

## Chapter – 6

### Cost Volume Profit Relationships

#### **Break Even Point (BEP):**

BEP means that point where total revenues and total expenses are equal.

#### **Contribution Margin:**

Contribution Margin is the amount remaining from sales revenue after variable expenses have been deducted. First it covers the fixed expenses and later contributes to profit.

$$CM \text{ Ratio} = \left( \frac{\text{Contribution Margin}}{\text{Sales}} \times 100 \right) \%$$

#### **Contribution Format Income Statement: (CVP-Relation)**

Acoustic Concepts, Inc. Contribution Income Statement For the Month of June		
	Total	Per Unit
Sales (400 speakers) . . . . .	\$100,000	\$250
Variable expenses . . . . .	60,000	150
Contribution margin . . . . .	40,000	\$100
Fixed expenses . . . . .	35,000	
Net operating income . . . . .	\$ 5,000	

**Net Operating Income = Profit = EBIT (Earnings before Interest and Taxes)**

### **CVP Relationship = Cost-Volume-Profit Relationship**

1. The contribution format income statement can be expressed in equation form as follows:

$$\textbf{Profit} = ( \textbf{Sales} - \textbf{Variable Cost} ) - \textbf{Fixed Cost}$$

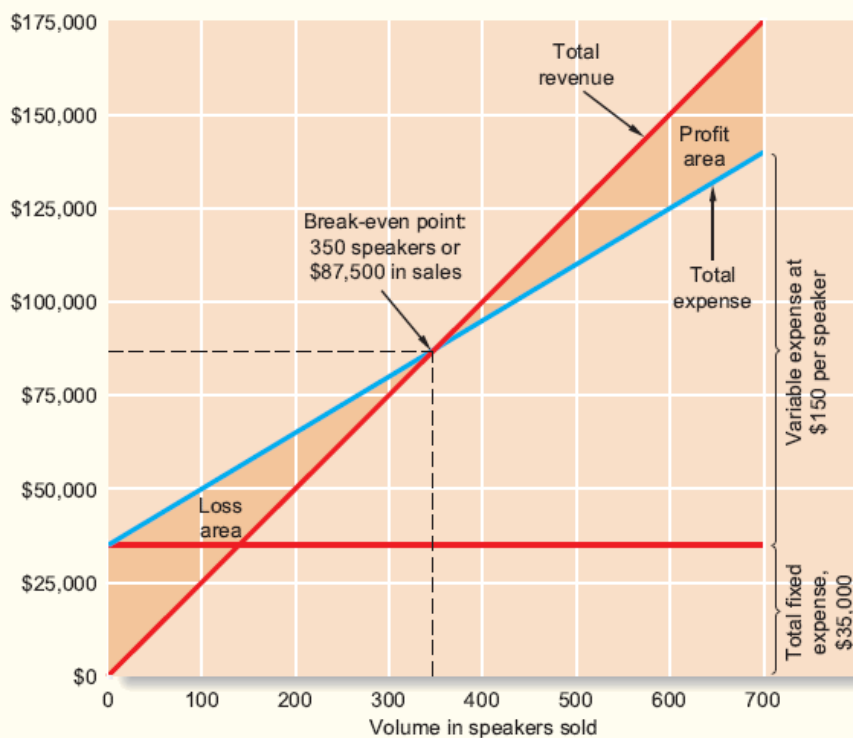
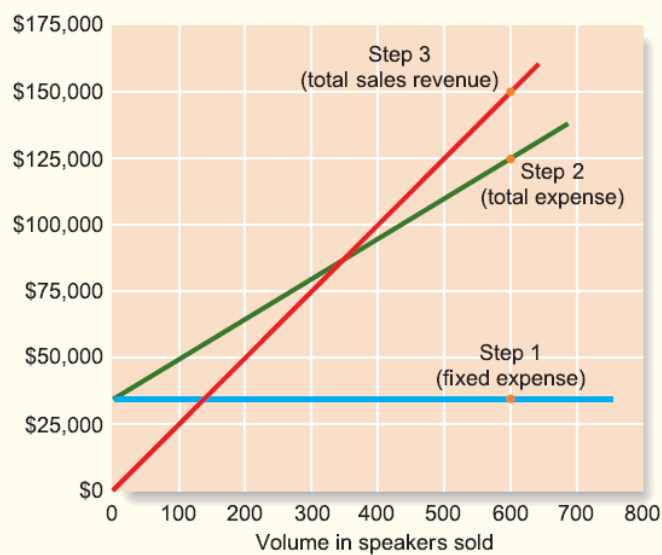
$$\textbf{Sales} = \textbf{Variable Cost} + \textbf{Fixed Cost} + \textbf{Profit (EBIT)}$$

