Cost, Sales Price and Volume

Racing Bicycle Company
Contribution Income Statement
For the Month of June

	Current Sales (500 bikes)	Projected Sales (650 bikes)
Sales revenue	$ 250,000	$ 312,000
Less: Variables expenses	150,000	195,000
Contribution margin	100,000	117,000
Less: Fixed expenses	80,000	95,000
Net income	$ 20,000	$ 22,000

Sales *increase* by $62,000, fixed costs increase by $15,000, and net operating income *increases* by $2,000.

Profitability Analysis:

Change in Variable Cost, Fixed Cost and Sales Volume

What is the profit impact if Racing (1) pays a $15 sales commission per bike sold instead of paying salespersons flat salaries that currently total $6,000 per month, and (2) increases unit sales from 500 to 575 bikes?

Change in Variable Cost, Fixed Cost and Sales Volume

Racing Bicycle Company
Contribution Income Statement
For the Month of June

	Current Sales (500 bikes)	Projected Sales (575 bikes)
Sales revenue	$ 250,000	$ 287,500
Less: Variables expenses	150,000	181,125
Contribution margin	100,000	106,375
Less: Fixed expenses	80,000	74,000
Net income	$ 20,000	$ 32,375

Sales *increase* by $37,500, variable costs *increase* by $31,125, but fixed expenses *decrease* by $6,000.

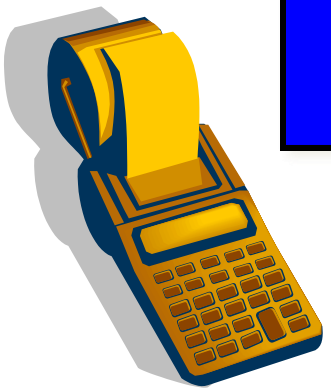
Profitability Analysis:
Change in Regular Sales Price

If Racing has an opportunity to sell 150 bikes to a wholesaler without disturbing sales to other customers or fixed expenses, what price would it quote to the wholesaler if it wants to increase monthly profits by $3,000?

Change in Regular Sales Price

$ 3,000 ÷ 150 bikes	=	$ 20	per bike
Variable cost per bike	=	300	per bike
Selling price required	=	$ 320	per bike

150 bikes × $320 per bike	=	$ 48,000
Total variable costs	=	45,000
Increase in net income	=	$ 3,000



Break-Even Analysis

Here is the information from Racing Bicycle Company:

	Total	Per Unit	Percent
Sales (500 bikes)	$ 250,000	$ 500	100%
Less: variable expenses	150,000	300	60%
Contribution margin	$ 100,000	$ 200	40%
Less: fixed expenses	80,000		
Net operating income	$ 20,000		

Equation Method

We calculate the break-even point as follows:

Sales = Variable expenses + Fixed expenses + Profits

$500Q = $300Q + $80,000 + $0

Where:

Q = Number of bikes sold
$500 = Unit selling price
$300 = Unit variable expense
$80,000 = Total fixed expense

Equation Method

We calculate the break-even point as follows:

Sales = Variable expenses + Fixed expenses + Profits

$$\$500Q = \$300Q + \$80{,}000 + \$0$$
$$\$200Q = \$80{,}000$$
$$Q = \$80{,}000 \div \$200 \text{ per bike}$$
$$Q = 400 \text{ bikes}$$

Equation Method

The equation can be modified to calculate the break-even point in sales dollars.

Sales = Variable expenses + Fixed expenses + Profits

$$X = 0.60X + \$80{,}000 + \$0$$

Where:

X = Total sales dollars at BeP

0.60 = Variable expenses as a % of sales (60%)

$80,000 = Total fixed expenses

Equation Method

The equation can be modified to calculate the break-even point in sales dollars.

