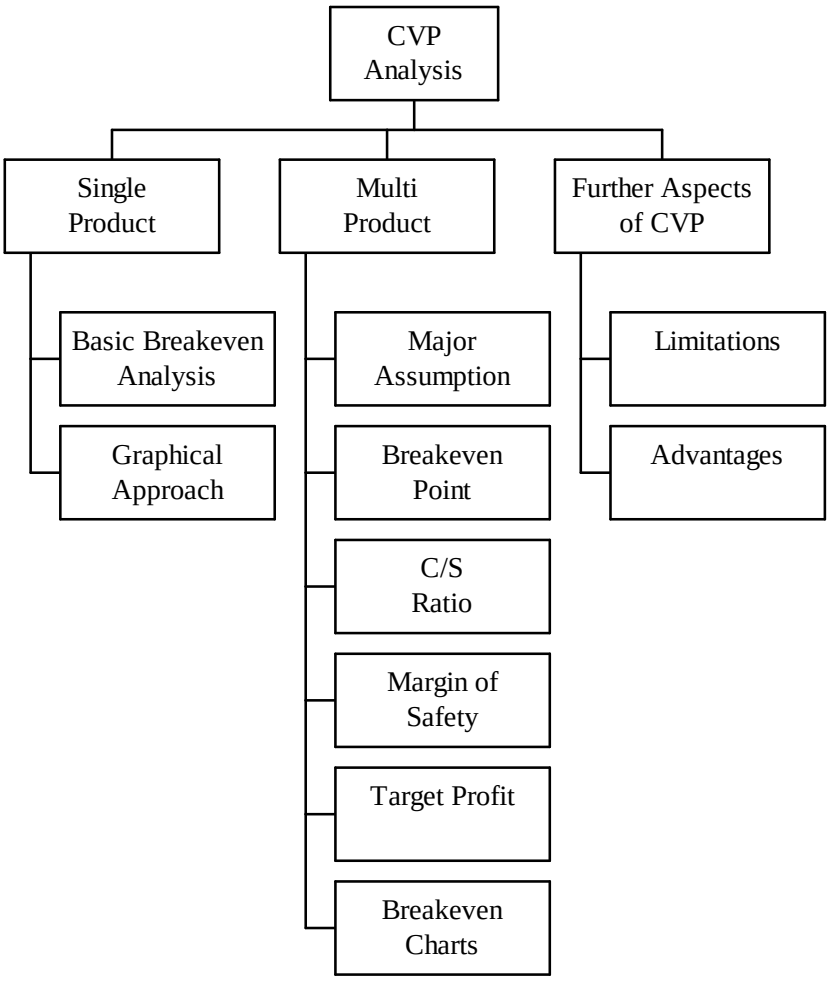
UNIT II – BREAK-EVEN ANALYSIS



COST-VOLUME-PROFIT (CVP) ANALYSIS

CVP analysis examines the interaction of a firm's sales volume, selling price, cost structure, and profitability. It is a powerful tool in making managerial decisions including marketing, production, investment, and financing decisions.

- How many units of its products must a firm sell to break even?
- How many units of its products must a firm sell to earn a certain amount of profit?
- Should a firm invest in highly automated machinery and reduce its labor force?
- Should a firm advertise more to improve its sales?

CVP Model – Assumptions

Key assumptions of CVP model

- Selling price is constant
- Costs are linear and can be divided into variable and fixed elements.
- In multi-product companies, sales mix is constant
- In manufacturing companies, inventories do not change.

Benefits of CVP:

- Assists in establishing prices of products.
- Assists in analyzing the impact that volume has on short-term profits.
- Assists in focusing on the impact that changes in costs (variable and fixed) have on profits.
- Assists in analyzing how the mix of products affects profits.

Cost-Volume-Profit Graph

CVP graphs can be used to gain insight into the behavior of expenses and profits. The basic CVP graph is drawn with Revenues in Rs. term on the vertical axis and unit sales on the horizontal axis. Total fixed expense is drawn first and then variable expense is added to the fixed expense to draw the total expense line. Finally, the total revenue line is drawn. The total profit (or loss) is the vertical difference between the total revenue and total expense lines. The break-even occurs at the point where the total revenue and total expenses lines cross.

The Limitations of CVP Analysis

A number of limitations are commonly mentioned with respect to CVP analysis:

- *The analysis assumes a linear revenue function and a linear cost function.*
- *The analysis assumes that price, total fixed costs, and unit variable costs can be accurately identified and remain constant over the relevant range.*
- *The analysis assumes that what is produced is sold.*
- *For multiple-product analysis, the sales mix is assumed to be known.*
- *The selling prices and costs are assumed to be known with certainty.*

Break-Even Analysis: We can accomplish break-even analysis in one of two ways. We can use the *equation* method or the *contribution margin* method. We get the same results regardless of the method selected. You may prefer one method over the other. It's a personal choice, but be aware that there are problems associated with either method. Some are easier to solve using the equation method, while others can be quickly solved using the contribution margin method.

Break-even analysis can be approached in two ways:

1. Equation method
2. Contribution margin method

Break-Even Analysis and Target Profit Analysis:-

Target profit analysis is concerned with estimating the level of sales required to attain a specified target profit. Break-even analysis is a special case of target profit analysis in which the target profit is zero.

1. **Basic CVP equations.** Both the equation and contribution (formula) methods of break-even and target profit analysis are based on the contribution approach to the income statement. The format of this statement can be expressed in equation form as:

$$\text{Profits} = \text{Sales} - \text{Variable expenses} - \text{Fixed expenses}$$

In CVP analysis this equation is commonly rearranged and expressed as:

$$\text{Sales} = \text{Variable expenses} + \text{Fixed expenses} + \text{Profits}$$

a. The above equation can be expressed in terms of unit sales as follows:

$$\text{Price} \times \text{Unit sales} = \text{Unit variable cost} \times \text{Unit sales} + \text{Fixed expenses} + \text{Profits}$$
$$\Downarrow$$
$$\text{Unit contribution margin} \times \text{Unit sales} = \text{Fixed expenses} + \text{Profits}$$
$$\Downarrow$$
$$\text{Unit sales} = \frac{\text{Fixed expenses} + \text{Profits}}{\text{Unit contribution margin}}$$

b. The basic equation can also be expressed in terms of sales in Rs. using the variable expense ratio:

$$\text{Sales} = \text{Variable expense ratio} \times \text{Sales} + \text{Fixed expenses} + \text{Profits}$$
$$\Downarrow$$
$$(1 - \text{Variable expense ratio}) \times \text{Sales} = \text{Fixed expenses} + \text{Profits}$$
$$\Downarrow$$
$$\text{Contribution margin ratio}^* \times \text{Sales} = \text{Fixed expenses} + \text{Profits}$$
$$\Downarrow$$
$$\text{Sales} = \frac{\text{Fixed expenses} + \text{Profits}}{\text{Contribution margin ratio}}$$

$$\begin{aligned} ^* 1 - \text{Variable expense ratio} &= 1 - \frac{\text{Variable expenses}}{\text{Sales}} \\ &= \frac{\text{Sales-Variable expenses}}{\text{Sales}} \\ &= \frac{\text{Contribution margin}}{\text{Sales}} \\ &= \text{Contribution margin ratio} \end{aligned}$$

2. **Break-even point using the equation method.** The break-even point is the level of sales at which profit is zero. It can also be defined as the point where sales total equals total expenses or as the point where total contribution margin equals total fixed expenses. Break-even analysis can be approached either by the equation method or by the contribution margin method. The two methods are logically equivalent.

   a. **The Equation Method—Solving for the Break-Even Unit Sales.** This method involves following the steps in section (1a) above. Substitute the selling price, unit variable cost and fixed expense in the first equation and set profits equal to zero. Then solve for the unit sales.

   b. **The Equation Method—Solving for the Break-Even Sales in Rs..** This method involves following the steps in section (1b) above. Substitute the variable expense ratio and fixed expenses in the first equation and set profits equal to zero. Then solve for the sales.