2. The relation among revenue, cost, profit and volume are illustrated on a cost volume-profit (CVP) graph. It is also known as break-even chart.

Fixed expense .....	\$ 35,000
Variable expense (600 speakers × \$150 per speaker) .....	90,000
Total expense .....	<u>\$125,000</u>

#### EXHIBIT 6-1

Preparing the CVP Graph



#### EXHIBIT 6-2

The Completed CVP Graph

### 3. Formula Method:

Here,

$$BEP \text{ (in units)} = \frac{\text{Fixed Cost} + \text{Target Profit}}{\text{Unit Contribution Margin}}$$

$$BEP \text{ (in \$)} = \frac{\text{Fixed Cost} + \text{Target Profit}}{\text{CM Ratio}}$$

$$\text{where, CM Ratio} = \frac{\text{Contribution Margin}}{\text{Sales}}$$

Unit is denoted by u

Currency is denoted by x

$$\text{Margin of safety} = \text{Desired Sale} - \text{Break Even Sales}$$

$$M.S. \text{ Ratio} = \frac{\text{Margin of Safety}}{\text{Sales}} \times 100$$

**Homework was Review Problem: CVP Relationship at Page 291 [PDF]**

**EXERCISE 6-6 Compute the Level of Sales Required to Attain a Target Profit [LO5]**

Lin Corporation has a single product whose selling price is \$120 and whose variable expense is \$80 per unit. The company's monthly fixed expense is \$50,000.

Required:

1. Using the equation method, solve for the unit sales that are required to earn a target profit of \$10,000.
2. Using the formula method, solve for the unit sales that are required to earn a target profit of \$15,000.

**Exercise 6-6 (10 minutes)**

1. The equation method yields the required unit sales, Q, as follows:

$$\begin{aligned}\text{Profit} &= \text{Unit CM} \times Q - \text{Fixed expenses} \\ \$10,000 &= (\$120 - \$80) \times Q - \$50,000 \\ \$10,000 &= (\$40) \times Q - \$50,000 \\ \$40 \times Q &= \$10,000 + \$50,000 \\ Q &= \$60,000 \div \$40 \\ Q &= 1,500 \text{ units}\end{aligned}$$

2. The formula approach yields the required unit sales as follows:

$$\begin{aligned}\text{Units sold to attain} &= \frac{\text{Target profit} + \text{Fixed expenses}}{\text{Unit contribution margin}} \\ \text{the target profit} &= \frac{\$15,000 + \$50,000}{\$40} \\ &= \frac{\$65,000}{\$40} = 1,625 \text{ units}\end{aligned}$$

**EXERCISE 6-7 Compute the Break-Even Point [LO6]**

Mauro Products distributes a single product, a woven basket whose selling price is \$15 and whose variable expense is \$12 per unit. The company's monthly fixed expense is \$4,200.

Required:

1. Solve for the company's break-even point in unit sales using the equation method.
2. Solve for the company's break-even point in sales dollars using the equation method and the CM ratio.
3. Solve for the company's break-even point in unit sales using the formula method.
4. Solve for the company's break-even point in sales dollars using the formula method and the CM ratio.