Sales = Variable expenses + Fixed expenses + Profits

$$X = 0.60X + \$80{,}000 + \$0$$

$$0.40X = \$80{,}000$$ **(At BeP the 40% of Sales has to cover all the fixed Costs)**

$$X = \$80{,}000 \div 0.40$$

$$X = \$200{,}000$$ **(At BeP the 100% of Sales cover TOTAL COSTS)**

Contribution Margin Method

The contribution margin method has two key equations.

$$\text{Break-even point in units sold} = \frac{\text{Fixed expenses}}{\text{CM per unit}}$$

$$\text{Break-even point in total sales dollars} = \frac{\text{Fixed expenses}}{\text{CM ratio}}$$

Contribution Margin Method

Let's use the contribution margin method to calculate the break-even point in total sales dollars at Racing.

$$\text{Break-even point in total sales dollars} = \frac{\text{Fixed expenses}}{\text{CM ratio}}$$

$$\frac{\$80{,}000}{40\%} = \$200{,}000 \text{ break-even sales}$$

Quick Check ✓

Coffee Klatch is an espresso stand in a downtown office building. The average selling price of a cup of coffee is $1.49 and the average variable expense per cup is $0.36. The average fixed expense per month is $1,300. 2,100 cups are sold each month on average. What is the break-even sales in units?

a. 872 cups

b. 3,611 cups

c. 1,200 cups

d. 1,150 cups

Quick Check ✓

Coffee Klatch is an espresso stand in a downtown office building. The average selling price of a cup of coffee is $1.
expense per cu
expense per m
each month on
sales in units?

a. 872 cups

b. 3,611 cups

c. 1,200 cups

d. 1,150 cups

$$\text{Break-even} = \frac{\text{Fixed expenses}}{\text{CM per Unit}}$$

$$= \frac{\$1{,}300}{\$1.49/\text{cup} - \$0.36/\text{cup}}$$

$$= \frac{\$1{,}300}{\$1.13/\text{cup}}$$

$$= \textit{1,150 cups}$$

Quick Check ✓

Coffee Klatch is an espresso stand in a downtown office building. The average selling price of a cup of coffee is $1.49 and the average variable expense per cup is $0.36. The average fixed expense per month is $1,300. 2,100 cups are sold each month on average. What is the break-even sales in dollars?

a. $1,300

b. $1,715

c. $1,788

d. $3,129

Quick Check ✓

Coffee Klatch is an espresso stand in a downtown office building. The average selling price of a cup of coffee is $1.49 and the average variable expense per cup is $0.36. The average fixed expense per month is $1,300. 2,100 cups are sold each month on average. What is the break-even sales in dollars?

a. $1,300

b. $1,715 ←

c. $1,788

d. $3,129

$$\text{Break-even sales} = \frac{\text{Fixed expenses}}{\text{CM Ratio}}$$

$$= \frac{\$1{,}300}{0.758}$$

$$= \$1{,}715$$

Exercise: D.P. 3-1 pt. a)

Jeff Jamail is evaluating a business opportunity to sell cookware at trade shows. Mr. Jamail can buy the cookware at a wholesale cost of $210 per set. He plans to sell the cookware for $350 per set. He estimates fixed costs such as plane fare, booth rental cost, and lodging to be $5,600 per trade show.

Required

a. Determine the number of cookware sets Mr. Jamail must sell at a trade show to break even (zero profit or loss). Use the following structure to answer this question:

(1) Contribution Margin Per Unit Approach:

a. Determine the amount of the contribution margin per unit.

b. Explain that when the total contribution margin is sufficient to pay for the fixed cost, Mr. Jamail will break even. Show the computation of break-even in units.

c. Show how to compute the break-even point in number of dollars using the break-even point in units and the selling price.

d. Confirm the results by preparing an income statement.

(2) Contribution Margin Ratio Approach.

a. Calculate the contribution margin ratio.

b. Use the ratio to calculate the break-even point in sales dollars, then use the results and the selling price to calculate the break-even point in units.

(3) Equation Approach.

a. Calculate the break-even point in units.

b. Calculate the break-even point in sales dollars.

Assessing the Pricing Strategy

Cost-Plus Pricing → Price products at variable/total cost plus some percentage of the variable/total, normally 50%.

Prestige Pricing → Price products with a premium because the product is new or has a prestigious name brand.

Target Pricing → Price products at the market price and then control costs to be profitable at the market price.

Target Pricing depends on Target Costing

Target Costing is the process of determining the *maximum allowable cost* for a new product and then developing a prototype that can be made for that maximum target cost figure. The equation for determining a target price is shown below:

Target Cost = Anticipated selling price – Desired profit

Once the target cost is determined, the product development team is given the responsibility of designing the product so that it can be made for no more than the target cost.

