COST VOLUME PROFIT

Key Topics to Know

- CVP analysis is based on the interactions among the following five elements:
  - Price or revenue of products
  - Volume or level of activity
  - Per units variable costs
  - Total fixed costs.
  - Mix of products sold (CVP analysis requires an assumption about sales mix)
- Contribution Margin
  - Difference between gross margin and contribution margin
  - Understand the relationship among:
    Revenue, variable cost and contribution margin per unit
    Why fixed costs and operating income per unit are never used.
    Total revenue, variable cost, contribution margin and fixed costs
    Level of activity versus number of units sold
  - Contribution Margin is the remaining amount of sales dollars available to cover fixed expenses and profit.
  - Contribution Margin in Dollars = Sales Revenue - Variable Expenses.
  - Contribution Margin per unit = Selling Price per unit – Variable Expense per unit or total contribution margin / units sold
  - Contribution Margin Ratio (%) = Contribution Margin / Sales
  - Break-Even Point
- At the Break-even Point:
  - Profit or operating income equals 0.
  - Total revenue equals total costs.
  - Total contribution margin equals fixed expenses.
- The break-even point is measured in sales dollars and/or units sold.
- Break-even sales and units sold are related by the unit selling price.
- The break-even point may be calculated using either the Equation Method or the Contribution Margin Method:

Equation Method:

In Units Sold:	sales $ per unit X units sold = variable expense $ per unit X units sold + fixed expenses + profit of 0
In Sales Dollars:	sales as a % of sales = variable expenses as a % of sales + fixed expenses + profit of 0

Contribution Margin Method:

In Units Sold:	$\frac{\text{(Fixed Expenses + Profit of 0)}}{\text{Contribution Margin per unit}}$
In Sales Dollars:	$\frac{\text{Fixed expenses + Profit of 0)}}{\text{Contribution Margin ratio}}$

- Calculate the break-even point in total sales dollars and total units sold for both single-product and multi-product companies. Sales mix, the relative combination in which a company's products are sold, is assumed to be constant for these companies.
- Breakeven point for multi-product companies is calculated based on total company sales, variable costs and fixed costs.
- Sales mix, the proportion of units sold for each product to the total units sold is assumed to remain constant.
- Changes in sales volume are assumed to increase or decrease according to the sales mix. That is, the change in total units sold is made up of changes in units sold for the individual products in proportion to the sales mix.
- Calculate the sales dollars and units sold necessary to achieve a target profit using the break-even formulas above and substituting the target profit for the break-even profit of 0.
- Understand how the revenue function, variable, fixed and total cost functions and the break-even point shift on the CVP graph when revenue and/or cost assumptions are changed
- Calculate the margin of safety. Margin of Safety is the excess of budgeted or actual sales over the break-even volume of sales.
    - Margin of safety in dollars = Total sales - Break-even sales
    - Margin of safety percentage = Margin of safety in dollars / Total sales
- Calculate the degree of leverage (leverage factor)
    - Operating Leverage is a way to measure, at a given level of sales, how a percentage change in sales volume will affect profits.

- Use the leverage factor to calculate the percent change in operating income for given a percent change in sales
- Explain how leverage changes when sales increase or decrease.
- Degree of operating leverage = Contribution margin / Net income

Problems

Problem #1

T Company manufactures and sells a single product. The company's sales and expenses for last month were:

	Total	Per Unit	Percentage
Sales	$500,000	$25	100%
Less: Variable expenses	200,000	10	40%
Contribution margin	300,000	15	60%
Less: Fixed expenses	270,000		
Net income	$ 30,000		

Required:

a) Calculate the monthly break-even point in units sold and in sales dollars.
   - using the equation method
   - using the contribution margin method
   - verify the answer by preparing a contribution income statement

b) Without any computations, what is the contribution margin and contribution margin ratio at the break-even point?

c) How many units would have to be sold each month to earn a minimum target net income of $60,000?

d) Verify the answer by preparing a contribution income statement at the target level of sales.

e) Refer to the original data above. Compute the company's margin of safety in both dollars and percentage.

f) Refer to the original data above.
   - What is the company's Contribution Margin Ratio?
   - If monthly sales increase by $25,000 and there is no change in fixed expenses, by how much would net income be expected to increase?

g) Refer to the original data above. If the company were able to reduce its variable expenses by $1 per unit,
   - What would be the new monthly break-even point in units and sales dollars?
   - Verify the answer by preparing a contribution income statement.

h) Compute the company's degree of operating leverage. If sales increase by 10% how much should net income increase?