**Exercise 6-7 (20 minutes)**

1. The equation method yields the break-even point in unit sales, Q, as follows:

$$\begin{aligned}\text{Profit} &= \text{Unit CM} \times Q - \text{Fixed expenses} \\ \$0 &= (\$15 - \$12) \times Q - \$4,200 \\ \$0 &= (\$3) \times Q - \$4,200 \\ \$3Q &= \$4,200 \\ Q &= \$4,200 \div \$3 \\ Q &= 1,400 \text{ baskets}\end{aligned}$$

2. The equation method can be used to compute the break-even point in sales dollars as follows:

$$\begin{aligned}\text{CM ratio} &= \frac{\text{Unit contribution margin}}{\text{Unit selling price}} \\ &= \frac{\$3}{\$15} = 0.20\end{aligned}$$

$$\begin{aligned}\text{Profit} &= \text{CM ratio} \times \text{Sales} - \text{Fixed expenses} \\ \$0 &= 0.20 \times \text{Sales} - \$4,200 \\ 0.20 \times \text{Sales} &= \$4,200 \\ \text{Sales} &= \$4,200 \div 0.20 \\ \text{Sales} &= \$21,000\end{aligned}$$

3. The formula method gives an answer that is identical to the equation method for the break-even point in unit sales:

$$\begin{aligned}\text{Unit sales to break even} &= \frac{\text{Fixed expenses}}{\text{Unit CM}} \\ &= \frac{\$4,200}{\$3} = 1,400 \text{ baskets}\end{aligned}$$

**EXERCISE 6-11 Using a Contribution Format Income Statement [LO1, LO4]**

Miller Company's most recent contribution format income statement is shown below:

	Total	Per Unit
Sales (20,000 units) .....	\$300,000	\$15.00
Variable expenses .....	180,000	9.00
Contribution margin .....	120,000	<u>\$ 6.00</u>
Fixed expenses .....	70,000	
Net operating income .....	<u>\$ 50,000</u>	

*Required:*

Prepare a new contribution format income statement under each of the following conditions (consider each case independently):

1. The number of units sold increases by 15%.
2. The selling price decreases by \$1.50 per unit, and the number of units sold increases by 25%.
3. The selling price increases by \$1.50 per unit, fixed expenses increase by \$20,000, and the number of units sold decreases by 5%.
4. The selling price increases by 12%, variable expenses increase by 60 cents per unit, and the number of units sold decreases by 10%.

**Exercise 6-11 (20 minutes)**

	Total	Per Unit
1. Sales (20,000 units $\times$ 1.15 = 23,000 units).....	\$345,000	\$ 15.00
Variable expenses.....	<u>207,000</u>	<u>9.00</u>
Contribution margin.....	138,000	<u>\$ 6.00</u>
Fixed expenses.....	<u>70,000</u>	
Net operating income.....	<u>\$ 68,000</u>	
2. Sales (20,000 units $\times$ 1.25 = 25,000 units).....	\$337,500	\$13.50
Variable expenses.....	<u>225,000</u>	<u>9.00</u>
Contribution margin.....	112,500	<u>\$ 4.50</u>
Fixed expenses.....	<u>70,000</u>	
Net operating income.....	<u>\$ 42,500</u>	
3. Sales (20,000 units $\times$ 0.95 = 19,000 units).....	\$313,500	\$16.50
Variable expenses.....	<u>171,000</u>	<u>9.00</u>
Contribution margin.....	142,500	<u>\$ 7.50</u>
Fixed expenses.....	<u>90,000</u>	
Net operating income.....	<u>\$ 52,500</u>	
4. Sales (20,000 units $\times$ 0.90 = 18,000 units).....	\$302,400	\$16.80
Variable expenses.....	<u>172,800</u>	<u>9.60</u>
Contribution margin.....	129,600	<u>\$ 7.20</u>
Fixed expenses.....	<u>70,000</u>	
Net operating income.....	<u>\$ 59,600</u>	

