4

Cost–Volume–Profit Analysis

Cost–Volume–Profit Analysis

4

Learning Outcomes

After completing this chapter, you should be able to:

- explain the concept of contribution and its use in cost–volume–profit (CVP) analysis;
- calculate and interpret the breakeven point, profit target, margin of safety and profit/volume ratio for a single product or service;
- prepare breakeven charts and profit/volume graphs for a single product or service;
- calculate the profit maximising sales mix for a multi-product company that has limited demand for each product and one other constraint or limiting factor.

4.1 Introduction

In this chapter, you will see how an understanding of cost behaviour patterns and a focus on identifying the costs that will alter as the result of a course of action are important in providing effective information as the basis for management decision-making.

4.2 Breakeven or cost–volume–profit analysis

Cost–volume–profit (CVP) analysis is defined in CIMA's *Terminology* as the 'study of the effects on future profit of changes in fixed cost, variable cost, sales price, quantity and mix'.

A common term used for this type of analysis is *breakeven analysis*. However, this is somewhat misleading, since it implies that the focus of the analysis is the *breakeven point* – that is, the level of activity which produces neither profit nor loss. You will see in this chapter that the scope of CVP analysis is much wider than this, as indicated in the definition. However, you should be aware that the terms 'breakeven analysis' and 'CVP analysis' tend to be used interchangeably.

4.2.1 The concept of contribution

In chapter 1 you learned that variable costs are those that vary with the level of activity. If we can identify the variable costs associated with producing and selling a product or service we can highlight a very important measure: *contribution.*

$$\text{Contribution} = \text{sales value} - \text{variable costs}$$

> Variable costs are sometimes referred to as marginal costs and the two terms are often used interchangeably.

Contribution is so called because it literally does contribute towards fixed costs and profit. Once the contribution from a product or service has been calculated, the fixed costs associated with the product or service can be deducted to determine the profit for the period.

4.2.2 Calculating the breakeven point

As sales revenues grow from zero, the contribution also grows until it just covers the fixed costs. This is the breakeven point where neither profits nor losses are made.

It follows that to break even the amount of contribution must exactly match the amount of fixed costs. If we know how much contribution is earned from each unit sold, then we can calculate the number of units required to break even as follows:

$$\text{Breakeven point in units} = \frac{\text{Fixed costs}}{\text{Contribution per unit}}$$

For example, suppose that an organisation manufactures a single product, incurring variable costs of £30 per unit and fixed costs of £20,000 per month. If the product sells for £50 per unit, then the breakeven point can be calculated as follows:

$$\text{Breakeven point in units} = \frac{£20{,}000}{£50 - £30} = 1{,}000 \text{ units per month}$$

4.3 The margin of safety

> The margin of safety is the difference between the expected level of sales and the breakeven point. The larger the margin of safety, the more likely it is that a profit will be made, that is, if sales start to fall there is more leeway before the organization begins to incur losses. (Obviously, this statement is made on the assumption that projected sales volumes are above the breakeven point.)
>
> In the above example, if forecast sales are 1,700 units per month, the margin of safety can be easily calculated.

$$\begin{aligned}\text{Margin of safety} &= \text{projected sales} - \text{breakeven point}\\ &= 1{,}700 \text{ units} - 1{,}000 \text{ units}\\ &= 700 \text{ units per month, or } 41\% \text{ of sales } (700/1{,}700 \times 100\%)\end{aligned}$$

The margin of safety should be expressed as a percentage of projected sales to put it in perspective. To quote a margin of safety of 700 units without relating it to the projected sales figure is not giving the full picture.

The margin of safety can also be used as one route to a profit calculation. We have seen that the contribution goes towards fixed costs and profit. Once breakeven point is reached the fixed costs have been covered. After the breakeven point there are no more fixed costs to be covered and all of the contribution goes towards making profits grow.

In our example, the monthly profit from sales of 1,700 units would be £14,000.

$$\begin{aligned}\text{Margin of safety} &= 700 \text{ units per month}\\ \text{Monthly profit} &= 700 \times \text{contribution per unit}\\ &= 700 \times £20\\ &= £14{,}000.\end{aligned}$$

4.4 The contribution to sales (C/S) ratio

The contribution to sales ratio is usually expressed as a percentage. It can be calculated for the product in our example as follows.

$$\begin{aligned}\text{Contribution to sales ratio (C/S ratio)} &= £20\,/\,£50 \times 100\%\\ &= 40\%\end{aligned}$$

A higher contribution to sales ratio means that contribution grows more quickly as sales levels increase. Once the breakeven point has been passed, profits will accumulate more quickly than for a product with a lower contribution to sales ratio.

You might sometimes see this ratio referred to as the profit–volume (P/V) ratio.

If we can assume that a unit's variable cost and selling price remain constant then the C/S ratio will also remain constant. It can be used to calculate the breakeven point as follows (using the data from the earlier example):

$$\text{Breakeven point in sales value} = \frac{\text{Fixed costs}}{\text{C/S ratio}} = \frac{£20{,}000}{0.40} = £50{,}000$$

This can be converted to 1,000 units as before by dividing by the selling price of £50 per unit.

Exercise 4.1

A company manufactures and sells a single product which has the following cost and selling price structure:

	£/unit	*£/unit*
Selling price		120
Direct material	22	
Direct labour	36	
Variable overhead	14	
Fixed overhead	12	
		84
Profit per unit		36

The fixed overhead absorption rate is based on the normal capacity of 2,000 units per month. Assume that the same amount is spent each month on fixed overheads.

Budgeted sales for next month are 2,200 units.

You are required to calculate:

(i) the breakeven point, in sales units per month;
(ii) the margin of safety for next month;
(iii) the budgeted profit for next month;
(iv) the sales required to achieve a profit of £96,000 in a month.

Solution

(i) The key to calculating the breakeven point is to determine the contribution per unit.

$$\text{Contribution per unit} = £120 - (£22 + £36 + £14) = £48$$

$$\text{Breakeven point} = \frac{\text{Fixed overhead}}{\text{Contribution per unit}} = \frac{£12 \times 2{,}000}{£48} = 500 \text{ units}$$

(ii) Margin of safety = budgeted sales − breakeven point
= 2,200 − 500
= 1,700 units (or 1,700 / 2,2000 × 100% = 77% of budgeted sales)

(iii) Once breakeven point has been reached, all of the contribution goes towards profits because all of the fixed costs have been covered.