Problem #2

U Company's first quarter income statement is presented below:

Sales		$800,000
Cost of Goods Sold		560,000
Gross Margin		240,000
Less: Operating Expenses:		
Selling Expenses	$100,000	
Administrative Expenses	110,000	210,000
Net Income		$ 30,000

On average, a book sells for $40.00. Variable selling expenses are $3.00 per book; the remaining selling expenses are fixed. The variable administrative expenses are 5% of sales; the remainder of the administrative expenses is fixed.

Required:

a) Prepare a contribution format income statement for the first quarter.
b) Prepare a breakeven income statement for the first quarter.
c) If 24,000 books are sold during the second quarter, calculate the company's expected contribution margin and net income.
d) If 22,000 books are sold during the second quarter, how much fixed expenses could increase if the company wanted to maintain a net income of $35,000? Calculate the company's expected contribution margin.

Problem #3

P Company's income statement for last year appears below:

Sales		$2,000,000
Cost of goods sold:		
Direct materials	$500,000	
Direct labor (variable)	150,000	
Variable manufacturing overhead	50,000	
Fixed manufacturing overhead	600,000	1,300,000
Gross Profit		700,000
Selling and administrative expenses		
Variable	100,000	
Fixed	200,000	300,000
Operating Income		400,000

Required:
a) Calculate the breakeven point.
b) Calculate the degree of operating leverage.
c) If units sold double next year, calculate the degree of leverage.

Problem #4

H Company produces and sells storage sheds. Its current sales are $500,000. The company's accountant provided the following information:

Selling price per unit	$40.00
Manufacturing costs	$100,000 + 40% sales
Selling costs	$30,000 + 10% sales
Administrative costs	$45,000 + 10% sales

Required:
a) Compute the product's contribution margin ratio.
b) Compute the company's current net income.
c) Compute the product's break-even point in dollars and units.
d) Compute the amount of revenue necessary to earn $60,000 in profit.
e) Compute the unit contribution margin.
f) Compute the company's current margin of safety ratio.
g) Should the company accept a proposal that increases sales by 20% and total fixed costs by 25%?

Problem #5

In 2013, G Company sold 160,000 units of its product at a selling price of $40. The variable cost per unit was $30. G Company reported net income for the year of $220,000.

Required: What was the amount of fixed costs for the year?

Problem #6

The P Company makes and sells two models of blenders, as follows:

	Smoothie Pro	Blendmaster
Selling price per unit	$50	$80
Variable cost per unit	$25	$45

The P Company expects to incur annual fixed costs of $151,250. The relative sales mix of the products is 3 units of Smoothie Pro for every one unit of Blendmaster.

Required:
a) Determine the total number of blenders (Smoothie Pro and Blendmaster combined) that Parsons must sell to break even.
b) What is the number of units of Smoothie Pro and of Blendmaster that Parsons would expect to sell at the break-even point?

Multiple Choice Questions

1. The formula for break-even point in terms of units is
   a) Total variable costs/Unit contribution margin
   b) Total fixed costs/Contribution margin ratio
   c) Total fixed costs/Unit contribution margin
   d) Total variable costs/Total fixed costs

2. The formula for break-even point in terms of revenue is
   a) Total variable costs/Contribution margin ratio
   b) Total fixed costs/Contribution margin ratio
   c) Total fixed costs/Unit contribution margin
   d) Total variable costs/Total fixed costs

3. Alfred Corp has a selling price of $15, variable costs of $10 per unit, and fixed costs of $25,000. How many units must be sold to break-even?
   a) 5,000
   b) 10,000
   c) 2,500
   d) 1,667

4. Piazza Corp has sales of $400,000, a contribution margin ratio of 40%, and a profit of $40,000. If 20,000 units were sold, what is the break-even point in units?
   a) 12,000
   b) 8,000
   c) 20,000
   d) 15,000

5. K Company had a $30,000 profit on sales of $250,000. Fixed costs are $60,000 a month. How much would sales have to decrease for K Company to break even?
   a) $90,000
   b) $83,333
   c) $166,667
   d) $280,000