**EXERCISE 6-12 Target Profit and Break-Even Analysis; Margin of Safety; CM Ratio [LO1, LO3, LO5, LO6, LO7]**

Menlo Company distributes a single product. The company's sales and expenses for last month follow:

	Total	Per Unit
Sales .....	\$450,000	\$30
Variable expenses .....	180,000	12
Contribution margin .....	270,000	<u>\$18</u>
Fixed expenses .....	216,000	
Net operating income .....	<u>\$ 54,000</u>	

Required:

- What is the monthly break-even point in units sold and in sales dollars?
- Without resorting to computations, what is the total contribution margin at the break-even point?
- How many units would have to be sold each month to earn a target profit of \$90,000? Use the formula method. Verify your answer by preparing a contribution format income statement at the target sales level.
- Refer to the original data. Compute the company's margin of safety in both dollar and percentage terms.
- What is the company's CM ratio? If sales increase by \$50,000 per month and there is no change in fixed expenses, by how much would you expect monthly net operating income to increase?

**Exercise 6-12 (30 minutes)**

$$\begin{aligned}
 1. \quad \text{Profit} &= \text{Unit CM} \times Q - \text{Fixed expenses} \\
 \$0 &= (\$30 - \$12) \times Q - \$216,000 \\
 \$0 &= (\$18) \times Q - \$216,000 \\
 \$18Q &= \$216,000 \\
 Q &= \$216,000 \div \$18 \\
 Q &= 12,000 \text{ units, or at } \$30 \text{ per unit, } \$360,000
 \end{aligned}$$

Alternative solution:

$$\begin{aligned}
 \text{Unit sales} &= \frac{\text{Fixed expenses}}{\text{Unit contribution margin}} \\
 \text{to break even} &= \frac{\$216,000}{\$18} = 12,000 \text{ units} \\
 &\text{or at } \$30 \text{ per unit, } \$360,000
 \end{aligned}$$

- The contribution margin is \$216,000 because the contribution margin is equal to the fixed expenses at the break-even point.

$$\begin{aligned}
 3. \quad \text{Units sold to attain target profit} &= \frac{\text{Target profit} + \text{Fixed expenses}}{\text{Unit contribution margin}} \\
 &= \frac{\$90,000 + \$216,000}{\$18} = 17,000 \text{ units}
 \end{aligned}$$

	Total	Unit
Sales (17,000 units × \$30 per unit).....	\$510,000	\$30
Variable expenses (17,000 units × \$12 per unit).....	204,000	12
Contribution margin.....	306,000	<u>\$18</u>
Fixed expenses.....	216,000	
Net operating income.....	<u>\$ 90,000</u>	

**Exercise 6-12 (continued)**

4. Margin of safety in dollar terms:

$$\begin{aligned}\text{Margin of safety in dollars} &= \text{Total sales} - \text{Break-even sales} \\ &= \$450,000 - \$360,000 = \$90,000\end{aligned}$$

Margin of safety in percentage terms:

$$\begin{aligned}\text{Margin of safety percentage} &= \frac{\text{Margin of safety in dollars}}{\text{Total sales}} \\ &= \frac{\$90,000}{\$450,000} = 20\%\end{aligned}$$

5. The CM ratio is 60%.

Expected total contribution margin: (\$500,000 × 60%).....	\$300,000
Present total contribution margin: (\$450,000 × 60%).....	<u>270,000</u>
Increased contribution margin.....	<u>\$ 30,000</u>

Alternative solution:

$$\$50,000 \text{ incremental sales} \times 60\% \text{ CM ratio} = \$30,000$$

Given that the company's fixed expenses will not change, monthly net operating income will also increase by \$30,000.

