Chapter 4 Solutions

Question 4.1

A) Explain the following

The term **marginal cost** refers to the additional costs incurred in providing a unit of product or service.

The term **contribution** refers to the amount that a product or service contributes towards covering fixed costs. It is simply sales value less variable costs.

A **fixed cost** is a cost that is unaffected by fluctuations in the level of activity (within a relevant range).

B) Marginal format

Marginal Statement

	€	€
Sales		4,300,000
Variable costs		
Direct material	1,250,000	
Direct labour	760,000	
Variable overhead	95,000	
Variable sales expenses	75,000	2,180,000
CONTRIBUTION		2,120,000
Fixed costs		
Fixed overhead	1,165,000	
Fixed sales expenses	450,000	
Fixed administration	550,000	2,165,000
NET LOSS		(45,000)

Solution 4.2

a) Profit Statement (showing apportionment of overheads)

		Dept. 1	Dept. 2	Dept. 3	Total
Volume sold		100,000	160,000	40,000	300,000
		€'000	€'000	€'000	€'000
Revenue		4,000	1,920	4,080	10,000
Purchase cost of sales		2,600	1,152	2,244	5,996
Specific departmental costs		460	520	770	1,750
Overhead costs:					
Centralised ordering & warehousing	*volume*	250	400	100	750
Centralised administration	*revenue*	200	96	204	500
Total cost		3,510	2,168	3,318	8,996
Profit		490	-248	762	1,004

b) Profit Statement (marginal principles)

		Dept. 1	Dept. 2	Dept. 3	Total
Volume sold		100,000	160,000	40,000	300,000
		€'000	€'000	€'000	€'000
Revenue		4,000	1,920	4,080	10,000
Purchase cost of sales		2,600	1,152	2,244	5,996
Specific departmental costs		460	520	770	1,750
Contribution		940	248	1,066	2,254
Centralised ordering & warehousing	*volume*				750
Centralised administration	*revenue*				500
Profit					1,004

c) Effect of closing Dept. 2

	Dept. 1	Dept. 2	Dept. 3	Total
Volume sold	100,000	160,000	40,000	300,000
	€'000	€'000	€'000	€'000
Revenue	4,000		4,080	8,080
Purchase cost of sales	2,600		2,244	4,844
Specific departmental costs	460		770	1,230
Contribution	940		1,066	2,006
Centralised ordering & warehousing				600
Centralised administration				500
Profit				806

Overall the company would reduce profit by €198,000 by closing department 2 (€1,004,000 before closure to €806,000). This can be explained by the lost contribution of €248,000 and only savings of €150,000 in overheads. I would advise management not to close department 2.

Question 4.3

Explain the following terms

The **break-even point** is the point at which neither a profit or a loss is incurred. Break-even occurs where total contribution is exactly equal to fixed cost and hence sales revenue is exactly equal to variable cost plus fixed cost. The break-even volume can be found by dividing the total fixed costs involved by the contribution per unit. The break-even revenue is found by multiplying the break-even volume by the sales price.

The **margin of safety** is the amount of sales the business can afford to lose and still not make a loss. It is the difference between the budgeted sales volume (or revenue) and the budgeted break-even volume (or revenue). It can be expressed in units / products or € sales or as a percentage.

The **contribution margin** is another name for the contribution to sales ratio or C/S ratio. Contribution margin is simply the contribution divided by sales, multiplied by 100. If a C/S ratio of 60% is calculated it means that for every €100 in sales, contribution will on average amount to €60 with variable costs at €40. The C/S ratio is an important financial indicator because in some instances, key information may be unavailable to properly utilise the CVP model.

Question 4.4

Explain the relationship between cost structure and profit stability

Cost structure refers to the proportion of fixed and variable costs within the total operating cost structure of the business. A business with a high proportion of fixed costs to total costs would be said to have a high fixed cost structure, sometimes called high operating gearing. Travel agents, although not capital intensive, would have a high fixed cost operating structure. Outdoor catering firms would have a mainly high variable cost structure. Operating risk is high where a business suffers from profit volatility and this occurs when profit is sensitive to small changes in key variables. Generally a business will have high operating risk or gearing when its cost structure is predominantly fixed. This is due to the fact that the pressure is on the business to achieve a required sales level to cover fixed costs. A business with a predominantly variable cost structure would have low operating risk or gearing as, should the business not achieve expected sales, the variable costs would not be charged.