Budgeted profit = 1,700 units margin of safety × £48 Contribution per unit
= £81,600

(iv) To achieve the desired level of profit, sufficient units must be sold to earn a contribution which covers the fixed costs and leaves the desired profit for the month.

$$\text{Number of sales units required} = \frac{\text{Fixed overhead} + \text{desired profit}}{\text{Contribution per unit}} = \frac{(£12 \times 2{,}000) + £96{,}000}{£48} = 2{,}500 \text{ units.}$$

4.5 Drawing a basic breakeven chart

A basic breakeven chart records costs and revenues on the vertical axis and the level of activity on the horizontal axis. Lines are drawn on the chart to represent costs and sales revenue. The breakeven point can be read off where the sales revenue line cuts the total cost line.

We will use our basic example to demonstrate how to draw a breakeven chart. The data is:

Selling price	£50 per unit
Variable cost	£30 per unit
Fixed costs	£20,000 per month
Forecast sales	1,700 units per month

> ! While you will not be required to draw a graph to scale in the assessment, you may need to do so in your working life or in future examinations for other subjects. Learning to draw a chart to scale will provide a firm foundation for your understanding of breakeven charts. To give yourself some practice, it would be a good idea to follow the step-by-step guide which follows to produce your own chart on a piece of graph paper.

- *Step 1. Select appropriate scales for the axes and draw and label them.* Your graph should fill as much of the page as possible. This will make it clearer and easier to read. You can make sure that you do this by putting the extremes of the axes right at the end of the available space.

  The furthest point on the vertical axis will be the monthly sales revenue, that is,

  1,700 units × £50 = £85,000

  The furthest point on the horizontal axis will be monthly sales volume of 1,700 units.

  Make sure that you do not need to read data for volumes higher than 1,700 units before you set these extremes for your scales.
- *Step 2. Draw the fixed cost line and label it.* This will be a straight line parallel to the horizontal axis at the £20,000 level.

  The £20,000 fixed costs are incurred in the short term even with zero activity.
- *Step 3. Draw the total cost line and label it.* The best way to do this is to calculate the total costs for the maximum sales level, which is 1,700 units in our example. Mark this point on the graph and join it to the cost incurred at zero activity, that is, £20,000.

	£
Variable costs for 1,700 units (1,700 × £30)	51,000
Fixed costs	20,000
Total cost for 1,700 units	71,000

- *Step 4. Draw the revenue line and label it.* Once again, the best way is to plot the extreme points. The revenue at maximum activity in our example is 1,700 × £50 = £85,000. This point can be joined to the origin, since at zero activity there will be no sales revenue.
- *Step 5. Mark any required information on the chart and read off solutions as required.* Check that your chart is accurate by reading off the measures that we have already calculated in this chapter: the breakeven point, the margin of safety, the profit for sales of 1,700 units.

The completed graph is shown in Figure 4.1.

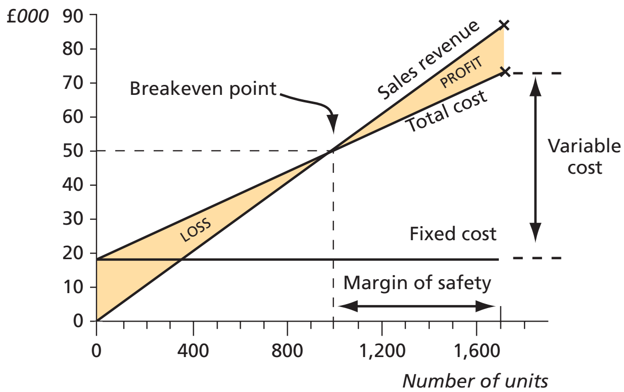


Figure 4.1 Basic breakeven chart

Your own graph should be considerably larger than this: a full A4 graph-ruled sheet is recommended to facilitate ease of interpretation.

4.6 The contribution breakeven chart

One of the problems with the conventional or basic breakeven chart is that it is not possible to read contribution directly from the chart. A contribution breakeven chart is based on the same principles but it shows the variable cost line instead of the fixed cost line (Figure 4.2). The same lines for total cost and sales revenue are shown so the breakeven point and profit can be read off in the same way as with a conventional chart. However, it is possible also to read the contribution for any level of activity.

Using the same basic example as for the conventional chart, the total variable cost for an output of 1,700 units is 1,700 × £30 = £51,000. This point can be joined to the origin since the variable cost is nil at zero activity.

The contribution can be read as the difference between the sales revenue line and the variable cost line.

This form of presentation might be used when it is desirable to highlight the importance of contribution and to focus attention on the variable costs.

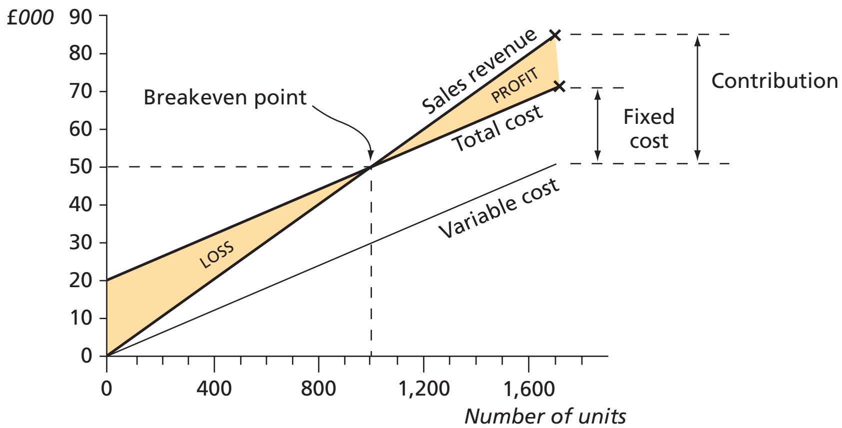


Figure 4.2 Contribution breakeven chart

4.7 The profit–volume chart

Another form of breakeven chart is the profit–volume chart. This chart plots a single line depicting the profit or loss at each level of activity. The breakeven point is where this line cuts the horizontal axis. A profit–volume graph for our example will look like Figure 4.3.

The vertical axis shows profits and losses and the horizontal axis is drawn at zero profit or loss.

At zero activity the loss is equal to £20,000, that is, the amount of fixed costs. The second point used to draw the line could be the calculated breakeven point or the calculated profit for sales of 1,700 units.

The profit–volume graph is also called a profit graph or a contribution–volume graph.