Reasons for Using Target Costing

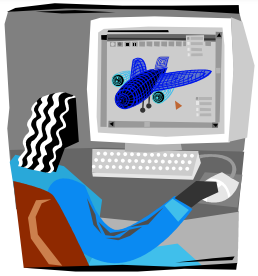
Two characteristics of prices and product costs include:

1. The market (i.e., supply and demand) determines price.
2. Most of the cost of a product is determined in the design stage.

Reasons for Using Target Costing

Target costing was developed in recognition of the two characteristics summarized on the previous screen.

Target costing begins the product development process by recognizing and responding to *existing market prices.* Other approaches allow engineers to design products without considering market prices.



Reasons for Using Target Costing

Target costing focuses a company's cost reduction efforts in the *product design* stage of production.

Other approaches attempt to squeeze costs out of the manufacturing process after they come to the realization that the cost of a manufactured product does not bear a profitable relationship to the existing market price.

Target Pricing

Handy Appliance feels there is a niche for a hand mixer with special features. The marketing department believes that a price of $30 would be about right and that about 40,000 mixers could be sold. An investment of $2 million is required to gear up for production. The company requires a 15% ROI on invested funds.

Let's see how we determine the target Price.

Target Costing

Projected sales (40,000 units × $30)	$ 1,200,000
Desired profit ($2,000,000 × 15%)	300,000
Target cost for 40,000 mixers	$ 900,000
Target cost per mixer ($900,000 ÷ 40,000)	$ 22.50

Each functional area within Handy Appliance would be responsible for keeping its actual costs within the target established for that area.

Target Profit Analysis

The equation and contribution margin methods can be used to determine the sales volume needed to achieve a target profit.

Suppose Racing Bicycle Company wants to know how many bikes must be sold to earn a profit of $100,000.

The CVP Equation Method

Sales = Variable expenses + Fixed expenses + Profits

$$\$500Q = \$300Q + \$80{,}000 + \$100{,}000$$

$$\$200Q = \$180{,}000$$

$$Q = 900 \text{ bikes}$$

The Contribution Margin Approach

The contribution margin method can be used to determine that 900 bikes must be sold to earn the target profit of $100,000.

$$\text{Unit sales to attain the target profit} = \frac{\text{Fixed expenses} + \text{Target profit}}{\text{CM per unit}}$$

$$\frac{\$80{,}000 + \$100{,}000}{\$200/\text{bike}} = 900 \text{ bikes}$$

✓Check Yourself

Matrix, Inc. manufactures one model of lawnmower that sells for $175. Variable expenses to produce the lawnmower are $100 per unit. Total fixed costs are $225,000 per month, and management wants to earn a profit in the coming month of $37,500. Matrix must sell the following number of lawnmowers:

1. **3,000.**
2. **3,500.**
3. **4,000.**
4. **4,500**

$$\frac{\$225{,}000 + \$37{,}500}{\$75} = \mathbf{3{,}500}$$

Quick Check ✓

Coffee Klatch is an espresso stand in a downtown office building. The average selling price of a cup of coffee is $1.49 and the average variable expense per cup is $0.36. The average fixed expense per month is $1,300. How many cups of coffee would have to be sold to attain target profits of $2,500 per month?

a. 3,363 cups

b. 2,212 cups

c. 1,150 cups

d. 4,200 cups

Quick Check

Coffee
office b
coffee
per cup
month
have to
month?

a. 3,363 cups

b. 2,212 cups

c. 1,150 cups

d. 4,200 cups

$$\text{Unit sales to attain target profit} = \frac{\text{Fixed expenses + Target profit}}{\text{Unit CM}}$$

$$= \frac{\$1{,}300 + \$2{,}500}{\$1.49 - \$0.36}$$

$$= \frac{\$3{,}800}{\$1.13}$$

$$= 3{,}363 \text{ cups}$$

Exercise: D.P. 3-1 pt. b) & c)

Jeff Jamail is evaluating a business opportunity to sell cookware at trade shows. Mr. Jamail can buy the cookware at a wholesale cost of $210 per set. He plans to sell the cookware for $350 per set. He estimates fixed costs such as plane fare, booth rental cost, and lodging to be $5,600 per trade show.