Compare and contrast the break-even chart and profit volume chart as providers of useful information to management

The break-even chart and profit-volume chart are both graphic methods of presenting information supplied through the CVP model. While the break-even chart is quite useful in determining the break-even point and giving a visual overview of revenue and cost relationship for a business, the profit volume chart is very useful in showing the impact on profit of different activity levels. The profit-volume chart can show the profit or loss for any given scenario.

Outline the arguments in favour of both the economists approach and the accountants approach to CVP analysis.

The Economist approach argues that the accountants approach to CVP analysis is overly simplistic. And hence not accurate. Some of the assumptions that underlie the CVP analysis come into conflict with economic theory, especially the assumption of linearity and the constancy of selling price and variable cost per unit. Economists argue that lowering selling price acts as a catalyst to increasing demand and thus as sales volumes increase, so will variable costs. However, on account of economies of scale and quantity discounts, the variable cost per unit should fall. This is reflected in the total revenue and total cost curves that economists use, rather than the straight lines simplifications in the accountants CVP model.

1. The total revenue curve begins to slope upwards but less steeply, as price reductions become necessary and then slopes downward as the effect of price reductions outweigh the beneficial effect of volume increases, as the business approaches capacity.
2. The total cost curve increases at a slower rate as the effects of economies of scale and quantity discounts show up. However the curve begins a steeper upward trend as the business rises towards full capacity, because the variable cost per unit will normally increase as a result of diminishing returns.

The accountants approach argues that it is not intended to provide a precise representation of total revenue and cost functions throughout all levels of activity. The objective of the accountant's CVP model is to represent an approximation of revenue and cost behaviour over the relevant range in the short term. As the relevant range of activity can be narrow and the short term time period less than 12 months, the linearity assumption is reasonable. Also, the cost of obtaining more accurate cost and revenue functions may outweigh the benefits to be gained from such information.

Question 4.5

a) Calculate the profit or loss if the above estimates prove to be correct

	€	€
Sales	5.00	375,000
Variable costs		
Variable labour	2.50	
Variable overhead	0.50	
Total variable cost	3.00	225,000
Contribution	2.00	150,000
Fixed costs		140,000
Profit		10,000

b) What is the break-even point in units and revenue

$$\frac{\text{Fixed Cost}}{\text{Contribution per unit}} \qquad \frac{140{,}000}{2.00} = 70{,}000 \text{ units and } €350{,}000 \text{ revenue}$$

c) What is the margin of safety in units and revenue

	Units	Revenue
Budgeted sales	75,000	€375,000
Break-even sales	70,000	€350,000
Margin of safety	6,000	€26,000

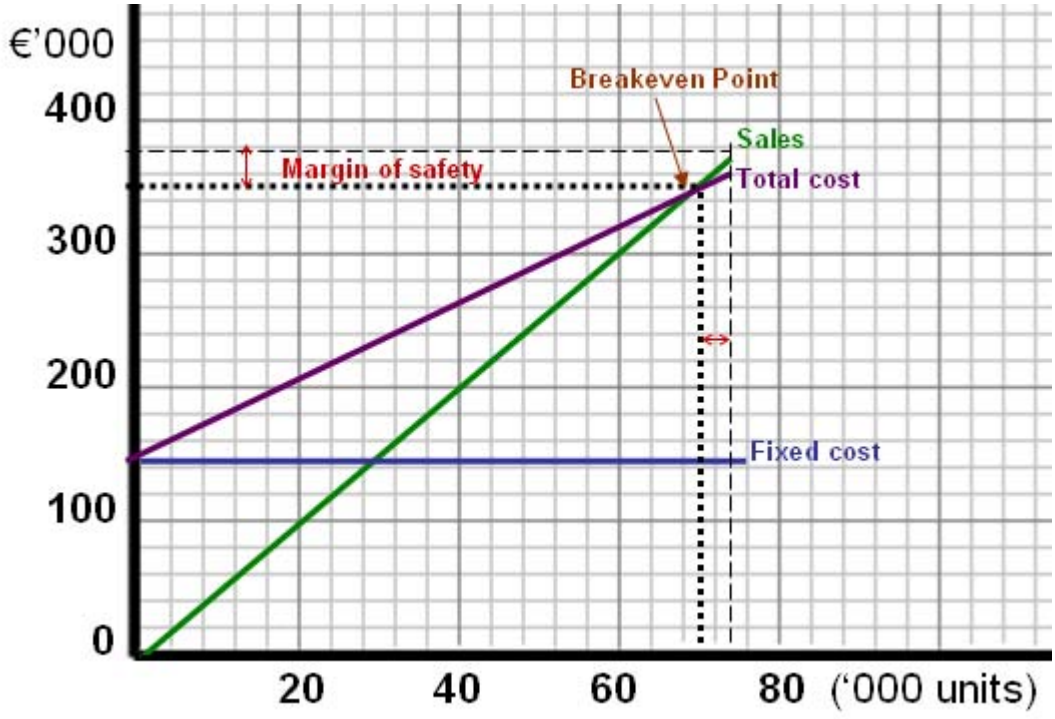
d) How many alterations need to be sold to achieve a profit of €30,000