**EXERCISE 6-13 Target Profit and Break-Even Analysis [LO3, LO4, LO5, LO6]**

Lindon Company is the exclusive distributor for an automotive product that sells for \$40 per unit and has a CM ratio of 30%. The company's fixed expenses are \$180,000 per year. The company plans to sell 16,000 units this year.

*Required:*

1. What are the variable expenses per unit?
2. Using the equation method:
  - a. What is the break-even point in units and sales dollars?
  - b. What sales level in units and in sales dollars is required to earn an annual profit of \$60,000?
  - c. Assume that by using a more efficient shipper, the company is able to reduce its variable expenses by \$4 per unit. What is the company's new break-even point in units and sales dollars?
3. Repeat (2) above using the formula method.

**Exercise 6-13** (30 minutes)

1. Variable expenses:  $\$40 \times (100\% - 30\%) = \$28$

2. a. Selling price.....	\$40	100%
Variable expenses.....	<u>28</u>	<u>70%</u>
Contribution margin.....	<u>\$12</u>	<u>30%</u>

Profit = Unit CM  $\times$  Q - Fixed expenses

$$\$0 = \$12 \times Q - \$180,000$$

$$\$12Q = \$180,000$$

$$Q = \$180,000 \div \$12$$

$$Q = 15,000 \text{ units}$$

In sales dollars: 15,000 units  $\times$  \$40 per unit = \$600,000

Alternative solution:

Profit = CM ratio  $\times$  Sales - Fixed expenses

$$\$0 = 0.30 \times \text{Sales} - \$180,000$$

$$0.30 \times \text{Sales} = \$180,000$$

$$\text{Sales} = \$180,000 \div 0.30$$

$$\text{Sales} = \$600,000$$

In units:  $\$600,000 \div \$40 \text{ per unit} = 15,000 \text{ units}$

b. Profit = Unit CM  $\times$  Q - Fixed expenses

$$\$60,000 = \$12 \times Q - \$180,000$$

$$\$12Q = \$60,000 + \$180,000$$

$$\$12Q = \$240,000$$

$$Q = \$240,000 \div \$12$$

$$Q = 20,000 \text{ units}$$

In sales dollars: 20,000 units  $\times$  \$40 per unit = \$800,000

**Exercise 6-13** (continued)

Alternative solution:

Profit = CM ratio  $\times$  Sales - Fixed expenses

$$\$60,000 = 0.30 \times \text{Sales} - \$180,000$$

$$0.30 \times \text{Sales} = \$240,000$$

$$\text{Sales} = \$240,000 \div 0.30$$

$$\text{Sales} = \$800,000$$

In units:  $\$800,000 \div \$40 \text{ per unit} = 20,000 \text{ units}$

c. The company's new cost/revenue relation will be:

Selling price.....	\$40	100%
Variable expenses (\$28 - \$4).....	<u>24</u>	<u>60%</u>
Contribution margin.....	<u>\$16</u>	<u>40%</u>

Profit = Unit CM  $\times$  Q - Fixed expenses

$$\$0 = (\$40 - \$24) \times Q - \$180,000$$

$$\$16Q = \$180,000$$

$$Q = \$180,000 \div \$16 \text{ per unit}$$

$$Q = 11,250 \text{ units}$$

In sales dollars: 11,250 units  $\times$  \$40 per unit = \$450,000

Alternative solution:

Profit = CM ratio  $\times$  Sales - Fixed expenses

$$\$0 = 0.40 \times \text{Sales} - \$180,000$$

$$0.40 \times \text{Sales} = \$180,000$$

$$\text{Sales} = \$180,000 \div 0.40$$

$$\text{Sales} = \$450,000$$

In units:  $\$450,000 \div \$40 \text{ per unit} = 11,250 \text{ units}$



**Exercise 6-13 (continued)**

3. a.

$$\begin{aligned}\text{Unit sales to break even} &= \frac{\text{Fixed expenses}}{\text{Unit contribution margin}} \\ &= \frac{\$180,000}{\$12 \text{ per unit}} = 15,000 \text{ units}\end{aligned}$$