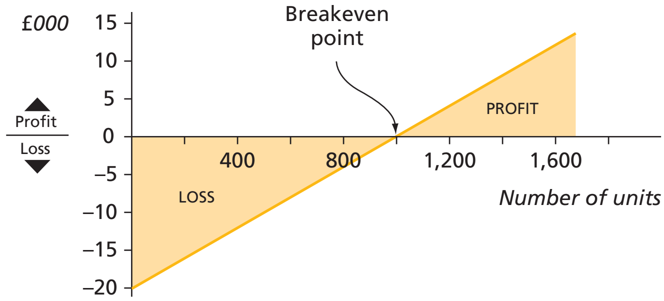


Figure 4.3 Profit–volume chart

Exercise 4.2

Make sure that you are clear about the extremes of the profit–volume chart axes. Practise drawing the chart to scale on a piece of graph paper.

4.7.1 The advantage of the profit–volume chart

The main advantage of the profit–volume chart is that it is capable of depicting clearly the effect on profit and breakeven point of any changes in the variables. An example will show how this can be done.

Example

A company manufactures a single product which incurs fixed costs of £30,000 per annum. Annual sales are budgeted to be 70,000 units at a sales price of £30 per unit. Variable costs are £28.50 per unit.

(a) Draw a profit–volume graph, and use it to determine the breakeven point.

The company is now considering improving the quality of the product and increasing the selling price to £35 per unit. Sales volume will be unaffected, but fixed costs will increase to £45,000 per annum and variable costs to £33 per unit.

(b) Draw, on the same graph as for part (a), a second profit–volume graph and comment on the results.

Solution

The profit–volume chart is shown in Figure 4.4.

The two lines have been drawn as follows:

- *Situation (a).* The profit for sales of 70,000 units is £75,000.

	£000
Contribution 70,000 × £(30 − 28.50)	105
Fixed costs	30
Profit	75

This point is joined to the loss at zero activity, £30,000, that is, the fixed costs.

- *Situation (b).* The profit for sales of 70,000 units is £95,000.

	£000
Contribution 70,000 × £(35 − 33)	140
Fixed costs	45
Profit	95

This point is joined to the loss at zero activity, £45,000, that is, the fixed costs.

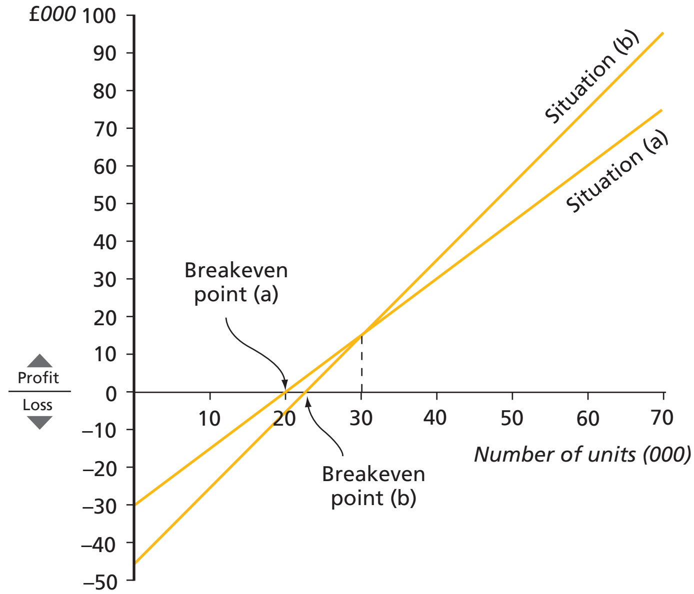


Figure 4.4 Showing changes with a profit–volume chart

Comment on the results. The graph depicts clearly the larger profits available from option (b). It also shows that the breakeven point increases from 20,000 units to 22,500 units but that this is not a large increase when viewed in the context of the projected sales volume. It is also possible to see that for sales volumes above 30,000 units the profit achieved will be higher with option (b). For sales volumes below 30,000 units option (a) will yield higher profits (or lower losses).

The profit–volume graph is the clearest way of presenting information like this. If we attempted to draw two conventional breakeven charts on one set of axes the result would be a jumble, which is very difficult to interpret.

4.8 The limitations of breakeven (or CVP) analysis

The limitations of the practical applicability of breakeven analysis and breakeven charts stem mostly from the assumptions which underlie the analysis:

(a) Costs are assumed to behave in a linear fashion. Unit variable costs are assumed to remain constant and fixed costs are assumed to be unaffected by changes in activity levels. The charts can in fact be adjusted to cope with non-linear variable costs or steps in fixed costs but too many changes in behaviour patterns can make the charts very cluttered and difficult to use.
(b) Sales revenues are assumed to be constant for each unit sold. This may be unrealistic because of the necessity to reduce the selling price to achieve higher sales volumes. Once again the analysis can be adapted for some changes in selling price but too many changes can make the charts unwieldy.
(c) It is assumed that activity is the only factor affecting costs, and factors such as inflation are ignored. This is one of the reasons why the analysis is limited to being essentially a short-term decision aid.
(d) Apart from the unrealistic situation of a constant product mix, the charts can only be applied to a single product or service. Not many organisations have a single product or service and if there is more than one, then the apportionment of fixed costs between them becomes arbitrary.

(e) The analysis seems to suggest that as long as the activity level is above the breakeven point, then a profit will be achieved. In reality certain changes in the cost and revenue patterns may result in a second breakeven point after which losses are made. This situation will be depicted in the next section of this chapter.

4.9 The economist's breakeven chart

An economist would probably depict a breakeven chart as shown in Figure 4.5.

The total cost line is not a straight line which climbs steadily as in the accountant's chart. Instead it begins to reduce initially as output increases because of the effect of economies of scale. Later it begins to climb upwards according to the law of diminishing returns.

The revenue line is not a straight line as in the accountant's chart. The line becomes less steep to depict the need to give discounts to achieve higher sales volumes.

However, you will see that within the middle range the economist's chart does look very similar to the accountant's breakeven chart. This area is marked as the relevant range in Figure 4.5.

For this reason, it is unreliable to assume that the cost–volume–profit relationships depicted in breakeven analysis are relevant across a wide range of activity. In particular, Figure 4.5 shows that the constant cost and price assumptions are likely to be unreliable at very high or very low levels of activity. Managers should therefore ensure that they work within the relevant range, that is, within the range over which the depicted cost and revenue relationships are more reliable.

> **!** You may recall that we discussed the relevant range in the context of cost behaviour patterns in Chapter 1.