$$\frac{\text{Fixed cost + profit}}{\text{Contribution per unit}} \qquad \frac{170{,}000}{2.00} = 85{,}000 \text{ alterations needed}$$

e) How much should be charged for each alteration if a profit of 20 per cent of selling price is required based on existing forecast sales volume

	€
Variable cost	3.00
Fixed cost (140,000 / 75,000)	1.87
Total cost	4.87
Profit 20% (€4.87 / 80 x 20)	1.22
Selling price	6.08

Prepare a break-even chart summarising the above CVP relationship showing clearly the break-even point and the margin of safety.



Solution 4.6

a) Calculate the break-even point in units and revenue

Fixed Cost	342,000	= 1,800 installations and €540,000 revenue
Contribution per unit	190.00	

b) Calculate the margin of safety in units and revenue

	Units	Revenue
Budgeted sales	2,000	€600,000
Break-even sales	1,000	€540,000
Margin of safety	200	€ 60,000

c) Calculate the number of installations needed to earn €50,000 profit

Fixed cost + profit	392,000	= 2,063 installations needed
Contribution per unit	190.00	

d) Calculate the installation price to be charged to ensure that the venture breaks even, if the number of installations falls to 1,600

	€
Variable cost	110.00
Fixed cost (342,000 / 1,600)	213.75
Total cost	323.75
Price to break-even	323.75

e) Explain the term 'contribution sales ratio' (C/S ratio) and show how it is calculated

The contribution sales ratio or C/S ratio is simply the contribution divided by sales, multiplied by 100. If a C/S ratio of 45% is calculated it means that for every €100 in sales, contribution will on average amount to €45 with variable costs at €55. It is calculated as follows

Contribution / Sales	x 100

Question 4.7

a) *Calculate the break-even point in both sales volume and revenue*

Before one can attempt this question one must classify costs into fixed and variable and calculate the contribution per person. In this question all the costs are fixed except for the commissions to the coach operators and management.

Selling Price (5.00 x 100/113.5 to exclude vat)			4.40
Variable cost per person 4.4 x 15%			0.66
Contribution per person			3.74

Fixed costs	Operating costs	39,500	
	Loan interest	4,800	44,300

Breakeven point in units and revenue

Fixed costs / Contribution per person	€44,300 / €3.74	= 11,845 persons
Units x sales price	11,845 x €4.40	= €52,117 revenue

b) *If Charlie requires a profit of €10,000, what turnover must he achieve*

$$\frac{\text{Fixed costs + Profit required}}{\text{Contribution per person}} = \frac{€44,300 + 10,000}{3.74} = 14,519 \text{ persons}$$

In sales value this will amount to €63,883 (14,519 x 4.40)

c) *If fixed costs increase by 10 per cent, calculate the level of sales Charlie will have to achieve to maintain his profit requirement*