Required

b. Assume Mr. Jamail desires to earn a profit of $4,900 per show.

(1) Determine the sales volume in units (sets of cookware) necessary to earn the desired profit.

(2) Determine the sales volume in dollars necessary to earn the desired profit.

(3) Using the contribution margin format, prepare an income statement to confirm your answers to parts 1 and 2.

c. Draw a CVP graph for Mr. Jamail's operation at a trade show.

Learning Objective

Calculate and interpret the margin of safety measure.

LO 4

The Margin of Safety

The margin of safety is the excess of budgeted (or actual) sales over the break-even volume of sales.

Margin of safety = Total sales - Break-even sales

Let's look at Racing Bicycle Company and determine the margin of safety.

The Margin of Safety

If we assume that Racing Bicycle Company has actual sales of $250,000, given that we have already determined the break-even sales to be $200,000, the margin of safety is $50,000 as shown.

	Break-even sales 400 units	Actual sales 500 units
Sales	$ 200,000	$ 250,000
Less: variable expenses	120,000	150,000
Contribution margin	80,000	100,000
Less: fixed expenses	80,000	80,000
Net operating income	$ -	$ 20,000

The Margin of Safety

The margin of safety can be expressed as **20%** of sales.
($50,000 ÷ $250,000)

	Break-even sales 400 units	Actual sales 500 units
Sales	$ 200,000	$ 250,000
Less: variable expenses	120,000	150,000
Contribution margin	80,000	100,000
Less: fixed expenses	80,000	80,000
Net operating income	$ -	$ 20,000

The Margin of Safety

The margin of safety can be expressed in terms of the number of units sold. The margin of safety at Racing is $50,000, and each bike sells for $500.

$$\text{Margin of Safety in units} = \frac{\$50{,}000}{\$500} = 100 \text{ bikes}$$

Exercise: D.P. 3-1 pt. d) & e)

Jeff Jamail is evaluating a business opportunity to sell cookware at trade shows. Mr. Jamail can buy the cookware at a wholesale cost of $210 per set. He plans to sell the cookware for $350 per set. He estimates fixed costs such as plane fare, booth rental cost, and lodging to be $5,600 per trade show.

Required

d. Determine the margin of safety between the sales volume at the break-even point and the sales volume required to earn the desired profit. Determine the margin of safety both in sales dollars and as a percentage.

e. After researching the market, Mr. Jamail concludes that the $350 per set selling price is too high. Customers will likely pay only $310 per set. Mr. Jamail believes he can obtain a cost reduction from his supplier of $20 per set (variable cost drops from $210 per set to $190 per set) and still provide the level of quality required to achieve a sales volume of 75 sets. Under these circumstances, what amount of fixed costs can Mr. Jamail incur and still obtain the target profit of $4,900? Support your answer with appropriate computations.

Learning Objective

Conduct sensitivity analysis using spreadsheet software and the equation method.

LO5

Performing Sensitivity Analysis Using Spreadsheet Software

Spreadsheet Report to Facilitate "What-If" Analysis

Microsoft Excel - ch03-masteing1.xls

	A	B	C	D	E	F	G	H	I	J
1		Selling Price =	$ 28.00							
2										
3		If	While			And Sales Volume is				
4		Fixed Cost	Variable Cost		2,000	3,000	4,000	5,000	6,000	
5		is	is			Then Profitability Will Be				
6										
7		$ 20,000	11		$ 14,000	$ 31,000	$ 48,000	$ 65,000	$ 82,000	
8		20,000	12		12,000	28,000	44,000	60,000	76,000	
9		20,000	13		10,000	25,000	40,000	55,000	70,000	
10		30,000	11		4,000	21,000	38,000	55,000	72,000	
11		30,000	12		2,000	18,000	34,000	50,000	68,000	
12		30,000	13		-	15,000	30,000	45,000	60,000	
13		40,000	11		(8,000)	11,000	28,000	45,000	62,000	
14		40,000	12		(8,000)	8,000	24,000	40,000	58,000	
15		40,000	13		(10,000)	5,000	20,000	35,000	50,000	
16										
17										

Sheet1 / Sheet2 / Sheet3 /

Ready NUM

Learning Objective

Perform multiproduct cost-volume-profit analysis.