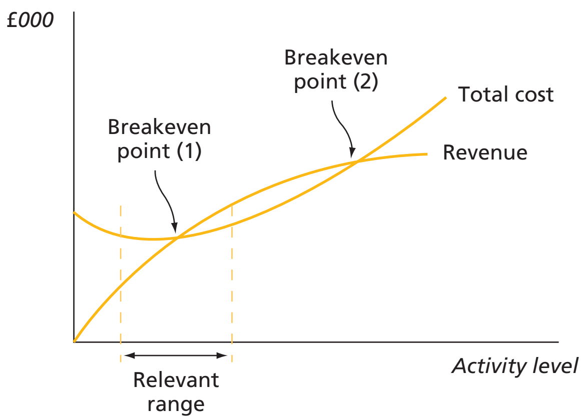


Figure 4.5 The economist's breakeven chart

4.10 Using CVP analysis to evaluate proposals

Use your understanding of breakeven analysis and cost behaviour patterns to evaluate the proposals in the following exercise.

Exercise 4.3

A summary of a manufacturing company's budgeted profit statement for its next financial year, when it expects to be operating at 75 per cent of capacity, is given below.

	£	£
Sales 9,000 units at £32		288,000
Less:		
direct materials	54,000	
direct wages	72,000	
production overhead – fixed	42,000	
– variable	18,000	
		186,000
Gross profit		102,000
Less: admin., selling and dist'n costs:		
– fixed	36,000	
– varying with sales volume	27,000	
		63,000
Net profit		39,000

It has been estimated that:

(i) if the selling price per unit were reduced to £28, the increased demand would utilise 90 per cent of the company's capacity without any additional advertising expenditure;
(ii) to attract sufficient demand to utilise full capacity would require a 15 per cent reduction in the current selling price and a £5,000 special advertising campaign.

You are required to:

(a) calculate the breakeven point in units, based on the original budget;
(b) calculate the profits and breakeven points which would result from each of the two alternatives and compare them with the original budget.

Solution

(a) First calculate the current contribution per unit.

	£000	*£000*
Sales revenue		288
Direct materials	54	
Direct wages	72	
Variable production overhead	18	
Variable administration etc.	27	
		171
Contribution		117
Contribution per unit (÷9,000 units)		£13

Now you can use the formula to calculate the breakeven point.

$$\text{Breakeven point} = \frac{\text{Fixed costs}}{\text{Contribution per unit}} = \frac{£42{,}000 + £36{,}000}{£13} = 6{,}000 \text{ units}$$

(b) *Alternative (i)*

Budgeted contribution per unit	£13
Reduction in selling price (£32 − £28)	£4
Revised contribution per unit	£9
Revised breakeven point = £78,000/£9	8,667 units
Revised sales volume = 9,000 × (90/75)	10,800 units
Revised contribution = 10,800 × £9	£97,200
Less fixed costs	£78,000
Revised profit	£19,200

Alternative (ii)

Budgeted contribution per unit	£13.00
Reduction in selling price (15% × £32)	£4.80
Revised contribution per unit	£8.20
Revised breakeven point $= \dfrac{£78{,}000 + £5{,}000}{£8.20}$	10,122 units
Revised sales volume = 9,000 units × (100/75)	12,000 units
Revised contribution = 12,000 × £8.20	£98,400
Less fixed costs	£83,000
Revised profit	£15,400

Neither of the two alternative proposals is worthwhile. They both result in lower forecast profits. In addition, they will both increase the breakeven point and will therefore increase the risk associated with the company's operations.

This exercise has shown you how an understanding of cost behaviour patterns and the manipulation of contribution can enable the rapid evaluation of the financial effects of a proposal. We can now expand it to demonstrate another aspect of the application of CVP analysis to short-term decision-making.

Exercise 4.4

The manufacturing company decided to proceed with the original budget and has asked you to determine how many units must be sold to achieve a profit of £45,500.

Solution

Once again, the key is the required contribution. This time the contribution must be sufficient to cover both the fixed costs and the required profit. If we then divide this amount by the contribution earned from each unit, we can determine the required sales volume.

$$\text{Required sales} = \frac{\text{Fixed costs} + \text{required profit}}{\text{Contribution per unit}}$$

$$= \frac{(£42{,}000 + £36{,}000 + £45{,}500)}{£13} = 9{,}500 \text{ units}$$

4.11 Limiting factor analysis

A limiting factor is any factor which is in scarce supply and which stops the organisation from expanding its activities further, that is, it limits the organisation's activities.

The limiting factor for many trading organisations is sales volume because they cannot sell as much as they would like. However, other factors may also be limited, especially in the short term. For example, machine capacity or the supply of skilled labour may be limited for one or two periods until some action can be taken to alleviate the shortage.

The concept of contribution can be used to make decisions about the best use of a limited resource.

4.11.1 Decisions involving a single limiting factor

If an organisation is faced with a single limiting factor, for example machine capacity, then it must ensure that a production plan is established which maximises the profit from the use of the available capacity. Assuming that fixed costs remain constant, this is the same as saying that the contribution must be maximised from the use of the available capacity. The machine capacity must be allocated to those products which earn the most contribution per machine hour.

This decision rule can be stated as 'maximising the contribution per unit of limiting factor'.

Example

LMN Ltd manufactures three products L, M and N. The company which supplies the two raw materials which are used in all three products has informed LMN that their employees are refusing to work overtime. This means that supply of the materials is limited to the following quantities for the next period:

Material A	1,030 kg
Material B	1,220 kg

No other source of supply can be found for the next period.
Information relating to the three products manufactured by LMN Ltd is as follows:

	L	*M*	*N*
Quantity of material used per unit manufactured:			
Material A (kg)	2	1	4
Material B (kg)	5	3	7
Maximum sales demand (units)	120	160	110
Contribution per unit sold	£15	£12	£17.50

Owing to the perishable nature of the products, no finished goods are held.

Requirements

(a) Recommend a production mix which will maximise the profits of LMN Ltd for the forthcoming period.
(b) LMN Ltd has a valued customer to whom they wish to guarantee the supply of 50 units of each product next period. Would this alter your recommended production plan?

Solution

(a) The first step is to check whether the supply of each material is adequate or whether either or both of them represent a limiting factor.

	L	*M*	*N*	*Total*
Maximum sales demand (units)	120	160	110	
Material A required per unit (kg)	2	1	4	
Total material A required (kg)	240	160	440	840
Material B required per unit (kg)	5	3	7	
Total material B required (kg)	600	480	770	1,850

There will be sufficient material A to satisfy the maximum demand for the products but material B will be a limiting factor.