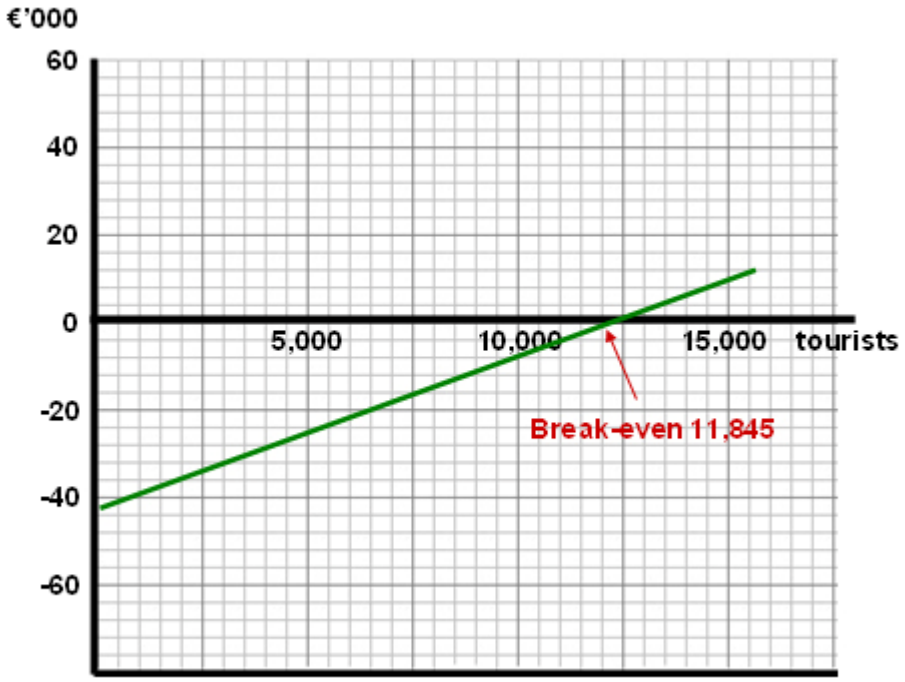
In this case fixed costs will increase to €48,730

The answer to the question is calculated using the same formula as in (b)

$$\frac{\text{Fixed costs + Profit required}}{\text{Contribution per person}} = \frac{€48,730 + 10,000}{3.74} = 15,703 \text{ persons}$$

In sales value this will amount to €69,093 (15,703 x 4.40)

d) Prepare a profit volume graph showing clearly the break-even point and the margin of safety, if he achieves his required profit.



e) Comment on the viability of the venture

At present the venture is not a viable one. To break-even requires 11,845 customers which equates with 228 visitors per week. This is very high and will just achieve break-even. The admission charge however is quire low. If this was increased to €9 including VAT (€7.93 net) then the break-even point would fall to 6573 persons which is 126 per week (see below). This is a more realistic figure.

The business should also consider adding in other revenue streams such as souvenir and café shop as well as possibly developing organic farm produce to sell.

Selling price excluding VAT =	(€9 x 100/112.5)	7.93
Less variance costs	15%	1.19
Contribution		6.74

New break-even point = 44,300/6.74 = 6573 persons

Question 4.8

a) The profit or loss at each of the four levels of projected demand

In this question the approach to take is to layout a profit statement at the four levels of demand and input the fixed and variable cost information given in the data. From this one can see that the calculation of sales is vital to answering the question. One can calculate sales at each level from using the C/S ratio of 60%. If the C/S = 60% that implies sales = 100% and variable costs = 40%. Thus sales is calculated by dividing the variable costs at each level by 40% and multiplying by 100%. For example sales under the adverse demand level is calculated as €30,000 x 100/40 = €75,000

Profit statement

	Adverse	**Average**	**Good**	**Excellent**
	('000)	('000)	('000)	('000)
Sales	75	112.5	150	212.5
Variable costs	30	45.0	60	85.0
Contribution	45	67.5	90	127.5
Fixed costs	46	46.0	46	46.0
Net profit	-1	21.5	44	81.5

b) The break-even point in sales value

As there is no unit information given in this question the break-even point must be calculated by using the contribution to sales ratio which calculates the break-even point in euro sales.

$$\frac{\text{Fixed costs}}{\text{C/S ratio}} \quad \frac{46{,}000}{0.60} \quad = \quad €76{,}667$$

c) The level of sales required for the business to make a return on an initial investment of 20 per cent

As there is no unit information given in this question the sales to make a required profit must be calculated by using the contribution to sales ratio which calculates this in euro sales. The required profit is €100,000 (20% x 500,000).

$$\frac{\text{Fixed costs + required profit}}{\text{C/S ratio}} \quad \frac{46{,}000 + 100{,}000}{0.60} \quad = \quad €243{,}333$$

d) Briefly comment on the viability of the venture

In this new venture according to the projected data the risk of failure seems quite low in the first year. However it does not seem likely that the project will achieve returns of 20%, at least not in its first year. Thus overall the project looks to be a safe one capable of achieving reasonable returns. It must be noted that this opinion is based on the accuracy of the research data which may be flawed.