LO6

The Concept of Sales Mix

- Sales mix is the relative proportion in which a company's products are sold.
- Different products have different selling prices, cost structures, and contribution margins.

Let's assume Racing Bicycle Company sells bikes and carts and that the sales mix between the two products remains the same.

Multi-product break-even analysis

Racing Bicycle Co. provides the following information:

	Bicycles		Carts		Total	
Sales	$250,000	100%	$ 300,000	100%	$550,000	100.0%
Variable expenses	150,000	60%	135,000	45%	285,000	51.8%
Contribution margin	$100,000	40%	$ 165,000	55%	265,000	48.2%
Fixed expenses					170,000	
Net operating income					$ 95,000	
Sales mix	$250,000	45%	$ 300,000	55%	$550,000	100%

$$\frac{\$265,000}{\$550,000} = 48.2\% \text{ (rounded)}$$

Multi-product break-even analysis

$$\text{Break-even sales} = \frac{\text{Fixed expenses}}{\text{CM Ratio}}$$

$$= \frac{\$170{,}000}{48.2\%}$$

$$= \$352{,}697$$

	Bicycles		Carts		Total	
Sales	$ 158,714	100%	$ 193,983	100%	$ 352,697	100.0%
Variable expenses	95,228	60%	87,292	45%	182,521	51.8%
Contribution margin	$ 63,486	40%	$ 106,691	55%	170,176	48.2%
Fixed expenses					170,000	
Net operating income			Rounding error →		$ 176	≃0
Sales mix	$ 158,714	45%	$ 193,983	55%	$ 352,697	100%

Break-Even Analysis for Multiple Products

	Synthetic C	Organic C
Sales Price	$7	$9
Variable Cost	5	6
Contribution Margin	$2	$3

This approach depends on the proportion share between the two products

The first step in determining the break-even point is to compute the ***weighted average contribution margin per unit***.

Fixed cost = 2,112 $

	Contribution Margin	Times Proportionate Share	Weighted Average
Synthetic C	$2	× .8	$1.60
Organic C	3	× .2	.60
Weighted average contribution margin			$2.20

Break-Even Analysis for Multiple Products

Using the per unit contribution margin approach, the break-even point in total units can be determined by dividing the fixed cost by the weighted average contribution margin as follows.

$$\text{Break-even units} = \frac{\text{Fixed costs}}{\text{Weighted average per unit cont. margin}}$$