The next step is to rank the products in order of their contribution per unit of limiting factor. The available material B can then be allocated according to this ranking.

	L	*M*	*N*
Contribution per unit sold	£15	£12	£17.50
Material B consumed (kg)	5	3	7
Contribution per kg of material B	£3	£4	£2.50
Ranking	2	1	3

The available material B will be allocated to the products according to this ranking, to give the optimum production plan for the next period.

Product	*Recommended production (units)*	*Material B utilised (kg)*
M	160 (maximum)	480
L	120 (maximum)	600
N	20	140 (balance)
		1,220

The available material B is allocated to satisfy the maximum market demand for products M and L. The balance of available material is allocated to the last product in the ranking, product N.

(b) The recommended production plan in part (a) does not include sufficient product N to satisfy the requirement of 50 units for the valued customer. Some of the material allocated to product L (second in the ranking) must be allocated to product N. The recommended production plan will now be as follows:

Product	*Recommended production (units)*	*Material B utilised (kg)*
N	50	350
M	160	480
L	78	390 (balance)
		1,220

This recommendation makes the best use of the available material B within the restriction of the market requirements for each product.

The identification of a limiting factor and the ranking of products to maximise contribution has been a favourite topic in the multiple-choice questions on past papers. Make sure that you are well prepared in case this topic comes up in your assessment.

Exercise 4.5

Gill Ltd manufactures three products E, F and G. The products are all finished on the same machine. This is the only mechanised part of the process. During the next period the production manager is planning an essential major maintenance overhaul of the machine. This will restrict the available machine hours to 1,400 hours for the next period. Data for the three products are:

	Product E £ per unit	*Product F £ per unit*	*Product G £ per unit*
Selling price	30	17	21.00
Variable cost	13	6	9.00
Fixed production cost	10	8	6.00
Other fixed cost	2	1	3.50
Profit	5	2	2.50
Maximum demand (units/period)	250	140	130

No inventories are held.

Fixed production costs are absorbed using a machine hour rate of £2 per machine hour.

You are required to determine the production plan that will maximise profit for the forthcoming period.

Solution

The first step is to calculate how many machine hours are required for each product. We can then determine whether machine hours are really a limiting factor.

	Product E	*Product F*	*Product G*	*Total*
Fixed production cost per unit @ £2 per hour	£10	£8	£6	
Machine hours per unit	5	4	3	
Maximum demand (units)	250	140	130	
Maximum hours required	1,250	560	390	2,200

Since 2,200 machine hours are required and only 1,400 hours are available, machine hours are a limiting factor.

The optimum production plan is the plan which maximises the *contribution* from the *limiting factor*.

Do not make the common mistake of allocating the available hours according to the profit per unit of product or according to the profit per hour.

The next step is to calculate the contribution per hour from each of the products.

	Product E	*Product F*	*Product G*
	£	£	£
Selling price per unit	30	17	21
Variable cost per unit	13	6	9
Contribution per unit	17	11	12
Machine hours per unit	5	4	3
Contribution per hour	£3.40	£2.75	£4.00
Ranking	2	3	1

The available hours can be allocated according to this ranking.

	Units to be produced	*Machine hours required*
Product G (maximum demand)	130	390
Product E (balance of hours)	202	1,010
		1,400

4.12 Summary

Having read this chapter the main points that you should understand are as follows.

1. Cost–volume–profit (CVP) analysis is the study of the effect on profit of changes in costs and sales price, quantity and mix. Another common term used in this context is 'breakeven analysis'.
2. Contribution is calculated as sales value minus variable cost.
3. The ratio of a cost unit's contribution to its selling price is usually assumed to be constant. This ratio may be referred to as the contribution to sales (C/S) ratio or the profit−volume (P/V) ratio, both of which are usually expressed as a percentage.
4. The breakeven point can be calculated as (fixed costs/contribution per unit) or (fixed costs/PV ratio).
5. The margin of safety is the difference between the expected level of sales and the breakeven point. It may be expressed as a percentage of the expected sales.
6. Contribution required to achieve a target profit = fixed costs + target profit.
7. A breakeven chart is a pictorial representation of costs and revenues depicting the profit or loss for the relevant range of activity.
8. A contribution breakeven chart shows the variable cost line instead of the fixed cost line, so that contribution can be read directly from the chart.
9. A profit–volume (PV) chart depicts a single line indicating the profit or loss for the relevant range of activity. It is particularly useful for demonstrating the effect on profit of changes in costs or revenues.
10. Breakeven or CVP analysis has a number of limitations and managers should be aware of these if they are to apply the technique effectively.
11. A limiting factor is any factor which is in scarce supply and stops the organisation from expanding its activities further. The decision rule in this situation is to maximise the contribution per unit of limiting factor.

Revision Questions 4

Question 1 Multiple choice

1.1 A Ltd has fixed costs of £60,000 per annum. It manufactures a single product which it sells for £20 per unit. Its contribution to sales ratio is 40 per cent.

A Ltd's breakeven point in units is:

(A) 1,200
(B) 3,000
(C) 5,000
(D) 7,500.

1.2 B Ltd manufactures a single product which it sells for £9 per unit. Fixed costs are £54,000 per month and the product has a variable cost of £6 per unit.

In a period when actual sales were £180,000, B Ltd's margin of safety, in units, was:

(A) 2,000
(B) 14,000
(C) 18,000
(D) 20,000.

1.3 For the forthcoming year, E plc's variable costs are budgeted to be 60 per cent of sales value and fixed costs are budgeted to be 10 per cent of sales value.

If E plc increases its selling prices by 10 per cent, but if fixed costs, variable costs per unit and sales volume remain unchanged, the effect on E plc's contribution would be:

(A) a decrease of 2 per cent.
(B) an increase of 5 per cent.
(C) an increase of 10 per cent.
(D) an increase of 25 per cent.

1.4 An organisation currently provides a single service. The cost per unit of that service is as follows:

	£
Selling price	130
Direct materials	22
Direct labour	15
Direct expenses	3
Variable overheads	10
Total variable cost	50

Total fixed costs for the period amount to £1,600,000. How many units of service (to the nearest whole unit) will the organisation need to provide to customers to generate a profit of £250,000?

(A) 20,000
(B) 20,555
(C) 23,125
(D) 26,428.

1.5 P Ltd provides plumbing services. Due to a shortage of skilled labour next period the company is unable to commence all the plumbing jobs for which customers have accepted estimates.

When deciding which plumbing jobs should be commenced, the jobs should be ranked according to the:

(A) Contribution to be earned from each job.
(B) Profit to be earned from each job.
(C) Contribution to be earned per hour of skilled labour on each job.
(D) Profit to be earned per hour of skilled labour on each job.