Solution 4.9

a) Calculate the break-even point per return flight and the overall break-even point per annum, assuming flights run 360 days per year

As with most questions in CVP analysis the relevant information must be extrapolated from the question. The information required is as follows

- *Fixed costs per return flight*
- *Variable costs per return flight*
- *Contribution per return flight*

Selling Price/person per return flight			120
Variable costs/person per return flight			20
Contribution			100
Fixed Costs per return flight			
Staff cost per flight		1,000	
Airport charges per return flight		500	
aircraft insurance per annum	(1152000/4 x 360)	800	
Fuel cost per return flight		4,500	
Administration cost for the year	100,000/4 x 360	70	
		6,870	
BEP per flight	6870 / 100	68.695	passengers
BEP per annum	(68.695 x 4 x 360)	98920.8	passengers

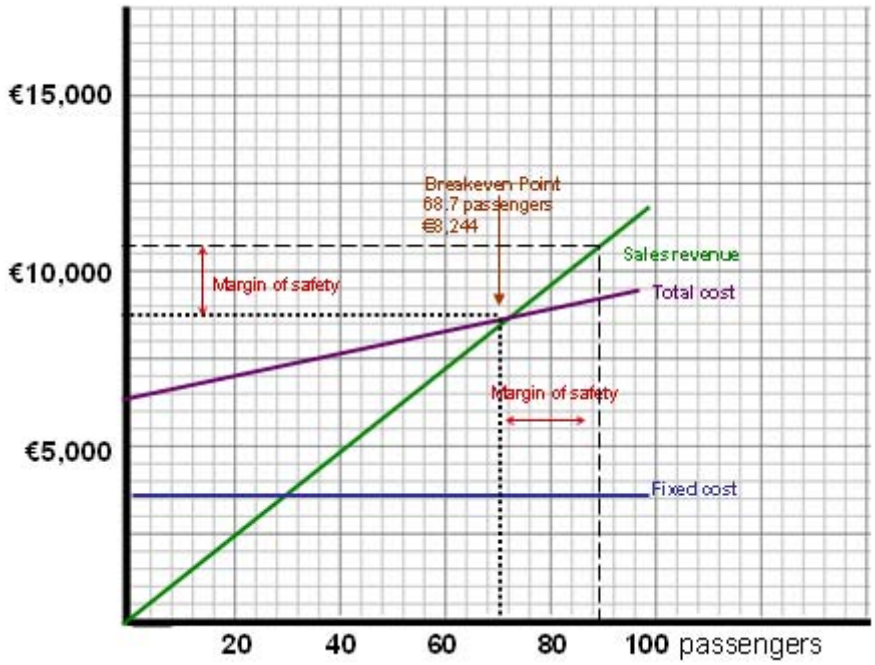
b) Calculate the annual profit given a load factor of 75 per cent

This requires the calculation of annual sales, annual variable costs and annual fixed costs. Annual sales is calculated as 90 persons (120 x 75% loan factor) x €120 x 4 return flights x 360 days.

Sales	(€120 x 120 x.75 x 4 x 360)	15,552,000
Less variable costs	(€20 x 120 x .75 x 4 x 360)	2,592,000
		12,960,000
Less Fixed costs	(6869.5 x 4 x 360)	9,892,080
Net profit		3,067,920

c) Prepare a break-even chart showing the break-even point and margin of safety based on a load factor of 75 per cent

The margin of safety based on a loan factor of 75% is 21 people. This is calculated as simply forecast sales of 90 persons less break-even point sales 69 persons per return flight



d) Calculate the number of customers per flight required to achieve a profit of €4,000,000 per annum

$$\frac{\text{Fixed costs + Profit required}}{\text{Contribution per person}} \quad \frac{6870 + (4{,}000{,}000 / 4 \times 360)}{100} = 96 \text{ persons}$$

Solution 4.10

a)Calculate, based on variable cost levels of 35 per cent, 40 per cent and 45 per cent, the annual break-even point for the heritage centre, t he number of customers required to give the heritage centre a return on investment of 20 per cent and the margin of safety at this level of profit.