In sales dollars: 15,000 units × \$40 per unit = \$600,000

Alternative solution:

$$\begin{aligned}\text{Dollar sales to break even} &= \frac{\text{Fixed expenses}}{\text{CM ratio}} \\ &= \frac{\$180,000}{0.30} = \$600,000\end{aligned}$$

In units: \$600,000 ÷ \$40 per unit = 15,000 units

b.

$$\begin{aligned}\text{Unit sales to attain target profit} &= \frac{\text{Fixed expenses} + \text{Target profit}}{\text{Unit contribution margin}} \\ &= \frac{\$180,000 + \$60,000}{\$12 \text{ per unit}} = 20,000 \text{ units}\end{aligned}$$

In sales dollars: 20,000 units × \$40 per unit = \$800,000

Alternative solution:

$$\begin{aligned}\text{Dollar sales to attain target profit} &= \frac{\text{Fixed expenses} + \text{Target profit}}{\text{CM ratio}} \\ &= \frac{\$180,000 + \$60,000}{0.30} = \$800,000\end{aligned}$$

In units: \$800,000 ÷ \$40 per unit = 20,000 units

**Exercise 6-13 (continued)**

c.

$$\begin{aligned}\text{Break-even point in unit sales} &= \frac{\text{Fixed expenses}}{\text{Unit contribution margin}} \\ &= \frac{\$180,000}{\$16 \text{ per unit}} = 11,250 \text{ units}\end{aligned}$$

In sales dollars: 11,250 units × \$40 per unit = \$450,000

Alternative solution:

$$\begin{aligned}\text{Break-even point in sales dollars} &= \frac{\text{Fixed expenses}}{\text{CM ratio}} \\ &= \frac{\$180,000}{0.40} = \$450,000\end{aligned}$$

In units: \$450,000 ÷ \$40 per unit = 11,250 units

**EXERCISE 6-16 Target Profit and Break-Even Analysis [LO4, LO5, LO6]**

Outback Outfitters sells recreational equipment. One of the company's products, a small camp stove, sells for \$50 per unit. Variable expenses are \$32 per stove, and fixed expenses associated with the stove total \$108,000 per month.

Required:

1. Compute the break-even point in number of stoves and in total sales dollars.
2. If the variable expenses per stove increase as a percentage of the selling price, will it result in a higher or a lower break-even point? Why? (Assume that the fixed expenses remain unchanged.)
3. At present, the company is selling 8,000 stoves per month. The sales manager is convinced that a 10% reduction in the selling price would result in a 25% increase in monthly sales of stoves. Prepare two contribution format income statements, one under present operating conditions, and one as operations would appear after the proposed changes. Show both total and per unit data on your statements.
4. Refer to the data in (3) above. How many stoves would have to be sold at the new selling price to yield a minimum net operating income of \$35,000 per month?

**Exercise 6-16 (30 minutes)**

1. Profit = Unit CM  $\times$  Q - Fixed expenses  
 $0 = (\$50 - \$32) \times Q - \$108,000$   
 $0 = (\$18) \times Q - \$108,000$   
 $\$18Q = \$108,000$   
 $Q = \$108,000 \div \$18$   
 $Q = 6,000$  stoves, or at \$50 per stove, \$300,000 in sales

Alternative solution:

$$\begin{aligned} \text{Unit sales to break even} &= \frac{\text{Fixed expenses}}{\text{Unit contribution margin}} \\ &= \frac{\$108,000}{\$18.00 \text{ per stove}} = 6,000 \text{ stoves} \end{aligned}$$

or at \$50 per stove, \$300,000 in sales.

2. An increase in variable expenses as a percentage of the selling price would result in a higher break-even point. If variable expenses increase as a percentage of sales, then the contribution margin will decrease as a percentage of sales. With a lower CM ratio, more stoves would have to be sold to generate enough contribution margin to cover the fixed costs.