$$\text{Break-even units} = \$2{,}112/\$2.20 = 960 \text{ total units}$$

Break-Even Analysis for Multiple Products

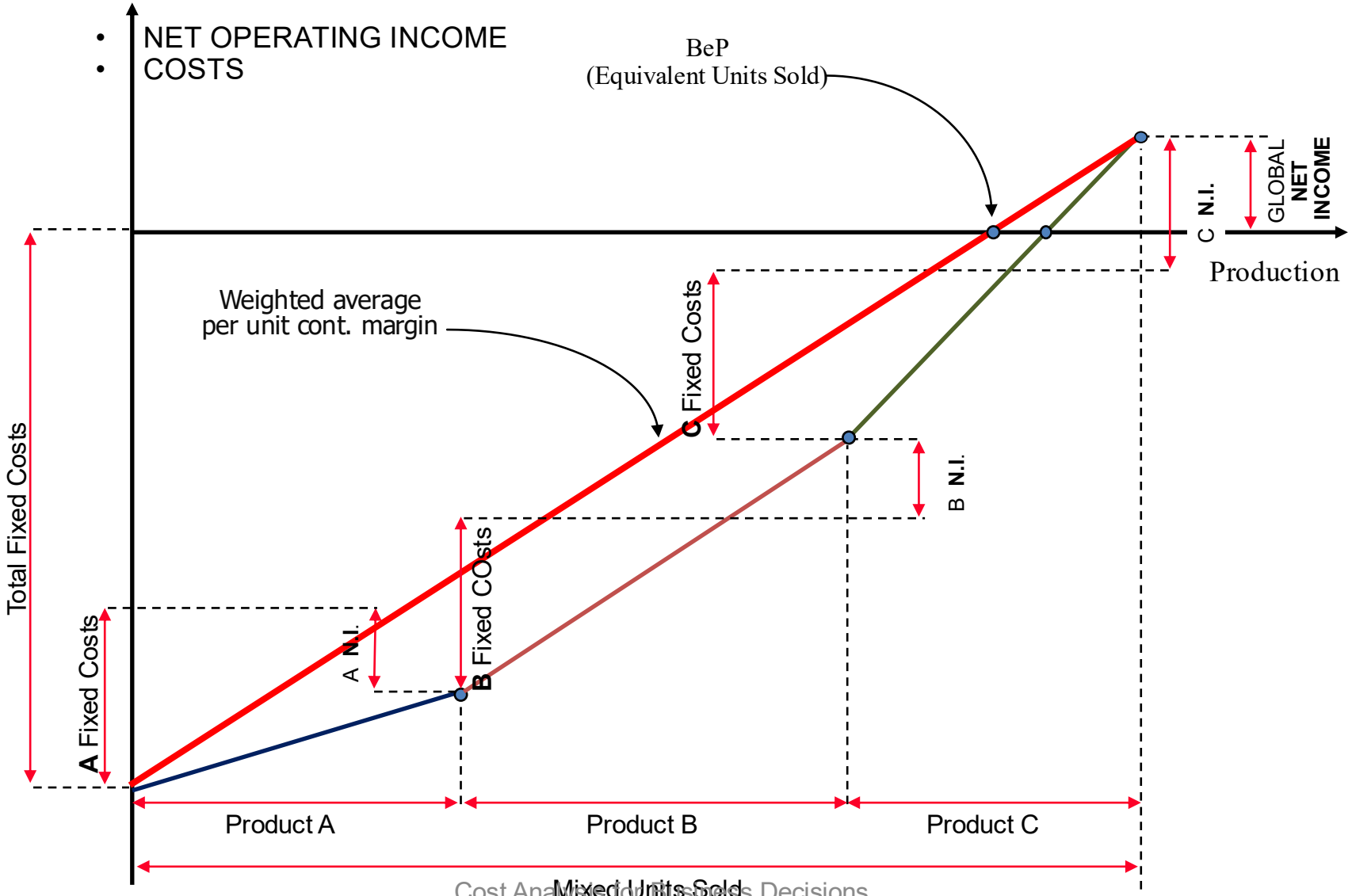
The following income statement confirms that these sales volume figures constitute the break-even point.

960 x 0.8 share of sales mix = 768

960 x 0.2 share of sales mix = 192

Sales of Synthetic C (768 bottles × $7)	$5,376
Sales of Organic C (192 bottles × $9)	1,728
Total sales	7,104
Variable cost of Synthetic C (768 bottles × $5)	(3,840)
Variable cost of Organic C (192 bottles × $6)	(1,152)
Contribution margin	2,112
Fixed cost	(2,112)
Net income	$ 0

Multiproduct CVP Analysis



Multiple Products and Target Profit

Suppose Bright Day's president wants to know the number of bottles of each product that must be sold to earn a profit of $264 from the sales event.

$$\text{Sales volume in units} = \frac{\text{Fixed cost + Desired profit}}{\text{Weighted average contribution margin per unit}}$$

$$\text{Sales volume in units} = \frac{\$2{,}112 + \$264}{\$2.20} = 1{,}080 \text{ Total Units}$$

Multiple Products and Target Profit

1,080 x 80% = 864

Sales of Synthetic C (864 bottles × $7)	$6,048
Sales of Organic C (216 bottles × $9)	1,944
Total sales	7,992
Variable cost of Synthetic C (864 bottles × $5)	(4,320)
Variable cost of Organic C (216 bottles × $6)	(1,296)
Contribution margin	2,376
Fixed cost	(2,112)
Net income	$ 264

1,080 x 20% = 216

Multiple Products and Managing the Sales Mix

960 x 0.6 share of sales mix = 648

The company considers a strategy where profitability can increase even though sales volume remains flat.

Sales of Synthetic C (648 bottles × $7)	$4,536
Sales of Organic C (432 bottles × $9)	3,888
Total sales	8,424
Variable cost of Synthetic C (648 bottles × $5)	(3,240)
Variable cost of Organic C (432 bottles × $6)	(2,592)
Contribution margin	2,592
Fixed cost	(2,112)
Net income	$ 480

By shifting to a 60/40 mix, this income statement shows an increase in income from $264 to $480, despite the same total number sold.

960 x 0.4 share of sales mix = 432

Cost-Volume-Profit Limitations

CVP is limited by a number of underlying assumptions.

1. The selling price is constant.
2. Costs are linear.
3. The multiproduct sales mix is constant.
4. Inventory levels in manufacturing companies are constant.
5. All CVP variables are within the relevant range.

EXERCISE

Bright Day Distributors sells one product called Delatine, a nonprescription herb mixture. The company plans to sell the product for $36. Delatine costs $24 per bottle.

The company's first concern is whether it can sell at least enough bottles of Delatine to cover $ 60.000 fixed costs!

DETERMINE the break-even point by using:

- the equation method,
- the contribution margin per unit method,
- the contribution margin ratio method.

Determining the Break-Even Point Using the Equation Method

The break-even point is the point where ***total revenue equals total costs*** (both variable and fixed). For Bright Day, the cost of advertising is estimated to be $60,000. Advertising costs are the fixed costs of the company. We use the following formula to determine the break-even point in ***units***.

The equation method begins by expressing the income statement as follows. At the break-even point, profit is equal to zero.

Sales – Total variable cost – Total fixed cost = Profit

$36* - $24N - $60,000 = 0

$12N = $60,000

N = $60,000/$12 = 5,000 Units

Determining the Contribution Margin per Unit

The contribution margin per bottle of Delatine is:

Sales revenue per bottle	$ 36
Variable cost per bottle	24
Contribution margin per bottle	$ 12

$$\text{Break-even volume in units} = \frac{\text{Fixed costs}}{\text{Contribution margin per unit}}$$

$$= \frac{\$60{,}000}{\$12} = \textbf{5,000 units}$$

Determining the Break-even Point

The break-even sales volume expressed in dollars can also be determined by dividing the fixed cost by the contribution margin ratio (which is contribution margin divided by sales) computed using either *total* or *per unit* figures.

Contribution margin ratio = Contribution margin ÷ Sales

$$\text{Break-even volume in dollars} = \frac{\text{Fixed costs}}{\text{Contribution margin ratio}}$$

$$= \frac{\$60{,}000}{\$60{,}000 \,/\, \$180{,}000} = \frac{\$60{,}000}{.33333} = \mathbf{\$180{,}000}$$

Determining the Break-even Point

For Delatine, the break-even point in sales dollars is $180,000 (5,000 bottles × $36 selling price).

Microsoft Excel - Breakeven Income Statement...

	A	B	C	D	E	F
1		Units		$		Total
2	Sales Revenue	5,000	×	$ 36	=	$ 180,000
3	Variable Expenses	5,000	×	$ 24	=	(120,000)
4	Contribution Margin	5,000	×	$ 12	=	60,000
5	Fixed Expenses					(60,000)
6	Net Income					$ -

Reaching a Target Profit

Bright Day's president wants the advertising campaign to produce profits of $40,000 to the company.

Sales – Total variable cost – Total fixed cost = Profit
$36N - $24N - $60,000 = $40,000
N = $100,000/$12 = 8,333.33 Units

$$\text{Sales volume in units} = \frac{\text{Fixed costs} + \text{Desired profit}}{\text{Contribution margin per unit}}$$

$$= \frac{\$60{,}000 + \$40{,}000}{\$12} = \mathbf{8{,}334\ units}$$

Reaching a Target Profit Level

At $36 per unit selling price, the sales dollars are equal to $300,000, as shown below:

	Income
Units sold	8,333.33
Revenue @ $36	$ 300,000
Variable Expenses @ $24	(200,000)
Contribution Margin @$12	100,000
Fixed Expenses	(60,000)
Net Income	$ 40,000

NOW Assess the following decisions:

1) price drop from $36 per bottle to **$28** per bottle; while the company's stated goal of producing a **$40,000** profit. How many units must to be sold to get this goal?