Fixed costs are €135,000

Profit for a return on investment of 20% = €62,000 (€310,000 x 20%)

	Variable costs	**Variable costs**	**Variable costs**
	35%	**40%**	**45%**
Sales price(9/1.125)	8.00	8.00	8.00
Variable Costs	2.80	3.20	3.60
Contribution	5.20	4.80	4.40
i) Break-even point	135,000 / 5.2 = 25961.54 customers	135,000 / 4.8 = 28125 customers	135,000 / 4.4 30681.82 customers
ii) RoI (20%x310,000)	135,000+62,000/5.2 37,885 customers	135,000+62,000/4.8 41,042 customers	135,000+62,000/4.4 44,773 customers
Margin of safety	11923.08 customers 31.47%	12916.67 customers 31.47	14090.91 customers 31.47%

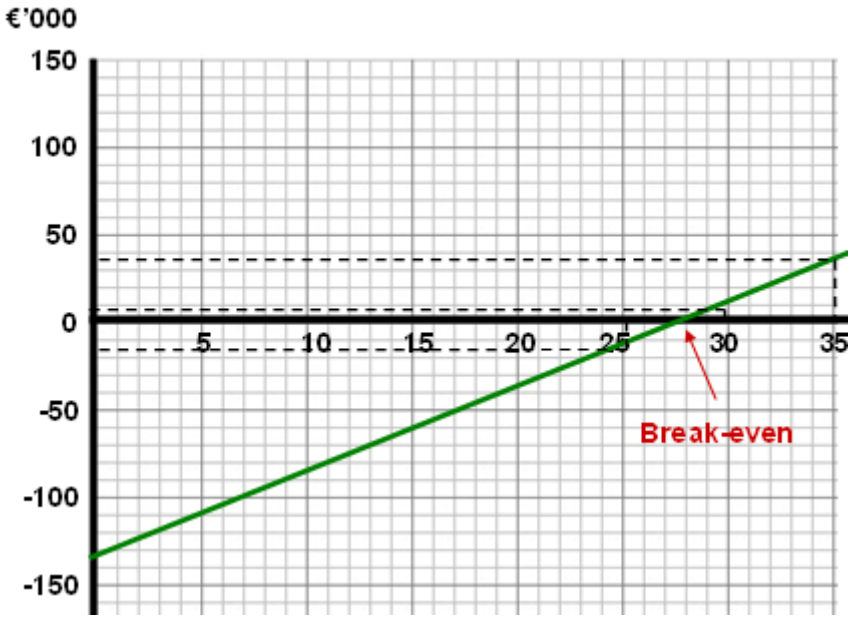
Note: The margin of safety is calculated by subtracting the break-even point calculated in (1) from the number of customers required to achieve the return. This it is assumed is the forecast sales. The margin of safety can also be calculated as a percentage. For example under variable costs at 35% the % margin of safety is calculated as 11,923/ 37885 x 100

b) Based on variable cost levels of 40 per cent, prepare a profit volume chart estimating profit at demand levels of 25,000, 30,000 and 35,000 customers

The profit or loss based on demand levels of 25,000, 30,000, and 35,000 customers is calculated below and presented in a profit volume chart

Profit at demand levels of

		25,000		**30,000**		**35,000**
Contribution	€4.8 x 25,000	120000	€4.8 x 30,000	144000	€4.8 x 35,000	168000
Less Fixed costs		135000		135000		135000
Profits		-15000		9000		33000



c) *If the initial study forecasts a demand of between 25,000 and 35,000 customers, comment on the viability of the venture.*

Based on the forecast figure the project is not feasibly if variable costs are greater than 40%. If variable costs are for example 35% then the project is a viable one however it is still unlikely to achieve the required returns of the investors.

Solution 4.11

a) Present a statement showing which of the marketing manager's proposals provide the greater amount of profit.