1.6 Z Ltd manufactures three products, the selling price and cost details of which are given below:

	Product X	*Product Y*	*Product Z*
	£	£	£
Selling price per unit	75	95	95
Costs per unit:			
Direct materials (£5/kg)	10	5	15
Direct labour (£8/hour)	16	24	20
Variable overhead	8	12	10
Fixed overhead	24	36	30

In a period when direct materials are restricted in supply, the most and the least profitable uses of direct materials are:

	Most profitable	*Least profitable*
(A)	X	Z
(B)	Y	Z
(C)	Z	Y
(D)	Y	X

Question 2 Short objective-test questions

2.1 OT Ltd plans to produce and sell 4,000 units of product C each month, at a selling price of £18 per unit. The unit cost of product C is as follows:

	£ per unit
Variable cost	8
Fixed cost	4
	12

To the nearest whole number, the monthly margin of safety, as a percentage of planned sales is ☐%.

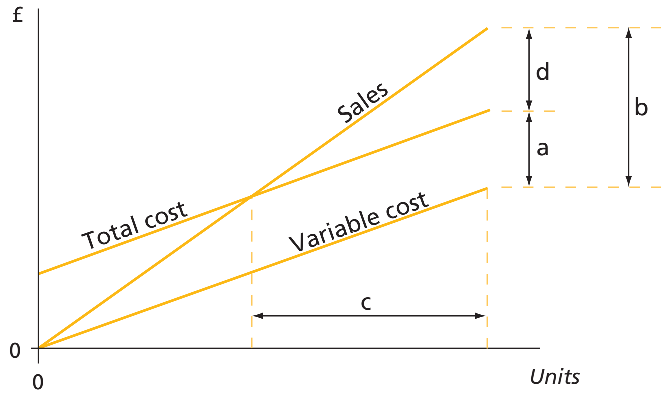
2.2 The P/V ratio is the ratio of profit generated to the volume of sales.

True ☐
False ☐

2.3 Product J generates a contribution to sales ratio of 30 per cent. Fixed costs directly attributable to product J amount to £75,000 per month. The sales revenue required to achieve a monthly profit of £15,000 is £ ☐.

2.4 Match the following terms with the labels **a** to **d** on the graph. Write a, b, c or d in the relevant boxes.

☐ Margin of safety
☐ Fixed cost
☐ Contribution
☐ Profit



2.5 Select *true* or *false* for each of the following statements about a profit–volume chart.

(a) The profit line passes through the origin.

True ☐
False ☐

(b) Other things being equal, the angle of the profit line becomes steeper when the selling price increases.

True ☐
False ☐

(c) Contribution cannot be read directly from the chart.

True ☐
False ☐

(d) The point where the profit line crosses the vertical axis is the breakeven point.

True ☐
False ☐

(e) Fixed costs are shown as a line parallel to the horizontal axis.

True ☐
False ☐

(f) The angle of the profit line is directly affected by the P/V ratio.

True ☐
False ☐

2.6 PH Ltd has spare capacity in its factory. A supermarket chain has offered to buy a number of units of product XZ each month, and this would utilise the spare capacity. The supermarket is offering a price of £8 per unit and the cost structure of XZ is as follows:

	£ per unit
Direct material	3
Direct labour	2
Variable overhead	1
Fixed overhead	3
	9

Fixed costs would not be affected.
On a purely financial basis, should the supermarket's offer be accepted or rejected?

Accept the offer ☐
Reject the offer ☐

2.7 The following tasks are undertaken when deciding on the optimum production plan when a limiting factor exists. Write 1, 2, 3 or 4 in the boxes to indicate the correct sequence of tasks.

☐ Rank the products according to the contribution per unit of limiting factor used.
☐ Calculate each product's contribution per unit of limiting factor used.
☐ Identify the limiting factor.
☐ Allocate the limited resource according to the ranking.

2.8 A manufacturer of cell phones is considering the following actions. Which of these is likely to increase the manufacturer's C/S (contribution/sales) ratio (tick all that apply)?

(i) ☐ taking advantage of quantity discounts for bulk purchases of material;
(ii) ☐ introducing training programmes designed to improve labour efficiency;
(iii) ☐ following the actions of a competitor who has cut prices substantially;
(iv) ☐ reducing exports to countries where there is intense price competition;
(v) ☐ offering retailers a lower price if they display the product more prominently.

? **Question 3** Profit statements and breakeven analysis

BSE Veterinary Services is a specialist laboratory carrying out tests on cattle to ascertain whether the cattle have any infection. At present, the laboratory carries out 12,000 tests each period but, because of current difficulties with the beef herd, demand is expected to increase to 18,000 tests a period, which would require an additional shift to be worked.

The current cost of carrying out a full test is:

	£ per test
Materials	115
Technicians' wages	30
Variable overhead	12
Fixed overhead	50

Working the additional shift would:

(i) require a shift premium of 50 per cent to be paid to the technicians on the additional shift;
(ii) enable a quantity discount of 20 per cent to be obtained for all materials if an order was placed to cover 18,000 tests;
(iii) increase fixed costs by £700,000 per period.

The current fee per test is £300.

Requirements

(a) The profit for the period at the current capacity of 12,000 tests is £ ☐.
(b) A framework for a profit statement if the additional shift was worked and 18,000 tests were carried out is as follows (complete the boxes to derive the period profit):

	£000
(i) Sales	☐
(ii) Direct materials	☐
(iii) Direct labour	☐
(iv) Variable overhead	☐
(v) Fixed costs	☐
(vi) Profit	☐

(c) It has been determined that for a capacity of 15,000 tests per period, the test fee would be £300. Variable costs per test would amount to £140, and period fixed costs would be £1,200,000. The breakeven number of tests at this capacity level is ☐ tests.

? Question 4 Profit–volume graphs

MC Limited manufactures one product only, and for the last accounting period has produced the simplified income statement below:

	£	£
Sales		300,000
Costs:		
Direct materials	60,000	
Direct wages	40,000	
Prime cost	100,000	
Variable production overhead	10,000	
Fixed production overhead	40,000	
Fixed administration overhead	60,000	
Variable selling overhead	40,000	
Fixed selling overhead	20,000	
		270,000
Net profit		30,000

Requirements

(a) A profit–volume graph is to be drawn for MC Ltd's product.

(i) The profit line drawn on the graph would cut the vertical axis (y-axis) at the point where y is equal to £ ☐.