2) considering an alternative mixture for Delatine along with new packaging; the product price is still $28 per bottle with variable cost per bottle of $12. the company's stated goal of producing is still **$40,000** profit. How many units must to be sold to get this goal

3) Under this second hypothesis, determine the required sales volume if advertising costs were reduced to **$30,000**, from the planned level of $60,000. Calculate also the margin of safety.

1) Effects of Changes in Sales Price

Using the equation method, the units required to yield a $40,000 profit are:

Sales – Total variable cost – Total fixed cost = Profit
$28N - $24N - $60,000 = $40,000
$4N = $100,000
N = $100,000/$4 = 25,000 Units

Using the contribution margin per unit method:

$$= \frac{\$60{,}000 + \$40{,}000}{\$4} = \textbf{25,000 units}$$

1) Effects of Changes in Sales Price

The required sales volume in dollars is $700,000 (25,000 units × $28 per bottle) as shown below:

	Income
Units sold	25,000
Revenue @ $28	$ 700,000
Variable Expenses @ $24	(600,000)
Contribution Margin @$4	100,000
Fixed Expenses	(60,000)
Net Income	$ 40,000

2) Assessing the Effects of Changes in Variable Costs

Sales – Total variable cost – Total fixed cost = Profit
$28N - $12N - $60,000 = $40,000
$16N = $100,000
N = $100,000/$16 = 6,250 Units

$$\text{Break-even volume in units} = \frac{\text{Fixed costs} + \text{Desired profit}}{\text{Contribution margin per unit}}$$

$$= \frac{\$60{,}000 + \$40{,}000}{\$16} = \mathbf{6{,}250\ units}$$

2) Assessing the Effects of Changes in Variable Costs

At $28 per unit selling price, the sales dollars are equal to $175,000 as shown below:

	Income
Units sold	6,250
Revenue @ $28	$ 175,000
Variable Expenses @ $12	(75,000)
Contribution Margin @$16	100,000
Fixed Expenses	(60,000)
Net Income	$ 40,000

3) Assessing the Effects of Changes in Fixed Costs

Bright Day's president has asked you to determine the required sales volume if advertising costs were reduced to $30,000, from the planned level of $60,000.

Sales – Total variable cost – Total fixed cost = Profit
$28N - $12N - $30,000 = $40,000
$16N = $70,000
N = $70,000/$16 = 4,375 Units

$$\text{Break-even volume (units)} = \frac{\$30{,}000 + \$40{,}000}{\$16} = 4{,}375 \text{ units}$$

4) Calculating the Margin of Safety

Recall that Bright Day must sell 4,375 bottles of Delatine to earn the desired profit. In dollars, budgeted sales are $122,500 (4,375 x $28 per bottle).

The margin of safety measures the cushion between budgeted sales and the break-even point. It quantifies the amount by which actual sales can fall short of expectations before the company will begin to incur losses.

Break-even unit sales assuming no profit would be:

$$\text{Break-even volume (units)} = \frac{\$30{,}000}{\$16} = 1{,}875 \text{ units}$$

4) Calculating the Margin of Safety

	In Units	In Dollars
Budgeted sales	4,375	$ 122,500
Break-even sales	(1,875)	(52,500)
Margin of safety	2,500	$ 70,000

$$\text{Margin of safety} = \frac{\text{Budgeted sales} - \text{Break-even sales}}{\text{Budgeted sales}}$$

$$\text{Margin of safety} = \frac{\$122{,}500 - \$52{,}500}{\$122{,}500} = 57.14\%$$

Management considers a new product, Delatine that has a sales price of $36 and variable costs of $24 per bottle. Fixed costs are $60,000. Break-even is 5,000 units.

Management wants to earn a $40,000 profit on Delatine. The sales volume to achieve this profit level is 8,334 bottles sold.

Marketing advocates a target price of $28 per bottle. The sales volume required to earn a $40,000 profit increases to 25,000 bottles.

Target costing is employed to reengineer the product and reduces variable cost per unit to $12. To earn the desired profit of $40,000, sales volume decreases to 6,250 units.

Target costing is applied and fixed costs are reduced to $30,000. The sales volume to earn the desired $40,000 profit is 4,375 units.

In view of the 57.14% margin of safety, management decides to add Delatine to its product line.