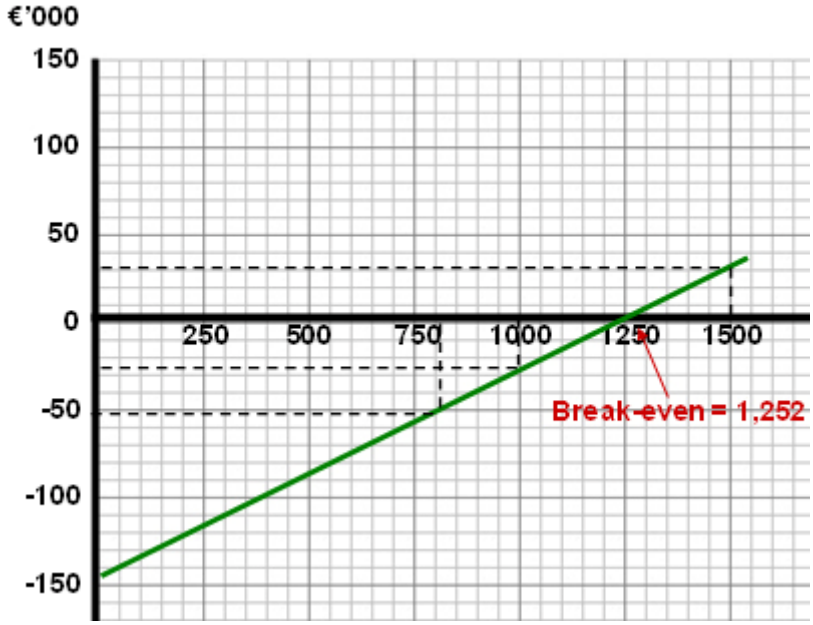
To answer this question one needs to know the number of packages sold in the current year. To calculate this figure one needs to use the information given on the current yerar. For example current year profit amount to €150,000 after fixed costs of €120,000 are deducted. That implies that current yea contribution is €270,000. If the current year contribution per package is €125 then the number of packages sold in the current year amounts to 2160 (270,000/125). Now one can prepare profit statements based on the marketing managers proposals.

		Proposal 1			**Proposal 2**
		€			€
Sales	(€250 x 2376)	594,000	€230	X 2700	621,000
Variable costs	(€135 x 2376)	320,760	€135	X 2700	364,500
Contribution	(€115 x 2376)	273,240	€95	X 2700	256,500
Fixed costs		144,000			144,000
		129,240			112,500

b) Calculate, in respect of each alternative, the break-even point in terms of sales volume and sales value

	Proposal-1	**Proposal 2**
Fixed costs	144000	144,000
Contribution per unit	115	95
Break-even point (packages)	**= 1252 packages**	**1515 = packages**
	1252 x €250	1515 x €230
Break-even point (sales value)	**= €313,043 revenue**	**= €348631 revenue**

c) Prepare a profit volume chart based on the marketing managers first proposal and from the chart, estimate the profit or loss based on demand levels of 800, 1,000 and 1,500 packages sold



From the profit volume chart

800 packages	-52,000
1000 packages	-29,000
1500 packages	28,500

d) Briefly outline four limitations of CVP analysis as a management information tool

As with any model, there are necessary, simplifying assumptions on which the whole model is based. These assumptions also represent the limitations of the CVP model. It is essential that managers, when interpreting CVP information, keep in mind these limitations and try to assess their influence in practical terms.

The assumptions are as follows:

1. Revenue and cost behaviour are linear over the relevant range, i.e. they take the form of a straight-line on a chart.
2. Variable costs per unit remain constant, thus ignoring the impact of quantity discounts.

3. Variable costs are directly proportional to sales.
4. Fixed costs remain constant within the relevant range.
5. All costs can be classified into their fixed and variable components.
6. Volume / activity levels are the only factors that influence costs. Clearly there are many other factors that influence revenues and costs such as quality of management and staff, industrial relations, economic conditions, working methods and conditions etc.
7. Selling price per unit remains constant although economists point out that in order to sell additional units, selling price is normally reduced.
8. The sales mix remains constant.