(ii) The profit line drawn on the graph would cut the horizontal axis (x-axis) at the point where x is equal to £ ☐.

(iii) The margin of safety indicated by the graph would be £ ☐.

(b) The effect of various changes in variables is to be indicated separately on the profit–volume graph. For each change, indicate whether the angle of the profit line and the breakeven point will increase, decrease or remain unchanged.

	The angle of the profit line will:		
Variable changed	*Increase*	*Decrease*	*Remain unchanged*
(i) Increase in selling price	☐	☐	☐
(ii) Increase in fixed cost	☐	☐	☐
(iii) Decrease in variable cost per unit	☐	☐	☐

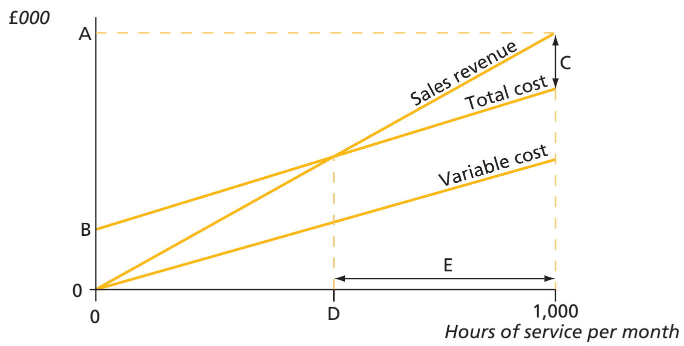
	The breakeven point will:		
	Increase	*Decrease*	*Remain unchanged*
(i) Increase in selling price	☐	☐	☐
(ii) Increase in fixed cost	☐	☐	☐
(iii) Decrease in variable cost per unit	☐	☐	☐

Question 5 Breakeven charts

The following data is available concerning HF Ltd's single service Q.

	£ per hour of service	*£ per hour of service*
Selling price		50
Variable cost		
Direct material	7	
Direct labour	8	
Variable overhead	5	
		20
Contribution		30
Fixed overhead		15
Profit		15

1,000 hours of service Q are provided to customers each month.



Requirements

The management accountant of HF Ltd has prepared the above contribution breakeven chart for service Q:

The values or quantities indicated by A to E on the chart are:

A £ ____
B £ ____
C £ ____
D ____ hours
E ____ hours

Question 6 Decision-making, limiting factor

ABC Ltd makes three products, all of which use the same machine, which is available for 50,000 hours per period.

The standard costs of the product, per unit, are:

	Product A	*Product B*	*Product C*
	£	£	£
Direct materials	70	40	80
Direct labour:			
Machinists (£8/hour)	48	32	56
Assemblers (£6/hour)	36	40	42
Total variable cost	154	112	178
Selling price per unit	200	158	224
Maximum demand (units)	3,000	2,500	5,000

Fixed costs are £300,000 per period.

Requirements

(a) The deficiency in machine hours for the next period is ____ hours.

(b) The optimum production plan that will maximise ABC Ltd's profit for the next period is:

Product A ____ units
Product B ____ units
Product C ____ units.

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Solutions to Revision Questions

4

Solution 1

- Question 1.3 is quite tricky. Try setting up a table of the selling price, variable cost and contribution before and after the change, perhaps using a selling price of £100. Remember that fixed costs are not relevant because they do not affect contribution.

1.1 Answer: (D)

$$\text{Contribution per unit} = 40\% \text{ of selling price} = £8$$

$$\text{Breakeven point} = \frac{£60{,}000}{£8} = 7{,}500 \text{ units}$$

1.2 Answer: (A)

$$\text{Contribution per unit} = £9 - £6 = £3$$

$$\text{Breakeven point} = \frac{\text{Fixed costs}}{\text{Contribution per unit}} = \frac{£54{,}000}{£3} = 18{,}000 \text{ units}$$

$$\text{Margin of safety} = \text{Actual sales} - \text{breakeven sales} = \frac{£180{,}000}{£9} - 18{,}000$$
$$= 2{,}000 \text{ units}$$

1.3 Answer: (D)
Fixed costs are not relevant because they do not affect contribution. Taking a selling price of, say, £100 per unit, the cost structures will look like this:

	Before change *£ per unit*		*After change* *£ per unit*
Sales price	100	+10%	110
Variable cost	60		60
Contribution	40		50

Contribution per unit increases by 25 per cent. If sales volume remains unchanged then total contribution will also increase by 25 per cent.

1.4 Answer: (C)

$$\frac{£1{,}600{,}000 + £250{,}000}{£80} = 23{,}125 \text{ units}$$

Working:

Contribution per unit	£
Selling price	130
Variable cost	(50)
Contribution/unit	80

1.5 Answer: (C)
The decision rule in a limiting factor situation is to maximise the contribution per unit of limiting factor.

1.6 Answer: (B)

Product	*X*	*Y*	*Z*
Contribution/unit	£41	£54	£50
Materials (kg/unit)	2	1	3
Contribution/kg	£20.50	£54	£16.66
Ranking	2	1	3

Solution 2

2.1 Monthly fixed costs = 4,000 units × £4 = £16,000.

$$\text{Breakeven point} = \frac{\text{Fixed costs}}{\text{Contribution per unit}} = \frac{£16{,}000}{£18 - £8} = 1{,}600 \text{ units}$$

$$\text{Margin of safety \%} = \frac{\text{Planned sales} - \text{breakeven sales}}{\text{Planned sales}} \times 100\%$$
$$= \frac{4{,}000 - 1{,}600}{4{,}000} \times 100\% = 60\%.$$

2.2 *False*. The P/V ratio is another term for the C/S ratio. It measures the ratio of the contribution to sales.

2.3 $$\text{Required sales revenue} = \frac{\text{Required contribution}}{\text{C/S ratio}} = \frac{£75{,}000 + £15{,}000}{0.30}$$
$$= £300{,}000.$$

2.4 **c** Margin of safety
a Fixed cost
b Contribution
d Profit.

2.5 (a) *False*. The profit line passes through the breakeven point on the horizontal axis, and cuts the vertical axis at the point where the loss is equal to the fixed costs.
(b) *True*. Profits increase at a faster rate if the selling price is higher.
(c) *True*. A contribution breakeven chart is needed for this.
(d) *False*. The breakeven point is where the profit line cuts the horizontal axis.
(e) *False*. No fixed cost line is shown on a profit–volume chart.
(f) *True*. The higher the P/V ratio or contribution to sales ratio, the higher will be the contribution earned per £ of sale and the steeper will be the angle of the profit line.