3. **Break-even point using the contribution method.** This is a short-cut method that jumps directly to the solution, bypassing the intermediate algebraic steps.

   a. **The Contribution Method—Solving for the Break-Even Unit Sales.** This method involves using the final formula for unit sales in section (1a) above. Set profits equal to zero in the formula.

$$\text{Break-even unit sales} = \frac{\text{Fixed expenses} + \$0}{\text{Unit contribution margin}} = \frac{\text{Fixed expenses}}{\text{Unit contribution margin}}$$

   b. **The Contribution Method—Solving for the Break-Even Sales in Rs.**. This method involves using the final formula for sales in section (1b) above. Set profits equal to zero in the formula.

$$\text{Break-even sales} = \frac{\text{Fixed expenses} + \$0}{\text{Contribution margin ratio}} = \frac{\text{Fixed expenses}}{\text{Contribution margin ratio}}$$

4. **Target profit analysis.** Either the equation method or the contribution margin method can be used to find the number of units that must be sold to attain a target profit. In the case of the contribution margin method, the formulas are:

$$\text{Unit sales to attain target profits} = \frac{\text{Fixed expenses} + \text{Target profits}}{\text{Unit contribution margin}}$$

$$\text{In Rs. sales to attain target profits} = \frac{\text{Fixed expenses} + \text{Target profits}}{\text{Contribution margin ratio}}$$

   Note that these formulas are the same as the break-even formulas if the target profit is zero.

E. Margin of Safety:- The margin of safety is the excess of budgeted (or actual) sales over the break-even volume of sales. It is the amount by which sales can drop before losses begin to be incurred. The margin of safety can be computed in terms of in Rs.:

$$\text{Margin of safety in Rs.} = \text{Total sales} - \text{Break-even sales}$$

or in percentage form:

$$\text{Margin of safety percentage} = \frac{\text{Margin of safety in dollars}}{\text{Total sales}}$$

F. Cost Structure. Cost structure refers to the relative proportion of fixed and variable costs in an organization. Understanding a company's cost structure is important for decision-making as well as for analysis of performance.

G. Operating Leverage:- Operating leverage is a measure of how sensitive net operating income is to a given percentage change in sales.

1. **Degree of operating leverage.** The degree of operating leverage at a given level of sales is computed as follows:

$$\text{Degree of operating leverage} = \frac{\text{Contribution margin}}{\text{Net operating income}}$$

2. **The math underlying the degree of operating leverage.** The degree of operating leverage can be used to estimate how a given percentage change in sales volume will affect net income at a given level of sales, assuming there is no change in fixed expenses. To verify this, consider the following:

$$\begin{aligned}
\underset{\text{leverage}}{\text{Degree of operating}} \times \underset{\text{in sales}}{\text{Percentage change}} &= \left(\frac{\text{Contribution margin}}{\text{Net operating income}}\right) \times \left(\frac{\text{New sales-Sales}}{\text{Sales}}\right) \\
&= \\
&\left(\frac{\text{Contribution margin}}{\text{Sales}}\right) \times \left(\frac{\text{New sales-Sales}}{\text{Net operating income}}\right) \\
&= \text{CM ratio} \times \left(\frac{\text{New sales-Sales}}{\text{Net operating income}}\right) \\
&= \left(\frac{\text{CM ratio} \times \text{New sales-CM ratio} \times \text{Sales}}{\text{Net operating income}}\right) \\
&= \left(\frac{\text{New contribution margin-Contribution margin}}{\text{Net operating income}}\right) \\
&= \left(\frac{\text{Change in net operating income}}{\text{Net operating income}}\right) \\
&= \text{Percentage change in net operating income}
\end{aligned}$$

Thus, providing that fixed expenses are not affected and the other assumptions of CVP analysis are valid, the degree of operating leverage provides a quick way to predict the percentage effect on profits of a given percentage increase in sales. The higher the degree of operating leverage, the larger the increase in net operating income.

3. **Degree of operating leverage is not constant.** The degree of operating leverage is not constant as the level of sales changes. For example, at the break-even point the degree of operating leverage is infinite since the denominator of the ratio is zero. Therefore, the degree of operating leverage should be used with some caution and should be recomputed for each level of starting sales.

4. **Operating leverage and cost structure.** Richard Lord, "Interpreting and Measuring Operating Leverage, points out that the relation between operating leverage and the cost

structure of the company is contingent. It is difficult, for example, to infer the relative proportions of fixed and variable costs in the cost structures of any two companies just by comparing their operating leverages. We can, however, say that if two single-product companies have the same profit, the same selling price, the same unit sales, and the same total expenses, then the company with the higher operating leverage will have a higher proportion of fixed costs in its cost structure. If they do not have the same profit, the same unit sales, the same selling price, and the same total expenses, we cannot safely make this inference about their cost structure. All of the statements in the text about operating leverage and cost structure assume that the companies being compared are identical except for the proportions of fixed and variable costs in their cost structures.

H. Structuring Sales Commissions. Students may have a tendency to overlook the importance of this section due to its brevity. You may want to discuss with your students how salespeople are ordinarily compensated (salary plus commissions based on sales) and how this can lead to dysfunctional behavior. For example, would a company make more money if its salespeople steered customers toward Model A or Model B as described below?

	Model A	*Model B*
Price	Rs.100	Rs.150
Variable cost	75	130
Unit CM	Rs. 25	Rs. 20

Which model will salespeople push hardest if they are paid a commission of 10% of sales revenue?

I. Sales Mix:- Sales mix is the relative proportions in which a company's products are sold. Most companies have a number of products with differing contribution margins. Thus, changes in the sales mix can cause variations in a company's profits. As a result, the break-even point in a multi-product company is dependent on the sales mix.

1. **Constant sales mix assumption.** In CVP analysis, it is usually assumed that the sales mix will not change. Under this assumption, the break-even level of sales in Rs. can be computed using the overall contribution margin (CM) ratio. In essence, it is assumed that the company has only one product that consists of a basket of its various products in a specified proportion. The contribution margin ratio of this basket can be easily computed by dividing the total contribution margin of all products by total sales.

$$\text{Overall CM ratio} = \frac{\text{Total contribution margin}}{\text{Total sales}}$$

2. **Use of the overall CM ratio.** The overall contribution margin ratio can be used in CVP analysis exactly like the contribution margin ratio for a single product company. For a multi-product company the formulas for break-even sales in Rs. and the sales required to attain a target profit are:

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

$$\text{Sales to achieve target profits} = \frac{\text{Fixed expenses + Target profits}}{\text{Overall CM ratio}}$$

Note that these formulas are really the same as for the single product case. The constant sales mix assumption allows us to use the same simple formulas.

3. **Changes in sales mix.** If the proportions in which products are sold change, then the overall contribution margin ratio will change. Since the sales mix is not in reality constant, the results of CVP analysis should be viewed with more caution in multi-product companies than in single product companies.

J. Assumptions in CVP Analysis. Simple CVP analysis relies on simplifying assumptions. However, if a manager knows that one of the assumptions is violated, the CVP analysis can often be easily modified to make it more realistic.

1. **Selling price is constant.** The assumption is that the selling price of a product will not change as the unit volume changes. This is not wholly realistic since unit sales and the selling price are usually inversely related. In order to increase volume it is often necessary to drop the price. However, CVP analysis can easily accommodate more realistic assumptions. A number of examples and problems in the text show how to use CVP analysis to investigate situations in which prices *are* changed.

2. **Costs are linear and can be accurately divided into variable and fixed elements.** It is assumed that the variable element is constant per unit and the fixed element is constant in total. This implies that operating conditions are stable. It also implies that the fixed costs are really fixed. When volume changes dramatically, this assumption becomes tenuous. Nevertheless, if the effects of a decision on fixed costs can be estimated, this can be explicitly taken into account in CVP analysis. A number of examples and problems in the text show how to use CVP analysis when fixed costs are affected.

3. **The sales mix is constant in multi-product companies.** This assumption is invoked so as to use the simple break-even and target profit formulas in multi-product companies. If unit contribution margins are fairly uniform across products, violations of this assumption will not be important. However, if unit contribution margins differ a great deal, then changes in the sales mix can have a big impact on the overall contribution margin ratio and hence on the results of CVP analysis. If a manager can predict how the sales mix will change, then a more refined CVP analysis can be performed in which the individual contribution margins of products are computed.

4. **In manufacturing companies, inventories do not change.** It is assumed that everything the company produces is sold in the same period. Violations of this assumption result in discrepancies between financial accounting net operating income and the profits calculated using the contribution approach. This topic is covered in detail in the chapter on variable costing.

Q1: How is CVP Analysis Used?

(a) Contribution per unit = unit selling price – unit variable costs

(b) Breakeven point = activity level at which there is **neither profit nor loss**

$$= \frac{Total\ fixed\ costs}{Contribution\ per\ unit}$$

(c) Contribution/sales (C/S) ratio = profit/volume (P/V) ratio

$$= \frac{Contribution}{Sales} \times 100\%$$

(d) Sales revenue at breakeven point = fixed costs ÷ C/S ratio

(e) Margin of safety (in units) = budgeted sales units – breakeven sales units

(f) Margin of safety (as %) $\dfrac{\text{Budgeted sales} - \text{breakeven sales}}{\text{Budgeted sales}} \times 100\%$

(g) Sales volume to achieve a target profit $\dfrac{\text{Fixed cost + target profit}}{\text{Contribution per unit}}$

Exercise 1: A company manufactures a single product which has the following cost structure based on a production budget of 10,000 units.

Materials – 4 kg at Rs.3/kg	Rs.12
Direct labour – 5 hours at Rs.7/hour	Rs.35

Variable production overheads are recovered at the rate of Rs.8 per direct labour hour.

Other costs incurred by the company are:

	Rs.
Factory fixed overheads	120,000
Selling and distribution overheads	160,000
Fixed administration overheads	80,000

The selling and distribution overheads include a variable element due to a distribution cost of Rs.2 per unit.

The fixed selling price of the unit is Rs.129.

Required:

(a) Calculate how many units have to be sold for the company to breakeven.

(b) Calculate the sales revenue which would give a net profit of Rs.40, 000.

(c) If the company could buy in the units instead of manufacturing them, calculate how much it would be prepared to pay if both:

(i) Estimated sales for next year are 9,500 units at Rs.129 each; and

(ii) Rs.197, 500 of fixed selling, distribution and administrative overheads would still be incurred even if there is no production (all other fixed overheads would be saved).

BREAK-EVEN CHART

The Graphical Approach for Single Product

The second way to find the break-even is to use the graphical method. The graphical method is based on the break-even chart, a graphical representation of cost-volume-profit relationships and the break-even point. It is an attempt to help management in their understanding of these relationships and so enable them to decide on the optimum level of output

Example 1

A new product has the following sales and cost data.

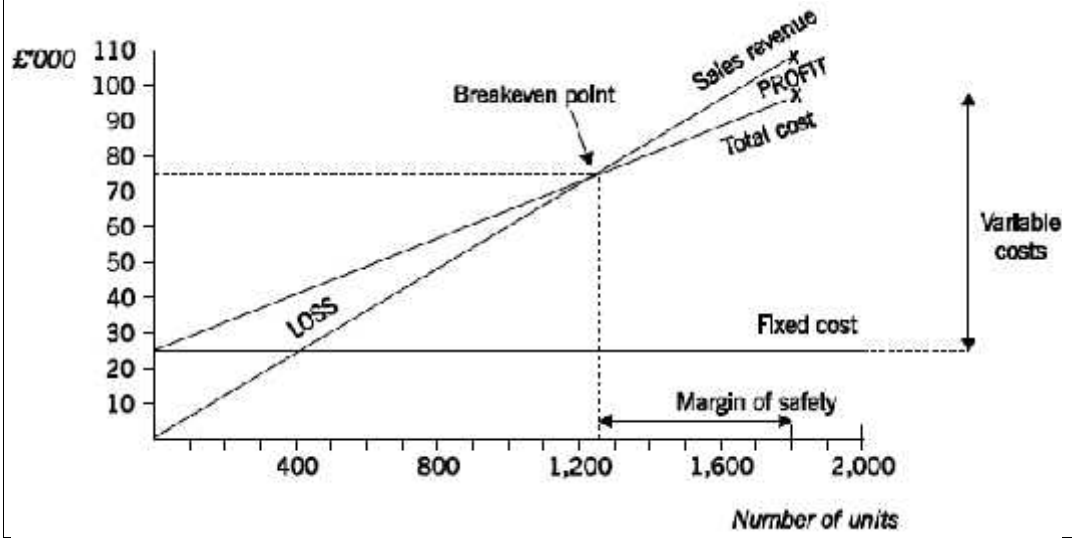
Selling price	Rs.60 per unit
Variable costs	Rs.40 per unit
Fixed costs	Rs.25,000 per month

Forecast sales 1,800 units per month

Required:

Prepare a breakeven chart using the above data.

Solution:



Breakeven Analysis for Multiple Products

A major assumption

Organisations typically produce and sell a variety of products and services. To perform breakeven analysis in a multi-product organisation, however, a **constant product sales mix must be assumed**. In other words, we have to assume that whenever x units of product A are sold, y units of product B and z units of product C are also sold.

Example 2

PL produces and sells two products. The M sells for Rs.7 per unit and has a total variable cost of Rs.2.94 per unit, while the N sells for Rs.15 per unit and has a total variable cost of Rs.4.5 per unit. The marketing department has estimated that for every five units of M sold, one unit of N will be sold. The organization's fixed costs total Rs.36,000.

Required: Calculate the breakeven point for PL.

Solution:

1. Calculate contribution per unit

	M	N

	Rs. per unit	Rs. per unit
Selling price	7.00	15.00
Variable cost	2.94	4.50
Contribution	4.06	10.50

2. Calculate contribution per mix
= Rs.4.06 x 5 + Rs.10.50 x 1 = Rs.30.80

3. Calculate the breakeven point in terms of the number of mixes
= fixed costs / contribution per mix
= Rs.36,000 / Rs.30.80
= 1,169 mixes (rounded)

4. Calculate the breakeven point in terms of the number of units of products
= (1,169 x 5) 5,845 units of M and (1,169 x 1) 1,169 units of N

5. Calculate the breakeven point in terms of revenue
= (5,845 x Rs.7) + (1,169 x Rs.15)
= Rs.40,915 of M and Rs.17,535 of N
= Rs.58,450 in total

Exercise 2

Alpha manufactures and sells three products, the beta, the gamma and the delta. Relevant information is as follows.

	Beta	Gamma	Delta
	Rs. per unit	Rs. per unit	Rs. per unit
Selling price	135.00	165.00	220.00
Variable cost	73.50	58.90	146.20

Total fixed costs are Rs.950,000.

An analysis of past trading patterns indicates that the products are sold in the ratio 3:4:5

Required:
Calculate the breakeven point for Alpha.

Contribution to sales (C/S) ratio for multiple products

- The **breakeven point in terms of sales revenue** can be **calculated as fixed costs / average C/S ratio**.
- Any change in the **proportions of products in the mix** will **change the contribution per mix and the average C/S ratio** and **hence the breakeven point**.
- You should know that the C/S ratio is sometimes called the **profit/volume ratio or P/V ratio**.

Example 3

As example 2 above, we can calculate the breakeven point of PL as follows.

Solution:

1. Calculate **revenue per mix**
   = (5 x Rs.7) + (1 x Rs.15) = Rs.50

2. Calculate **contribution per mix** (see example 2)
   = Rs.4.06 x 5 + Rs.10.50 x 1 = Rs.30.80

3. Calculate **average C/S ratio**
   = Rs.30.80/Rs.50.00 x 100%
   = 61.6%

4. Calculate the **breakeven point**
   = fixed costs ÷ C/S ratio
   = Rs.36,000 ÷ 0.616
   = Rs.58,443 (rounded)

5. Calculate **revenue ratio of mix**
   = (5 x Rs.7) : (1 x Rs.15)
   = 35 : 15 or 7 : 3

6. Calculate breakeven sales
   M = Rs.58,442 x 7/10 = Rs.40,909 (rounded)
   N = Rs.58,442 x 3/10 = Rs.17,533 (rounded)

Exercise 3

Calculate the breakeven sales revenue of product Beta, Gamma and Delta (see Exercise 2 above) using the approach shown in Example 3.

Points to Bear in Mind

Any change in the proportions of products in the mix will change the contribution per mix and the average C/S ratio and hence the breakeven point.

(a) If the **mix shifts towards products with lower contribution margins**, the **breakeven point (in units) will increase** and **profits will fall** unless there is a corresponding increase in total revenue.

(b) A shift towards products with **higher contribution margins** without a corresponding decrease in revenues will cause an **increase in profits** and a **lower breakeven point**.

(c) If sales are at the specified level but **not in the specified mix**, there will be **either a profit or a loss** depending on whether the **mix shifts towards products with higher or lower contribution margins**.

Margin of safety for multiple products

The **margin of safety** for a multi-product organisation is **equal to the budgeted sales in the standard mix less the breakeven sales in the standard mix**. It may be expressed as a percentage of the budgeted sales.

Example 4

BA produces and sells two products. The W sells for Rs.8 per unit and has a total variable cost of Rs.3.80 per unit, while the R sells for Rs.14 per unit and has a total variable cost of Rs.4.20. For every five units of W sold, six units of R are sold. BA's fixed costs are Rs.43,890 per period.

Budgeted sales revenue for next period is Rs.74,400, in the standard mix.

Required:

Calculate the margin of safety in terms of sales revenue and also as a percentage of budgeted sales revenues.

Solution:

1. Calculate contribution per unit

	W	R
	Rs. per unit	Rs. per unit
Selling price	8.00	14.00
Variable cost	3.80	4.20
Contribution	4.20	9.80

2. Calculate contribution per mix
   = Rs.4.20 x 5 + Rs.9.80 x 6 = Rs.79.80

3. Calculate the breakeven point in terms of the number of mixes
   = fixed costs / contribution per mix
   = Rs.43,890 / Rs.79.80
   = 550 mixes

4. Calculate the breakeven point in terms of the number of units of products
   = (550 x 5) 2,750 units of W and (550 x 6) 3,300 units of R

5. Calculate the breakeven point in terms of revenue
   = (2,750 x Rs.8) + (3,300 x Rs.14)
   = Rs.22,000 of W and Rs.46,200 of R
   = Rs.68,200 in total

6. Calculate the margin of safety
   = budgeted sales – breakeven sales
   = Rs.74,400 – Rs.68,200
   = Rs.6,200 sales in total, in the standard mix
   = Rs.6,200 / Rs.74,400 x 100%
   = 8.3% of budgeted sales

Target profits for multiple products

The number of mixes of products required to be sold to achieve a target profit is calculated as:

(fixed costs + required profit)/contribution per mix.

Example 5

An organisation makes and sells three products, F, G and H. The products are sold in the

proportions F:G:H = 2:1:3. The organisation's fixed costs are Rs.80,000 per month and details of the products are as follows.

Product	Selling price Rs. per unit	Variable cost Rs. per unit
F	22	16
G	15	19
H	19	13

The organisation wishes to earn a profit of Rs.52,000 next month. Calculate the required sales value of each product in order to achieve this target profit.

Solution:

1. Calculate contribution per unit

	F Rs. per unit	G Rs. per unit	H Rs. per unit
Selling price	22	15	19
Variable cost	16	12	13
Contribution	6	3	6

2. Calculate contribution per mix
   = (Rs.6 x 2) + (Rs.3 x 1) + (Rs.6 x 3)
   = Rs.33

3. Calculate the required number of mixes
   = (Fixed costs + required profit)/contribution per mix
   = (Rs.80,000 + Rs.52,000)/Rs.33
   = 4,000 mixes

4. Calculate the required sales in terms of the number of units of the products and sales revenue of each product

Product		Units	Selling price Rs. per unit	Sales revenue required Rs.
F	4,000 x 2	8,000	22	176,000
G	4,000 x 1	4,000	15	60,000
H	4,000 x 3	12,000	19	228,000
Total				464,000

The sales revenue of Rs.464,000 will generate a profit of Rs.52,000 if the products are sold in the mix 2:1:3.

Alternatively the C/S ratio could be used to determine the required sales revenue for a profit of Rs.52,000. The method is again similar to that demonstrated earlier when calculating the breakeven point.

Example 6

Using the information as Example 5, calculate the required sales of each products by using the C/S ratio.

Solution:

1. Calculate revenue per mix
   = (2 x Rs.22) + (1 x Rs.15) + (3 x Rs.19)
   = Rs.116
2. Calculate contribution per mix
   = (Rs.6 x 2) + (Rs.3 x 1) + (Rs.6 x 3)
   = Rs.33
3. Calculate average C/S ratio
   = (Rs.33/Rs.116) x 100%
   = 28.45%
4. Calculate the required total revenue
   = required contribution ÷ C/S ratio
   = (Rs.80,000 + Rs.52,000) ÷ 28.45%
   = Rs.463,972
5. Calculate revenue ratio of mix
   = (2 x Rs.22) : (1 x Rs.15) : (3 x Rs.19)
   = 44 : 15 : 57
6. Calculate required sales
   Required sales of F = 44/116 x Rs.463,972 = Rs.175,989
   Required sales of G = 15/116 x Rs.463,972 = Rs.59,996
   Required sales of H = 57/116 x Rs.463,972 = Rs.227,986

Which, allowing for roundings, is the same answer as calculated in the first example.

Multi-product breakeven charts

(A) Breakeven charts

Breakeven charts for multiple products can be drawn if a **constant product sales mix is assumed**. Here, there are three approaches to draw the multi-product breakeven charts.

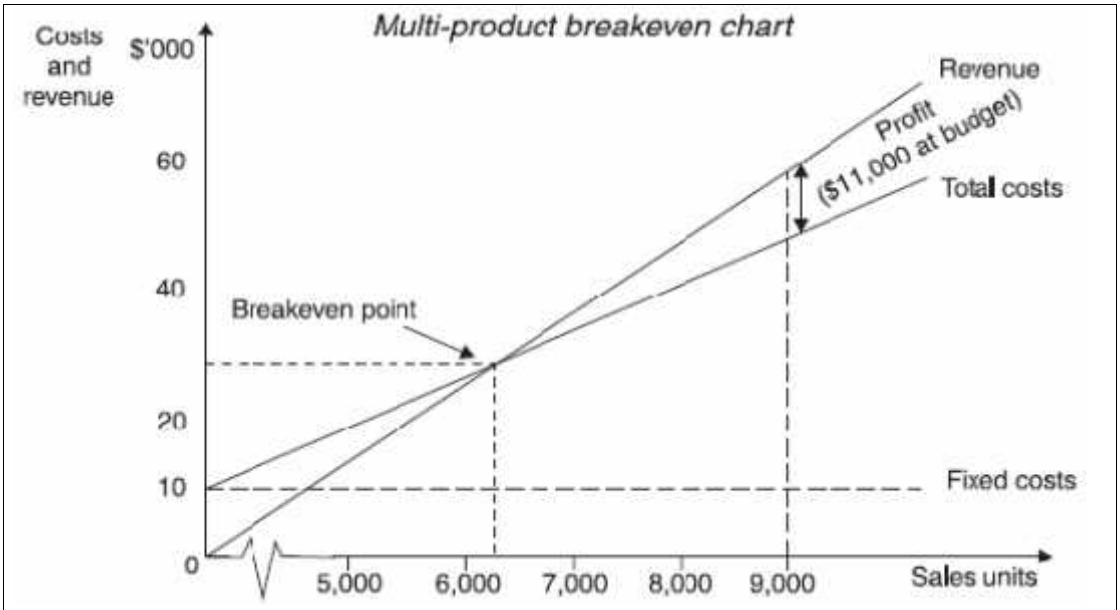
Example 7 – Approach 1: Output in Rs. Sales and a Constant Product Mix

Assume that budgeted sales are 2,000 units of X, 4,000 units of Y and 3,000 units of Z. A breakeven chart would make the assumption that output and sales of X, Y and Z are in the proportions 2,000: 4,000: 3,000 at all levels of activity, in other words that the sales mix is 'fixed' in these proportions.

We begin by carrying out some calculations.

Budgeted costs		Costs Rs.		Revenue Rs.
Variable costs of X	(2,000 x Rs.3)	6,000	X (2,000 x Rs.8)	16,000
Variable costs of Y	(4,000 x Rs.4)	16,000	Y (4,000 x Rs.6)	24,000
Variable costs of Z	(3,000 x Rs.5)	15,000	Z (3,000 x Rs.6)	18,000
Total variable costs		37,000	Budgeted revenue	58,000
Fixed costs		10,000		
Total budgeted costs		47,000		

The breakeven chart can now be drawn.



The breakeven point is approximately Rs.27,500 of sales revenue. This may either be read from the chart or computed mathematically.

(a) The budgeted C/S ratio for all three products together is contribution/sales = Rs.(58,000 – 37,000)/Rs.58,000 = 36.21%.

(b) The required contribution to break even is Rs.10,000, the amount of fixed costs. The breakeven point is Rs.10,000/36.21% = Rs.27,500 (approx) in sales revenue.

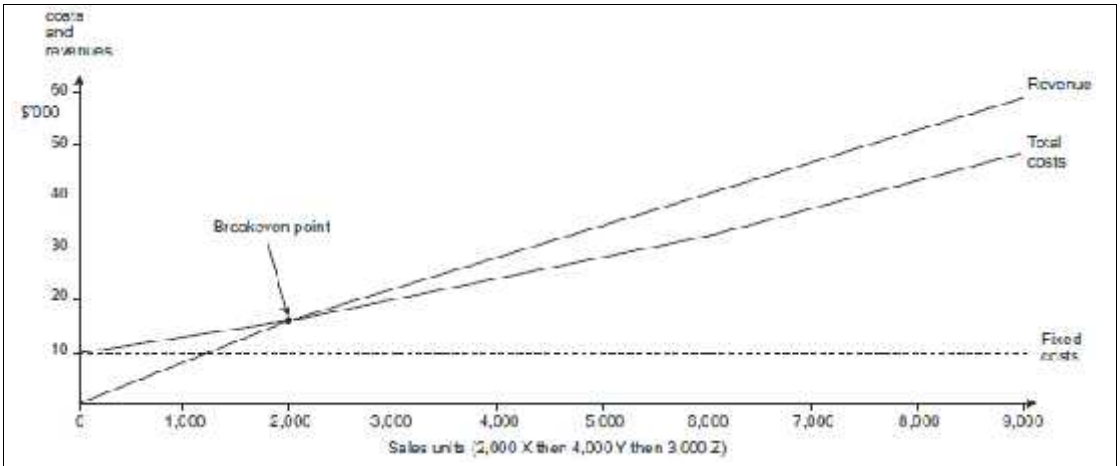
The margin of safety is approximately Rs.(58,000 – 27,500) = Rs.30,500.

Example 8 – Approach 2: Products in Sequence

The products could be plotted in a particular sequence (say X first, then Y, then Z). Using the data from Approach 1, we can calculate cumulative costs and revenues as follows.

Product	Cumulative units	Cumulative costs Rs.	Cumulative revenue Rs.
	Nil	10,000	Nil
X (2,000 units)	2,000	16,000	16,000
Y (4,000 units)	6,000	32,000	40,000
Z (3,000 units)	9,000	47,000	58,000

The breakeven chart can now be drawn.



In this case the breakeven point occurs at 2,000 units of sales (2,000 units of product X). The margin of safety is roughly 4,000 units of Y and 3,000 units of Z.

Example 9 – Approach 3: Output in Terms of % of Forecast Sales and a Constant Product Mix

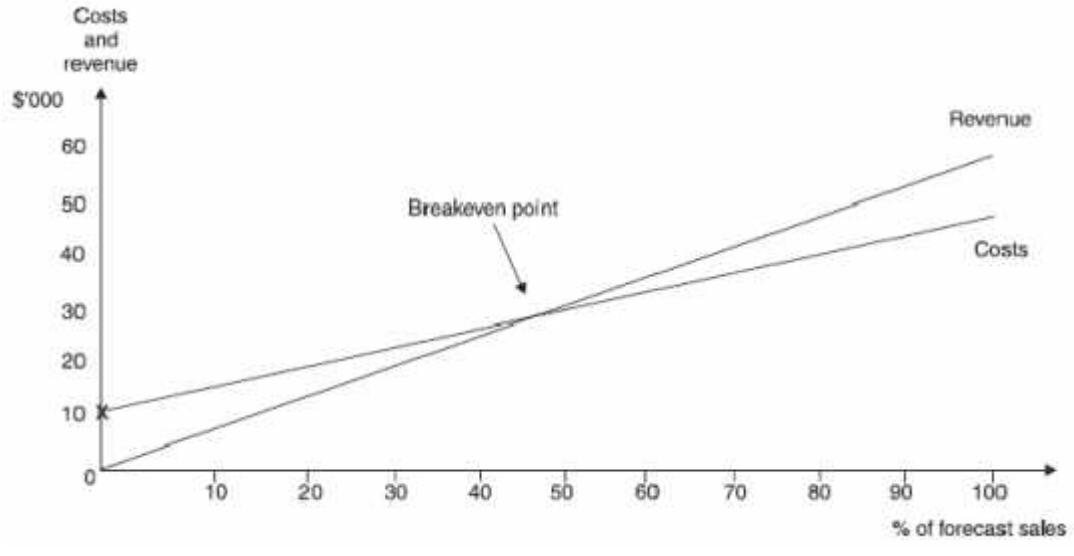
The breakeven point can be read from the graph as approximately 48% of forecast sales (Rs.30,000 of revenue).

Alternatively, with contribution of Rs.(58,000 – 37,000) = Rs.21,000, one percent of forecast sales is associated with Rs.21,000/100 = Rs.210 contribution.

Breakeven point (%) = fixed costs/contribution per 1%

= Rs.10,000/Rs.210 = 47.62%

∴ Margin of safety = (100 – 47.62) = 52.38%



(B) Multi-product P/V charts

The same information could be shown on a P/V chart.

Example 10

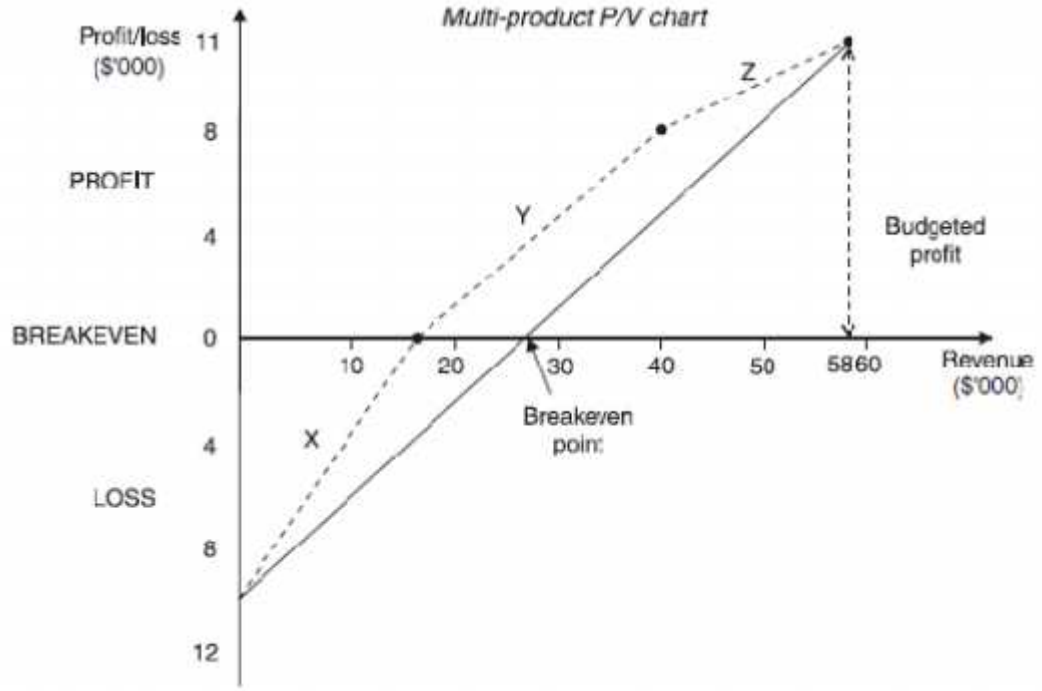
Same information as Example 7,

Product	Contribution	Sales	C/S ratio
	Rs.	Rs.	%
X	10,000	16,000	62.50
Y	8,000	24,000	33.33
Z	3,000	18,000	16.67
Total	21,000	58,000	36.21

By convention, the **products are shown individually** on a P/V chart from **left to right**, **in order of the size of their C/S ratio**. In this example, product X will be plotted first, then product Y and finally product Z. A dotted line is used to show the **cumulative profit/loss and the cumulative sales** as each product's sales and contribution in turn are added to the sales mix.

Product	Cumulative sales		Cumulative profit
	Rs.		Rs.
X	16,000	(Rs.16,000 – Rs.16,000)	-
X and Y	40,000		8,000
X, Y and Z	58,000		11,000

You will see on the graph which follows that these three pairs of data are used to plot the dotted line, to indicate the contribution from each product. The solid line which joins the two ends of this dotted line indicates the average profit which will be earned from sales of the three products in this mix.



The diagram **highlights** the following points.

(a) Since X is the most profitable in terms of C/S ratio, it might be worth considering an increase in the sales of X, even if there is a consequent fall in the sales of Z.

(b) Alternatively, the pricing structure of the products should be reviewed and a decision made as to whether the price of product Z should be raised so as to increase its C/S ratio (although an increase is likely to result in some fall in sales volume).

The **multi-product P/V chart** therefore helps to **identify** the following.

(a) The overall company breakeven point.

(b) Which products should be expanded in output and which, if any, should be discontinued.

(c) What effect changes in selling price and sales volume will have on the company's breakeven point and profit.

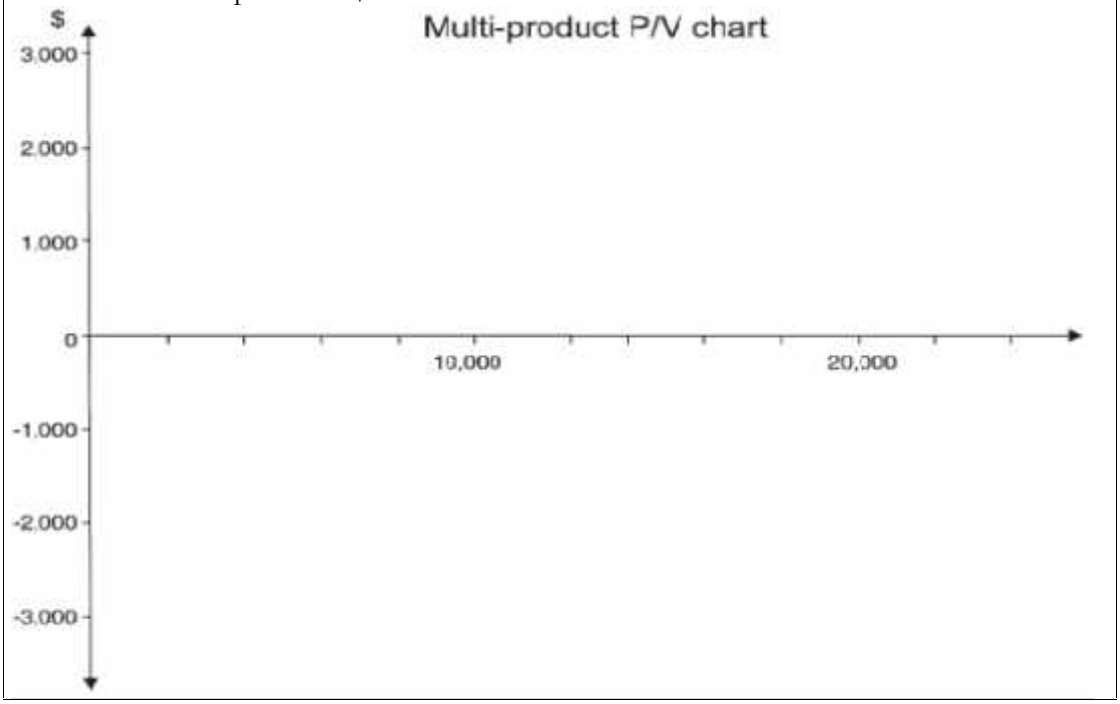
Exercise 4

A company sells three products, X, Y and Z. Cost and sales data for one period are as follows.

	X	Y	Z
Sales volume	2,000 units	2,000 units	5,000 units
Sales price per unit	Rs.3	Rs.4	Rs.2
Variable cost per unit	Rs.2.25	Rs.3.50	Rs.1.25
Total fixed costs	Rs.3,250		

Required:

Construct a multi-product P/V chart based on the above information on the axes below.



Further Aspects of CVP Analysis

The usefulness of CVP analysis is restricted by its **unrealistic assumptions**, such as constant sales price at all levels of activity. However CVP has the advantage of being more **easily understood by non-financial managers** due to its graphical depiction of cost and revenue data.

Limitations:

(a) It is assumed that **fixed costs are the same in total and variable costs are the same per unit** at all levels of output. This assumption is a great simplification.
   (i) Fixed costs will change if output falls or increases substantially (most fixed costs are step costs).
   (ii) The variable cost per unit will decrease where economies of scale are made at higher output volumes, but the variable cost per unit will also eventually rise when diseconomies of scale begin to appear at even higher volumes of output (for example the extra cost of labour in overtime working).

(b) The assumption is only correct within a normal range or relevant range of output. It is generally assumed that both the budgeted output and the breakeven point lie **within this relevant range**.

(c) It is assumed that **sales prices will be constant at all levels of activity**. This may not be true, especially at higher volumes of output, where the price may have to be reduced to win the extra sales.

(d) **Production and sales are assumed to be the same**, so that the consequences of any increase in inventory levels or of 'de-stocking' are ignored.

(e) **Uncertainty in the estimates** of fixed costs and unit variable costs is often **ignored**.

Advantages:

(a) **Graphical representation** of cost and revenue data (breakeven charts) can be more **easily understood** by non-financial managers.

(b) A breakeven model **enables profit or loss at any level of activity** within the range for which the model is valid to be **determined**, and the **C/S ratio can indicate the relative profitability of different products**.

(c) Highlighting the breakeven point and the margin of safety gives managers some **indication of the level of risk involved**.

Examination Style Questions

Question 1 – Breakeven Chart with Increases in Fixed Costs

(a) Identify and discuss briefly five assumptions underlying cost-volume-profit analysis.

(b) A local authority, whose area include a holiday resort situated on the east coast, operates, for 30 weeks each year, a holiday home which is let to visiting parties of children in care from other authorities. The children are accompanied by their own house mothers who supervise them throughout their holiday. From six to fifteen guests are accepted on terms of ₹ 100 per person per week. No differential charges exist for adults and children.

Weekly costs incurred by the host authority are:

	₹ per guest
Food	25
Electricity for heating and cooking	3
Domestic (laundry, cleaning, etc.) expenses	5

Use of minibus 10

Seasonal staff supervise and carry out the necessary duties at the home at a cost of ₹ 11,000 for the 30-week period. This provides staffing sufficient for six to ten guests per week but if eleven or more guests are to be accommodated, additional staff at a total cost of ₹ 200 per week are engaged for the whole of the 30-week period.

Rent, including rates for the property, is ₹ 4,000 per annum and the garden of the home is maintained by the council's recreation department which charges a nominal fee of ₹ 1,000 per annum.

Required:

(i) Tabulate the appropriate figures in such a way as to show the break-even point(s) and to comment on your figures.

(ii) Draw, on the graph paper provided, a chart to illustrate your answer to (b)(i) above.

Question 2 – Multi-product Profit-volume Graph

JK Limited has prepared a budget for the next 12 months when it intends to make and sell four products, details of which are shown below:

Product	Sales in units (000)	Selling price per unit ₹	Variable cost per unit ₹
J	10	20	14.00
K	10	40	8.00
L	50	4	4.20
M	20	10	7.00

Budgeted fixed costs are ₹ 240,000 per annum and total assets employed are ₹ 570,000.

Required:

(a) Calculate the total contribution earned by each product and their combined total contributions.

(b) Plot the data of your answer to (a) above in the form of a contribution to sales graph (or P/V graph) on the graph paper provided.

(c) Explain your graph to management, to comment on the results shown and to state the break-even point.

(d) Describe briefly three ways in which the overall contribution to sales ratio could be improved.

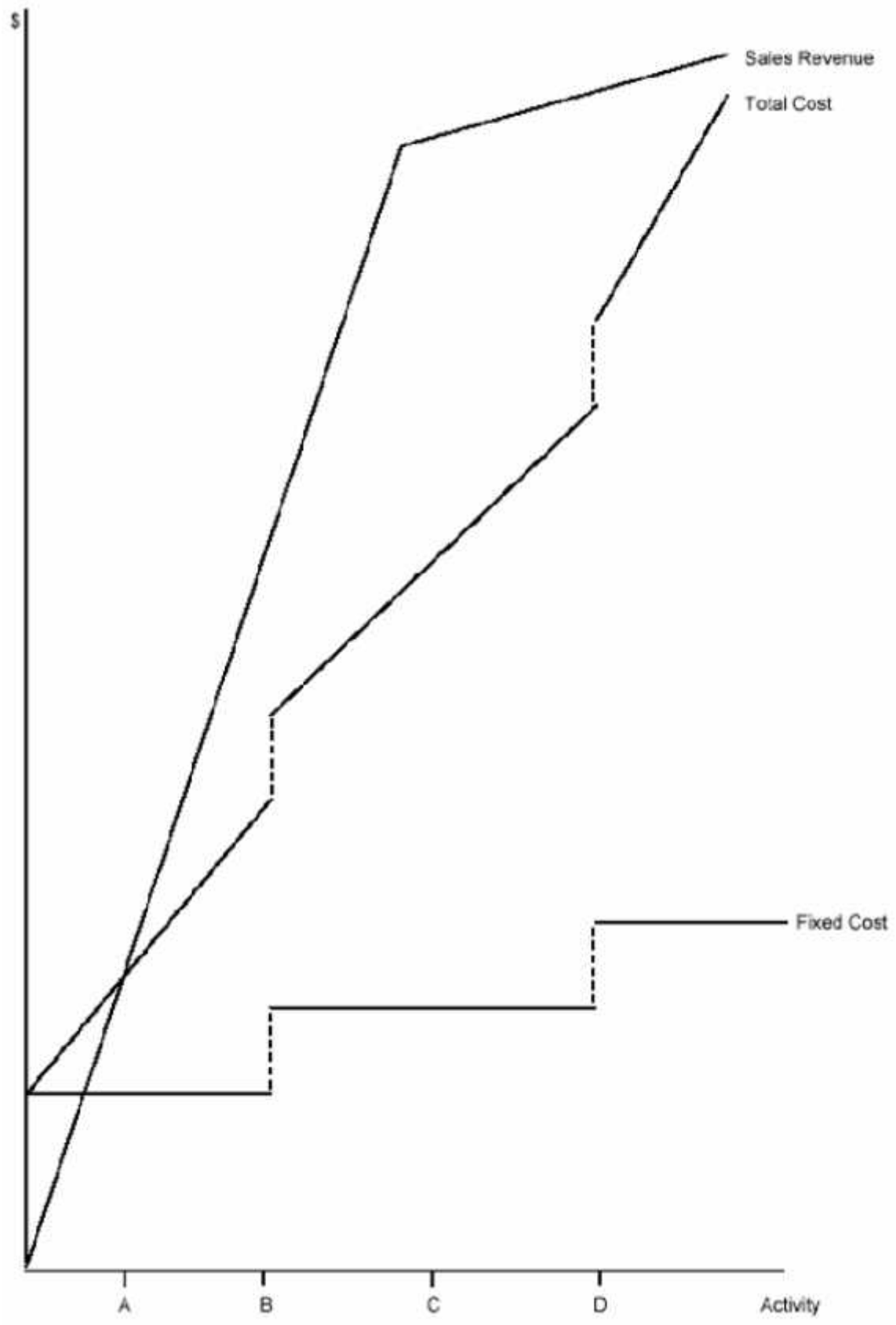
Question 3

You are the assistant management accountant of QXY plc, a food manufacturer. The Board of Directors is concerned that its operational managers may not be fully aware of the importance of understanding the costs incurred by the business and the effect that this has on their operational decision making. In addition, the operational managers need to be aware of the implications of their pricing policy when trying to increase the volume of sales.

You are scheduled to make a presentation to the operational managers tomorrow to explain to them the different costs that are incurred by the business, the results of some research that has been conducted into the implications for pricing and the importance of understanding these issues for their decision making. The diagram on the next page has already been prepared for the presentation.

Required:

You are required to interpret the diagram and explain how it illustrates issues that the operational managers should consider when making decisions. (Note: your answer must include explanations of the Sales Revenue, Total Cost and Fixed Cost lines, and the significance of each of the activity levels labelled A, B, C, D.)


$
Sales Revenue
Total Cost
Fixed Cost
A
B
C
D
Activity

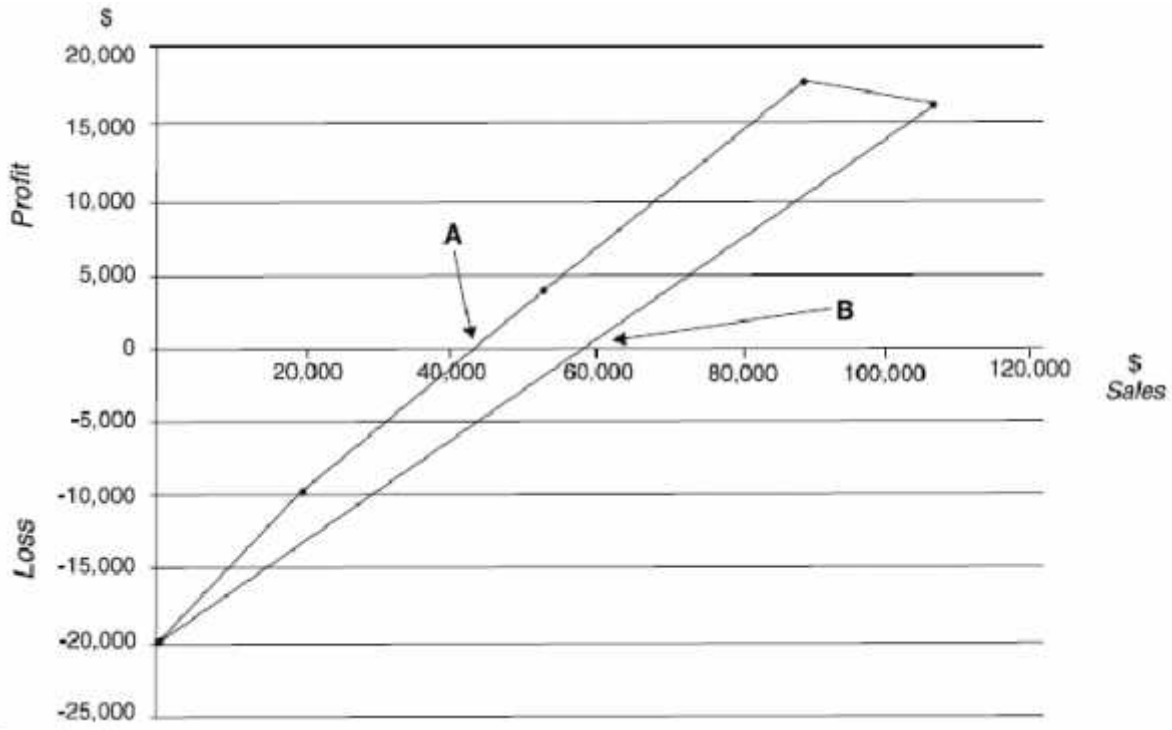
Question 4

RDF Ltd offers four services to television companies The number of services provided is measured in service units and details of RDF Ltd's draft budget for its year ending 30 June 2005 are as follows.

	Service K	Service L	Service M	Service N
No. of service units	1,000	2,300	1,450	1,970
Selling price per unit (Rs.)	18	16	12	20
Variable cost per unit (Rs.)	8	10	13	13
Fixed cost per unit (Rs.)	2	3	2	4

The budgeted level of activity shown in the table above has been based on fully meeting the forecasted market demand for each type of service.

The following chart has been prepared based on the draft budget above.



Required:

(a) Explain the meaning of the values shown as points A and B on the chart. (Note. Calculations are not required.)

(b) Further investigation into the nature of the fixed costs has shown that some of those shown in the original budget are incurred as a direct result of providing specific services as follows.

	Rs.
Service K	4,400
Service L	3,700
Service M	Nil
Service N	2,650

The remaining budgeted fixed costs are general fixed costs that will be incurred regardless of the type and number of services provided.

RDF Ltd entered into a three-year contract in June 2002 which requires it to provide 500 units of service M per year or suffer significant financial penalties. These services are included in the

budgeted demand.

Required:

(i) Evaluate the financial viability of each of the four services currently provided.

(ii) Recommend the operating plan that will maximise profit for the year ended 30 June 2005 and state the resulting profit. Explain the assumptions that led to your decision and other factors that should be considered.

(iii) Calculate the overall breakeven sales value for the operating plan you have recommended in answer to (b)(ii), stating clearly the assumptions made in your calculations.

(iv) Comment on any limitations of using breakeven analysis for decision making purposes.