Solution 4.12

Workings

	Product 1	Product 2	Product 3	Product 4	Total
Volume	15,000	5,000	10,000	7,500	37,500
Total sales revenue	€37,500	€16,250	€43,000	€13,125	€109,875
Contribution per unit *	€1.55	€2.00	€2.30	€1.10	
Total contribution	€23,250	€10,000	€23,000	€8,250	€64,500

*Contribution per unit is found by dividing sales revenue by volume to get sales price per unit and then deducting variable costs.

a) Calculate the total revenue required to break-even based on the current sales mix

Fixed cost: 37,500 units x 50p = €18,750

C/S ratio: €64,500 / €109,875 x 100 = 58.7% (average based on mix ratio)

Break-even: €18,750 / 0.587 = **€31,942 revenue**

b) Calculate the number of units of each product required to break-even based on the current sales mix

Average selling price: €109,875 / 37,500 = €2.93

Total units to break-even: €31,942 / €2.93 = 10,902 units

Ratio: 15 : 5 : 10 : 7.5

Product 1:	10,902 / 37.5 x 15	**4,361 units**
Product 2:	10,902 / 37.5 x 5	**1,454 units**
Product 3:	10,902 / 37.5 x 10	**2,907 units**
Product 4:	10,902 / 37.5 x 7.5	**2,180 units**

c) Calculate the margin of safety in revenue

€109,875 - €31,942 = **€77,933 revenue**

d) Calculate the break-even point and margin of safety if the business follows a strategy of increasing advertising by €15,000 which is forecast to increase sales by 10 per cent

	Product 1	Product 2	Product 3	Product 4	Total
Volume	15,000	5,000	10,000	7,500	37,500
New volume + 10%	16,500	5,500	11,000	8,250	41,250
Contribution per unit	€1.55	€2.00	€2.30	€1.10	
New contribution	€25,575	€11,000	€25,300	€9,075	€70,950

New sales:	€109,875 x 110% = €120,863
C/S ratio:	€70,950 / €120,863 x 100 = 58.7%
New fixed cost:	€18,750 + €15,000 = €33,750
Break-even:	€33,750 / 0.587 = **€57,493**
Margin of safety:	€120,863 - €57,493 = **€63,370**

e) Should the increase in advertising be implemented?

Existing profit: €64,500 - €18,750 = €45,750

New profit: €70,950 - €33,750 = €37,200

NO, although the proposal increases volume the proposal should not be implemented as the profit will fall from €45,750 to €37,200 the break-even revenue will increase and the margin of safety decrease.

Solution 4.13

a) How much sales revenue must be generated per week from the shop in order to break-even. (You may assume the trading year is 50 weeks)

To begin this question the information must be presented in a marginal costing format with costs classified according to whether they are fixed or variable and contribution calculated. Then calculating the average C/S ratio one can calculate the break-even point in sale value

	Skis	**Suits**	**Total**
	(168 x 100/120)	(240x100/120)	
Selling Price excl vat	140	200	340
Less variable costs per unit			
Purchases excluding vat	70	120	190
Commissions	28	40	68
	98	160	258
Contribution per unit	**42**	**40**	**82**

Fixed Costs

Wages & salaries	45,000
Estimated Overheads for the year	14,400
Loan Interest (8% x 50,000)	4,000
Depreciation of fixed assets	10,000
	73,400

Weighted Average C/S (82/340) = 0.24

Break-even point

Fixed cost	73,400	€305,833
C/S ratio	0.24	

b) Calculate the amount of sales revenue to be generated per week if a return on equity of 20 percent is required

A return on capital of 20% equates to a net profit figure of €32,000 (160,000 x 20%)

Using the required profit formula one can calculate the amount of sales that can generate such as return.

$$\frac{\text{Fixed costs + required profit}}{\text{C/S ratio}} \quad \frac{73{,}400 + 32{,}000}{.24} = \text{€}439{,}167$$

c) *If an advertising campaign promoting a 15 per cent off deal on wet suits at the year-end is launched, how many extra wet suits need to be sold to cover the costs of the promotion which is estimated to cost €5,000.*

In this scenario one must calculate the new contribution per wetsuit after the 15% discount is taken into account. The costs of the promotion then divided by the new contribution to get the number of wets suits required to be sold to cover the additional fixed costs

Selling price wet suits		(€200 x 85%)	170
Less variable costs			
Purchase		120	
Commission	(170 x 20%)	34	154
Contribution per unit			16

Fixed costs / Contribution per unit 5000 / 16 = 313 wet suits

Thus the promotion and discount are only worthwhile if more that 313 wet suits are sold.