6. M Company had a $60,000 loss on sales of $300,000. Fixed costs are $120,000 a month. What revenue is needed to break even?
   a) $360,000
   b) $480,000
   c) $600,000
   d) $420,000

7. P Company has fixed costs of $200,000 and a contribution margin ratio of 40%. How much sales revenue must be earned for a profit of $50,000?
   a) $125,000
   b) $500,000
   c) $625,000
   d) $1,000,000

8. B Company has sales of $300,000, a contribution margin ratio of 30%, and a profit of $30,000. If 20,000 units were sold, what is the variable cost per unit?
   a) $15.00
   b) $10.50
   c) $4.50
   d) $2.00

9. P Company sold 20,000 units, had variable costs of $12 per unit, fixed costs of $100,000, and profits of $60,000. What is the selling price per unit?
   a) $8
   b) $17
   c) $20
   d) $32

10. Degree of operating leverage is used to
    a) calculate sales change given profit change.
    b) calculate profit change given sales change.
    c) calculate break-even sales given sales change.
    d) calculate break-even sales given profit change.

11. Contribution margin is the amount remaining after:
    a) variable expenses have been deducted from sales revenue.
    b) fixed expenses have been deducted from sales revenue.
    c) fixed expenses have been deducted from variable expenses
    d) cost of goods sold has been deducted from sales revenues.

12. If a company decreases the variable expense per unit while increasing the total fixed expenses, the total expense line relative to its previous position will:
    a) shift downward and have a steeper slope.
    b) shift downward and have a flatter slope
    c) shift upward and have a flatter slope.
    d) shift upward and have a steeper slope

13. J Company's fixed monthly expenses are $21,000 and its contribution margin ratio is 61%. Assuming that the fixed monthly expenses do not change, what is net operating income in a month when sales are $74,000?
    a) $7,860
    b) $45,140
    c) $24,140
    d) $53,000

14. C Company's operating leverage is 5.9. If the company's sales increase by 19%, its net operating income should increase by about:
    a) 5.9%
    b) 31.1%
    c) 19.0%
    d) 112.1%

15. G Company sells a single product. If the selling price per unit and the variable expense per unit both increase by 10% and fixed expenses do not change, then:

	Contribution margin per unit	Contribution margin ratio	Break-even in units
A.	Increases	Increases	Decreases
B.	No change	No change	No change
C.	No change	Increases	No change
D.	Increases	No change	Decreases

    a) A
    b) B
    c) C
    d) D

16. Data concerning H Company's two products for the most recent month is:

	Product V06Z	Product U85C
Sales	$18,000	$17,000
Variable expenses	$8,820	$1,330

The fixed expenses were $24,010. The break-even point for the company is:
a) $33,817
b) $10,990
c) $34,160
d) $24,010

17. U Company produces and sells a single product. Data concerning that product appear below:

Selling price per unit	$100.00
Variable expense per unit	$34.00
Fixed expense per month	$312,180

Assume the company's target profit is $12,000. The unit sales to attain that target profit is closest to:
a) 3,242
b) 4,912
c) 9,535
d) 5,896

18. D Company's current sales are 25,400 units at $120 per unit. Break-even sales are 18,542 units. What is the margin of safety in dollars?
a) $822,960
b) $2,032,000
c) $3,048,000
d) $2,225,040

19. E Company's product has a selling price of $120.00 per unit and variable expense of $37.20 per unit. Monthly fixed expense is $356,040. What are the sales necessary to reach a target profit of $15,000?
a) $371,040
b) $537,739
c) $701,894
d) $1,196,903

20. F Company produces and sells two products. Data concerning those products for the most recent month appear below:

	Product M06M	Product Q20I
Sales	$11,000	$38,000
Variable expenses	$2,420	$16,690

Fixed expenses for the entire company were $26,570. The break-even point for the entire company is closest to:

a) $43,557
b) $26,570
c) $22,430
d) $45,680

Solutions to Problems

Problem #1

a) Monthly break-even point in units and sales dollars:

	Sales Dollars	Units
Equation method:	X =.40X + $270,000	$25X = $10X + $270,000
	.6X = $270,000	$15X = $270,000
	X = $450,000	X = 18,000 units
CM method:	$270,000 / .6 = $450,000	$270,000 / $15 = 18,000 units
Proof:	18,000 units X $25 = $450,000	

b) The contribution margin is $270,000, equal to the fixed expenses.
The contribution margin ratio is $270,000/$450,000 = 60%

Sales	$450,000
Less: Variable expenses	180,000
Contribution margin	270,000
less: Fixed expenses	270,000
Net income	$ 0

c) Target level of sales:
(270,000 + 60,000) / 15 = 22,000 units
22,000 units X $25 = $550,000

d) Income statement:

Sales	$550,000
Less: Variable expenses	220,000
Contribution margin	330,000
less: Fixed expenses	270,000
Net income	$ 60,000

e) Margin of safety:
$500,000 - $450,000 = $50,000
$50,000 / $500,000 = .10 or 10%

f) Increase in net income

Contribution margin ratio is 60% (300,000 / 500,000 = .60 or 60%)
Net income should increase by $15,000 (60% of $25,000)

g) New breakeven point

New contribution margin is $16 per unit ($25.00-($10.00-$1.00))
New break-even point is $270,000 / $16 = 16,875 units x $25.00 = $421,875

Proof:

Sales	$421,875
Less: Variable expenses	151,875
Contribution margin	270,000
less: Fixed expenses	270,000
Net income	$0

h) Degree of operating leverage

Degree of operating leverage is 10; ($300,000 / $30,000=10)
Net income should increase by 100%; (10 X 10% = 100%)

Proof: Compare original data with income statement in d) above. Sales increased 10% from $500,000 to $550,000 and net income increased 100%, from $30,000 to $60,000.

Problem #2

	Per Unit	%	b) Total $	c) Total $	d) Total $	e) Total $
Units sold	1		20,000	15,715	24,000	22,000
Sales	$40.00	100.0	$800,000	$628,600	$960,000	$880,000
Variable expenses:						
Cost of goods sold	28.00	70.0	560,000	440,020	672,000	616,000
Selling	3.00	7.5	60,000	47,145	72,000	66,000
Administrative	2.00	5.0	40,000	31,430	48,000	44,000
Contribution margin a)	7.00	17.5	140,000	110,005	168,000	154,000
Fixed expenses:						
Additional S&A						9,000
Selling			40,000	40,000	40,000	40,000
Administrative			70,000	70,000	70,000	70,000
Operating income b)			$30,000	$0	$58,000	$35,000

Problem #3

Sales		$2,000,000
Direct materials	$500,000	
Direct labor (variable)	150,000	
Variable manufacturing overhead	50,000	
Variable selling and administrative	100,000	800,000
Contribution margin		1,200,000

a) CM ratio = 1,200,000 / 2,000,000 = 60%
Breakeven point = 300,000 / 60% = $500,000

b) Degree of leverage = 1,200,000 / 400,000 = 3

c) Degree of leverage = (1,200,000 + 1,200,000) / (400,000 + 1,200,000) = 1.5

Problem #4

a)	Contribution margin ratio	100%-40%-10%-10%	40%
b)	Net income		
	Contribution margin	$500,000 x 40% =	$200,000
	Fixed expenses		175,000
			$25,000
c)	Breakeven sales	$175,000 / 40% =	$437,500
	Breakeven units	$437,500 / $40 =	10,938
d)	Sales for $60,000 income	($175,000 + $60,000) / 40% =	$587,500
e)	Unit contribution margin	$40 - $24 =	$16
f)	Margin of safety ratio	($500,000 - $437,500) / $500,000	12.5%

g) No; a sales increase of $100,000 will generate an additional $40,000 in contribution margin but total fixed costs will increase by $43,750. Therefore, income will be reduced by $3,750.

Problem #5

Contribution margin per unit	$40 - $30 =	$10
Total contribution margin	$10 × 160,000 =	$1,600,000
Net income		220,000
Fixed expenses		$1,380,000

Problem #6

a) Weighted average contribution margin $\frac{(3 \times \$25)+(1 \times \$35)}{4 \text{ units}}$ = \$27.50

Breakeven units $\frac{\$151,250}{\$27.50}$ = 5,500 units

b) Units of Blendmaster $\frac{1}{4}$ X 5,500 = 1,375 units

Solutions to Multiple Choice Questions

1. C
2. B
3. A
4. D
5. B
6. C
7. C
8. B
9. C
10. B
11. C
12. A
13. C
14. C
15. D
16. D
17. C
18. A
19. C
20. B
21. A
22. B
23. A