2.6 *Accept the offer.* On a purely financial basis, the price of £8 per unit exceeds the variable cost of £6 per unit. Since the fixed cost would not be affected, the units sold to the supermarket will each earn a contribution of £2.

2.7
1. Identify the limiting factor.
2. Calculate each product's contribution per unit of limiting factor used.
3. Rank the products according to the contribution per unit of limiting factor used.
4. Allocate the limited resource according to the ranking.

2.8 (i), (ii) and (iv) will increase the contribution/sales ratio.

(i) Lower variable costs per unit, higher contribution per unit = higher C/S ratio
(ii) Lower variable costs per unit, higher contribution per unit = higher C/S ratio
(iii) Lower selling price per unit, lower contribution per unit = lower C/S ratio
(iv) Higher average contribution per unit = higher C/S ratio
(v) Lower selling price per unit, lower contribution per unit = lower C/S ratio

Solution 3

- In part (b) do not be tempted to use unit rates to calculate the new level of fixed costs. The current level of fixed costs is £600,000 *per period*. This will increase by £700,000.
- Also in part (b), notice that the shift premium applies only to the technicians working on the additional shift. It does not apply to all technicians' wages.

(a) £1,116,000
Workings: profit statement for current 12,000 capacity

		£000
Sales	12,000 tests @ £300/test	3,600
Direct materials	12,000 tests @ £115/test	(1,380)
Direct labour	12,000 tests @ £30/test	(360)
Variable overhead	12,000 tests @ £12/test	(144)
Contribution		1,716
Fixed costs	12,000 tests @ £50/test	(600)
Profit		1,116

(b) *Profit statement for 18,000 capacity, with additional shift*

		£000	£000	
Sales	18,000 tests @ £300/test		5,400	**(i)**
Direct materials	18,000 tests @ £92/test		(1,656)	**(ii)**
Direct labour	12,000 tests @ £30/test	(360)		
	6,000 tests @ £45/test	(270)		
			(630)	**(iii)**
Variable overhead	18,000 tests @ £12/test		(216)	**(iv)**
Contribution			2,898	
Fixed costs			(1,300)	**(v)**
Profit			1,598	**(vi)**

(c) $$\text{Breakeven volume} = \frac{£1{,}200{,}000}{(£300 - £140)} = 7{,}500 \text{ tests.}$$

Solution 4

- The profit line cuts the vertical axis at the point equal to the fixed costs, that is, the loss when no sale is made.
- The profit line cuts the horizontal axis at the breakeven point. Therefore, for (a)(ii) you will need to calculate the breakeven point. For (a)(iii), the margin of safety is the difference between £300,000 sales and the breakeven point.

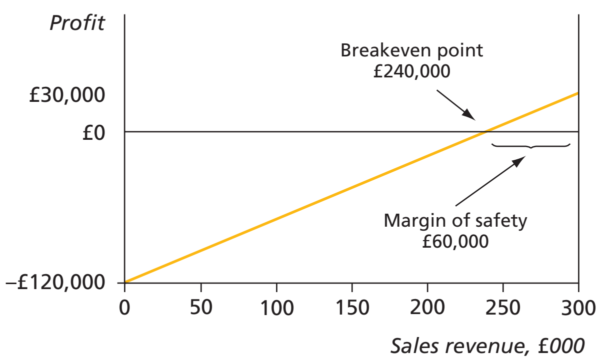
(a) (i) −£120,000
(ii) £240,000
(iii) £60,000.

Workings:

$$\text{Contribution-to-sales ratio} = \frac{£(300{,}000 - 100{,}000 - 10{,}000 - 40{,}000)}{£300{,}000} \times 100 = 50\%$$

$$\text{Breakeven point} = \frac{\text{Fixed costs}}{\text{C/S ratio}} = \frac{£(40{,}000 + 60{,}000 + 20{,}000)}{0.5} = £240{,}000$$

$$\text{Margin of safety} = £(300{,}000 - 240{,}000) = £60{,}000$$



(b)

	The angle of the profit line will:	*The breakeven point will:*
(i) Increase in selling price	Increase	Decrease
(ii) Increase in fixed cost	Remain unchanged	Increase
(iii) Decrease in variable cost per unit	Increase	Decrease

Solution 5

- Remember that a contribution breakeven chart shows the variable cost line instead of the fixed cost line.
- This means that contribution can be read directly from the chart, as the difference between the sales value and the variable cost. This is the main advantage of the contribution breakeven chart.

A £50,000 (1,000 hours × £50 selling price)
B £15,000 (fixed cost at zero activity)
C £15,000 (profit for 1,000 hours – see below)
D 500 hours (breakeven point – see below)
E 500 hours (margin of safety (1,000 hours − 500 hours breakeven))

Workings:

	£	£
Sales value for 1,000 hours = 1,000 × £50		50,000
Total cost for 1,000 hours:		
variable cost 1,000 × £20	20,000	
fixed cost 1,000 × £15	15,000	
		35,000
Profit for 1,000 hours		15,000

$$\text{Breakeven point} = \frac{\text{Fixed costs}}{\text{Contribution per hour}} = \frac{£15{,}000}{£30} = 500 \text{ hours}$$

Solution 6

- In part (b) remember to rank the products according to their contribution per machine hour. Then allocate the available machine hours according to this ranking.

(a) The deficiency in machine hours for the next period is 13,000 hours.
(b) Product A 3,000 units
Product B 2,500 units
Product C 3,142 units

Workings:

(a) Deficiency in machine hours for next period

	Product A	*Product B*	*Product C*	*Total*
Machine hours required per unit	48/8 = 6	32/8 = 4	56/8 = 7	
Maximum demand (units)	3,000	2,500	5,000	
Total machine hours to meet maximum demand	18,000	10,000	35,000	63,000
Machine hours available				50,000
Deficiency of machine hours				13,000

(b)

	Product A	*Product B*	*Product C*
	£	£	£
Selling price per unit	200	158	224
Variable cost per unit	(154)	(112)	(178)
Contribution per unit	46	46	46
Machine hours required per unit	6	4	7
Contribution per machine hour	£7.67	£11.50	£6.57
Order of production	2	1	3

Therefore, make:

	Machine hours
2,500 units of product B, using machine hours of (4 × 2,500)	10,000
3,000 units of product A, using machine hours of (6 × 3,000)	18,000
	28,000
Machine hours left to make product C	22,000
	50,000

Therefore, the company should make 3,142, that is, (22,000/7) units of product C.