	Present: 8,000 Stoves		Proposed: 10,000 Stoves*	
	Total	Per Unit	Total	Per Unit
Sales.....	\$400,000	\$50	\$450,000	\$45 **
Variable expenses.....	<u>256,000</u>	<u>32</u>	<u>320,000</u>	<u>32</u>
Contribution margin.....	144,000	<u>\$18</u>	130,000	<u>\$13</u>
Fixed expenses.....	<u>108,000</u>		<u>108,000</u>	
Net operating income....	<u>\$ 36,000</u>		<u>\$ 22,000</u>	

\*8,000 stoves  $\times$  1.25 = 10,000 stoves

\*\*\$50  $\times$  0.9 = \$45

As shown above, a 25% increase in volume is not enough to offset a 10% reduction in the selling price; thus, net operating income decreases.

### Exercise 6-16 (continued)

$$\begin{aligned} 4. \quad \text{Profit} &= \text{Unit CM} \times Q - \text{Fixed expenses} \\ \$35,000 &= (\$45 - \$32) \times Q - \$108,000 \\ \$35,000 &= (\$13) \times Q - \$108,000 \\ \$13 \times Q &= \$143,000 \\ Q &= \$143,000 \div \$13 \\ Q &= 11,000 \text{ stoves} \end{aligned}$$

Alternative solution:

$$\begin{aligned} \text{Unit sales to attain target profit} &= \frac{\text{Target profit} + \text{Fixed expenses}}{\text{Unit contribution margin}} \\ &= \frac{\$35,000 + \$108,000}{\$13} \\ &= 11,000 \text{ stoves} \end{aligned}$$

### EXERCISE 6-17 Break-Even Analysis and CVP Graphing [LO2, LO4, LO6]

The Hartford Symphony Guild is planning its annual dinner-dance. The dinner-dance committee has assembled the following expected costs for the event:

Dinner (per person) . . . . .	\$18
Favors and program (per person) . . . . .	\$2
Band . . . . .	\$2,800
Rental of ballroom . . . . .	\$900
Professional entertainment during intermission . . . . .	\$1,000
Tickets and advertising . . . . .	\$1,300

The committee members would like to charge \$35 per person for the evening's activities.

*Required:*

1. Compute the break-even point for the dinner-dance (in terms of the number of persons who must attend).
2. Assume that last year only 300 persons attended the dinner-dance. If the same number attend this year, what price per ticket must be charged in order to break even?
3. Refer to the original data (\$35 ticket price per person). Prepare a CVP graph for the dinner-dance from zero tickets up to 600 tickets sold.

**Exercise 6-17** (30 minutes)

1. The contribution margin per person would be:

Price per ticket.....		\$35
Variable expenses:		
Dinner.....	\$18	
Favors and program.....	<u>2</u>	<u>20</u>
Contribution margin per person.....		<u>\$15</u>

The fixed expenses of the dinner-dance total \$6,000. The break-even point would be:

$$\text{Profit} = \text{Unit CM} \times Q - \text{Fixed expenses}$$

$$\$0 = (\$35 - \$20) \times Q - \$6,000$$

$$\$0 = (\$15) \times Q - \$6,000$$

$$\$15Q = \$6,000$$

$$Q = \$6,000 \div \$15$$

$$Q = 400 \text{ persons; or, at } \$35 \text{ per person, } \$14,000$$

Alternative solution:

$$\text{Unit sales to break even} = \frac{\text{Fixed expenses}}{\text{Unit contribution margin}}$$

$$= \frac{\$6,000}{\$15} = 400 \text{ persons}$$

or, at \$35 per person, \$14,000.

2. Variable cost per person (\$18 + \$2)..... \$20  
Fixed cost per person (\$6,000 ÷ 300 persons)... 20  
Ticket price per person to break even..... \$40

3. Cost-volume-profit graph:

