Answers to extra questions for Chapter 3 Cost assignment

Answer to question 3.1

a)

	(£)	(£)
Photography: 64 pages at £150 per page		9 600
Set-up:		
Labour – 64 plates × 4 hours per plate = 256 hours at £7 per hour	1 792	
Materials – 64 plates at £35 per plate	2 240	
Overhead – 256 labour hours at £9.50 per hour	2 432	
		6 464
Printing:		
Materials (paper): 100 000 catalogues × 32 sheets × $\frac{£12}{1000} \times \frac{100}{98}$	39 184	
Materials (other): $\frac{100\,000}{500} \times £7$	1 400	
Labour and Overheads $\frac{100\,000}{1000}$ m/c hours at £62 per hour	6 200	
		46 784
Binding:		
Labour and Overheads $\frac{100\,000}{2500}$ m/c hours at £43 per hour		1 720
Total costs		64 568
Selling price – £64 568 × $\frac{100}{90}$		71 742

(b) Estimated hours = 256

Actual hours = 256 × $\frac{100}{90}$
= 284.4

Additional costs = (284.4 – 256) × £16.50 (£7 labour rate + £9.50 overhead rate)
= £469.3

Answer to question 3.2

(a) The service department cost should be reallocated using the following bases:
Canteen: Number of employees
Engineering shop: Number of service hours
Stores: Number of stores orders
The canteen does not receive any services from the other service departments. Therefore the canteen should be reallocated first. The Engineering Shop receives services from the other two service departments and should be reallocated last.

Dept.	Basis	M/C	Assemb	Paint shop	Eng shop	Stores	Canteen
			Overhead allocation				
		(£)	(£)	(£)	(£)	(£)	(£)
Allocation		180 000	160 000	130 000	84 000	52 000	75 000
Canteen	Employees	27 000	17 000	13 000	10 000	8 000	(75 000)
Stores	Orders	24 000	18 000	12 000	6 000	(60 000)	
Eng. shop	Service hrs	45 000	30 000	25 000	(100 000)		
Total overhead		276 000	225 000	180 000			
Machine hours		9 200					
Direct labour hours			11 250				
Labour cost				£45 000			
Machine hour rate		£30					
Direct labour hour rate		£20					
Direct labour cost rate		400% of direct labour cost					

(b) *Overhead absorption statement*

	M/C (£)	Assembly (£)	Paint shop (£)
Overhead absorbed[a]	300 000	156 000	140 000
Actual overhead	290 000	167 000	155 000
(Under-)		11 000	15 000
Over-absorption	10 000		

Notes

[a]10 000 machine hours × £30 per hour.
7800 Direct labour hours at £20 per hour.
400% of direct labour cost of £35 000.

(c) See 'Budgeted overhead rates' in Chapter 3 for an explanation of why overheads should be absorbed using predetermined bases. The second part of the question relates to whether or not volume allocation base (i.e. machine hours and direct labour hours or cost) are appropriate, particularly when direct labour is a small proportion of total cost. The answers should discuss the need for developing non-volume-based cost driver rates using activity-based costing systems.

Answer to question 3.3

(a) With the direct method of allocation inter-service department apportionments are ignored, service department costs are reapportioned to production departments only.

	Personnel and Administration (£000)	Maintenance (£000)	Stores (£000)	Moulding (£000)	Extrusion (£000)	Finishing (£000)
Materials	36	23		330	170	20
Labour	155	25	18.72	168.75	115.2	81
Variable overhead				71.25	151.8	30
Fixed overhead	15	15	17.28	449.30	371.7	67
	206	63	36	1019.3	808.7	198
Personnel[a]	(206)			100.98	64.63	40.39
Maintenance reallocation[b]		(63)		18	36	9
Stores reallocation[c]			(36)	8	12	16
Total cost				£1146.28	£921.33	£263.39

Notes

[a]Personnel costs are reapportioned on the basis of the number of employees in each production department. For example, 25/51 of the personnel department costs of £206 000 are apportioned to the moulding department.
[b]Maintenance costs are reapportioned in proportion to the total maintenance hours worked in each department.
[c]Stores costs are reapportioned in proportion to stores floorspace.

(b) This method is the specified order of closing described in Appendix 3.1. There the service department that provided the largest proportion of services for other service departments was closed first. In this answer the service department providing the largest value of cost input to other service departments (namely the personnel department) is closed first, and the department providing the second largest value of cost input to other service departments is closed next. Return charges are not made.

	Personnel and Administration (£000)	Maintenance (£000)	Stores (£000)	Moulding (£000)	Extrusion (£000)	Finishing (£000)
Original allocation	206	63	36	1019.3	808.7	198
Personnel reallocation	(206)	14.21(4/58)	10.65(3/58)	88.79(25/58)	56.83(16/58)	35.52(10/58)
Maintenance reallocation		(77.21)	13.63(15/85)	18.17(20/85)	36.33(40/85)	9.08(10/85)
Stores reallocation			(60.28)	13.4(20/90)	20.09(30/90)	26.79(40/90)
Total cost				£1139.66	£921.95	£269.39

(c) The reciprocal method incorporates all inter-servicing relationships. Let

P = total cost of personnel and administration
M = total cost of maintenance
S = total cost of stores

The total costs that will be transferred to the service departments can be expressed as:

$P = 206 + 0.0556M$ (*W1*)
$M = 63 + 0.0690P$ (*W2*) $+ 0.15$ (*W3*)
$S = 36 + 0.166M$ (*W4*) $+ 0.0517P$ (*W5*)

The total costs of the production department will be:

Moulding (£000) $1019.3 + 0.431P$ (*W6*) $+ 0.22M$ (*W7*) $+ 0.2S$ (*W8*)
Extrusion (£000) $808.7 + 0.276P$ (*W9*) $+ 0.44M$ (*W10*) $+ 0.3S$ (*W11*)
Finishing (£000) $198.0 + 0.172P$ (*W12*) $+ 0.11M$ (*W13*) $+ 0.4S$ (*W14*)

Workings

(*W1*) M coefficient = 5/90
(W2) P coefficient = 4/58
(*W3*) S coefficient = 10/100
(*W4*) M coefficient = 15/90
(*W5*) P coefficient = 3/58
(*W6*) P coefficient = 25/58
(*W7*) M coefficient = 20/90
(*W8*) S coefficient = 20/100
(*W9*) P coefficient = 16/58
(*W10*) P coefficient = 40/90
(*W11*) S coefficient = 30/100
(*W12*) P coefficient = 10/58
(*W13*) M coefficient = 10/90
(*W14*) S coefficient = 40/100

(d) The direct method is the simplest, but ignores inter-service department apportionments. If there is a significant proportion of inter-servicing apportionments, this method is likely to result in inaccurate calculations.

The step-down method gives partial recognition to inter-department servicing, and does not involve time-consuming apportionments. The reciprocal method takes full account of inter-department servicing, and is the only method that will yield accurate results.

The choice of method will depend on cost behaviour. If a significant proportion of costs are variable then service department reallocations will be important for decision-making and cost control. In this situation the reciprocal method should be used. However, if the vast majority of costs are fixed, the cost allocations should not be used for cost control and decision-making, and here is a case for using the direct or step-down method.

(e) The answer to this question should include a discussion of cost-plus pricing. See 'Limitations of cost-plus pricing' and 'Reasons for using cost-plus pricing' in Chapter 11 for the answer to this question.

Answers to extra questions for Chapter 4 Accounting entries for a job costing system

Answer to question 4.1

(a) The opening WIP balance indicates that overheads are absorbed as follows:

Process 1 = Production overhead (125)/Direct wages (50) = 250% of direct wages
Process 2 = Production overhead (105)/Direct wages (70) = 150% of direct wages

(b) NB Limited accounts (All figures in £000)

Building account

	(£)		(£)
Balance	800		

Plant account

	(£)		(£)
Balance	480		

Provision for depreciation – plant account

	(£)		(£)
Balance c/fwd	108	Balance b/fwd	100
		Production overhead control (96/12 months)	8
	108		108
		Balance b/fwd	108

Raw material stocks account

	(£)		(£)
Balance b/fwd	400	Creditors	10
Creditors	210	Work in progress 1	136
		Work in progress 2	44
		Balance c/fwd	420
	610		610
Balance b/fwd	420		

Work in Progress 1 account

	(£)		(£)
Balance b/fwd	246	Abnormal loss[a]	20
Raw material stock	136	Work in progress[b]	483
Production overhead control (£84 × 250%)	210	Balance c/fwd	173
Direct wages	84		
	676		676
Balance b/fwd	173		

Work in Progress 2 account

	(£)		(£)
Balance b/fwd	302	Finished goods[b]	908
Raw material stock	44	Abnormal loss[a]	33
Direct wages	130	Balance c/fwd	213
Production overhead control (£130 × 150%)	195		
Work in progress 1	483		
	1154		1154
Balance b/fwd	213		

Finished goods account

	(£)		(£)
Balance b/fwd	60	Cost of sales	844
Work in progress 2	908	Balance c/fwd	124
	968		968
Balance b/fwd	124		

Debtors account

	(£)		(£)
Balance b/fwd	1120	Bank	1140
Sales	1100	Balance c/fwd	1080
	2220		2220
Balance b/fwd	1080		

Capital account

	(£)		(£)
		Balance b/fwd	2200

Retained profit account

	(£)		(£)
		Balance	220

Creditors account

	(£)		(£)
Raw material stocks	10	Balance b/fwd	300
Bank	330	Raw material stocks	210
Balance c/fwd	170		
	510		510
		Balance c/fwd	170

Bank account

	(£)		(£)
Debtors	1140	Balance b/fwd	464
Balance c/fwd	466	Direct wages	200
		Production overhead control	170
		Production overhead control	250
		Creditors	330
		Administration overhead	108
		Selling/distribution overhead	84
	1606		1606
		Balance b/fwd	466

Sales account

	(£)		(£)
Balance c/fwd	2300	Balance b/fwd	1200
		Debtors	1100
	2300		2300
		Balance c/fwd	2300

Cost of sales account

	(£)		(£)
Balance b/fwd	888	Balance c/fwd	1732
Finished goods	844		
	1732		1732
Balance b/fwd	1732		

Abnormal loss account

	(£)		(£)
Balance b/fwd	9	Balance c/fwd	62
Work in progress 1[a]	20		
Work in progress 2[a]	33		
	62		62
Balance b/fwd	62		

Production overhead control account

	(£)		(£)
Bank	170		
Bank	250	Work in progress 1	210
Provision for depreciation	8	Work in progress 2	195
		Production overhead under/over-absorbed (Balance)	23
	428		428

Production overhead over/under absorbed account

	(£)		(£)
Production overhead control	23	Balance b/fwd	21
		Balance c/fwd	2
	23		23
Balance b/fwd	2		

Administration overhead account

	(£)		(£)
Balance b/fwd	120	Balance c/fwd	228
Bank	108		
	228		228
Balance b/fwd	228		

Selling and distribution overhead account

	(£)		(£)
Balance b/fwd	80	Balance c/fwd	164
Bank	84		
	164		164
Balance b/fwd	164		

Wages account

	(£)		(£)
Bank	200	Work in progress 1	84
Balance c/fwd	14	Work in progress 2	130
	214		214
		Balance b/fwd	14

Notes

[a]The total cost of the abnormal losses are:

	Process 1	Process 2
	(£)	(£)
Direct materials	6	18
Direct wages	4	6
Production overhead	10 (250% × £4)	9 (150% × £6)
	20	33

[b]WIP transfers are:

	From WIP1 to WIP2	From WIP2 to Finished goods
	(£)	(£)
Direct materials	154	558
Direct wages	94	140
Production overhead	235 (250% × £94)	210 (150% × 140)
	483	908

(c) See 'Normal and Abnormal losses' in Chapter 5 for an explanation and possible reasons for abnormal losses.

Answer to question 4.2

(a) (i) *Raw materials stock account*

	(£)		(£)
Opening stock (110 − 7)	103	Issues (difference)	578
Purchases	640	Returns (to supplier)	20
		Closing stock (130 + 15)	145
	743		743

(ii) *Work in progress account*

	(£)		(£)
Opening stock (25 + 3)	28	Finished goods a/c (difference)	984
Raw materials a/c	578	Closing stock (27 – 5)	22
Direct labour (220 + 20)	240		
Production overhead absorbed (240 at $66\frac{2}{3}\%$)	160		
	1006		1006

(iii) *Finished goods account*

	(£)		(£)
Opening stock (82 – 9)	73	Cost of sales a/c (difference)	989
Work in progress a/c	984	Closing stock (72 – 4)	68
	1057		1057

(iv) *Profit and loss account*

	(£)		(£)
Sales returns a/c	30	Sales a/c	1530
Cost of sales a/c	989		
Gross profit c/d	511		
	1530		1530
Production overheads under absorbed	2	Gross profit b/d	511
Administration expenses	200		
Net profit	309		
	511		511

The reconciliation statement indicates that discounts, selling expenses and debenture interest are not included in the cost accounts. Therefore these items are not included in the costing profit and loss account.

(b) Interest on capital tied up in stocks should be taken into account for decision-making and cost control purposes. This is because the interest on capital tied up in stocks represents an opportunity cost (in terms of the lost interest) which would have been earned if the money tied up in stocks had been invested.

Interest on capital tied up in stocks should not be included in product costs for stock valuation purposes per SSAP 9. Therefore the cost accumulation system will not include notional costs for stock valuation purposes. Nevertheless it is essential that all *relevant* costs (including opportunity costs) are included in cost statements for the purpose of decision-making and cost control.

Answers to extra questions for Chapter 5 Process costing

Answer to question 5.1

a)

Cost element	Opening WIP value (£)	Current cost (£)	Total cost (£)	Completed units	WIP equivalent units	Total equivalent units	Cost per unit (£)	WIP value (£)
Direct materials	17 400	162 600	180 000	8200	800	9000	20	16 000
Conversion	10 000	173 920	183 920	8200	160	8360	22	3 520
			363 920				42	19 520
					Completed units 8200 × £42 =			344 400
						Total cost		363 920

Process account

	Units	(£)		Units	(£)
Opening WIP	1000	27 400	Process B	8200	344 400
Materials	8000	162 600	Closing WIP c/d	800	19 520

Conversion cost	173 920	
	363 920	363 920

(b) *Calculation of equivalent production produced during current period*

	Total equivalent units	Opening WIP equivalent units	Equivalent units produced during period
Materials	9000	1000	8000
Conversion cost	8360	400	7960

Performance report

	Standard cost (£)	Actual cost (£)	Difference (£)
Materials	160 000 (8000 × £20)	162 600	2600 A
Conversion cost	183 080 (7960 × £23)	173 920	9160 F
			6560 F

Answers to extra questions for Chapter 6 Joint and by-product costing

Answer to question 6.1

(a) *Process 1 account*

	(kg)	(£)		(kg)	(£)
Materials	7000	3500	Normal loss (*W2*)	700	280
Labour and overhead		4340	Transferred to process 2 (*W1*)	6430	7716
Abnormal gain (*W3*)	130	156			
	7130	7996		7130	7996

Workings
(*W1*)

$$\text{Cost per unit} = \frac{\text{cost of production (£7840)} - \text{scrap value of normal loss (£280)}}{\text{expected output (6300 kg)}}$$

=£1.20 per kg

(*W2*) Normal loss is 10% of *total* output, which in this case is equivalent to total input [therefore normal loss = (10% × (6430 + 570))].
(*W3*) Abnormal gain = actual output (6430) − expected output (6300)

Normal loss account

	(£)		(£)
Process 1 (700 × £0.40)	280	Abnormal gain a/c (130 × £0.40)	52
		Cash (570 × £0.40)	228
	280		280

Abnormal gain account

	(£)		
Normal loss (130 × £0.40)	52	Process 1	156
P & L a/c	104		
	156		156

Process 2 account

	(kg)	(£)		(kg)	(£)
Previous process cost	6430	7 716	By-product net income	430	645
Labour and overhead		12 129	Output to be account for		19 200
			E	2000	
			F	4000	
	6430	19 845		6430	19 845

The allocation of £19 200 to E and F depends on the apportionment method used.

(i) *Physical output method*

E	F
(£)	(£)

1. Total output cost	6400 $\left(\frac{2000}{6000} \times £19\,200\right)$	12 800 $\left(\frac{4000}{6000} \times £19\,200\right)$
2. Closing stock	2880 $\left(\frac{2000 - 1100}{2000} \times £6400\right)$	2 560 $\left(\frac{4000 - 3200}{4000} \times £12\,800\right)$
3. Cost of sales	3520 $\left(\frac{1100}{2000} \times £6400\right)$	10 240 $\left(\frac{3200}{4000} \times £12\,800\right)$
4. Sales revenue	7700 (1100 × £7)	8 000 (3200 × £2.50)
5. Profit (4 − 3)	4180	(2 240)

(ii) *Market value of output method*

	E (£)	F (£)
1. Market value of output	14 000 (2000 × £7)	10 000 (4000 × £2.50)
2. Cost of output	11 200 $\left(\frac{14}{24} \times £19\,200\right)$	8 000 $\left(\frac{10}{24} \times £19\,200\right)$
3. Closing stock	5 040 $\left(\frac{[900]}{2000} \times £11\,200\right)$	1 600 $\left(\frac{[800]}{4000} \times £8\,000\right)$
4. Cost of sales	6 160 $\left(\frac{1100}{2000} \times £11\,200\right)$	6 400 $\left(\frac{3200}{4000} \times £8\,000\right)$
5. Sales revenue	7 700	8 000
6. Profit (5 − 4)	1 540	1 600

(c) See Chapter 6 for the answer to this question. In particular, the answer should stress that joint cost apportionments are necessary for stock valuation, but such apportionments are inappropriate for decision-making. For decision-making relevant costs should be used. It can be seen from the answer to part (b) that one method of apportionment implies that F makes a loss whereas the other indicates that F makes a profit. Product F should only be deleted if the costs saved from deleting it exceed the revenues lost.

Answer to question 6.2

(a)

	B (£)	K (£)	C (£)	Total (£)
Revenue	35 000	50 000	60 000	
Pre-separation joint costs (1)	17 500	12 500	10 000	
Post separation costs	20 000	10 000	22 500	
Profit/(loss)	(2 500)	27 500	27 500	52 500

(b)

Incremental costs	20 000	10 000	22 500	
Incremental revenue	14 000	30 000	42 000	
Incremental benefit	(6 000)	20 000	19 500	

Therefore profit will increase by £6000 if B is sold at split off point and the revised profit statements will be:

Revenue	21 000	50 000	60 000	
Pre-separation costs[a]	17 500	12 500	10 000	
Post separation costs	—	10 000	22 500	
Profit	3 500	27 500	27 500	58 500

Note

[a]B = 3500/8000 × £40 000; K = 2500/8000 × £40 000; C = 2000/8000 × £40 000.

Answers to extra questions for Chapter 7 Income effects of alternative cost accumulation systems

Answer to question 7.1

(a) See sections on some arguments in support of variable costing and some arguments in support of absorption costing in Chapter 7 for the answer to this question.

(b) (i)

		(£)	
Fixed production overhead per unit	=	0.60	(£144 000/240 000 units)
Variable production cost per unit	=	1.30	(£312 000/240 000 units)
Variable selling and administration overhead per unit	=	0.10	(£24 000/240 000 units)
Fixed selling and administration overhead per unit	=	0.40	(£96 000/240 000 units)
		2.40	
Selling price		3.00	
Profit		0.60	

	(£)
Fixed production overhead incurred	144 000
Fixed production overhead absorbed (260 000 × £0.60)	156 000
Over-recovery	£12 000

(ii) *Absorption costing profit*:

	(£)
Opening stock (40 000 × £1.90)	76 000
Production cost (260 000 × £1.90)	494 000
	570 000
Less closing stock (70 000 × £1.90)	133 000
Cost of sales (230 000 × £1.90)	437 000
Less over recovery of fixed production overhead	12 000
	425 000
Selling and administration overhead:	
Variable (230 000 × £0.10)	23 000
Fixed	96 000
Total cost	544 000
Sales (230 000 × £3)	690 000
Profit	£146 000

Marginal costing profit:

	(£)
Contribution (230 000 × (£3 − £1.40))	368 000
Less fixed costs (£144 000 + £96 000)	240 000
Profit	£128 000

(iii)

	(£)
Absorption costing profit	146 000
Fixed overhead included in stock increase (30 000 × £0.60)	18 000
Marginal costing profit	£128 000

(iv) The profit figure will be the same with both systems whenever production equals sales and therefore opening stock equals closing stock.

Answer to question 7.2

(a)

Cost element	Total cost (£)	Completed units	WIP equivalent units	Total equivalent units	Cost per unit (£)	WIP (£)
Materials	714 000	98 000	4000	102 000	7.00	28 000
Labour	400 000	98 000	2000	100 000	4.00	8000
Variable overhead	100 000	98 000	2000	100 000	1.00	2000
Fixed overhead	350 000	98 000	2000	100 000	3.50	7000
	1 564 000				15.50	45 000

(b) *Absorption costing profit statement*:

	(£)	(£)
Sales		1 800 000
Production cost	1 564 000	
Closing WIP	(45 000)	
Closing finished goods stock (8000 × £15.50)	(124 000)	1 395 000
Gross profit		405 000
Less: Variable selling and administration costs (£1.60 × 90 000)		(144 000)
Fixed selling and administration costs		(250 000)
Net profit		£11 000

(c) *Marginal costing profit statement*:

	(£)	(£)
Sales		1 800 000
Variable cost of production	1 214 000	
Closing WIP	(38 000)	
Closing finished goods stock (8000 × £12)	(96 000)	
Variable cost of sales	1 080 000	
Variable selling and administration costs	144 000	1 224 000
Contribution		576 000
Less: Fixed costs (350 + 200 + 50)		(600 000)
Net loss		£(24 000)

(d) The absorption costing statement shows a profit of £11 000 whereas the marginal costing statement shows a net loss of £24 000. The difference of £35 000 is due to the fact that the closing stock valuation includes £35 000 fixed overhead (£7000 WIP and £28 000 finished goods) whereas the fixed overheads are not included in the stock valuation when the marginal costing approach is used. Instead, *all* the fixed overheads are charged as a period cost. With the absorption costing system, the fixed overheads of £35 000 that are included in the stock valuation will be recorded as an expense when the stocks are sold. Consequently, the absorption costing method shows £35 000 greater profits than the marginal costing method. For a detailed discussion of a comparison of the impact on profits of the two methods see Chapter 7.

For internal profit measurement purposes both methods are acceptable, but for external reporting SSAP 9 requires that stocks should be valued on an absorption costing basis.

Answers to extra questions for Chapter 8 Cost-volume-profit-analysis

Answer to question 8.1

(a) This question requires the separation of total cost into the fixed and variable elements using the high–low method.

	Low (£)		High (£)	
Sales at £30 000 per unit	480 000	(16 × £30 000)	900 000	(30 × £30 000)
Profit	40 000		250 000	
Total costs (difference)	440 000		650 000	

An increase in output of 14 units results in an increase in total costs of £210 000. Assuming that fixed costs are constant for all activity levels the variable cost per unit is £15 000 (£210 000/14 units). At 30 units activity the variable costs will be £450 000 and monthly fixed costs are £200 000 (£650 000 − £450 000). Over a six-month period total fixed costs are £1 200 000.

Break-even point = Fixed costs (£1 200 000)/unit contribution (£15 000)
= 80 units

See Figure Q8.14 for graph.

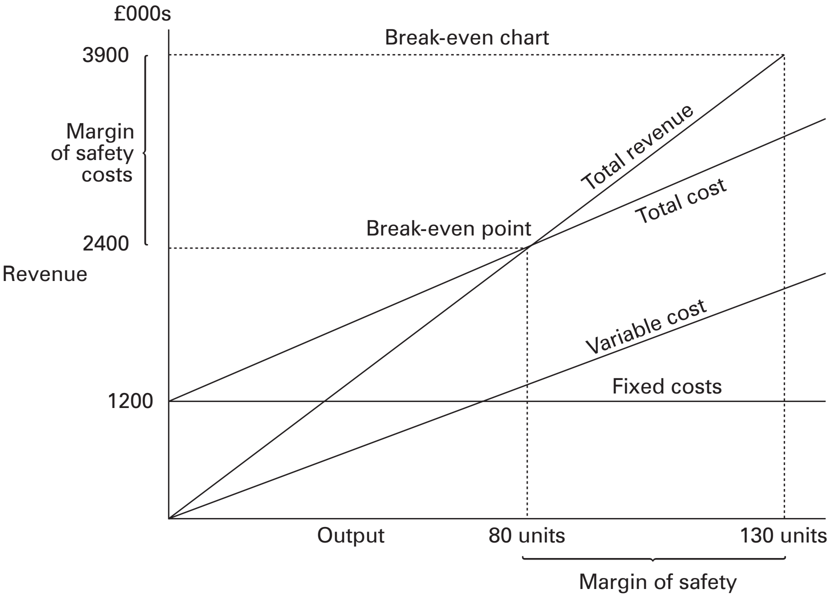


Figure Q8.14

(b) Revised unit contribution £10 000
Revised total contribution £143 000 (130 units × £1.10 × £10 000)
Revised profit £230 000 (£1 430 000 − £1 200 000 fixed costs)
Current profit £750 000 (130 × £15 000 − £1 200 000 fixed costs)

The selling price should not be reduced because profits will decline by £520 000.

(c) Costs may not be variable and fixed throughout the entire production range. For example, unit variable cost may not be constant because of bulk discounts on purchases and increasing and decreasing returns (see 'Economists' model', Chapter 8). Costs may also be semi-fixed or semi-variable (see Chapter 2 for an explanation of these terms).

Answer to question 8.2

(a)

	August (£)	September (£)	Change (£)
Sales	80 000	90 000	10 000
Cost of sales	50 000	55 000	5 000
Selling and distribution	8 000	9 000	1 000
Administration	15 000	15 000	Nil

The only activity measure that is given is sales revenue. An increase in sales of £10 000 results in an increase in cost of sales of £5000 and an increase in selling and distribution costs of £1000. It is therefore assumed that the increase is attributable to variable costs and variable cost of sales is 50% of sales and variable selling and distribution costs are 10% of sales.

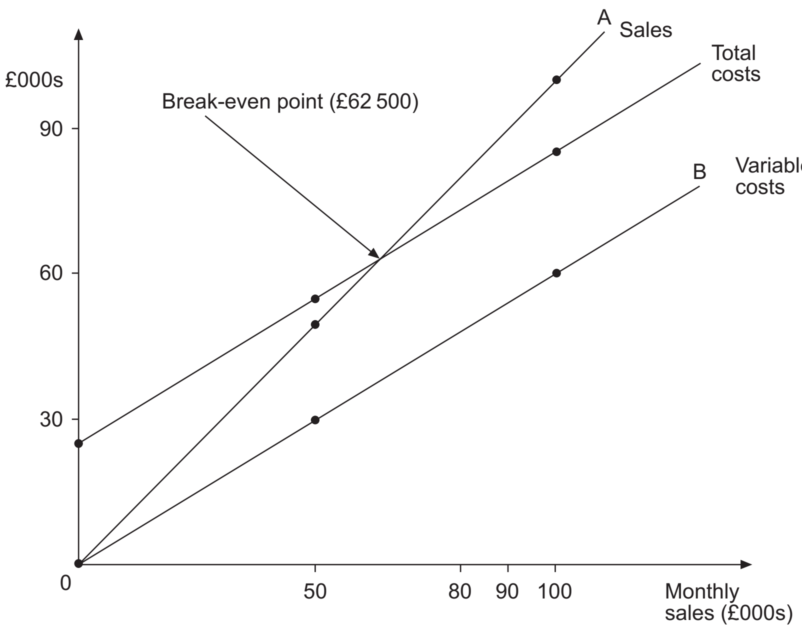
Fixed costs are derived by deducting variable costs from total costs for either month. The figures for August are used in the calculations below:

	Total cost (£)	Variable cost (£)	Fixed cost (Balance) (£)
Cost of sales	50 000	40 000	10 000
Selling and distribution	8 000	8 000	Nil
Administration	15 000	Nil	15 000
			25 000

Total cost = £25 000 fixed costs + variable costs (60% of sales)

(b) The following items are plotted on the graph:

	Variable cost	Total cost
Zero sales	Nil	£25 000 fixed cost
£80 000 sales	£48 000 (60%)	£73 000
£90 000 sales	£54 000 (60%)	£79 000
£50 000 sales	£30 000 (60%)	£55 000
£100 000 sales	£60 000	£85 000



Area of contribution = Area AOB

Figure Q8.15 *Contribution break-even graph.*

$$\text{Break-even point} = \frac{\text{Fixed costs (£25 000)}}{\text{Contribution to sales ratio (0.40)}} = \text{£62 500 sales}$$

(c)

		(£)
Actual sales = 1.3 × Break-even sales (£62 500)	=	81 250
Contribution (40% of sales)	=	32 500
Fixed costs	=	25 000
Monthly profit	=	7 500
Annual profit	=	90 000

(d)

		(£)
Annual contribution from single outlet (£32 500 × 12)	=	390 000
Contribution to cover lost sales (10%)	=	39 000
Specific fixed costs	=	100 000
Total contribution required		529 000

Required sales = £529 000/0.4 = £1 322 500

(e) The answer should draw attention to the need for establishing a sound system of budgeting and performance reporting for each of the different outlets working in close conjunction with central office. The budgets should be merged together to establish a master budget for the whole company.

Answer to question 8.3

(a) *With promotion*

Unit variable cost	=	£1.54	(55% × £2.80)
Promotional selling price	=	£2.24	(80% × £2.80)
Promotional contribution per unit	=	£0.70	
Contribution for 4 week promotion period	=	£16 800	(6000 × 4 weeks × £0.70)
Less incremental fixed costs	=	£5 400	
		£11 400	

Without promotion

Normal contribution per unit	=	£1.26	(£2.80 × 45%)
Contribution for 4 week period	=	£12 096	(£1.26 × 2400 × 4 weeks)

Therefore the promotion results in a reduction in profits of £696.

(b) Required contribution = £17 496 (£12 096 + £5400 fixed costs)
Required sales volume in units = 24 994 (£17 496/£0.70 unit contribution)
Required weekly sales volume = 6249 units (24 994/4 weeks)
Sales multiplier required = 2.6 (6249/2400)

(c) Other factors to be considered are:
(i) The effect of the promotion on sales after the promotion period.
(ii) Impact of the promotion on sales of other products during and after the promotion.

Answer to question 8.4

(a) *Calculation of total contribution*

		(£)
Product A (460 000 × £1.80)	=	828 000
Product B (1 000 000 × £0.78)	=	780 000
Product C (380 000 × £1.40)	=	532 000
		2 140 000

Calculation of total sales revenue

		(£)
Product A (460 000 × £3)	=	1 380 000
Product B (1 000 000 × £2.45)	=	2 450 000
Product C (380 000 × £4)	=	1 520 000
		5 350 000

Break-even point (sales revenue basis) $= \dfrac{\text{fixed costs (£1 710 000)} \times \text{total sales (£5 350 000)}}{\text{total contribution (2 140 000)}}$

= £4 275 000

(b) *£2.75 selling price*

Total contribution 590 000 × (£2.75 − £1.20)	914 500
Existing planned contribution	828 000
Extra contribution	86 500
Less additional fixed costs	60 000
Additional contribution to general fixed costs	26 500

£2.55 selling price

	(£)
Total contribution 650 000 × (£2.55 − £1.20)	877 500
Existing planned contribution	828 000
Extra contribution	49 500
Less additional fixed costs	60 000
Contribution to general fixed costs	(10 500)

It is worthwhile incurring the expenditure on advertising and sales promotion at a selling price of £2.75.

(c) Required contribution = existing contribution (£828 000)
+ additional fixed costs (£60 000)
= £888 000

The required sales volume at a selling price of £2.75 that will generate a total contribution of £888 000 is 572 903 units (£888 000/£1.55 unit contribution).

(d) See 'Margin of safety' in Chapter 8 for the answer to this question. At the existing selling price for product A, the margin of safety for Z Ltd is £1 075 000 (£5 350 000 sales revenue − £4 275 000 break-even point) of sales revenue. This is 20.1% of the current level of sales. If Z Ltd incurs the advertising and promotion expenditure and reduces the selling price to £2.75 for product A, the break-even point will increase to £4 446 000 and total sales revenue will increase to £5 593 000. This will result in a margin of safety of £1 147 000 or 20.5% of sales.

Answer to question 8.5

Break-even point	$\dfrac{\text{fixed costs}}{\text{contribution per unit}}$
Product X	25 000 units (£100 000/£4)
Product Y	25 000 units (£200 000/£8)
Company as a whole	57 692 units (£300 000/£5.20[a])

Note

$${}^{a}\text{Average contribution per unit} = \frac{(70\,000 \times £4) + (30\,000 \times £8)}{100\,000 \text{ units}}$$
$$= £5.20$$

The sum of the product break-even points is less than the break-even point for the company as a whole. It is incorrect to add the product break-even points because the sales mix will be different from the planned sales mix. The sum of the product break-even points assumes a sales mix of 50% to X and 50% to Y. The break-even point for the company as a whole assumes a planned sales mix of 70% to X and 30% to Y. CVP analysis will yield correct results only if the planned sales mix is equal to the actual sales mix.

Answer to question 8.6

(a) (£000)

Period 2 sales volume at period 1 prices (1108.1 × 100/105)	=	1055.333
Period 1 sales volume at period 1 prices	=	902.000
Increase in sales attributable to sales volume		153.333
% increase in sales volume (153.333/902 × 100)	=	17%

(b) (i)

	(£000)
Increase in sales attributable to sales volume	153.333
Contribution based on period 1 cost structure (60% of sales)	92.000
Fixed costs are assumed to be unaffected by volume changes	
Increase in profit attributable to volume	92.000

(b) (ii)

	Period 2 sales volume at period 1 prices and period 1 production methods (£000)	Period 2 sales volume at period 1 prices and period 2 production methods (£000)
Sales	1055.333	1055.333
Variable costs	422.133[a]	379.905[b]
Contribution	633.200	675.428
Fixed costs	490.500[c]	522.857[d]
Net profit	142.700	152.571

	(£000)
Reduction in variable costs arising from reorganization in production methods	42.228
Increase in fixed costs arising from reorganization in production methods	(32.357)
	9.871

Notes:
[a] Sales × period 1 contribution to sales ratio of 60%
[b] £398.9 × 100/105
[c] Fixed costs are assumed to be unaffected by changes in sales volume
[d] £549.0 × 100/105

(c) Required contribution = Period 2 fixed costs (£549 000) + Period 1 profit (£50 700) = £599,700. The contribution/sales ratio (profit–volume ratio) for period 2 is 64% (£709.2/£1108.1). In other words each £1 sale generates £0.64 contribution. To generate a contribution of £599 700 sales revenue of £937 031 is required (£599 700/0.64).

(d) The formula for the break-even point in sales revenue is:

$$\frac{\text{Fixed costs}}{\text{Contribution/sales ratio}} \text{ or Fixed costs} \times \frac{\text{Sales}}{\text{Contribution}}$$

When sales revenue generates a contribution that is exactly equal to fixed costs break-even point is achieved. To determine this level of sales revenue fixed costs must be divided by the rate at which contribution is made per £1 of sales.

Answer to question 8.7

(a) *Budgeted ROCE*

	Sales (£000)		Gross profit (£000)	
Accommodation	1350	(45%)	945	(70%)
Restaurant	1050	(35%)	210	(20%)
Bar	600	(20%)	180	(30%)
	3000		1335	
Less fixed costs			565	
Profit before tax			770	

ROCE 770/7000 × 100 = 11%

(b) (i) Required additional profits = £280 000 (4% × £7 million)
Contribution per two-night holiday:

		Sales (£)	Gross profit % margin (£)	Contribution (£)
Accommodation	(2 × £25)	50	70	35
Restaurant	(40% × £50)	20	20	4
Bar	(20% × £50)	10	30	3
				42

Number of holidays required to provide a contribution of £280 000 = 6667 (£280 000/42)
Number of holidays per week in three off-peak quarters = 171 (6667/39)

		(£000)
(ii) Required additional contribution		280
Contribution arising from increases in selling prices from:		
Restaurant (10% × £1 050 000)	105	
Bar (5% × £600 000)	30	135
Required additional contribution from accommodation		145

Percentage required increase in accommodation prices = 145/1350 × 100
= 10.74%

To achieve the desired increase in ROCE, accommodation prices would have to increase by 10.74%. It is assumed that demand would be unaffected by a price increase of this magnitude.

(c) The major problems arising are:

(i) *Two-flight cheap holidays*

1. Avoiding an increase in fixed costs. For 9 months, the proposal would require 171 additional customers staying at the hotel each week. Will this increased demand cause an increase in fixed costs (e.g. reception and maintenance staff)?
2. The calculations in (a) assume that variable costs vary with sales revenue rather than the number of customers. It is assumed that the gross margin percentage will be the same on cheaper holidays. This implies that the variable costs as a percentage of sales revenue will be reduced. It is therefore important that the assumptions made in (a) regarding variable costs being a function of sales revenue are appropriate. An alternative assumption, such as variable costs being a function of the number of guest days, would result in a different answer.
3. Will the introduction of cheap holidays affect the sales volume relating to normal business?

(ii) *Increasing prices*

1. An increase in selling prices may lead to a reduction in demand.
2. With this proposal, it is also assumed that variable costs are a function of sales revenue. If variable costs per guest night were to remain unchanged, the gross profit percentage margin would increase if prices were increased.
3. There is a need to obtain more information before increasing prices. For example, when were the prices last increased, how does the price increase compare with current levels of inflation, how do the hotel prices compare with competitors' prices?

Recommendation

The assumptions in (a) regarding the percentage reduction in variable costs and no increase in fixed costs are questionable. Also, a large number of holidays would need to be sold in order to achieve the target ROCE. In contrast, a modest price increase of 10% seems possible without adversely affecting demand. On the basis of the information given, it is recommended that the second alternative be chosen.

Answer to question 9.1

(a) Company gross profit % = 38% (£3268/£8600 × 100)

Therefore Division 5 gross profit %	= 19%
Division 5 sales	= £860 000 (10% × £8.6m)
Division 5 gross profit	= £163 400 (19% × £860 000)
Division 5 contribution	= £479 400 (£316 000 + £163 400)

The situation for the year ahead if the division were not sold would be as follows:

Contribution	= £527 340 (£479 400 × 1.1)
Less avoidable fixed costs	= £455 700 [£316 000 + (£156 000 − £38 000)] × 1.05
Add contribution from other divisions	= £20 000
Expected profit	£91 640

If Division 5 were sold, the capital sum would yield a return of £75 400. Therefore the decision on the basis of the above information should be not to sell Division 5.

(b) Other factors that should influence the decision include:
   (i) The need to focus on a longer-term time horizon. A decision based solely on the year ahead is too short and ignores the long-term impact from selling Division 5.
   (ii) The impact on the morale of the staff working in other divisions arising from the contraction of activities and the potential threat of redundancies.
   (iii) Alternative use of the resources currently deployed in Division 5 instead of their current use.

(c) If Division 5 is sold, the capital sum would yield a return of £75 000, but a contribution of £20 000 is lost. Consequently, a profit of £55 000 is required. The required contribution is therefore £510 700 (£55 000 + £455 700) and the percentage increase required is 6.5% (£510 700/£479 400 − 100%).

Answer to question 9.2

(a)

Planned/total contribution and profit for the year ending 31 December

Route	W (£)	X (£)	Y (£)	Z (£)	Total (£)
Income:					
Adult	140 400	187 200	351 000	137 280	
Child[a]	46 800	74 880	35 100	34 320	
Total	187 200	262 080	386 100	171 600	
Variable costs:					
Fuel and repairs[b]	24 570	21 060	25 740	22 230	
Bus contribution	162 630	241 020	360 360	149 370	
Specific fixed costs:					
Wages[c]	74 880	74 880	74 880	74 880	
Vehicle fixed costs	4 000	4 000	4 000	4 000	
Route contribution	83 750	162 140	281 480	70 490	597 860
General administration					300 000
Profit					297 860

Notes
[a] 52 weeks × 6 days × 5 journeys per day × number of passengers × return fare × 2 vehicles
[b] 52 weeks × 6 days × 5 journeys per day × return travel distance × £0.1875 × 2 vehicles
[c] 52 weeks × 6 days × £120 × 2 vehicles

(b) (i) The relevant (differential) items are the return fares and the average number of passengers per journey:

	Adult (£)	Child (£)
Existing revenue per journey	45 (15 × £3.00)	15 (10 × £1.50)
Revised revenue per journey	45 (12 × £3.75)	12 (8 × £1.50)
Net gain/(loss)	nil	(3)

The contribution per return journey will decrease by £3.

(b) (ii) The above analysis suggests that the fare should not be amended on route W. The only justification is that the current prices result in the average number of passengers being 25 per journey so it is possible that occasionally demand may exceed full capacity of 30 passengers resulting in some passengers not being able to be carried. With the price increase the average number of passengers will be 20 and it is less likely that some passengers will not be able to be carried.

(c) (i) *Annual cost of existing maintenance function*

	(£)	(£)
Staffing		
Fitters (£15 808 × 2)	31 616	
Supervisor	24 000	55 616
Material costs		
Bus servicing (499 200 km[a]/4000) × £100	12 480	
Bus safety checks (48 per year at £75)	3 600	
Taxi servicing (128 000 km/4000 × 6 vehicles) × £100	19 200	
Taxi safety checks (36 per year at £75)	2 700	37 980
Total cost		93 596

Note
[a] 160 km per journey × 5 journeys × 52 weeks × 6 days × 2 vehicles

(c) (ii)

	(£)	(£)
Annual cost of keeping own maintenance		
Annual operating costs	93 596	
Cost of new employee	20 000	113 596
Annual cost of buying in maintenance		
Contract cost	90 000	
Redundancy costs for fitters	15 808	105 808
Savings in the first year from buying in maintenance		7 788

There will be a saving after the first year from buying in maintenance of £23 596 because the redundancy cost will be incurred for one year only.

(c) (iii) AZ will lose control of the operations if the service is carried out externally. It will be more difficult to ensure quality of work and schedule the servicing as required. Once the skills have been lost from outsourcing it may be difficult to re-establish them. Also AZ will be at the mercy of the supplier when the contract is re-negotiated. The extent to which AZ will be dependent on the supplier will be influenced by how competitive the market is for providing a maintenance service.

AZ could also consider making vehicle servicing a profit centre which competes with external competitors for the work of the group.

Answer to question 9.3

(a) *Hours of installation labour required to satisfy maximum demand*

		(hours)
Day scan:	2000 units × 3 hours per unit	6 000
Night scan:	3000 units × 4 hours per unit	12 000
Omni scan:	1800 units × 5.5 hours per unit	9 900
		27 900
Available hours		25 000
Shortfall		2 900

Note that the labour hours per unit = installation labour cost/£8.

(b)

	Day scan	Night scan	Omni scan
	(£)	(£)	(£)
Selling price	250	320	460
Variable costs			
Material	(70)	(110)	(155)
Manufacturing labour	(40)	(55)	(70)
Installation labour	(24)	(32)	(44)
Variable overheads	(16)	(20)	(28)
Contribution per unit	100	103	163

Installation hours required	3	4	5.5
Contribution per installation hour	£33.33	£25.75	£29.64
Production priority	1st	3rd	2nd

Best production plan

	Units		Hours used
Day scan to maximum demand	2000	(× 3)	6000
Omni scan to maximum demand	1800	(× 5.5)	9900

This leaves (25 000 – 6000 – 9900) = 9100 installation labour hours for Night scan.

Therefore production of Night scan $= \dfrac{9100}{4} = 2275$ units

(c) *Maximum profit achievable*

	Total	Day scan	Omni scan	Night scan
Units		2000	1800	2275
	(£)	(£)	(£)	(£)
Contribution	727 725	200 000	293 400	234 325
Fixed costs	(450 000)			
	277 725			

(d) *Revised contributions*

	Day scan (£ per unit)	Night scan (£ per unit)	Omni scan (£ per unit)
Previous contribution	100	103	163
Reduction[a]	(12)	(16)	(22)
New contribution	88	87	141

Note
a Increase in labour cost at £4 per hour.
The profit arising from the production and sales of the maximum demand will be as follows:

	Total	Day scan	Night scan	Omni scan
Units		2000	3000	1800
	(£)	(£)	(£)	(£)
Contribution	690 800	176 000	261 000	253 800
Fixed costs	(450 000)			
Maximum profit	240 800			

Therefore, since the maximum profit would be reduced the firm should not implement the proposal.

Answer to question 9.4

(a)

	Chairs	Benches	Tables	Total
Timber required per unit (m^2)	2.5(£5/£2)	7.5(£15/£2)	5(£10/£2)	
Budgeted sales volume (units)	4 000	2 000	1 500	
Total timber required (m^2)	10 000	15 000	7 500	32 500

Production requirements exceed the available supply of materials by 12 500 m^2.

	Chairs	Benches	Tables
Unit contributions (£)	8	17.50	16
Timber requirements (m^2)	2.5	7.5	5
Contribution per m^2 (£)	3.2	2.33	3.20
Ranking	1	3	1

The scarce materials should be allocated as follows:

	Materials used	Balance unused
Chairs (4000 units × 2.5)	10 000	10 000
Tables (1500 units × 5)	7 500	2 500
Benches (2500/7.5 = 333 units)	2 500	—

The above production plan is sufficient to meet the order that has already been accepted. The profit arising from the above production plan is calculated as follows:

	(£)
Chairs (4000 units × £8 contribution)	32 000
Tables (1500 units × £16 contribution)	24 000
Benches (333 units × £17.50 contribution)	5 827
Total contribution	61 827
Fixed overheads (4000 × £4.50) + (2000 × £11.25) + (1500 × £9)	54 000
Profit	7 827

(b) The above production plan indicates that maximum sales demand for chairs and tables has been met but there is unutilized demand for benches. Therefore any additional materials purchased will be used to make benches yielding a contribution per unit sold of £17.50 and contribution per metre of material used of £2.33 (see part (a) for calculation). The company should not pay above £2.33 in excess of the acquisition cost of materials. The maximum purchase price is £4.33 (£2 + £2.33).

(c) See Chapter 2 for an explanation of each of the items listed in the question.

Answer to question 9.5

(a)

The constraints on producing Part A are:

Line S = 6666 units (4000/0.6 hrs)
Line T = 9000 units (4500/0.5 hrs)
Material restriction = 8125 units (13 000/1.6 kg)
Therefore the constraint of Line S limits production to 6666 units

The constraints on producing Part B are:

Line S = 16 000 units (4000/0.25 hrs)
Line T = 8182 units (4500/0.55 hrs)
Material restriction = 8125 units (13 000/1.6 kg)
Maximum production of Part B is 8125 units

Maximum contributions for Parts A and B are:

	Part A (£)		Part B (£)	
Line S machine time	48	(0.6 hrs × £80)	20	(0.25 hrs × £80)
Line T machine time	50	(0.5 hrs × £100)	55	(0.55 hrs × £100)
Materials	20	(1.6 kg × £12.50)	20	(1.6 kg × £12.50)
Variable cost	118		95	
Selling price	145		115	
Unit contribution	27		20	
Maximum output	6666	units	8125	units
Maximum contribution	£79 982		£162 500	

Therefore Part A should be produced since it yields the largest contribution.

(b) The company will earn a contribution of £179 982 but it cannot meet the maximum call off due to the limitations of Line S.

(c)

	Part A		Part B	
Original selling price	145		115	
10% reduction in selling price	14.50		11.50	
Revised unit contribution	12.50	(£27 − £14.50)	8.50	(£20 − £11.50)
Output	6666	units	8125	units
Total contribution	£83 325		£69 062	

Payment for unused machine hours[a]	£70 020	£120 000
Revised contribution	£153 345	£189 062

Note

[a]The payment for unused machine hours is calculated as follows:

	Part A (£)	
Line S at £60 per hour	—	(Fully used)
Line T at £60 per hour	70 020	(4500 − [6666 × 0.5 hrs])
	70 020	

	Part B (£)	
Line S at £60 per hour	118 125	(4000 − [8125 × 0.25 hrs])
Line T at £60 per hour	1 875	(4500 − [8125 × 0.55 hrs])
	120 000	

With the alternative pricing arrangement the company should produce Part B.

Answer to question 9.6

(a) Maximum production of each product is as follows:

	Traditional		Modern	
Machine X hour limitation	6800	(1700/0.25)	11 333	(1700/0.15)
Machine Y hour limitation	9600	(1920/0.20)	8 533	(1920/0.225)
Timber (m^2 limitation)	8500	(17 000/2)	8 500	(17 000/2)
Maximum sales	7400		10 000	
Maximum possible production	6800		8 500	

The contribution per unit of output is:

	Traditional (£)		Modern (£)	
Variable costs:				
Timber	5.00		5.00	
Machine X	6.25	(0.25 × £25)	3.75	(0.15 × £25)
Machine Y	6.00	(0.20 × £30)	6.75	(0.225 × £30)
	17.25		15.50	
Selling price	45.00		40.00	
Contribution	27.75		24.50	

Assuming that only one of the products can be sold the maximum contribution from the sales of each product is:

Traditional	£188 700 (6800 × £27.75)
Modern	£208 250 (8500 × £24.50)

The company should therefore sell 8500 units of the 'Modern' lampstand.

(b) The spare machine capacity assuming that 6800 units of the 'Traditional' lamp-stand or 8500 of the 'Modern' lampstand are produced is as follows:

	Machine X (Hours)	Machine Y (Hours)
Production of 6800 of Traditional	Nil [1700 − (6800 × 0.25)]	560 [1920 − (6800 × 0.20)]
Production of 8500 of Modern	425 [1700 − (8500 × 0.15)]	7.5 [1920 − (8500 × 0.225)]

The revised contributions are:

	Traditional (£)	Modern (£)	
Original contribution	188 700	208 250	
Sales from unused capacity of machine X	Nil	8 500	(425 × £20)

Sales from unused capacity of machine Y	16 800	(560 × £30)	225	(7.5 × £30)
	205 500		216 975	

The above figures indicate that the 'Modern' lampstands should still be sold when an alternative sales outlet exists.

(c)

	Traditional		Modern		Total
Units produced and sold	4250		4250		
Timber (metres) used (2 metres per unit)	8500		8500		17 000
Machine X hours used	1062.5	(4250 × 0.25)	637.5	(4250 × 0.15)	1700
Machine Y hours used	850	(4250 × 0.20)	956.25	(4250 × 0.225)	1806.25
Contribution	£117 937.50	(4250 × £27.75)	£104 125	(4250 × £24.50)	£222 062.50
Contribution from machine Y spare capacity [(1920 − 1806.25) × £30]					£3 412.50
Total contribution					£225 475.00

(d) In order to overcome the capacity constraints the following alternative courses of action should be considered:

(i) Hire additional machinery to meet short-term demand and evaluate purchase of additional machinery if the shortage of capacity is expected to continue in the long term.

(ii) Increase output per machine hour by more efficient operating or increasing machine speeds. However, additional costs and lost output might arise from machine breakdowns.

(iii) Increase machine capacity by introducing additional shifts. This will lead to increased shift and overtime payments and may also result in machine breakdowns arising from more intensive use of machinery.

(iv) Sub-contract production but this will lead to increased costs and possibly lost sales arising from inferior quality products, late delivery etc.

(v) Seek alternative supplies of timber since this is a limiting factor. Care should be taken to ensure that any additional purchase and delivery costs do not exceed the contribution from increased sales.

Answer to question 9.7

(a) Existing capacity of direct labour:

	(£)
P 4560 kg at £1.96 per kg	8 937.60
Q 6960 kg at £1.30 per kg	9 048.00
R 3480 kg at £0.99 per kg	3 445.20
S 2300 kg at £1.70 per kg	3 910.00
	25 340.80
5% increase to full capacity	1 267.04
Direct labour cost at full capacity	26 607.84

If 2000 kg of product Q is purchased from an outside supplier then this will release direct labour by £2600 (2000 kg at £1.30 per kg). Consequently, £3867 capacity is available (£2600 plus extra capacity of £1267) for producing product P. Therefore output of P can be increased by 1973 kg (£3867/£1.96). The impact on profits will be:

	(£)
Additional contribution from P (1973 kg at £6.88)	13 574
Loss of contribution from Q (2000 kg at £3.536[a])	7 072
Additional contribution	6 502

EF should subcontract 2000 kg of Q and produce an extra 1973 kg of P.

Note

[a] Contribution = selling price (0.9 × £11.64) − variable cost (£6.94) = £3.536

(b)

	P	Q	R	S
	(£)	(£)	(£)	(£)
Proposed subcontract price (90% of selling price)	14.58	10.476	8.928	12.312
Variable cost	9.32	6.94	5.65	7.82
Loss of contribution	5.26	3.536	3.278	4.492

Direct labour released from subcontracting 2000 kg	*Additional production (kg) from releasing direct labour*			
	P	Q	R	S
£3920 from P[a]	—	3015[e]	3959[f]	2305[g]
£2600 from Q[b]	1326[h]	—	2626	1529
£1980 from R[c]	1010	1523	—	1164
£3400 from S[d]	1734	2615	3434	—
Extra 5% of capacity (£1267)	646[i]	974	1280	745

Notes
[a]2000 × £1.96; [b] 2000 × £1.30; [c] 2000 × £0.99; [d] 2000 × £1.70; [e] £3920/£1.30 per kg; [f] 3920/£0.99; [g] £3920/£1.70; [h] £2600/£1.96; [i] £1267/£1.96.

	Extra contribution gained (£)			
	P	Q	R	S
Contribution per kg	6.88	4.70	4.27	5.86
2000 kg of P subcontracted	—	8228[a]	11 850[b]	7353[c]
2000 kg of Q subcontracted	6495[d]	—	9 607[e]	6253[f]
2000 kg of R subcontracted	4837[g]	5180[h]	—	4630[i]
2000 kg of S subcontracted	7390[j]	7884[k]	11 144[l]	—

Notes
[a] (3015 + 974) × £4.70 − (2000 × £5.26 lost contribution)
[b] (3959 + 1280) × £4.27 − (2000 × £5.26 lost contribution)
[c] (2305 + 745) × £5.86 − (2000 × £5.26 lost contribution)
[d] (1326 + 646) × £6.88 − (2000 × £3.536 lost contribution)
[e] (2626 + 1280) × £4.27 − (2000 × £3.536 lost contribution)
[f] (1529 + 745) × £5.86 − (2000 × £3.536 lost contribution)
[g] (1010 + 646) × £6.88 − (2000 × £3.278 lost contribution)
[h] (1523 + 974) × £4.70 − (2000 × £3.278 lost contribution)
[i] (1164 + 745) × £5.86 − (2000 × £3.278 lost contribution)
[j] (1734 + 646) × £6.88 − (2000 × £4.492 lost contribution)
[k] (2615 + 974) × £4.70 − (2000 × £4.492 lost contribution)
[l] (3434 + 1280) × £4.27 − (2000 × £4.492 lost contribution)

Recommendations:
The most profitable combination is to subcontract 2000 kg of P and replace this with 5239 kg (3959 + 1280) of R, thus increasing contribution by £11 850.

Answers to extra questions for Chapter 11 Pricing decisions and profitability analysis

Answer to question 11.1

(a) (i) Contract price for contract A using the normal pricing method.

	(£)
Materials	
Z (100 × £7) + (1000 × £10)	10 700
Y (150 × £40)	6 000
X (300 × £35) + (300 × £33)	20 400
W (200 × £20)	4 000
	41 100
Labour: Craftsmen 2 × ($\frac{1}{2}$ × £16 000 + £700)	17 400
Labourers 3 × £4000	12 000
	70 500
Add 100% mark-up	70 500
Contract price	£141 000

(ii) Minimum price based on relevant costs

	(£)
Materials: Z (1100 × £10)	11 000
Y (150 × £44)	6 600
X (300 × £25) + (300 × £33)	17 400
W (200 × £16)	3 200
	38 200
Labour: Craftsmen (£11 800 + 2 × £700)	13 200
Labourers (3 × £4000)	12 000

Equipment: General purpose (£16 400 − £12 600)	3 800
Specialized (£9000 − £5800)	3 200
Administrative expenses	5 000
Contract price	75 400

It is assumed that the specialized equipment would be purchased new for £9000.

(b)

	(£)
Expected sales value (0.7 × £100 000) + (0.3 × £120 000)	106 000
Expected building costs (0.4 × £60 000) + (0.4 × £80 000) + (0.2 × £95 000)	(75 000)
Building plot	(20 000)
Expected profit	11 000

Using expected profit as a measure of the alternative use of the capacity, the minimum price using the relevant cost approach would be £86 400 (£75 400 + £11 000). In other words, Wright would wish to ensure that the contract price is in excess of the profit available from the alternative use of the facilities, and this would depend on his assessment of the 'utility value' of project B. Note that the expected value approach is covered in Chapter 12.

(c) This question requires a discussion of cost-plus pricing and the relevant cost (that is, opportunity cost) approach to pricing. For a discussion of the limitations and merits of cost-plus pricing see 'Limitations of cost-plus pricing' and 'Reasons for using cost-based pricing formulae' in Chapter 11. The advantages of basing selling prices on relevant costs include:

(i) The alternative uses of resources are incorporated into the analysis.
(ii) It distinguishes between relevant and irrelevant costs and indicates the incremental cash flows incurred in manufacturing and selling a product.
(iii) It provides the information to enable tenders to be made at more competitive prices.

The limitations include:

(i) It is a cost-based pricing method that ignores demand.
(ii) It may provide an incentive to sell at low prices, resulting in total sales revenue being insufficient to cover total fixed costs.
(iii) There is difficulty in determining the opportunity cost of resources because information on available opportunities may not be known.
(iv) Where special contracts are negotiated that are in excess of relevant (incremental) costs but less than full costs, there is a danger that customers will expect repeat business at this selling price. Care must be taken to ensure that negotiating 'special one-off' contracts does not affect the demand for other products.

Relevant cost pricing is more appropriate for 'one-off' pricing decisions. It is also appropriate in situations where a firm has unutilized capacity or can sell in differentiated markets at different prices. Relevant cost pricing may also be appropriate where the policy is to sell certain products as 'loss leaders'. It is important that cost information be used in a flexible manner and that product costs not be seen as the only factor that should determine the final selling price.

Answer to question 11.2

(a) Selling prices using the existing policy of full cost 1 5%

Cost of 1250 filter elements	(£)
Direct labour	18 750
Materials	43 750
Variable overhead	12 500
Variable cost (£60 per unit)	75 000
Fixed overhead	5 000
Fixed packaging and selling cost	7 000
	87 000

Full cost per filter element = $\frac{£87\,000}{1250}$ = £69.60

Full cost per complete unit = £69.60 + £305 = £374.60

Using full cost + 5%, rounded up to nearest £1:

Selling price for complete unit = £374.60 × 1.05 = £394.00

Selling price for replacement elements = £69.60 × 1.05 = £74.00

(b) At a selling price of 20% above the market leader for the replacement filter sales of the complete units will not be affected. Therefore the maximum price of £96 (£80 × 1.20) should be charged for replacement filters.

At a selling price of £280 demand is expected to be 800 units (40% × 2000). Each increase in price of £1 causes demand to fall by 5 units. Therefore at a selling price of £440 demand will be zero. To increase demand by one unit the selling price must be reduced by £0.20. Thus the maximum selling price for an output of x units is:

$SP = £440 - £0.20x$
Total revenue for an output of x units $= £440x - £0.20x^2$
Marginal revenue $= dTR/dx = £440 - £0.40x$
Total cost $= 305x + 60x + £5000 + £7000$
Marginal cost $= £365$

The sale of one complete unit results in the sale of four replacement filters during its life at a marginal revenue of £96 and a marginal cost of £60 per unit.

Total MC $= £365 + (4 \times £60) = £605$
Total MR $= £440 - 0.4x + (4 \times £96) = £824 - 0.4x$
At the optimal output level where MR = MC:
$£824 - 0.4x = £605$
$x = 548$ units

This gives a selling price of £440 − 0.20 (548) = £330.40

(c) *Original selling price*

The profit for each of the years would be constant:

		(£)	(£)
Sales:	complete units 250 @ £394		98 500
	replacement elements 1000 @ £74		74 000
			172 500
Variable costs:	pumps 250 @ £305	76 250	
	other 1250 @ £60	75 000	
			(151 250)
Contribution			21 250
Fixed costs:			(12 000)
Profit			9 250

Revised selling price

	2002		2003		2004	
	(£)	(£)	(£)	(£)	(£)	(£)
Revenues:						
Complete units 548 @ £330.40		181 059.20		181 059.20		181 059.20
Replacement elements @ £96[a]		96 000.00		124 608.00		153 216.00
		277 059.20		305 667.20		334 275.20
Variable costs:						
Complete units 548 @ £305	167 140		167 140		167 140	
Replacement elements @ £60[a]	92 880		110 760		128 640	
		(260 020.00)		(277 900.00)		(295 780.00)
		17 039.20		27 767.20		38 495.20
Fixed costs		(12 000.00)		(12 000.00)		(12 000.00)
Profit		5 039.20		15 767.20		26 495.20
Change in profits		(4210.80)		6 517.20		17 245.20

Note
[a]The number of replacement filters will increase over the next four years because they are replaced at the end of each year (four times during their lifetime). Therefore sales of replacement filters are related to sales in previous periods. The question also states that production of replacement filters must be sufficient to meet annual sales demand plus the production of a filter to be included in the sale of one completed unit. Thus production of filters will exceed sales by 548 filters per year. The sales and production volumes of replacement filters is calculated as follows:

2002	Sales (Based on previous year's sales volume)	1000
	Production (1000 + 548)	1548

2003	Sales = ($\frac{3}{4} \times 1000$) + ($\frac{1}{4} \times [548 \times 4]$)		1298
	Production (1298 + 548)		1846
2004	Sales = ($\frac{1}{2} \times 1000$) + ($\frac{1}{2} \times [548 \times 4]$)		1596
	Production (1596 + 548)		2144

(d) The major competitor has set the selling price at £390 and the traditional cost-plus method results in a selling price of £394. The proposed new selling price is £330.40. The major concern with setting the new price is the possible reaction of competitors. Given that the total market is stable, a large decrease in selling price to increase market share is likely to cause competitors to reduce prices. This could result in a price cutting war in which market shares are merely maintained at lower prices. In the long term the company might be worse off.

A further problem is that the lower price may be perceived by customers as indicating an inferior quality product. Customers might therefore be reluctant to switch from their existing suppliers.

To overcome these problems the price reduction should be accompanied with an effective advertising campaign that emphasizes the price and quality aspects of the product.

(e) For the answer to this question see 'Limitations and Cost-plus pricing' and 'Reasons for using cost-plus prices' in Chapter 11.

Answers to extra questions for Chapter 12 Decision-making under conditions of risk or uncertainty

Answer to question 12.18

(a) *Decision tree and expected value calculation for site A*
See Figure Q12.18.

Year 0 Cash flows	Year 1 Cash flows	Year 2 Cash flows	Joint probability	PV (£)	Expected NPV (£)
		0	0.0625	90 910	5 628
		(0.25)			
	£100 000	£100 000	0.125	173 550	21 694
	(0.25)	(0.50)			
		£200 000	0.0625	256 190	16 012
		(0.25)			
		£100 000	0.125	264 640	33 080
		(0.25)			
Investment	£200 000	£200 000	0.25	347 100	86 775
outlay (£300 000)	(0.50)	(0.50)			
		£300 000	0.125	429 740	53 718
		(0.25)			
		£200 000	0.0625	438 010	27 376
		(0.25)			
	£300 000	£300 000	0.125	520 650	65 081
	(0.25)	(0.50)			
		£350 000	0.0625	561 970	35 123
		(0.25)	1.000		344 487
			Less investment outlay		300 000
			Expected NPV		44 487

Figure Q12.18 *Decision tree and expected value calculation for site A.*

(b) (i) It is assumed that the decision to abandon the project can be taken at the end of year 1. At this point in time, the cash flows for year 2 will be receivable in one year's time, whereas the sale proceeds will be receivable at the point when the decision is taken at the end of year 1. Therefore the decision should be to abandon the project if the PV of the cash flows receivable in one year's time is less than the £150 000 selling price. If the cash inflows in year 1 are £100 000 then the expected PV of the cash flows in year 2 will be:

Cash flows (£)	PV (£)	Probability	Expected PV (£)
100 000	90 910	0.50	45 455
200 000	181 820	0.25	45 455
			90 910

The site should therefore be sold for £150 000. If the cash flow for year 1 is £200 000, the expected PV of the cash inflows in year 2 will be:

Cash flows (£)	PV (£)	Probability	Expected NPV (£)
100 000	90 910	0.25	22 727
200 000	181 820	0.50	90 910
300 000	272 730	0.25	68 182
			181 819

The expected NPV is in excess of the sale proceeds, and therefore the project should not be abandoned.

(ii) If the cash flow in year 1 is £100 000 then the project will be abandoned and sold for £150 000 at the end of year 1. Therefore there is a probability of 0.25 that £250 000 will be received at the end of year 1. Hence the expected NPV will be £56 819. Therefore the entries in the expected value column of the decision tree in (a) for the first three branches (£5628, £21 694 and £16 012, totalling £43 334) will be replaced with an expected value of £56 819. Hence the total expected value will increase by £13 485 to £57 972 (£13 485 + £44 487).

(c) At time zero the financial effect is that the NPV of the project is increased by £13 485.

Answers to extra questions for Chapter 13 Capital investment decisions: 1

Answer to question 13.1

(a) The answer should stress that NPV is considered superior to the payback method and the accounting rate of return because it takes account of the time value of money. For a description of the time value of money you should refer to 'Compounding and discounting' and 'The concept of net present value' in Chapter 13. The answer should also draw attention to the limitations of the payback method and accounting rate of return described in Chapter 13.

(b) (i) To compute the NPV it is necessary to convert the profits into cash flows by adding back depreciation of £25 000 per annum in respect of the asset purchased at the end of year 3 for £75 000. The NPV calculation is as follows:

Year	Cash flow (£)	Discount factor	NPV
3	(75 000)	0.675	(50 625)
4	35 000	0.592	20 720
5	28 000	0.519	14 532
6	27 000	0.465	12 555
			(2 818)

(ii) The cash flows are based on the assumption that the reinvestment in R is not made at the end of year 3.

Year	Discount factor	Project T cash flows[a] (£)	Project T NPV (£)	Project R cash flows (£)	Project R NPV (£)
1	0.877	27 000	23 679	40 000 (3)[c]	35 080
2	0.769	30 000	23 070	45 000	34 605
3	0.675	32 000	21 600	45 000 (4)[d]	30 375
4	0.592	44 000	26 048		
5	0.519	40 000[b]	20 760		
			115 157		100 060
Investment outlay			70 000		60 000
NPV			45 157		40 060

Payback: T = 2 years + (£70 000 − £57 000)/£32 000 = 2.41 years
R = 1 year + (£60 000 − £40 000)/45 000 = 1.44 years

The decision should be to invest in Project T because it has the higher NPV.

Notes

[a]Yearly profits plus (£70 000 − £10 000)/5 years depreciation.
[b]£18 000 profits + £12 000 depreciation + £10 000 sale proceeds.
[c]Profits plus £60 000/3 years depreciation.
[d]£75 000 investment outlay − £50 000 = Annual profit (£25 000). Cash flow = £25 000 profit + £20 000 depreciation.

(c) For an explanation of the meaning of the term 'discount rate' see 'The opportunity cost of an investment' in Chapter 13.

The discount rate can be derived from observations of the returns shareholders require in financial markets. Where a project is to be financed fully by borrowing, the cost of borrowing could be used as a basis for determining the discount rate.

Answer to question 13.2

(a) The PV of the cash outflows is calculated as follows:

Year	Cash outflows (£)	PV at 10%
0	2 000 000	2 000 000
1	100 000	90 910
2	100 000	82 640
3	700 000	525 910
4	100 000	68 300
5	100 000	62 090
		2 829 850

Assuming that the contribution per hour is constant the contribution per hour is £666.67 (£1 600 000/2400 hrs). Over a 5-year period the present value per hour is £2527 (£666.67 × 3.791 discount factor for 5 years at 10%). Thus the annual flying hours to break even are 1120 (£2 829 850/£2527).

If the aircraft is rented the PV of the fixed rental charges is £1 042 500 (£250 000 × [1 + 3.170 discount factor]). The revised net contribution per hour is £305.67 (£666.67 − £361) giving a present value of £1 158.80 (£305.67 × 3.791 discount factor). Thus the annual hours to break even are 900 (£1 042 500/£1158.80).

To determine the indifference point between renting and buying let x = Annual flying hours. The indifference point is where:

$$\begin{aligned} £2527x &- £2\,829\,850 = £1158.80x - £1\,042\,500 \\ 1368.2x &= £1\,787\,350 \\ x &= 1306 \end{aligned}$$

Thus, at an activity level of 1306 flying hours per annum, the two options are equally financially viable. At activity levels of less than 1306 hours renting is preferable, whereas buying is preferable at activity levels in excess of 1306 hours.

(b) Profits are maximized when the aircraft are operated at full capacity of 2400 hours per year. Thus two aircraft should be purchased utilizing 4800 hours. A third aircraft will be required for the remaining 950 hours. At this activity level it is more profitable to rent the third aircraft.

Answer to question 13.3

(a)

Type A project appraisal	(£)	(£)
Cash inflows:		
Additional sales revenue from further processing (2000 × (£12.50 − £2))		21 000
Cash outflows:		
Direct costs (2000 × £2.50)	5 000	
Fixed costs	10 000	
Compensation payment	500	15 500
Annual net cash inflows		5 500
Cumulative discount factor (4 years at 8%)		3.312
PV of net cash inflows		£18 216
Investment outlay		£20 000
Net present value		(£1 784)

It is assumed that the apportioned rental cost of £2500 per annum will still continue if the project is not undertaken.

Type B waste	(£)	(£)
Cash inflows:		
Sales income (4000 × £11)	44 000	
Savings in contractor's fees (4000 × £14)	56 000	
Employee costs	9 000	109 000
Cash outflows:		
Direct costs (£13.50 × 4000)	54 000	
Fixed costs	20 000	74 000
Net cash inflow		35 000
Discount factor at 15% for 6 years		3.784

Present value of net cash inflows	£132 440
Investment outlay	
(£120 000 − sale of containers at £18 000)	£102 000
Net present value	£ 30 440

The project should therefore not be accepted.

The above analysis is based on the assumption that the contract for the sale of the product lasts for 6 years. If the customer does not renew the contract at the end of 4 years, the present value of the net cash inflows will be reduced by £40 898 [£44 000 × (0.4972 + 0.4323)]. This would result in a negative NPV of £10 458 (£30 440 − £40 898) plus any disposal cost of the unwanted product. On the other hand, if the company can sell more than 1023 units of the product [£10 458/(£11 × 0.9295)] in years 5 and 6, the project will have a positive NPV.

The project should be accepted if management are optimistic that the contract will be renewed or are confident that more than 1023 units can be sold in each of years 5 and 6.

(b) The major reservations about the project for Type B waste are as follows:
  (i) There could be additional redundancy costs if the existing employee is made redundant. If the employee is not made redundant, there might not be any cash flow savings.
  (ii) The technology is new, and operating problems that cannot be foreseen might arise.
  (iii) The present system seems to work satisfactorily. Will there be any additional risks, given that the process is hazardous, with the extra processing?

Answer to question 13.4

(a) The current return on capital employed is 20% (£20m profit/(£75m fixed assets + £25m stocks))

The computation of the capital employed for the new project is calculated as follows:

Year	1	2	3	4
	(£m)	(£m)	(£m)	(£m)
Sales	10.0 (£5 × 2m)	8.10 (£4.50 × 1.8m)	6.40 (£4 × 1.6m)	5.60 (£3.50 × 1.6m)
Op. cost	(2.00)	(1.80)	(1.60)	(1.60)
Fixed costs	(1.50)	(1.35)	(1.20)	(1.20)
Depreciation	(3.00)	(3.00)	(3.00)	(3.00)
Profit	3.50	1.95	0.60	(0.20)

Capital employed (start-of-year):

Fixed	14.00	11.00	8.00	5.00
Stocks	0.50	0.50	0.50	0.50
Total	14.50	11.50	8.50	5.50

Average profits = Total profits of £5.85m/4 years = £1.46m

Average capital employed = Capital employed at the mid point of the project's life (i.e. capital employed at the start of year 3) = £8.50m

Alternatively the average capital employed can be calculated as indicated in Chapter 13 (i.e. initial cost of the equipment of £14m plus the estimated residual value of £2m multiplied by 0.5 giving £8m). The investment in stocks is £0.5m so the total average investment is £8.5m.

Average rate of return = £1.46m/£8.5m = 17.2%

The proposal has an expected return in excess of the minimum of 10% specified by the company but it is unlikely that the manager will submit the proposal for approval because the proposed return is less than the current average of 20%. If the proposed project is undertaken the overall average return will be less than 20%. For an explanation of this point you should refer to 'The effect of performance measurement on capital investment decisions' in Chapter 13.

(b) (i) The following problems arise with the use of the average accounting rate of return on capital employed.
  (i) It ignores the time value of money.
  (ii) Accounting profits are used rather than cash flows. Both depreciation and fixed costs are not cash flows and would not be incorporated in a NPV calculation.
  (iii) The accounting rate of return can be expressed in a variety of ways and it is therefore subject to manipulation. For example, different methods of depreciation will produce different average rates of return.

(b) (ii) The accounting return on capital employed (also known as return on investment) is widely used by financial markets to evaluate the performance of the company as a whole. Because of this top management are likely to be interested in the impact that the project will have on the overall return on capital employed of the company. The accounting return on capital employed on proposed projects provides this information. Also many managers are evaluated on the overall return of their divisions on capital employed. If this is the case, it is likely that managers will focus on the return on capital employed of individual projects. Thus the way that performance is measured is likely to have a profound effect on the criteria that is used to appraise projects. For a more detailed explanation of this point see 'The effect of performance measurement on capital investment decisions' in Chapter 13.

Answer to question 13.5

(a) *Incremental operating costs*

Output (000 units)	Machine X (£000)	Machine Y (£000)
10	53	43
20	80	57
30	96	66
40	122	139

Minimum cost table

	Machine X		Machine Y		Total
Output (000 units)	Output (000 units)	Cost (£000)	Output (000 units)	Cost (£000)	cost (£000)
10	—	—	10	43	43
20	—	—	20	57	57
30	—	—	30	66	66
40	10	53	30	66	119
50	20	80	30	66	146
60	30	96	30	66	162
70	40	122	30	66	188
80	40	122	40	139	261

(b) (i) *Profitability*

Output (000 units)	Sales (£000)	Costs (£000)	Contribution (£000)
10	60	43	17
20	120	57	63
30	180	66	114
40	240	119	121
50	300	146	154
60	360	162	198
70	420	188	232
80	480	261	219

Profits are maximized at an output level of 70 000 units.

(ii) At an output level of 40 000 units machine X has the lowest cost. Machine Y should therefore be offered for sale. It is assumed that if machine Y is not sold, the output from the two machines over the next five years would be 60 000 units (75% × 80 000). The financial effect of selling machine Y would be as follows:

	Two machines (60 000 units) (£)	Machine X only (40 000 units) (£)
Sales	360 000	240 000
Costs	162 000	122 000
Contribution	198 000	118 000
Add annual cost savings		45 000
	198 000	163 000

It is assumed that the company would save £45 000 (£65 000 − £20 000) direct costs in other sections of the company if machine Y were sold. Annual future cash flows would therefore decline by £35 000 (£198 000 − £163 000). The PV of £35 000 annual cash flows for 5 years is £123 095 (£35 000 × 3.517). In addition, there would be a loss of scrap value of £20 000 in year 5. The PV of £20 000 receivable in year 5 is £10 856. Therefore the PV of the lost cash flows if machine Y was sold is £133 951 (£123 095 + £10 856). The minimum selling price is £134 000.

(c) Other factors that should be considered are:

(i) The impact of disruption of supplies if machine X breaks down. With two machines, the company can meet urgent orders if one machine breaks down. With only one machine, there is a distinct possibility that the company will fail to meet delivery dates if machine X breaks down.

(ii) The effect of not being able to meet the annual demand of 60 000 units per annum from LC Ltd. What is the likelihood that LC Ltd will seek another supplier?

(iii) It is assumed that the company will save £45 000 direct expenses elsewhere in the company if machine Y is sold. In practice, such savings might not be made, or may be made gradually. It is important that the company establishes the likely savings over the five-year period prior to negotiating a selling price with LC Ltd.

Answer to question 13.6

(a) The present values of the capital costs are as follows:

Year	Staff (£000)	Expenses	Contingency	Total	Discount factor	Present value (£)
1	20	5	2.5	27.5	0.8772	24 123
2	22	5	2.5	29.5	0.7695	22 700
3	24	5	2.5	31.5	0.675	21 262
4	26	5	2.5	33.5	0.5921	19 835
5	28	5	2.5	35.5	0.5194	18 439
						106 359
Initial outlay						60 000
						166 359

Let x = required net annual income

Therefore the PV of the net annual income over 5 years equates with the PV of the capital costs, where:

$$\begin{aligned} 0.35 \times 0.8772x + 0.65 \times 0.7695x + 0.675x + 0.5921x + 0.5194x &= £166\,359 \\ 2.593x &= £166\,359 \\ x &= £64\,155 \end{aligned}$$

If net income is 50% of sales then food sales would need to be £128 310 (£64 155 × 2) in years 3–5. Therefore annual sales required are:

	(£)
Year 1	44 908 (0.35 × £128 310)
2	83 401 (0.65 × £128 310)
3	128 310
4	128 310
5	128 310

(b) Aspects of the proposal that might merit further consideration include:

(i) Is the 14% discount rate equivalent to the opportunity cost of funds allocated by the Management Board?
(ii) Prices, potential demand and product range need to be considered. What is the probability that total income will be sufficient to generate the sales revenue specified in (a)?
(iii) How does the proposed product range, service and price structure compare with other catering facilities available within the locality?
(iv) Is there sufficient expertise and time available for existing staff to operate the new facilities?
(v) What alternative uses are available for the surplus accommodation?

Answers to extra questions for Chapter 14 Capital investment decisions: 2

Answer to question 14.1

The report should include the information contained in items (a) to (c) below:

(a) Depreciation is not a cash flow. The operating net cash inflows (before tax) therefore consist of sales less materials and labour costs. The NPV calculation is as follows:

Year	0 (£)	1 (£)	2 (£)	3 (£)	4 (£)
Net cash inflows before tax		80 000	75 000	69 750	
Tax[a]			(14 025)	(15 469)	4826
Investment outlay	(150 000)				
Net cash flow	(150 000)	80 000	60 975	54 281	4826
Discount factor (18%)	1.000	0.847	0.718	0.609	0.516
Present value	(150 000)	67 760	43 780	33 057	2490

NPV = −£2 913

Note:

The tax computation is as follows:

Year	1	2	3
	(£)	(£)	(£)
Net cash inflows before tax	80 000	75 000	69 750
Writing down allowances	37 500	28 125	84 375
Taxable profit	42 500	46 875	(14 625)
Tax at 33%	14 025	15 469	(4 826)
Writing down allowances:			
Opening WDV	150 000	112 500	84 375
Writing down allowances (25%)	37 500	28 125	
Closing WDV	112 500	84 375	Nil
Balancing allowance			84 375

(b) Because corporation taxes are payable on taxable profits and not accounting profits depreciation has been replaced by the Inland Revenue's allowable depreciation (known as written-down allowances). The net cost of the asset is £150 000 and written-down allowances received amounted to £65 625 (£37 500 + £28 125). Therefore a balancing allowance is available at the end of the asset's life of £84 375 (£150 000 − £65 625). The Inland Revenue allows the net cost of the asset to be claimed over its life with a balancing adjustment in the final year. Because taxation is normally payable 9 months after the company's accounting year end the taxation cash flows are shown to be delayed by one year. This is a simplification of the actual situation but is normally sufficiently accurate for appraising investments.

(c) Other factors to be considered include:
  (i) The probability of obtaining a subsequent contract. There would be no need to purchase a further machine and the project would therefore yield a positive NPV.
  (ii) The negative NPV is very small and if the company has other profitable activities it may be worthwhile accepting in order to have the chance of obtaining a second contract and establishing long-term relationships with a large multinational customer.
  (iii) Capacity that is available. If other profitable opportunities have to be forgone to undertake the contract because of shortage of capacity then the opportunity cost should be included in the financial analysis.

Answer to question 14.2

PV of cost of operating new machines

	(£)
Purchase price (£52 000 × 4)	208 000
PV of annual operating costs for 7 years (£15 000 × 4 × 4.564)	273 840
Salvage value (4 × £4000 × 0.4523)	(7 237)
PV of costs over 7-year life	474 603

$$\text{Equivalent annual cost} = \frac{\text{PV of costs}}{\text{annuity factor for } n \text{ years at } R\%} = \frac{£474\,603}{4.564} = £103\,988$$

PV of cost of operating old machine

	(£)
Opportunity cost of selling machines (10 × £5000)	50 000
Operating costs (10 × £10 000 × 2.402)	240 200
PV of costs over 3-year life	290 200

Equivalent annual cost (£290 200/2.402) = £120 816

The new machines have the lowest equivalent annual cost. Therefore they should be replaced now. This decision is based on the assumption that no superior or cheaper machines will be available in three years' time. If other opportunities are likely to be available in three years' time then the combination of operating the old machines and replacing with more efficient or cheaper machines should be considered.

The costs of modifying the factory building should be compared with the savings that result from the installation of the new machines. Equivalent annual savings from purchasing the new machines are £16 828 (£120 816 − £103 988) for three years. The PV of these savings is £40 421 (£16 828 × 2.402). It is assumed that if the factory is not modified now, it will have to be modified in three years' time when the current machines reach the end of their life. Assuming the cost of modification will still be £60 000 in three years' time, the relevant cost of the modification is:

	(£)
PV of modification now	60 000
Less PV of modification in 3 years' time (£60 000 × 0.712)	42 720
Relevant cost of modification now	17 280

It is therefore worthwhile to incur a cost of £17 280 now in order to achieve savings with a PV of £40 421.

Answer to question 14.3

(a) *PV of acquiring Exe (12-year life)*

	(£)	Discount factor at 10%	Present value (£)
Annual repair costs (years 1–12)	2 000	6.814	13 628
Overhead cost (year 8)	4 000	0.4665	1 866
Purchase price (year 0)	19 000	1.000	19 000
Trade-in value (year 12)	(3 000)	0.3186	(956)
			33 538
PV of acquiring Wye			
Annual repair costs (years 1–6)	2 600	4.355	11 323
Overhead cost (year 4)	2 000	0.683	1 366
Purchase price (year 0)	13 000	1.000	13 000
Trade-in value (year 6)	(3 000)	0.5645	(1 694)
			23 995

The machines have unequal lives, and to compensate for this the equivalent annual cost method should be used:
Exe equivalent annual cost = £4922 (£33 538/6.814)
Wye equivalent annual cost = £5510 (£23 995/4.355)
Exe should be purchased, since it has the lowest equivalent annual cost. It is assumed that both machines have the same performance reliability, quality and output and that there is no inflation.

(b) The answer should describe one of the three approaches outlined in Chapter 14. For a description of these approaches see 'The evaluation of mutually exclusive investments with unequal lives'.

(c) See 'Life cycle costing' in Chapter 22 for the answer to this question.

Answer to question 14.4

(a) Proposal one

Time	0 (31.12.00) (£)	1 (31.12.01) (£)	2 (31.12.02) (£)	3 (31.12.03) (£)	4 (31.12.04) (£)
Investment outlay	(62 500)				
Scrap proceeds				5 000	
Net cash inflows		40 000	55 000	70 000	
Tax on net inflows			(20 000)	(27 500)	(35 000)
Writing down allowance[a]		6 250	5 000	4 000	13 500
Working capital[b]	(4 000)	(1 500)	(1 500)	7 000	
Net cash flow	(66 500)	44 750	38 500	58 500	(21 500)
Discount factor[c]	1	0.826	0.696	0.597	0.517
Present values	(66 500)	36 964	26 796	34 925	(11 116)

Net present value = £21 069

Proposal two

Time	0 (31.12.00) (£)	1 (31.12.01) (£)	2 (31.12.02) (£)	3 (31.12.03) (£)	4 (31.12.04) (£)
Opportunity cost of disposal proceeds foregone[d]		(60 000)			
Balancing charge avoided[d]				30 000	
Net cash inflows[e]		68 000	67 840		

Tax on inflows			(34 000)	(33 920)	
Working capital	(7 000)		7 000		
Net cash flow	(7 000)	8 000	40 840	(3 920)	
Discount factor[c]	1	0 826	0 696	0 597	
Present values	(7 000)	6 608	28 425	(2 340)	

Net present value = £25 693
Proposal two should be chosen because it has the highest NPV.

Notes
[a] The writing down allowances are calculated as follows:

A/c Period ended		(£)		(£)	Time
31.12.00	Investment	62 500			
	WDA at 20%	(12 500)	Tax saved at 50%	6 250	1
		50 000			
31.12.01	WDA at 20%	(10 000)	Tax saved at 50%	5 000	2
		40 000			
31.12.02	WDA at 20%	(8 000)	Tax saved at 50%	4 000	3
		32 000			
31.12.03	Scrap proceeds	(5 000)			
	Balancing allowance	27 000	Tax saved at 50%	13 500	4

[b] Working capital requirements are 10% of net cash inflows (i.e. £4000 at Time 0, £5500 at Time 1 and £7000 at Time 2). Only incremental changes in working capital are included in the cash flow analysis.
[c] Because the cash flows have been expressed in nominal terms the discount rates should also be expressed in nominal terms. Nominal discount rate = (1 + Real discount rate) × (1 + Anticipated inflation rate) − 1.

$$2001 = (1.10) \times (1.10) - 1 = 0.21 \quad (21\%)$$
$$2002 = (1.10) \times (1.08) - 1 = 0.188\ (18.8\%)$$
$$2003 = (1.10) \times (1.06) - 1 = 0.166\ (16.6\%)$$
$$2004 = (1.10) \times (1.05) - 1 = 0.155\ (15.5\%)$$

The discount factors are:

$$\text{Time 1} = 1/1.21 = 0.826$$
$$\text{Time 2} = 1/1.21 \times 1/1.188 = 0.696$$
$$\text{Time 3} = 1/1.21 \times 1/1.188 \times 1/1.166 = 0.597$$
$$\text{Time 4} = 1/1.21 \times 1/1.188 \times 1/1.166 \times 1/1.155 = 0.517$$

The above calculations reflect the fact that different discount rates are used each year. For example, cash flows in Time 4 have to be discounted back to Time 3 at 15.5%, Time 3 back to Time 2 at 16.6%, Time 2 back to Time 1 at 18.8% and Time 1 back to Time 0 at 21%.
[d] Proposal 2 utilizes existing machinery which would otherwise be sold. Therefore the opportunity cost should be included as a cash flow. If Proposal 2 is not undertaken the company has the choice of either selling the machine at 31 December 2000 for £50 000 or selling it at 1 January 2002 for £60 000.
The PV calculations are:

Sale at 31 December 2000	(£)
Sale at 31 December 2000 (Time 0)	50 000
Balancing charge at 31 December 2001 (Time 1) = £25 000 × 0.826	(20 650)
PV	29 350

Sale at 1 January 2002 (Time 1)	(£)
Sale proceeds (£60 000 × 0.826)	49 560
Balancing charge at 31 December 2003 (Time 3) = £30 000 × 0.597	(17 910)
PV	31 650

Therefore the company should sell the machine at January 2002 if Proposal 2 is not accepted and the latter cash flows therefore represent the relevant cash flows to be included in the analysis.
[e] The incremental labour cash flows arising from the project are £22 000 for 2001 and £23 760 for 2002, but £20 000 and £21 600 have been included in the operating cash inflows given in the question. Therefore cash inflows must be reduced by £2000 in 2001 and £2160 in 2002.

(b) Reservations relating to the figures used in (a) include:
1. The accuracy of the estimated cash flows, inflation rates and discount rates.
2. It is assumed that all cash flows are received at the year end whereas they are likely to occur throughout the year.
3. The projects may entail different levels of risk but this has been ignored in the analysis.

Answer to question 14.5

(a) *Relevant cash flows*

Year	0	1	2	3	4
		(£000)	(£000)	(£000)	(£000)
Sales[a]		1320	2021	2183	2355
Cash costs					
Direct labour[b]		354	553	608	668
Material Z[c]		102	161	174	188
Components P and Q[d]		250	382	413	445
Other variable costs[e]		25	39	42	45
Management salaries[f]		67	72	77	82
Selling expenses[g]		166	174	183	192
Rental[h]		120	126	132	139
Other fixed overhead[i]		50	53	55	58
		1134	1560	1684	1817
Sales less cash costs		186	461	499	538
Tax[j]		9	(87)	(100)	(114)
Initial investment	(864)				
Residual value					12
	(864)	195	374	399	436

Notes

[a] Sales revenue: year 1 = 12 000 × £110
2 = 17 500 × £110 × (1.05)
3 = 18 000 × £110 × $(1.05)^2$
4 = 18 500 × £110 × $(1.05)^3$

[b] Labour costs: year 1 = 12 000 × £29.50, year 2 = 17 500 × £29.50 × (1.07), year 3 = 18 000 × £29.50 × $(1.07)^2$, year 4 = 18 500 × £29.50 × $(1.07)^3$.

[c] 72 000 kg are required in year 1. The relevant cost for the 70 000 kg in stock is £99 000 opportunity cost. The acquisition cost for the remaining 2000 kg is £2920 (2000 × £1.46). For the remaining years the relevant costs are: year 2 = 17 500 × 6 kg × £1.46 × (1.05), year 3 = 18 000 × 6 kg × £1.46 × $(1.05)^2$, year 4 = 18 500 × 6 kg × £1.46 × $(1.05)^3$.

[d] Components P and Q (£20.80 per unit): year 1 = 12 000 × £20.80, year 2 = 17 500 × £20.80 × (1.05), year 3 = 18 000 × £20.80 × $(1.05)^2$, year 4 = 18 500 × £20.80 × $(1.05)^3$.

[e] Year 1 = 12 000 × £2.10, year 2 = 17 500 × £2.10 × (1.05), year 3 = 18 000 × £2.10 × $(1.05)^2$, year 4 = 18 500 × £2.10 × $(1.05)^3$.

[f] Relevant cash outflows for year 1 are (£25 000 × 2) + £17 000 = £67 000, year 2 = £67 000 × (1.07), year 3 = £67 000 × $(1.07)^2$, year 4 = £67 000 × $(1.07)^3$.

[g] Selling expenses £166 000 per annum adjusted at 5% for inflation.

[h] Rental opportunity cost = £120 000 per annum adjusted at 5% for inflation.

[i] Relevant cash flows for other fixed overheads = £70 000 − £20 000 apportioned costs. The cash flows are adjusted at a 5% compound inflation rate for years 2–4.

[j] The tax cash flows are calculated as follows:

Year	1	2	3	4
	(£000)	(£000)	(£000)	(£000)
Sales less cash costs	186	461	499	538
Capital allowances	213	213	213	213
Taxable profits	(27)	248	286	325
Tax at 35%	(9)	87	100	114

It is assumed in year 1 that the company has sufficient taxable profits to set-off the negative table profits from the project.

Apportionment of head office costs are not relevant cash flows.

Interest payments are not included, because the cost of finance is already reflected in the discount rate.

The IRR can be found by using the interpolation method. The objective is to find the discount rate where the sum of the present values for years 1–4 equals £864 000 initial outlay. At 15% and 25% the NPVs are respectively + £101 000 and − £86 000. Using the interpolation method:

$$\text{IRR} = 15\% + \frac{101}{101 - (-86)} \times 10\% = \text{approximately } 20\%$$

(b) An asset beta reflects the beta of the company, assuming all equity financing. In contrast, the equity beta reflects the beta for a particular mixture of debt and equity. Equity betas include the additional financial risk from gearing, and will therefore be higher than asset beta because of the additional risk.

Assuming that Amble plc is all equity-financed, the asset beta can be used to estimate the required rate of return (discount rate for the project):

$$\text{RRR} = \begin{matrix}\text{risk-free} \\ \text{rate (8\%)}\end{matrix} + \left[\begin{matrix}\text{market} \\ \text{return (15\%)}\end{matrix} - \begin{matrix}\text{risk-free} \\ \text{rate (8\%)}\end{matrix}\right] \times \text{beta (1.2)}$$

$$= 16.4\%$$

The IRR of 20% is in excess of the required rate of return (16.4%). On a purely financial evaluation the project should be accepted.

(c) Using a discount rate of 17%, the expected NPV is:

Year	Cash flow (£000)	Discount factor	Present value (£000)
0	(864)	1	(864)
1	195	0.855	167
2	374	0.731	273
3	399	0.624	249
4	436	0.534	233
		Net present value	58

The product will not be financially viable when the present value of the additional taxation exceeds £58 000.

The taxable cash flows calculated in (a) are:

Year 1 (£000)	Year 2 (£000)	Year 3 (£000)	Year 4 (£000)
(27)	248	286	325

Let x = % increase in taxation rate.

Using the discount factors of 0.855, 0.731 etc. for a discount rate of 18%, the increase in the taxation rate can be ascertained from the following formula:

$$\begin{aligned} -27 \times (0.855x) + 248 \times (0.731x) + 286 \times (0.624x) + 325 \times (0.534x) &= 58 \\ 510.1x &= 58 \\ x &= 0.11 \end{aligned}$$

Therefore taxation rates can increase by 11% from 35% to 46% before NPV becomes negative.

Answer to question 14.6

(a) The present value of the capital costs is:

	(£)
Purchase price	50 000
Costs of making the mine operational (£95 000 × 0.8264)	78 508
Cost of special equipment (£48 000 × 0.8264)	39 667
	168 175

Note that the cash flows of £95 000 and £48 000 arise at t_1.

The life of the project depends on the rock formations:

Rock type A = 10 years (240 tonnes/24 tonnes per year)
Rock type B = 5 years (120 tonnes/24 tonnes per year)
Rock type C = 3 years (72 tonnes/24 tonnes per year)

The net cash flow for the first year of production (received at t_2) is (24 tonnes × £9900) − £187 000 = £50 600. Because of inflation, the cash flows for the remaining years are expected to increase at 10% per annum, so the present value of the net cash flows from t_2 onwards can be calculated as follows:

$$\overset{t_2}{\frac{£50\,600}{(1.21)^2}} + \overset{t_3}{\frac{£50\,600 \times 1.10}{(1.21)^3}} + \overset{t_4}{\frac{£50\,600 \times 1.10}{(1.21)^4}} \cdots$$

For a 3-year life the net cash flows from t_2 to t_4 are discounted, for a 5-year life those from t_2 to t_6 are discounted and for a 10-year life those from t_2 to t_{11} are discounted. It should be noted that the required rate of return of 1.21 can be expressed as 1.10 × 1.10, and 1.10 also appears in the numerator as the inflation compounding factor. We can therefore take an alternative short-cut approach by initially discounting the cash flows back to t_2 and then discounting the cash flows from t_2 back to t_0. The cash flows can be expressed as follows:

$$50\,600 + \frac{£50\,600 \times 1.10}{£50\,600 \times 1.10 \times 1.10} + \frac{£50\,600 \times (1.10)^2}{(1.10)^2 \times (1.10)^2} + \frac{£50\,600 \times (1.10)^3}{(1.10)^3 \times (1.10)^3} \cdots$$

It can be seen that the above expression is equivalent to discounting £50 600 by 10%. This approach enables the cumulative discount tables to be used.

10-year life = £50 600 + (£50 600 × 5.759) = £342 005
5-year life = £50 600 + (£50 600 × 3.170) = £211 002
3-year life = £50 600 + (£50 600 × 1.736) = £138 442

The above cash flows are expressed in terms of t_2. They are now discounted at 21% back to t_0.

10-year life = £342 005 × 0.683 = £233 589
5-year life = £211 002 × 0.683 = £144 114
3-year life = £138 442 × 0.683 = £94 556

The present values of the machinery sales are:

$$\text{10-year life} = \frac{£48\,000 - (240 \times £200)}{(1.21)^{11}} = 0$$

$$\text{5-year life} = \frac{£48\,000 - (120 \times £200)}{(1.21)^{6}} = £7647$$

$$\text{3-year life} = \frac{£48\,000 - (72 \times £200)}{(1.21)^{4}} = £15\,675$$

The NPV can now be calculated by combining the above cash flows:

Type A (10-year life) = £233 589 + 0 − £168 175 = £65 414
Type B (5-year life) = £144 114 + £7647 − £168 175 = −£16 414
Type C (3-year life) = £94 556 + £15 675 − £168 175 = −£57 944

The expected NPV for the purchase of the mine is:

(0.4 × £65 414) − (0.4 × £16 414) − (0.2 × £57 944) = +£8011

(b) If the survey is commissioned, the company will avoid the negative NPVs resulting from formation types B and C by cancelling the project. The value of the survey can be found by comparing the expected NPVs with and without the survey:

		(£)
Expected NPV with survey:	Rock type A (£65 414 × 0.4)	26 166
	Rock type B (cancel)	0
	Rock type C (cancel)	0
		26 166
Expected NPV without survey		8 011
Benefit from survey		18 155
Cost of survey		10 000
Net benefit from survey		8 155

The company should commission the survey based on the expected value decision rule. The major weakness of the expected value approach is that it ignores risk. However, if the range of possible outcomes from the two alternatives is compared, it can be seen that the geological survey substantially reduces the range of outcomes. Without the survey, the outcomes range from −£57 944 to £65 414, whereas with it the range is from −£10 000 (cost of the survey) to £55 414 (£65 414 − £10 000 cost of the survey). This substantial reduction in risk provides a further justification for commissioning the survey.

Answers to extra questions for Chapter 15 The budgeting process

Answer to question 15.1

a) Corporate planning can be defined as 'The systematic study of *long-term* objectives and the strategies required to achieve them'. Budgeting is the preparation of detailed financial and/or quantitative statements that are drawn up and approved prior to a defined period of time (normally one year). For a comparison of the aims and main features of corporate planning and budgeting systems see 'Stages in the planning process' and 'Multiple functions of budgets' in Chapter 15.

(b) See 'Zero-base budgeting' in Chapter 15 for the main items that should be included in answering this question.

Answer to question 15.2

(a)

Product		A		B		C	Total
Sales mix weighting		1		2		4	
		(£)		(£)		(£)	(£)
Unit selling price		215		250		300	
Unit costs:							
Frame		20		20		20	
Component D (at £8 per unit)	40		8		24		
E (at £5 per unit)	5		35		25		
F (at £3 per unit)	12	57	15	58	3	52	
Labour:							
Skilled (at £6 per hour)	12		9		9		
Unskilled (at £4.50 per hour)	9	21	9	18	13.5	22.5	
Variable production overhead		5		4		3.5	
Contribution		112		150		202	
Weighted by sales mix		112		300		808	1220

Required period 1 contribution:	(£m)
Profit	0.500 (£6.5m/13)
Add fixed costs:	
Production	0.056 (£0.728m/13)
Selling and distribution	0.028 (£0.364m/13)
Administration	0.026 (£0.338m/13)
	0.610

∴ 500 (£610 000/£1220) 'mixes' must be sold each period.

(i) *Sales budget*

	A	B	C
Sales quantities	500	1 000	2 000
Sales value (£)	107 500	250 000	600 000

(ii) *Production budget*

Sales quantities	500	1000	2000
Closing stock	270	630	1440
	770	1630	3440
Opening stock	300	700	1600
Production	470	930	1840

(iii) *Material usage budget*

Usage:				Total (units)
Frame	470	930	1 840	3 240
D	2 350	930	5 520	8 800
E	470	6 510	9 200	16 180
F	1 880	4 650	1 840	8 370

(iv) *Purchases budget*

Purchases (units):	Frame	D	E	F
Closing stock	900	3 600	9 000	3 600
Add used in production	3 240	8 800	16 180	8 370
	4 140	12 400	25 180	11 970
Less opening stock	1 000	4 000	10 000	4 000
Purchases (units)	3 140	8 400	15 180	7 970
Cost (£)	62 800	67 200	75 900	23 910

(v) *Manpower budgets*

	Machining (hours)	Assembly (hours)
A (units produced × hrs per unit)	940	940
B	1395	1860
C	2760	5520
	5095	8320
Hours available per period (4 × 37.5)	150	150
Number of people required	34	56

(b) The following factors would need to be considered:
  (i) The ability to be able to plan future production requirements, since production might be halted if there was a sudden increase in production. If production is volatile, there is a danger that stockouts might occur.
  (ii) The speed and reliability of the delivery service. If suppliers can deliver at short notice then stockouts are less likely to occur.
  (iii) The extra costs involved arising from more frequent deliveries in terms of ordering costs and quantity discounts.
  (iv) Alternative use of storage space.
  (v) The savings in holding costs arising from the reduction in stocks. Stock reductions in units would be as follows:

	Frames	D	E	F
End of period 1	900	3600	9000	3600
Requirements for 1 week	810 (3240/4)	2200 (8800/4)	4045 (16 180/4)	2092 (8370/4)
Stock reduction	90	1400	4955	1508

Answer to question 15.3

Task 1

(a) *Production budget – third quarter ending 17 September*

	Alphas	Betas
Budgeted sales in units	2000	2400
Add closing stock[a]	200	480
Less opening stock (given)	(500)	(600)
Production of completed units	1700	2280

(b) *Materials purchases budget – third quarter ending 17 September*

	kilograms
Material required for Alpha production (8kg × 1700)	13 600
Material required for Beta production (12kg × 2280)	27 360
	40 960
Add closing material stock[b]	16 384
Less opening material stock (given)	(12 000)
Material purchases	45 344

(c) *Cost of material purchases* (45 344 × £10) £453 440

(d) *Labour budget – third quarter ending 17 September*

Labour hours required for Alpha production (3 hours × 1700)	5 100
Labour hours required for Beta production (6 hours × 2280)	13 680
Total hours required before efficiency adjustment	18 780
Efficiency adjustment ($^{20\%}/_{80\%}$)	4 695
Total labour hours	23 475

Normal hours (50 employees × 35 hours × 12 weeks)	21 000
Overtime hours	2 475

(e)	Normal hours (50 employees × 12 weeks × £210)	£126 000
	Overtime (2475 hours × £9)	£22 275
	Cost of labour	£148 275

Notes	*Alphas*	*Betas*
[a]Sales this quarter	2000	2400
Add 20% seasonal variation	400	480
Budgeted sales next quarter	2400	2880
Closing stock (5/60 × 2400 = 200) (10/60 × 2880 = 480)	200	480
[b]Closing stock of materials		
Production this period		40 960
Add 20%		8 192
Material required for production next period		49 152
Stock required (20/60 × 49 152)		16 384

Task 2

(a) Some of the following limitations should be included in the report:
   (i) Past data are normally used as a basis for determining the linear regression formula. If only a small number of past observations are available the resulting regression formula is not likely to be very accurate.
   (ii) The technique assumes that a linear relationship exists whereas in practice a curvilinear relationship may exist.
   (iii) If past data are used to make future predictions it is assumed that the past trend will continue into the future. However, past trends may suddenly change for a variety of reasons.
   (iv) If abnormal observations are included in past data the regression equation will not be typical of future normal relationships.

Task 2

(b) The report should identify the following alternative methods of forecasting:
   (i) Market research involving customer surveys of likely future demand.
   (ii) Obtaining estimates from salespersons who deal with the customers and who have the knowledge to predict future demand.

Note that linear regression is dealt with in Chapter 24.

Answer to question 15.4

(a) *Monthly cash budget*

	Month 1 (£000)	Month 2 (£000)	Month 3 (£000)	Month 4 (£000)
Cash inflows:				
Sales (*W1*)	24.0	93.6	92.6	90.7
Cash outflows:				
Business purchase	315.0	—	—	—
Delivery van	—	15.0	—	—
Raw materials (*W2*)	—	44.375	29.375	30.625
Direct labour (*W2*)	27.0	17.25	18.0	18.75
Production overhead (*W3*)	10.5	10.5	10.5	10.5
Selling and administration overhead (*W4*)	39.875	14.875	14.875	14.875
	392.375	102.0	72.75	74.75
Surplus/(deficit) for month	(368.375)	(8.4)	19.85	15.95
Opening balance	—	(368.375)	(376.775)	(356.925)
Closing balance	(368.375)	(376.775)	(356.925)	(340.975)

Workings

		Month 1	Month 2	Month 3	Month 4
(*W1*)	Cash inflow from sales	24	24	23	24
	Cash inflow from credit sales	—	72	72	69
	Less discount	—	(2.4)	(2.4)	(2.3)
		—	69.6	69.6	66.7
	Total cash inflow	24	93.6	92.6	90.7

(*W2*) Selling price at a mark-up of 60% on production cost is £8 per unit (£5.00 × 1.60).

Sales units = sales revenue/8.

(000 units)	Month 1	Month 2	Month 3	Month 4	Month 5	Month 6
Sales	12	12	11.5	12	12.5	13
+ Closing stock of finished goods	12	11.5	12	12.5	13	
− Opening stock of finished goods	6	12	11.5	12	12.5	
= Production	18	11.5	12	12.5	13	
+ Closing stock of raw materials	5.75	6	6.25	6.5		
− Opening stock of raw materials	6	5.75	6	6.25		
= Purchase of raw materials	17.75	11.75	12.25	12.75		

	Month 1	Month 2	Month 3	Month 4
Raw material cost (£000)				
= Purchases at £2.50	44.375	29.375	30.265	31.875
Raw material payment (£000)	—	44.375	29.375	30.625
Direct labour cost and payment (£000)				
= Production × £1.50	27	17.25	18	18.75

(*W3*) Production overhead = £1.00 × 150 000 units
= £150 000

Less depreciation	£24 000	(£120 000/5)
Annual payment	£126 000	
Monthly payment	£10 500	

(*W4*) Selling and administration overhead = £208 000

Less depreciation (year 1)	4 500	(£15 000 × 30%)
	203 500	
Less rent and rates	25 000	
Year 1 payment	178 500	(excluding rent and rates)
Monthly payment	£14 875	(plus £25 000 in month 1)

(b)

	(£)
Finished goods stock (12 500 units × £5 per unit)	62 500
Raw materials stock (6500 units × £2.50 per unit)	16 250
Debtors	69 600
	148 350
Creditors	31 875

Apart from the purchase of the business, the cash budget suggests that there will be sufficient cash inflows to meet the cash outflows. The current assets and debtors provide sufficient funds to cover the creditors. However, this does not take into account possible funding by bank overdraft to finance the business purchase.

Answer to question 15.5

(a) (i) *Cash budget*

	January (£)	February (£)	March (£)	April (£)
Balance b/d	10 000	9 000	3 890	9 090
Sales (*W1*)	—	15 200	57 100	80 000
	10 000	24 200	60 990	89 090
Purchases (*W3*)	—	11 550	24 500	26 950
Wages (*W4*)	—	4 800	19 800	22 200

Variable overhead (*W5*)	—	960	4 600	7 080
Fixed overhead (*W6*)	1 000	3 000	3 000	3 000
	1 000	20 310	51 900	59 230
Balance c/d	9 000	3 890	9 090	29 860

Workings

(*W1*) Sales

	Amount	20%	Discount 5%	Net	50%	20%	8%	Total cash receipts
January	—	—	—	—	—	—	—	
February	80 000	16 000	800	15 200				15 200
March	90 000	18 000	900	17 100	40 000			57 100
April	100 000	20 000	1000	19 000	45 000	16 000		80 000
May	100 000	20 000	1000	19 000	50 000	18 000	6400	93 400

(*W2*) Production:

					Total
January	800				800
February	2400	900			3300
March		2700	1000		3700
April			3000	1000	4000
May				3000	
	3200	3600	4000	4000	

(*W3*) Purchases at £7 per unit:

	Production	Current month	Following month	Total	Value (£)
January	February (3300)		1650	1650	11 550
February	March (3700)	1650	1850	3500	24 500
March	April (4000)	1850	2000	3850	26 950

(*W4*) Direct wages:

February payment	$800 \times £6 =$	£4 800
March payment	$3300 \times £6 =$	£19 800
April payment	$3700 \times £6 =$	£22 200

(*W5*) Variable overhead at £2 per unit:

Production	February (£)	March (£)	April (£)	May (£)
January (£1600)	960	640		
February (£6600)		3960	2640	
March (£7400)			4440	2960
	960	4600	7080	2960

(*W6*) Fixed overhead:

	January (£)	February (£)	March (£)	April (£)
January	1000	2000		
February		1000	2000	
March			1000	2000
April				1000
	1000	3000	3000	3000

(ii) It is assumed that the question relates to the amount received from customers in May and not the amount due. The answer is £93 400 (see *W1*).

(b) A software package would eliminate the tedious arithmetical calculations that are necessary to produce cash budgets. Furthermore, it would enable alternative scenarios to be considered, such as what the outcome would be if any of the parameters were changed.

Answers to extra questions for Chapter 16 Management control systems

Answer to question 16.1

(a) The answer should include the following points:
   (i) The system should lead to improved performance measures and cost control.
   (ii) Service departments are motivated to provide services efficiently because any excess spending might lead to an investigation as to why it is cheaper to buy from outside the local authority.
   (iii) The user departments will have greater independence, since they will be charged the economic price (or lower) for the services they use. The user department is likely to view this as a fairer method than the alternative of a charge based on the costs of the service department only.

(b) Problems that might be encountered include:
   (i) How should cost be determined? Should it include the direct cost of the service department only or should it include indirect costs of the service departments, such as apportionments of central administrative charges?
   (ii) How should the market price be determined if there are several different market prices or the services offered are not identical?
   (iii) Difficulty in monitoring the scheme. The costs might exceed the benefits if the service departments provide a wide variety of services, resulting in many cost and market value comparisons.
   (iv) Acceptance by the service departments. The new system might be seen as a method of imposing punitive controls.
   (v) If the user department charges for its services and its costs include transferred in costs that are below the market price then it may be underpricing its services.

(c) The above problems might be overcome by:
   (i) Market prices could be established by inviting tenders from suppliers and basing the market price on the lowest tender. This is the market price that the user department would have paid if the department were free to obtain the services from outside the organization. However, the minimum market price should represent a long-run price and not a temporary distress price.
   (ii) The scheme should be clearly explained to all interested parties, emphasizing that the aim is to encourage increased efficiency and to help managers control their activities more effectively. It should be emphasized that the objective is not to use the new system as a basis for undertaking punitive post-mortems.
   (iii) Comparisons of market and cost based charges should be on a random basis rather than comparing each transaction.
   (iv) The user department should ensure that margins are added to the service department transferred costs so as to ensure that its services are charged out at a fair market price.

Answer to question 16.2

(a) (i) For a description of how budgetary control systems can be likened to a system of thermostatic control see 'Cybernetic control systems' in Chapter 16. This analogy is inappropriate in respect of the following:
   1. Standards cannot always be easily pre-set, and they are unlikely to remain constant over time. Unpredictable changes may have occurred since the plans were made, and thus the current standard may be inappropriate.
   2. Measurement errors may occur in reporting the actual results for the period, and this may distort the control process.
   3. It is not clear what corrective action is required when the process is out of control. The variance may be due to random factors (see Chapter 19), or the pre-determined standard may no longer be appropriate. Alternatively, the process may be out of control and require corrective action. Thus the appropriate response to variances is not easy to specify, and there is no guarantee that investigation of the variances will ensure that future actions will conform to the existing standard.
   4. Human responses are unpredictable and, unlike mechanical control systems, it is possible that responses to 'out of control' situations may not be implemented as intended.
   5. With the thermostatic control system the output of the process is continuously monitored, whereas with a budgetary control system the outcomes for a period are measured and reported at discrete periodic intervals. Consequently, there may be a lag between the process going 'out of control' and corrective action being taken, thus allowing matters to get further out of control. Corrective action is also taken on the assumption that conditions that continued in the past will continue in the future. In a dynamic business environment this assumption may not be valid.

(ii) The following items need to be considered when setting a structure for an effective budgetary control system:
   1. Clearly defined responsibility centres should be determined so that managers are accountable only for items that are under their control.
   2. Appropriate control periods should be established that result in frequent reporting feedback so as to ensure that there is no unnecessary delay in taking corrective action.
   3. Budgets and standard should be frequently reviewed, and revised where necessary, in order to ensure that actual results are compared with appropriate standards.
   4. Actual results should be compared with ex-post standards (see Chapter 19 for a discussion of ex-post standards).
   5. A suitable system for measuring and collecting control information should be established. For a discussion of the factors to be considered see 'Responsibility accounting' in Chapter 16.

(b) The answer to this question should include a discussion of the following points:
  (i) Timely reporting and frequent feedback.
  (ii) Variances should be suitably analysed in order to help pinpoint where corrective action is necessary.
  (iii) For control purposes actual results should be compared against ex-post standards.
  (iv) Actual results should be compared with flexed budgets.
  (v) Not all variances should be investigated. Clear rules should be established as to the criteria that should be used to establish whether a variance investigation is justified (see Chapter 19).
  (vi) The behavioural considerations specified in Chapters 16 and 17 should be taken into account when operating a system of budgetary control.

Answer to question 16.3

Flexible budget at 85% activity

	(£)	(£)
Variable cost		
Direct materials[a]	1 386 056	
Direct wages[b]	2 356 949	
Variable production overhead[c]	489 584	
Variable selling and distribution overhead[d]	69 940	
		4 302 529
Fixed costs		
Fixed production overhead[c]	330 115	
Fixed selling and distribution overhead[d]	161 266	
Administration overhead	132 000	623 381
Total cost		4 925 910
Sales[e]		5 911 092
Profit		985 182

Notes

[a] Costs increase by £153 800 for each of the changes in activity. Thus at 85% capacity level costs will be (£1 153 800 + £153 800) 1.04 after taking account of the predicted price change of 4%.

[b] Costs have increased by increments of £269 150. At 85% capacity level predicted costs are (£2 019 150 + £269 150) 1.03.

[c] Costs have increased by increments of £53 830. However, the question indicates that there is a fixed and variable element. Therefore at 85% capacity variable costs are predicted to be 8.5 (10% increments) × £53 830 per 10% increment = £457 555 × 1.07 price increase = £489 584. The fixed cost element before the price increase is £703 830 total costs at 75% capacity less variable costs of 7.5 (10% increments) × £53 830 = £300 105. The predicted fixed costs after the price increase are £300 105 (1.10) = £330 115.

[d] Costs have increased in increments of £7690. Using the same principles as those outlined in [c] variable costs at 85% capacity are predicted to be 8.5 × £7690(1.07 inflation factor) = £69 940. Fixed cost element = £207 690 total cost at 75% capacity less 7.5 (£7690) = £150 015 before the price increase. After the price increase the estimated fixed costs will be £150 015(1.075) = £161 266.

[e] Total cost (£4 925 910) × 100/83.333.

(b) Problems that can arise from a change in capacity level include:
  1. Step increase in fixed costs to enable output to be expanded.
  2. Inability to sell the increased output resulting in an increase in stocks.
  3. Working the plant more intensively might result in bottlenecks and machine breakdowns and this may result in an increase in unit variable costs because of diminishing returns to scale (See 'Economist's model' in Chapter 8).

(c) The budget committee should consist of high level executives who represent the major segments of the business. For example, the committee might consist of the chief executive (or his or her deputy), the production manager, the marketing manager, the management accountant and the human resource manager. Its major task is to communicate the long-term objectives of the organization, ensure that the budgets are realistically established and that they are coordinated satisfactorily.

Answers to extra questions for Chapter 18 Standard costing and variance analysis 1

Answer to question 18.1

Task

(a) Soap pack price variance = (Standard price − Actual price) Actual quantity
= (£1.20 − £1.30) 920 = £92A
= (£1.20 − £1.40) 1130 = £226A
£318A

Soap pack usage variance = (Standard quantity − Actual quantity) Standard price
= (8400 − 8580) £1.20
= £216A

Cleaning labour rate variance = (Standard rate − Actual rate) Actual hours
= (£3.60 − £3) 1850 = £1 110F
= (£3.60 − £4.50) 700 = £630A
£480F

Cleaning labour efficiency variance = (Standard hours − Actual hours) Standard rate
= (8400 × 0.25 hours = 2100 − 2550) £3.60
= £1620A

(b) (i) The soap price variance could be due to inflation and a general increase in the market price. In such circumstances the standard price should be altered to reflect the current standard price.
(ii) The adverse soap usage variance could be due to theft or excess issues. Managers should check that stocks are securely locked away and that only the standard quantity is issued each day.
(iii) The labour rate variance may have arisen because proportionately less weekend work was undertaken than that allowed for in the standard. It may be appropriate to maintain separate standards for weekend and non-weekend work and separate records so that variances can be reported for both categories of labour.
(iv) The standard time may represent an inappropriate standard that must be changed. Alternatively, excessive idle time may have occurred because of rooms not being vacated when the cleaners are being paid. Working practices and vacation procedures should be investigated to ensure that vacation is synchronized with when the cleaners are employed for cleaning the rooms.

Answer to question 18.2

Task 1

(a) Material price variance = (Standard price − Actual price) × Actual quantity
= (Standard price × Actual quantity) − Actual cost
= (78 000 × £20) − £1 599 000
= £1 560 000 − £1 599 000
= £39 000A

Material usage variance = (Standard quantity − Actual quantity) × Standard price
= (9500 × 8 = 76 000 litres − 78 000 litres) × £20
= £40 000 Adverse

Wage rate variance = (Standard price − Actual price) × Actual hours
= (Standard price × Actual hours) − Actual cost
= (£6 × 39 000 = £234 000) − £249 600
= £15 600A

Labour efficiency variance = (Standard hours − Actual hours) × Standard rate
= (9500 × 4 = 38 000 − 39 000) × £6
= £6000A

(b)

		£	£
Standard cost of production (9500 × £184)			1 748 000
Add adverse variances:	Material price	39 000	
	Material usage	40 000	
	Wage rate	15 600	
	Labour efficiency	6000	100 600
Actual cost			1 848 600

Task 2

(a) Material used in standard quantities (1500 × 100/80 × 8 litres) = 15 000
Standard usage for special order (1500 × 8) = 12 000
Material usage variance arising from special order (3000 kg × £20) = £60 000A
Material price variance arising from special order (15 000 kg × (£22 − £20)) = £18 000A
Wage rate variance arising from special order (1500 × 4 hrs × £6 × 50%) = £18 000A

(b)	Revised standard price (247.2/240 × £20)	£20.60
	Increase over original standard	£0.60
	Material used excluding special order (78 000 − 15 000)	63 000 litres
	Price variance arising from price increase (63 000 × £0.60)	£37 800A

(c)		£	£
	Standard cost of production		1 748 000
	Add non-controllable variances		
	Special order material usage variance	60 000A	
	Special order material price variance	30 000A	
	Special order wage rate variance	18 000A	
	Material price variance due to increase in market price	37 800A	145 800A
	Add controllable variances:		
	Material price (£39 000 − £30 000 − £37 800)	28 800F	
	Material usage (£40 000 − £60 000)	20 000F	
	Wage rate (£15 600 − £18 000)	2 400F	
	Labour efficiency	6 000A	45 200F
	Actual cost		1 848 600

(d) The answer should draw attention to the fact that the divisional total variance was £100 600 but £145 800 was not controllable by the manager. This consisted of £37 800 arising from an increase in market prices and £108 000 arising from the special order. The manager should be congratulated on the favourable controllable variances.

If the index of material prices was applicable to the type of materials used by the division then the standard should be altered to reflect the price change. The profitability of the special order should be recalculated after taking into account the extra cost arising from the adverse variances and the sales director informed. The sales director should also be requested to provide details of special orders to the relevant managers so that steps can be taken to ensure that the materials can be obtained from the normal supplier.

Answer to question 18.3

(a) £3 is the sum of the predicted unit costs given in the question.
Therefore budgeted profit = (£7.50 budgeted selling price – £3) × 750 budgeted menus sold = £3375.

(b) Actual profit = Actual sales (860 × £7) – Actual costs (£2548) = £3472

Note that the actual cost is the sum of the direct costs given in the question.

(c) The usage (quantity) cost variances for all of the ingredients can be calculated as follows:
((Actual sales quantity × standard quantity of ingredients per menu) × Actual quantity) × standard price

	(£)
Mushrooms ((860 × 0.1kgs) – 90kgs) × £3	= 12A
Beef (860 × 0.1 kgs) – 70 kg) × £15	= 240F
Potatoes (860 × 0.2 kgs) × £0.25	= 2A
Vegetables (860 × 0.3 kgs) × £0.90	= 11A
Fresh fruit (860 × 0.15 kgs) × £3	= 33A

The price variance for all of the ingredients is:

(Standard price – Actual price) × Actual quantity of ingredients
= (Actual × standard price) – (Actual quantity × Actual price)

	£
Mushrooms (90kgs × £3) – (£300)	= 30A
Beef (70 kgs × £15) – (£1148)	= 98A
Potatoes (180kgs × £0.25) – (£40)	= 5F
Vegetables (270kgs × £0.90) – (£250)	= 7A
Fresh fruit (140kgs × £3) – (£450)	= 30A

Details of prices and quantities per menu are not given for cream and other ingredients so it is not possible to analyse the total variance by price and quantity. The total variance is calculated as follows:

(Actual sales quantity × standard price) – Actual cost

	£		
Cream etc. (860 × £0.20) – £160		=	12A
Other ingredients (860 × £0.23) – £200		=	2A
Sales price variance	= (Actual selling price – Budgeted selling price) × Actual sales quantity		
	= (£7.0 – £7.50) × 860	=	£430A

Sales volume variance = (Actual volume – Budgeted volume) × Standard margin
= (860 – 750) × £4.50 = 495F

Reconciliation of budgeted and actual profit

			(£)
Budgeted profit			3375
Sales volume variance			495
Budgeted profit on actual sales			3870
Sales price variance			430
			3440
	Price	Usage	
Ingredients:	(£)	(£)	
Mushrooms	30A	12A	42A
Cream, etc.	n/a	n/a	12F
Beef	98A	240F	142F
Potatoes	5F	2A	3F
Vegetables	7A	11A	18A
Other	n/a	n/a	2A
Fresh fruit	30A	33A	63A
Actual profit			3472

(d) The sales volume and sales price are the two most significant variances. The adverse sales price variance is due to a reduction in selling price which may have been implemented to stimulate demand. The reduction in the selling price would appear to be the reason for the increase in sales volume and the favourable variance. Overall the selling price reduction has been beneficial with the favourable volume variance exceeding the adverse price variance.

Answer to question 18.4

(a) It is assumed that the term 'standard costing profit statement' means budgeted profit statement (i.e. budgeted sales less standard cost of budgeted sales). Alternatively, the term 'standard costing profit statement' can be interpreted as actual sales less standard cost of actual sales. Adopting this interpretation will mean that a sales volume variance will not be reported.

Budgeted profit statement:

		(£)
Sales (16 000 units × £140)		2 240 000
Materials		
007 (16 000 × 6 kg × £12.25)	1 176 000	
XL90 (16 000 × 3 kg × £3.20)	153 600	
Labour		
16 000 × 4.5 hours × £8.40	604 800	
Overheads		
All fixed (given)	86 400	1 882 560
Profit		219 200

Actual profit statement:

		(£)
Sales (15 400 units × £138.25)		2 129 050
Materials		
007	1 256 640	
XL90	132 979	
Labour	612 766	
Overheads	96 840	2 099 225
Profit		29 825

Note that the above statements are prepared on a marginal costing basis.

(b) Material price variance = (Standard price − Actual price) × Actual quantity
= (Actual quantity × Standard price) − Actual cost
Material 007 = (98 560 kg × £12.25) − £1 256 640 = £49 280A
Material XL90 = (42 350 kg × £3.20) − £132 979 = £2541F
Material usage variance = (Standard quantity − Actual quantity) × Standard price
Material 007 = (15 400 × 6 kg = 92 400 − 98 560) × £12.25 = £75 460
Material XL90 = (15 400 × 3 kg = 46 200 − 42 350) × £3.20 = £12 320F

Wage rate variance	= (Standard price − Actual price) × Actual hours
	= (£8.40 − £8.65) × £612 766/£8.65 = £17 710A
Labour efficiency variance	= (Standard hours − Actual hours) × Standard price
	= (15 400 × 4.5 hrs = 69 300 − 70 840[a]) × £8.40 = £12 936A
Fixed overhead expenditure	= Budgeted cost − Actual cost
	= £86 400 − £96 840 = £10 440A
Sales margin price	= (Actual price − Budgeted price) × Actual volume
	= (£138.25 − £140) × 15 400 = £26 950A
Sales margin volume	= (Actual volume – Budgeted volume) × Standard margin
	= (15 400 − 16 000) × £19.10[b] − £11 460A

Notes:

[a] Actual hours = £612 766/£8.65 = 70 840

	(£)
[b] Budgeted contribution margin = Selling price	140.00
Less Direct materials (6 × £12.25) + (3 × £3.20)	83.10
Direct labour (4.5 × £8.40)	37.80
	19.10

Reconciliation statement:	(£)
Budgeted profit	219 200
Add favourable variances (£2541 + £12 320)	14 861
	234 061
Less adverse variances (£49 280 + £75 460 + £17 710 + £12 936) (+ £10 440 + £26 950 + £11 460)	204 236
Actual profit	29 825

(c) The purchase of cheap, poor quality materials below standard price will result in a favourable price variance but may be the cause of an adverse material usage and labour efficiency variance. Similarly, the use of unskilled instead of skilled labour will result in a favourable wage rate variance and may be the cause of an adverse material usage variance arising from spoilt work and excessive usage of materials. The use of less skilled labour may also result in an adverse labour efficiency variance if the workers are not as efficient as skilled workers.

Answer to question 18.5

a) *Calculation of standard unit cost*

	(£)
Materials (336 000 kg/240 000 units = 1.40 kg at £4.10 per kg)	5.74
Direct labour (216 000 hrs/240 000 units = 0.9 hrs at £4.50 per hour	4.05
Variable overhead (0.9 hrs at £475 200/216 000 hrs = £2.20 per hour)	1.98
Fixed overhead (£1 521 600/240 000 units)	6.34
	18.11

Variance calculations

Material price: (Standard price − Actual price) × Actual quantity (£4.10 − £1 245 980/313 060 kg)313 060 kg	£37 566F
Material usage: (Standard quantity − Actual quantity) × Standard price (220 000 units × 1.40 kg = 308 000 kg − 313 060 kg) × £4.10	£20 746A
Wage rate: (Standard rate − Actual rate) × Actual hours (£4.50 − £886 886/194 920 hrs)194 920 hrs	£9 746A
Labour efficiency: (Standard hours − Actual hours) × Standard rate (220 000 units × 0.9 hrs) = 198 000 hours − 194 920 hrs × £4.50	£13 860F
Variable overhead efficiency: (Standard hours − Actual hours) × Standard rate (198 000 − 194 920) × £2.20	£6 776F
Variable overhead expenditure: (Actual hours × Standard rate) − Actual cost (194 920 × £2.20 = £428 824) − £433 700	£4 876A

Fixed overhead expenditure: (Budgeted cost − Actual cost)		
	(£1 521 600 − £1 501 240)	£20 360F
Fixed overhead volume: (Actual output − Budget output) × Standard rate		
	(220 000 − 240 000) × £6.34	£126 800A
Total variances		£831 606A

(b) The favourable labour efficiency variance may be due to:
   (i) Efficient production in less than standard time due to efficiency of the labour force.
   (ii) Easily attainable standard.
   (iii) Lack of production delays.

   The variable overheads are absorbed on the basis of direct labour hours and therefore the variable overhead efficiency variance will be a direct result of the labour efficiency variance.

   The fixed overhead volume variance is due to actual production being less than budgeted production. This may be due to reduced sales or reduction in stock levels. However, because the fixed overhead is a sunk cost changes in volume will not result in a change in fixed overheads incurred and the variance is of a dubious value for cost control purposes.

Answer to question 18.6

(a) Because some variable overheads vary with machine hours and other variable overheads vary with direct labour hours separate variable overhead efficiency and expenditure variances should be computed for machine-related and labour-related variable overheads.

Variable overhead efficiency variance:
(Standard hours − Actual hours) × Standard rate
Machine related = (5450 × 4 hours = 21 800 − 22 000) × £8 = £1600A
Labour related = (5450 × 2 hours = 10 900 − 10 800) × £4 = £400F

Variable overhead expenditure variance:
(Actual hours × Standard rate) − Actual variable overheads incurred
Machine related = 22 000 × £8 = £176 000 − £176 000 = Nil
Labour related = 10 800 × £4 = £43 200 − £42 000 = £1200F

Fixed overhead expenditure variance
= Budgeted cost − Actual cost
= 5500 units × £20 = £110 000 − £109 000
= £1000F

Fixed overhead volume = (Actual production − Budgeted production) × Standard rate
= (5450 − 5500) × £20 = £1000A

(b) The variable overhead machine-related efficiency variance arises because machine hours exceeded target (standard) hours that should have been used for the actual output. Because it is assumed that some variable overheads vary with machine hours the excess usage has resulted in additional spending on variable overheads. Failure to maintain machinery may have resulted in the use of hours in excess of standard.

The variable overhead labour-related variance arises because actual direct labour hours were less than the hours that should have been used for the actual output. This has resulted in reduced expenditure on those variable overheads that vary with direct labour hours. An improvement in the efficiency of direct labour has resulted in the favourable variance.

The variable overhead labour-related expenditure variance arises because actual spending was less than budgeted spending flexed to the actual level of activity. Prices paid for variable overhead items (e.g. indirect materials) may have been lower than the figures used to derive the budgeted expenditure. For a more detailed answer see the section on variable overhead expenditure variance in Chapter 18.

(c) See the comparison of ABC and traditional product costing systems in Chapter 10 for the answer to this question. In particular, the answer should demonstrate how the use of multiple cost drivers should result in the reporting of more accurate product costs than when a single cost driver is used. In order to understand and manage costs more effectively there is a need to measure overhead resource consumption using cost drivers that are the causes of overhead expenditure. Different cost drivers, rather than a single cost driver, provide a better explanation of cost behaviour. Thus multiple cost drivers should also result in better cost management (see the section on activity-cost management in Chapter 22 for a more detailed explanation of this point).

Answer to question 18.7

(a) (i) Material price variance = (SP − AP)AQ = (SP × AQ) − (AQ × AP)
= (£1.20 × 142 000) − £171 820
= £1420A

(ii) Material usage variance = (SQ − AQ)SP
= (1790 × 9 = 16 110 − 16 270) × £1.20
= £192A

(iii) Actual price per kg in period 1 = £1.21 (£171 820/142 000 kg)
The actual price per kg for period 2 is not given and must be calculated from the data given in the question.

Standard price = £1.20 × 1.06 = £1.272
(SP × AQ) = £1.272 × 147 400 (AQ) = £187 492.80
Price variance (£1031.80F)= (SP × AQ) − (AQ × AP)
£1031.80F = £187 492.80 − (147 400 × AP)

$$AP = \frac{£187\,492.80 - £1031.80}{147\,400}$$

= £1.265 per kg
Cost inflation = (£1.265/£1.21 − 1) × 100% = 4.5%

(iv) Actual usage per unit in period 1 = 16 270 kg/1790 units = 9.0894 kg
Actual usage in period 2 = 0.995 × 9 kg Standard usage = 8.995 kg
Change in usage (9.0894 − 8.995)/9.0894 × 100% = 1.5% improvement.

(b) See 'Types of cost standards' in Chapter 18 for the answer to this question.

Answer to question 18.8

(a) Month ended 31 October

	Original budget	Flexible budget	Actual results	Variance against flexible budget	
Units	5000	4500	4500	—	
	(£)	(£)	(£)	(£)	
Sales	600 000	540 000	550 000	10 000	(F)
Less variable costs:					
Direct materials	150 000	135 000	130 000	5 000	(F)
Direct labour	200 000	180 000	189 000	9 000	(A)
Variable production overhead	50 000	45 000	46 000	1 000	(A)
Variable selling overhead	75 000	67 500	72 000	4 500	(A)
Total variable cost	475 000	427 500	437 000	9 500	(A)
Contribution	125 000	112 500	113 000	500	(F)
Less fixed production overhead	25 000	25 000	29 000	4 000	(A)
Fixed selling overhead	50 000	50 000	46 000	4 000	(F)
Profit	50 000	37 500	38 000	500	(F)

Volume variance against original budget (37 500 − 50 000)	12 500	(A)
Variances, actual against flexible budget	500	(F)
Total variances per original statement	12 000	(A)

(b) The variances have been calculated using a variable costing approach.

Sales margin volume:
(actual sales volume − budgeted sales volume)
× standard contribution margin
(4500 − 5000) × £25 (*W1*) = £12 500A

Sales margin price:
(actual price − budgeted price) × actual sales volume
(£550 000/4500 − £120) × 4500 = £10 000F

Direct material cost:
(as per statement in (a)) = £5 000F

Wage rate:
(SR − AR) × actual hours
(£4 − £189 000/47 500) × 47 500 = £1 000F

Labour efficiency:
(Standard hours − actual hours) × standard rate
[(90% × 50 000 = 45 000) − 47 500] × £4 = £10 000A

Variable overhead efficiency:
(SH − AH) × variable overhead rate
(45 000 − 47 500) × £1 = £2 500A
Variable overhead expenditure:
DLH's flexed budget − actual cost
(47 500 × £1 − £46 000) = £1 500F
Variable selling overhead:
flexed budget (£67 500 − £72 000) = £4 500A
Fixed overhead expenditure variances (budgeted cost − actual cost):
Production overhead (£25 000 − £29 000) = £4 000A
Fixed selling overhead (£50 000 − £46 000) = £4 000F
Total variances £12 000A

Working
(*W1*) Standard contribution per unit
= budgeted contribution (£125 000)/budgeted volume (5000 units)

(c) The report is based on a variable costing approach and shows the lost contribution arising from a decline in sales volume. With a variable costing system, fixed overheads are not allocated to products, and therefore the volume variance is not applicable. The report compares actual costs with a flexible budget in order to derive the cost variances. (For a description of flexible budgets see 'Flexible budgeting' in Chapter 16.) In addition, the original budget is compared with the flexible budget in order to highlight the decline in profits arising from a failure to achieve the budgeted sales volume.

The report for this period shows that the total cost variances were £500 favourable, but the major problem relates to the decline in sales volume, which accounted for a reduction in profits of £12 500.

Answers to extra questions for Chapter 19 Standard costing and variance analysis 2: further aspects

Answer to question 19.10

(a) *Workings*

(i) *Material price variance identified on purchase of material*
Variance = (SP − AP) × quantity purchased
4 November (£1.04 − £10 530/10 000) × 10 000 = £130A
23 November: (£1.04 − £8480/8000) × 8000 = £160A

Material Z stock account

	(£)		(£)
Opening balance (9000 kg at £1.04)	9 360	2/11 WIP (2000 × £1.04)	2 080
4/11 Purchases (10 000 × £1.04)	10 400	7/11 WIP (4500 × £1.04)	4 680
23/11 Purchases (8000 × £1.04)	8 320	20/11 WIP (4000 × £1.04)	4 160
		27/11 WIP (6000 × £1.04)	6 240
		Closing balance (10 500 × £1.04)	10 920
	28 080		28 080

Creditors account

		4/11 Material Z stock account	10 400
		4/11 Material price variance account	130
		23/11 Material Z stock account	8 320
		23/11 Material price variance account	160

Material price variance account

4/11 Creditors account	130	30/11 Profit and Loss account	290
23/11 Creditors account	160		

(ii) *Material price variance identified at time of issue of material*
Using the weighted average basis, the actual issue prices are calculated as follows:

	(£)
Opening balance (9000 × £1.07)	9 630
2 November issue (2000 × £1.07)	(2 140)
Balance 7000 at £1.07 (£7490/7000)	7 490
4 November purchase (10 000 kg)	10 530
Balance (17 000 kg at £1.06)	18 020
7 November issue (4500 × £1.06)	(4 770)
20 November issue (4000 × £1.06)	(4 240)
Balance (8500 × £1.06)	9 010
23 November purchase (8000 kg)	8 480
Balance (16 500 kg at £1.06)	17 490
27 November issue (6000 kg × £1.06)	6 360

Variance = (SP − AP) × actual issues
2 November: (£1.04 − £1.07) × 2000 = £60A
7 November: (£1.04 − £1.06) × 4500 = £90A
20 November: (£1.04 − £1.06) × 4000 = £80A
27 November: (£1.04 − £1.06) × 6000 = £120A

Note that the entries in the stock account in (a) (i) are based on the approach described in Chapter 19 whereby the stock account is debited at the standard cost and the variances are extracted at the time of purchase. Where variances are extracted at the time of issue, it is preferable to use an alternative approach when preparing the stock account. With this approach, the stock account is debited at actual cost, and issues are recorded at standard cost and the price variances are recorded within the stock account.

(iii)

Material Z

	(kg)	(£/unit)	(£)		(kg)	(£/unit)	(£)
1/11 Opening balance	9 000	1.07	9 630	2/11 Work-in-process	2 000	1.04	2 080
4/11 Purchases	10 000	1.053	10 530	2/11 Materials price variance			60
23/11 Purchases	8 000	1.06	8 480	7/11 Work-in-process	4 500	1.04	4 680
				7/11 Materials price variance			90
				20/11 Work-in-process	4 000	1.04	4 160
				20/11 Materials price variance			80
				27/11 Work-in-process	6 000	1.04	6 240
				27/11 Materials price variance			120
				30/11 Closing balance	10 500	1.06	11 130
	27 000		28 640		27 000		28 640

Material price variance

	(£)		(£)
2/11 Material Z	60	30/11 Profit and loss	350
7/11 Material Z	90		
20/11 Material Z	80		
27/11 Material Z	120		
	350		350

(b) The method by which variances are extracted at the time of purchase is preferred because variances are reported at the earliest opportunity. In addition, the stock recording system is simplified.

(c) *Workings*:
Equivalent units

	Materials	Labour and overhead
Completed production	9 970	9 970
Add closing WIP	8 000	6 000
	17 970	15 970
Less opening WIP	6 000	3 000
Equivalent production	11 970	12 970

Material usage variance
(actual usage − standard usage) × standard price
[6000 kg − (11 970 units × 0.5)] × £1.04
£15. 60A

Labour efficiency variance
(actual hours − standard hours) × standard rate
[1340 hrs − (12 970 units × 0.1)] × £4.80
£206.40A

Overhead variance
actual cost − standard cost
6680 − (12 970 units × 0.1 × £5.00)
£195A

Standard cost per unit: product X

Materials	0.5 kg × £1.04/kg	= £0.52
Direct labour	0.1 hrs × £4.80/hr	= £0.48
Overhead	0.1 hrs × £5.00/hr	= £0.50
		£1.50

Process 1

	(£)		(£)
Opening balance:		Finished goods:	
Materials:		9970 units × £1.50	14 955
6000 units × £0.52		Closing balance:	
Direct labour and overhead:		Materials:	
3000 units × £0.98	6 060	8000 units × £0.52	
Materials:		Direct labour and overhead:	
6000 kilos × £1.04	6 240	6000 units × £0.98	10 040
Direct labour:		Material usage variance	15.6
1340 hours × £4.80	6 432	Labour efficiency variance	206.4
Overheads	6 680	Overhead variance	195
	25 412		25 412

Answer to question 19.2

The standard composition of a work team is as follows:

	Proportions
2 supervisors	0.083
10 fitters	0.417
6 electricians	0.25
2 electronic engineers	0.083
4 labourers	0.167
24	1.000

The standard cost for an output of 90 standard hours is:

		(£)
8.3 hours (supervisors) at £8 per hour	=	66.40
41.7 hours (fitters) at £6 per hour	=	250.20
25 hours (electricians) at £6 per hour	=	150.00
8.3 hours (electronic engineers) at £7 per hour	=	58.10
16.7 hours (labourers) at £4 per hour	=	66.80
		591.50

Standard cost per standard hour of output = £6.572 (£591.50/90 hours).

(a) *Wage rate variance*
Actual hours at standard rate:

		(£)
Supervisors (170 × £8)	=	1 360
Fitters (820 × £6)	=	4 920
Electricians (420 × £6)	=	2 520
Electronic engineers (230 × £7)	=	1 610
Labourers (280 × £4)	=	1 120
		11 530
Actual wages cost		£11 721
Wage rate variance (£11 530 − £11 721)		£191A

(b) (i) *Team composition variance*

(Actual hours at standard mix − actual hours at actual mix) × standard rate

(1920 × 0.083 = 159.36 − 170) × £8 =	−£85.12
(1920 × 0.417 = 800.64 − 820) × £6 =	−£116.16
(1920 × 0.25 = 480 − 420) × £6 =	£360.00
(1920 × 0.083 = 159.36 − 230) × £7 =	−£494.48
(1920 × 0.167 = 320.64 − 280) × £4 =	£162.56
	£173.20A

(ii) *Team productivity variance*

(actual output − standard output) × standard cost per unit of output

[1650 standard hours − (0.9 × 1920 standard hours)]

× £6.5722 per standard hour = £512.62A

(iii) *Labour efficiency variance*

(actual output × standard cost per unit of output)

− (actual hours × standard rate)

(1650 standard hours × £6.5722 = £10 844.16) − £11 530 = £685.82

Alternatively, the labour efficiency variance can be computed by adding the productivity and composition variances (£512.62 + £173.20 = £685.82)

(c) The team composition and the team productivity variances are similar to the material mix and yield variances. For a discussion of the meaning of these variances and their limitations see 'Mix and yield variances' in Chapter 19.

Answer to question 19.3

(a) (i) *Actual absorption costing*

Inventory is 20% of the output for the period, and there are no opening stocks. Therefore value of inventory = 20% × £4 080 000 = £816 000

(ii) *Standard absorption costing with variances written off*

Standard cost of production for period = 50 000 × £75

= £3 750 000

Therefore closing stock = 20% × £3 750 000

= £750 000

The variances are written off as a period cost and not included in the stock valuation.

(iii) *Standard absorption costing with variances pro-rated between cost of sales and inventory*

Variances for the period = £330 000A (4 080 000 − £3 750 000 standard cost)

Variances pro-rated to inventory = £66 000 (£330 000 × 20%)

Inventory valuation = standard cost of inventory (£750 000) + pro-rated variances (£66 000) = £816 000

(iv) *Actual direct costing*

Value of inventory = 20% × actual variable costs (£3 700 000)

= £740 000

(v) *Standard direct costing with variances written off*

Standard variable cost of production = £3 250 000 (50 000 × £65 variable standard unit cost)

Inventory valuation = £650 000 (20% × £3 250 000)

(vi) *Standard direct costing with variances pro-rated between cost of sales and inventory*

Standard variable cost of production = £3 250 000

Standard variable cost of production = £3 700 000

Variance = £450 000A

Inventory valuation = standard variable cost of inventory (£650 000) + pro-rated variances (20% × £450 000) = £740 000

(b) Inventory valuations based on absorption costing treats fixed production overheads as product costs. This will cause the stock valuation to be influenced by the level of activity that is used to determine the fixed overhead rate per unit. In addition, profits will be influenced by the production and stock-holding policy.

Variable absorption costing methods treat fixed production overheads as period costs, resulting in lower stock valuations compared with absorption costing. Profits are a function of sales volume only.

When actual costing methods are used, inefficiencies are included in stock valuation. In theory, they should be written off in the period when they are incurred. Where a standard costing system is used and variances are pro-rated between cost of sales and inventory, the stock valuations are identical with the valuations based on actual cost systems. Therefore the same criticism regarding the inefficiencies being included in the stock valuation apply.

When a standard costing system is used and all variances are written off, inefficiencies are not included in the stock valuation. However, not all variances represent inefficiencies. Some may be due to permanent changes in standard (e.g. price variances). Variances that do not reflect inefficiencies should be pro-rated between cost of sales and inventories, whereas variances that represent inefficiencies should be written off as a period cost.

(c) (i) *Discussion of the relevance of overhead cost absorption procedures for pricing*

The answer should include the following:

1. Disadvantages of arbitrary apportionment of joint costs to products.

2. Influence of activity level in calculating predetermined overhead rates. Overhead will only be recovered in sales revenue if demand is equivalent to the activity level that was used to calculate the overhead rate.
3. Limitations that apply when common costs are apportioned to products and an example of how this can lead to incorrect decisions.
4. Limitations of cost-plus pricing.
5. Arguments in support of cost-plus pricing.
6. An indication that full costs including overhead apportionments might provide an indication of the long-run production cost.

Most of the above points are included in Chapters 9–11.

(ii) *Overhead cost absorption procedures for control of costs*
The answer should state that costs should be analysed into controllable and non-controllable elements. Apportioned costs should be separately shown in a section headed 'Uncontrollable costs' in the performance report. The answer should stress accountability and responsibility when costs are attributed to individuals for control purposes. Overhead absorption should be used for product costing purposes, but not for cost control purposes.

Answer to question 19.4

(a)

	Original standard			Revised standard			Actual		
			(£)			(£)			(£)
Fruit	400	× 0.16	64	400	× 0.19	76	428	× 0.18	77.04
Glucose	700	× 0.10	70	700	× 0.12	84	742	× 0.12	89.04
Pectin	99	× 0.332	32.868	99	× 0.332	32.868	125	× 0.328	41.00
Citric acid	1	× 2.00	2	1	× 2.00	2	1	× 0.95	0.95
	1200		168.868	1200		194.868	1296		208.03
Labour			58.500			58.500	—		60.00
	1200		227.368	1200		253.368	1296		268.03
Loss	36		—	36		—	132		—
	1164		227.368	1164		253.368	1164		268.03

Planning variances:	(£)
Fruit extract (£64 − £76)	12A
Glucose syrup (£70 − £84)	14A
Total	26

(b) Ingredients operating variances:

Total (£194.868 − £208.03)	£13.162A
Price variances: (SP − AP) × AQ	
Fruit extract (£0.19 − £0.18) × 428	£4.28F
Glucose syrup	Nil
Pectin (£0.332 − £0.328) × 125	£0.50F
Citric acid (£2 − £0.95) × 1	£1.05F
	£5.83F

Usage variances: (SQ for output of one batch − AQ) × SP

	(£)
Fruit extract (400 − 428) × £0.19	5.32A
Glucose syrup (700 − 742) × £0.12	5.04A
Pectin (99 − 125) × £0.332	8.632A
Citric acid	nil
	18.992A

(c) The advantages of distinguishing between planning and operation variances are:
(i) Comparisons are made against targets that take into account the changing conditions from when the targets were originally set. The revised *ex post* standard thus compares actual results with an adjusted standard that reflects these changed conditions.
(ii) Variances reflect only factors under control of managers, and managers will be more highly motivated if their performance is compared against more realistic targets.
(iii) Planning variances provide useful feedback information on the accuracy of predicting standards and budgets.

The disadvantages are:
(i) Difficulty in establishing revised standards.
(ii) Managers accountable for variances might try and influence the allocation of the variances to the planning/uncontrollable category.

(d) *Mixture variance*

actual usage in standard mix	−	actual usage in actual mix	×	standard price		
				(£)		(£)
432	−	428	×	0.19	=	0.76F
756	−	742	×	0.12	=	1.68F
106.92	−	125	×	0.332	=	6.003A
1.08	−	1	×	2.00	=	0.16F
1296		1296				3.403A

Yield variance: (actual yield − standard yield from actual input)
× standard cost per unit of output
[1164 − (0.97 × 1296)] × £194.868/1164
= £15.589A
Usage variance (£18.992) = mix variance (£3.403) + yield variance (£15.589)

(e) Total variance = £227.368 − £268.03 = £40.662A
The total variance is analysed as follows:

	(£)
Ingredients planning variances	26.00A
Ingredients operating variances	13.162A
Labour operating variance (£58.50 − £60)	1.50A
	40.662

Answer to question 19.5

(a) *Variance calculations*

Sales volume: (Actual sales volume − Budgeted sales volume) × Standard unit contribution (450 − 500) × £79	3950A
Sales price: (Actual price − Budgeted price) Actual sales volume (83 250/450 − £175) × 450	4500F
Material price: (Standard price − Actual price) Actual quantity (£2 − £7650/3690) × 3690	270A
Material usage: (Standard quantity − Actual quantity) × Standard price (450 × 8 kg = 3600 kg − 3690) × £2	£180A
Wage rate: (Standard rate − Actual rate) Actual hours (£5 − £8100/1840 hrs) × 1840 hrs	1100F
Labour efficiency: (Standard hours − Actual hours) × Standard rate (450 × 4 hrs = 1800 hrs − 1840 hrs) × £5	200A
Variable overhead efficiency: (Standard hours − Actual hours) × Standard rate (450 × 4 hrs = 1800 hrs − 1840 hrs) × £15	600A
Variable overhead expenditure: (Actual hours × Standard rate − Actual cost) (1840 × £15 = £27 600) − £28 350	750A
Fixed overhead expenditure: (Budgeted cost − Actual cost) (£25 000 − £24 650)	350F

Reconciliation statement

	(£)	(£)
Budgeted sales revenue	87 500	
Budgeted standard variable cost	48 000	
Budgeted contribution		39 500
Sales contribution variances		
volume	(3 950)	
price	4 500	550
		40 050

Variable cost variances

Materials		
usage	(180)	
price	(270)	(450)
Labour		
efficiency	(200)	
rate	1 100	900
Variable overhead		
efficiency	(600)	
expenditure	(750)	(1 350)
Actual contribution		39 150
Fixed costs		
budgeted	(25 000)	
expenditure variance	350	24 650
Actual profit		14 500

(b) The revised presentation differs from the original because it takes into account changes in the production volume by flexing the budget. The original presentation adopts a fixed budgeting approach and compares the budgeted costs for the original budget of 500 units with the actual costs for an actual output of 450 units. Thus, like is not being compared with like and favourable variances are likely to be incorrectly recorded for variable costs whenever actual production is less than the original fixed budget.

Variance reporting should be based on flexing the budget, as shown in the revised presentation. The revised presentation supports the comments of the managers because it shows adverse production variances, and that sales have been made at above standard prices, but volume is down on budget.

(c) A number of writers have questioned the usefulness of standard costing in a modern manufacturing environment. They question whether variance analysis is meaningful in those situations where costs are not variable in the short run. Where costs are fixed and sunk within the performance reporting operating period the reported variances may be of little use for short-term operational cost control. In a modern manufacturing environment a large proportion of costs may be unrelated to short-term changes in production volume and efficiencies/ inefficiencies.

The value of reporting of traditional material price variances has been questioned in those firms that have adopted JIT purchasing techniques. If purchasing price variances are used to evaluate the performance of purchasing management, it is likely that the purchasing manager will be motivated to focus entirely on obtaining materials at the lowest possible price even if this results in:

(i) The use of many suppliers (all of them selected on the basis of price);
(ii) Large quantity purchases thus resulting in higher inventories;
(iii) Delivery of lower quality goods;
(iv) Indifference to attaining on-time delivery.

JIT companies will want to focus on performance measures which emphasize quality and reliability, rather than material price variances, which draw attention away from the key factors.

It is also claimed that the setting of standards is not consistent with today's climate of continuous improvement. When standards are set, a climate is created whereby they represent a target to be achieved and maintained, rather than a philosophy of continuous improvement.

Standard costing systems have also been criticized because they emphasize cost control rather than reporting on areas such as quality, reliability, lead times, flexibility in responding to customer requirements and customer satisfaction. These variables represent the critical areas where firms must be successful to compete in today's competitive environment.

Nevertheless, despite these criticisms, standard costing systems continue to be widely used because they provide cost data for many different purposes. For example, they provide data for setting budgets, simplifying the task of inventory valuation, predicting future costs for use in decision-making, and providing data for cost control and performance appraisal. Standard costs and variance analysis would still be required for other purposes even if variance analysis were abandoned for cost control and performance appraisal.

Answers to extra questions for Chapter 21 Transfer pricing in divisionalized companies

Answer to question 21.1

(a) *Advantages of absorption cost*

Provides an indication of the long-run production costs of the supplying division. Therefore the receiving department will be charged at the long-run cost of production.

Disadvantages of absorption cost

(i) Cannot be guaranteed to motivate a divisional manager to make sound decisions. Transfer prices based on absorption cost are not consistent with the optimum transfer price rule outlined in Chapter 21.

(ii) Transfer prices are imposed, resulting in divisional autonomy being undermined.
(iii) Ignores market prices.
(iv) Inefficiencies will be passed on to the receiving division if actual cost is used.
(v) Zero profits will be earned by the supplying division. Therefore this measure will not be a reasonable measure of the economic performance of the division.

(b) *Advantages of marginal cost*
Will motivate sound decisions if set at the marginal cost of supplying division for the output at which marginal cost equals the sum of the receiving division's net marginal revenue from using the intermediate product and the marginal revenue from the sale of the intermediate product.
Disadvantages of marginal cost
(i) Imposed transfer prices.
(ii) May not provide a meaningful performance measure. If variable cost is constant then the supplying division will make a loss equal to the total amount of the fixed costs.
(iii Inefficiencies will be passed on to the receiving division if actual cost is used.

(c) *Advantages of cost-plus*
Provides an indication of the long-run production costs of the company and may provide a reasonable measure of economic performance of the supplying and receiving divisions since transfer prices might approximate a fair market price when no external market exists.
Disadvantages of cost-plus
See absorption cost disadvantages.

(d) *Advantages of standard cost*
Ensures that inefficiencies are charged to the supplying division and are not passed on to the receiving division.
Disadvantages of standard cost
Depends on whether standard absorption, marginal or absorption-plus is used. See (a) – (c) above for their respective disadvantages.

Answer to question 21.2

A sound transfer pricing system should accomplish the following objectives:
(i) It should motivate the divisional manager to make *sound decisions* and it should communicate information that provides a reliable basis for such decisions. This will happen when actions that divisional managers take to improve the reported profit of their divisions also improve the profit of the company as a whole.
(ii) It should result in a report of divisional profits that is a reasonable measure of the *managerial performance* of the division.
(iii) It should ensure that divisional *autonomy* is not undermined.

It can be shown that full-cost transfer prices may not meet any of the above objectives. Full-cost transfer prices contain unitized fixed costs, which can easily be misinterpreted as variable costs. This will result in incorrect pricing and output decisions. See 'Full-cost transfer prices' or 'Cost plus a mark-up transfer prices' in Chapter 21 for an explanation of how full-cost based transfer prices can lead to incorrect decisions.

When *actual* full-cost transfer prices are used, objectives (ii) and (iii) will not be met since inefficiencies of the supplying division will be passed on to the receiving division. This will mean that actual results will not represent a reasonable measure of divisional performance, and divisional autonomy will be undermined. If standard costs are used and there is no external market for the intermediate then objective (ii) above may be satisfied if the transfer price represents the long-run cost of supplying the intermediate product.

Answer to question 21.3

(a) The calculation of selling price for product X based on the cost-plus pricing system operated by L Ltd is calculated as follows:

	(£)
Direct materials	18
Direct wages	15
Variable overhead (1 hour × £10)	10 (£70 000/7000 hours)
	43
Fixed overhead (1 hour × £8)	8 (£56 000/7000 hours)
Total cost	51
Profit (60% of total cost)	30.6
Selling price	81.6

Since the company is committed to producing Y, any internal transfers of product X will not reduce capacity that could be used for producing product Y. If product X is not sold externally, there will be an opportunity cost to the group of £81.60 representing the lost sales revenue. Assuming that the transfer price is set at £81.60 market price, K Ltd will make a profit of £1.4 per kg of product Z [£100 − (£15 + £2 + £81.60)]. The total profit on the order is £2800 (2000 kg × £1.40).

It is therefore profitable for K Ltd to produce product Z. The transfer price reflects the opportunity cost from the lost sales revenue from product X. Each division and the group as a whole should be indifferent to whether K Ltd acquires product X internally or purchases it on the external market. If the product is purchased on the external market at

£81.60, additional costs of £81.60 are incurred, but this will enable additional revenue of £81.60 to be obtained from sales by L Ltd. The transfer price should therefore be set at £81.60. If K Ltd can purchase product X on the external market at a price below £81.60, it should do so, since this would be in the best interests of the group as a whole.

The above recommendation assumes that L Ltd will not save any selling costs if the product is transferred internally. If, for example, variable selling overheads of £3 per unit could be saved then the transfer price should be reduced by £3 + 60% to reflect the variable cost savings. Without further information, the potential transfer price range would be between £76.80 (£81.60 − £4.80) and £81.60.

(b) The question specifies that K Ltd is working at full capacity. If additional units of product X could be produced by working overtime and this output could not be sold on the external market then the incremental cost per unit of the additional output would represent the appropriate transfer price.

Alternatively, if product X is in short supply, L Ltd should be instructed to supply 2000 kg to K Ltd and use the balance of its capacity for sales on the external market.

Answer to question 21.4

(a) (i) *Monthly profits at present sales level*

		(£000)
L Ltd:	Sales (10 000 drums[a] at £20 per drum)	200
	Costs: Raw materials (£9 per drum)	(90)
	Other costs	(30)
	Contribution	80
	Fixed costs	40
	Profit	40
M Ltd:	Sales (750 000 kilolitres at £9 per 25 litres)	270
	Costs: Variable	(150)
	Fixed	(60)
	Profit	60

Note

[a]Sales of L Ltd = 250 000 kilolitres internal transfers/25 000 litres per drum.

(ii) *Monthly profits at higher sales level*

		(£000)
L Ltd:	Sales (18 000 drums at £16 per drum)	288
	Costs: Raw materials (£9 per drum)	(162)
	Other expenses	(54)
	Contribution	72
	Fixed costs	40
	Profit	32
M Ltd:	Sales (950 000 kilolitres[a] at £9 per 25 litres)	342
	Costs: Variable	(190)
	Fixed	(60)
	Profit	92

Note

[a]Internal transfers (18 000 drums at 25 litres per drum) plus 500 000 kilolitres external sales.

(b) (i) The use of a market price as the transfer price produces difficulties because L Ltd is not motivated to reduce the selling price, in order to increase volume, because its profits decline from £40 000 to £32 000. However, the profits of M Ltd increase from £60 000 to £92 000. Thus the profits for the company as a whole increase by £24 000. Hence the transfer price does not encourage goal congruence in this particular situation.

(ii) In order to overcome the above difficulties, there is a need to offer some inducement to L Ltd such that its profits will increase as a result of lowering the selling price in order to increase volume. Factors to consider are the following:

1. The significance of the loss in profits arising from the difference between profits at the optimum output level and profits based on the output using the current transfer pricing system.
2. Savings in selling and distribution costs arising from internal transfers compared with external sales. The savings per unit should be deducted from the market price.
3. The probability of divisional managers selecting optimal output levels if they are allowed to negotiate the prices of transfers between the divisions.
4. The extent to which divisional autonomy will be undermined if corporate headquarters determines the transfer prices that will motivate divisional managers to produce at the optimum output level.

(c) M Ltd has spare production capacity, and any transfer price in excess of variable cost, for output in excess of the present transfers of 250 kilolitres, would increase the profits of M Ltd. The profits of L Ltd will increase if the transfer price on the extra output of 8000 drums is reduced by more than £1 (£8000 loss in profits/ 8000 drums) per drum. The variable cost per kilolitre of M Ltd is £200. Thus the variable cost per 25 kilolitres (i.e. the raw materials required for 1 drum) is £5. If the transfer price for output in excess of 10 000 drums is set at above £5 and less than £8 per drum then both divisions will gain if the selling price of the final product is reduced by 20% and volume is increased by 80%.

Answer to question 21.5

(a) *Division A*

At present the selling price is £40 and demand is 2000 units. Each increase or decrease in price of £1 results in a corresponding increase or decrease in demand of 40 units. Therefore if selling price were increased to £90, demand would be zero. To increase demand by one unit, selling price must be reduced by £0.025 (£1/40 units). The maximum selling price for an output of x units is:

$$SP = £\,90 - £0.025x$$

Total revenue (TR) for an output of x units = $£90x - 0.025x^2$
Marginal cost = £20

$$MR = dTR/dx = £90 - 0.05x$$

The optimal output level is where MR = MC
That is, where $£90 - 0.05x = £20$
so that $x = 1400$ units
and SP = £90 – £0.025(1400) = £55.

Division B

At present the selling price is £100 and demand is 100 units. Each increase or decrease in price of £1 results in a corresponding increase or decrease in demand of 10 units. Therefore if selling price were increased to £200, demand would be zero. To increase demand by one unit, selling price must be reduced by £0.10 (£1/10 units). The maximum selling price for an output of x units is:

$$SP = £200 - £0.1x$$

Total revenue (TR) for an output of x units = $£200x - 0.1x^2$
Marginal cost = £20

$$MR = dTR/dx = £200 - 0.2\,x$$

The optimal output level is where MR = MC
That is, where $£200 - 0.2x = £45$
so that $x = 775$ units
and SP = £200 – £0.1(775) = £122.50
To ensure overall company optimality it is assumed that the transfer price has been set equal to the marginal cost of the intermediate product. Note that the market for both products is imperfect.

(b) The demand function for Aye is based on the external demand for the intermediate product and the internal demand from Division B. The demand function for sales to Division B will be based on the optimal output level for Division B which will be at the point where its marginal revenue is equal to its marginal cost. The marginal cost consists of £25 marginal conversion costs plus the market price paid for Aye. Therefore the marginal cost is:

$$MC = £25 + SP_A$$

Marginal revenue remains unchanged so that:

$$MR = £200 - 0.2x$$

Optimal output and demand function is where $£200 - 0.2x = £25 + SP_A$
so that $0.2x = 175 - SP_A$
and $x = (175 - SP_A) / 0.2$

The external demand function is:
$SP = 90 - 0.025x$
so that $0.025x = 90 - SP_A$
and $x = (90 - SP_A) / 0.025$
To determine the optimal output for Division A we add the demand functions together for internal and external sales:

$$\begin{aligned} x &= (175 - SP_A) / 0.2 + (90 - SP_A) / 0.025 \\ &= 875 - 5SP_A + 3600 - 40SP_A \\ &= 4475 - 45SP_A \end{aligned}$$

Therefore $SP_A = 99.44 - 0.02222x$
and total revenue (TR) = $99.44x - 0.02222x^2$.

$$MR = 99.44 - 0.0444x$$

The optimal output level is where the MC of £20 is equal to MR
i.e. $20 = 99.44 - 0.0444x$
$x = 1788$ units and Division A will therefore select a selling price of £99.44 – 0.0222(1788) = £59.77 per unit).
At this price Division B will determine its optimum output where:

$$£200 - 0.2x = £25 + SP_A$$

so that $0.2x = 200 - 25 - 59.77$
and $x = 576$ units
and SP = £200 – 0.1(576) = £142.40 per unit.

(c) See 'Difficulties in applying economic theory' in Chapter 11 for the answer to this question.

Answer to question 21.6

(a) (i) Profits for the group as a whole will be maximized where the marginal cost of Chem is equal to the net marginal revenue of Drink.

$$\text{Price} = £45 - £0.0008Q_D$$

Therefore

$$\text{Total revenue} = Q_D(45 - 0.0008Q_D) = 45Q_D - 0.0008Q_D^2$$

Therefore

$$MR = \frac{dTR}{dQ_D} = 45 - 0.0016Q_D$$

$$MC_D = \frac{dTC_D}{dQ_D} = 11 + 0.0002Q_D$$

$$NMR_D = MR_D - MC_D = 34 - 0.0036Q_D$$

$$MC_C = \frac{dTC_C}{dQ_C} = 5.50 + 0.004Q_C$$

So profits are maximized where

$$5.50 + 0.0004Q_C = 34 - 0.0036Q_D$$

Because there is no intermediate market, both divisions must agree on the output level. Therefore $Q_C = Q_D = Q$, and so

$$0.0076Q = 28.50$$
$$Q = 3750 \text{ (i.e. optimum monthly output is 3750 units)}$$

(ii) The optimum transfer price is the marginal cost of Chem for that output at which the marginal cost equals Drink's net marginal revenue from processing the intermediate product (i.e. at an output level of 3750 units as calculated in (i)). The marginal cost of Chem at an output level of 3750 units is:

$$5.50 + 0.004 \times 3750 = £20.50$$

At 3750 units the price that Drink would charge for selling the final product is:

$$45 - 0.0008 \times 3750 = £42$$

The resulting profits for each division would be:

Chem	(£)	Drink	(£)
Revenues (3750 × £20.50 TP)	76 875	Revenues (3750 × £42)	157 500
Costs (*W1*)	(58 750)	Conversion costs (*W2*)	(70 312)
Profit	18 125	Transferred costs	(76 875)
		Profit	10 313

Group profit = £28 438 (£18 125 + £10 313)

Workings
(*W1*) $TC_C = £10\,000 + £5.50 \times 3750 + £0.002 \times (3750)^2 = £58\,750$
(*W2*) $TC_D = £15\,000 + £11 \times 3750 + £0.001 \times (3750)^2 = £70\,312$

(b) (i) In (a) the marginal cost for Chem at different output levels was equated to the NMR of Drink. It is assumed that the question implies that Chem would quote transfer prices based on its marginal cost at given output levels, so that Drink would regard these transfer prices ($5.5 + 0.0004Q_C$) to be constant per unit for all output levels. Drink's net profit (NP) will be as follows:

$$\begin{aligned} NP &= [(45Q - 0.0008Q^2) - (15\,000 + 11Q + 0.001Q^2) - Q(5.5 + 0.004Q)] \\ &= 28.5Q - 0.0058Q^2 - 15\,000 \end{aligned}$$

Profit is maximized where $dNP/dQ = 0$; that is, where

$$\begin{aligned} 28.5 - 0.0116Q &= 0 \\ Q &= 2457 \text{ units} \end{aligned}$$

An alternative approach is to equate the net marginal revenue with the marginal cost of the transfers. Chem will transfer out at a marginal cost of $5.5 + 0.0004Q_C$, and Drink will treat this price at a constant sum per unit. Therefore the total cost of transfers to Drink will be:

$$Q_C(5.5 + 0.0004Q_C) = 5.5Q_C + 0004Q_C^2$$

Therefore the marginal cost of transfers will be:

$$5.5 + 0.008Q_C$$

The transfer price for Drink that maximizes its profits is where NMR = MC, i.e. where

$$\begin{aligned} 34 - 0.0036Q &= 5.5 + 0.008Q \\ Q &= 2457 \text{ units} \end{aligned}$$

(ii) The level that maximizes profit for Drink determines the transfer price. At an output level of 2457 units the transfer price will be:

$$5.5 + (0.004 \times 2457) = £15.33$$

At 2457 units the price that Drink would charge for selling the final product is:

$$45 - (0.0008 \times 2457) = £43.034$$

Chem	(£)	Drink	(£)
Revenues (2457 × £15.33)	37 666	Revenues (2457 × £43.034)	105 735
Cost (*W1*)	(35 587)	Conversion costs (*W2*)	(48 064)
		Transferred costs	(37 666)
Profit	2 079	Profit	20 005

Group profit = £22 084

Workings

(*W1*) $TC_C = £10\,000 + (£5.50 \times 2457) + [£0.002 \times (2457)^2]$

(*W2*) $TC_D = £15\,000 + (£11 \times 2457) + [£0.001 \times (2457)^2]$

(c) A sound transfer pricing system should accomplish the following objectives:

(i) It should motivate divisional managers to make sound decisions that will lead to maximization of group profits.

(ii) It should enable a report to be made of divisional profits that is a reasonable measure of the management performance of the division.

(iii) It should ensure that divisional autonomy is not undermined.

When there is a perfect market for the intermediate product, the correct transfer price is the market price, and it will be possible to achieve all the above objectives. However, when there is no market price, it is unlikely that all the above objectives can be achieved. The result in (a) achieves the first objective and possibly the second, depending upon the managers' attitudes to the relative profits. However, to achieve the first objective, it has been necessary to set the transfer price centrally, and this means that the prices of internal inputs and outputs are not set by the divisional managers. Therefore divisional autonomy is undermined.

In (b) the output and transfer pricing decision has been delegated to the divisions. Drink determines its own optimum output level based on Chem's marginal cost, and thus sets the transfer price. This approach does not result in maximizing group profits and fails to provide a reasonable measure of each divisions contribution to total group profit. Central management is likely to regard the solution as unacceptable, because of the loss of profits, and the management of Chem will have to accept the transfer price determined by Drink and the resulting low profitability and spare capacity. The end result is likely to be intervention by central management. The implications for Megacorp are that, in order to achieve goal congruence, transfer pricing decisions cannot be made independently by either division.

(d) The answer should include a discussion of market-based transfer prices, cost-plus transfer prices, transfer prices based on linear programming methods and negotiated transfer prices. See Chapter 20 for a discussion of these methods.

Answers to questions for Chapter 22 Cost management

Answer to question 22.1

(a) Value for money audits are also known as management or performance audits. See 'Management audits' in Chapter 22 for the answer to this question. In particular, the answer should stress that a value for money audit normally consists of an independent appraisal of the economy, efficiency and effectiveness of the activities of a public sector organization (normally a local authority). The basic principles on which value for money audits are conducted are:
   (i) The auditor should ascertain whether or not an appropriate system exists to ensure economy, efficiency and effectiveness.
   (ii) The audit should focus on a number of specific projects and assess how far value for money is being achieved and where appropriate recommendations for improvements should be made.

   Examples of methods of analysis that should be employed in practice include:
   (i) Cost comparisons with previous years and other organizations of a similar character. The objective should be to try and keep costs at their most economical level.
   (ii) Management and systems review.
   (iii) Analysis of planning and control processes.
   (iv) Efficiency assessment.
   (v) Effectiveness review.

   You will find a detailed explanation of items (i)–(v) in Chapter 22.

(b) The problems experienced with PPBS are:
   (i) PPBS requires that budgeting and planning should be related to specific programme areas that cut across existing functional departmental structures. Consequently, programme structures are unlikely to match the organization's existing structure, and there is a need to change organizational structures and long-term budgeting systems. Staff may be resistant to such changes.
   (ii) PPBS is a long-term planning process, and organizations are reluctant to commit themselves to long-term plans, particularly when top management (in terms of ruling elected political parties in local government) and objectives are likely to change at frequent intervals. The emphasis tends to be on short-term budgets, with frequent changes in policy being preferred, rather than a commitment to long-term plans and policies.
   (iii) PPBS requires that programme objectives be clearly defined. However, the difficulty in clearly specifying objectives and measuring the extent to which they are being achieved has been an important obstacle in implementing PPBS.

   The major differences between PPBS and VFM are:
   (i) A value for money audit focuses on an organization's success in achieving economy, efficiency and effectiveness, and such an investigation does not require changes in organizational structures or budget systems.
   (ii) VFM focuses on systems, procedures and comparative statistics, with the emphasis on recommendations for improvements, whereas PPBS focuses on a re-structuring of the organization's long-term planning process. VFM tends to focus on short-term improvements.

Answers to questions for Chapter 24 Cost estimation and cost behaviour

Answer to question 24.1

(a)

x	y	x^2	xy
150	162	22 500	24 300
180	184	32 400	33 120
200	184	40 000	36 800
230	248	52 900	57 040
760	778	147 800	151 260

The regression equation can be found from the following equations:

$$\Sigma y = Na + b\Sigma x$$
$$\Sigma xy = a\Sigma x + b\Sigma x^2$$

Therefore

$$778 = 4a + 760b \qquad (1)$$

$$151\,260 = 760a + 147\,800b \qquad (2)$$

To solve for b, multiply equation (1) by 190 to give:

$$147\,820 = 760a + 144\,400b \qquad (3)$$

Subtracting equation (3) from equation (2) gives:

$$3400b = 3440$$
$$b = 1.012$$

Substituting for b in equation (1):

$$778 = 4a + 760 \times 1.012$$
$$a = 2.22$$

At the planned output level of 260 000 units the contribution is:

$$2.22 + 1.012 \times 260 = 265.34 = £265\,340$$

(b) The 95% confidence limit is:

$$265.34 \pm 4.303 \times 14.5 = 265.34 \pm 62.39$$

Upper limit	£327 730
Lower limit	£202 950

These are the limits within which we can be 95% certain the actual value of the contribution will be, given the assumptions made.

(c) The advantages of using linear regression are:

(i) It takes into account all available observations and yields more accurate results than the high–low method.

(ii) It determines the line of best fit mathematically, and is more accurate than visually determining the line of best fit using graphical or scattergraph method.

(iii) It is a statistically valid method, and is preferable to subjective methods based on guesswork from past observations.

For a discussion of the limitations of the technique see pages 964–68 in Chapter 24.

Answer to question 24.2

(a) An estimate of the normal fixed and variable costs of production is required. The figures shown below therefore exclude the winter heating costs of £10 000 in January and February.

	Output x (000)	Total cost y (£000)	xy (000)	x^2 (000)
January	9	105.2[a]	946.8	81
February	14	172.0	2408.0	196
March	11	125.4	1379.4	121
April	8	96.0	768.0	64
May	6	78.0	468.0	36
June	12	140.4	1684.8	144
	60	717.0	7655.0	642

Note

[a](9000 × £12.80) − £10 000

The regression equation can be derived from the following two equations (see formulae (24.1) and (24.2) in Chapter 24) and solving for a and b:

$$\Sigma y = Na + b\Sigma x$$

$$\Sigma xy = a\Sigma x + b\Sigma x^2$$

Inserting the above computations into the formulae:

$$717 = 6a + 60b \qquad (1)$$

$$7655 = 60a + 642b \qquad (2)$$

Multiplying equation (1) by 10:

$$7170 = 60a + 600b \qquad (3)$$

Subtracting equation (3) from equation (2):

$$485 = 42b$$

$$b = 11.5476$$

Substituting the value for b in one of the above equations gives a value of 4.024 for a.

Alternatively, the formula outlined in the question can be used:

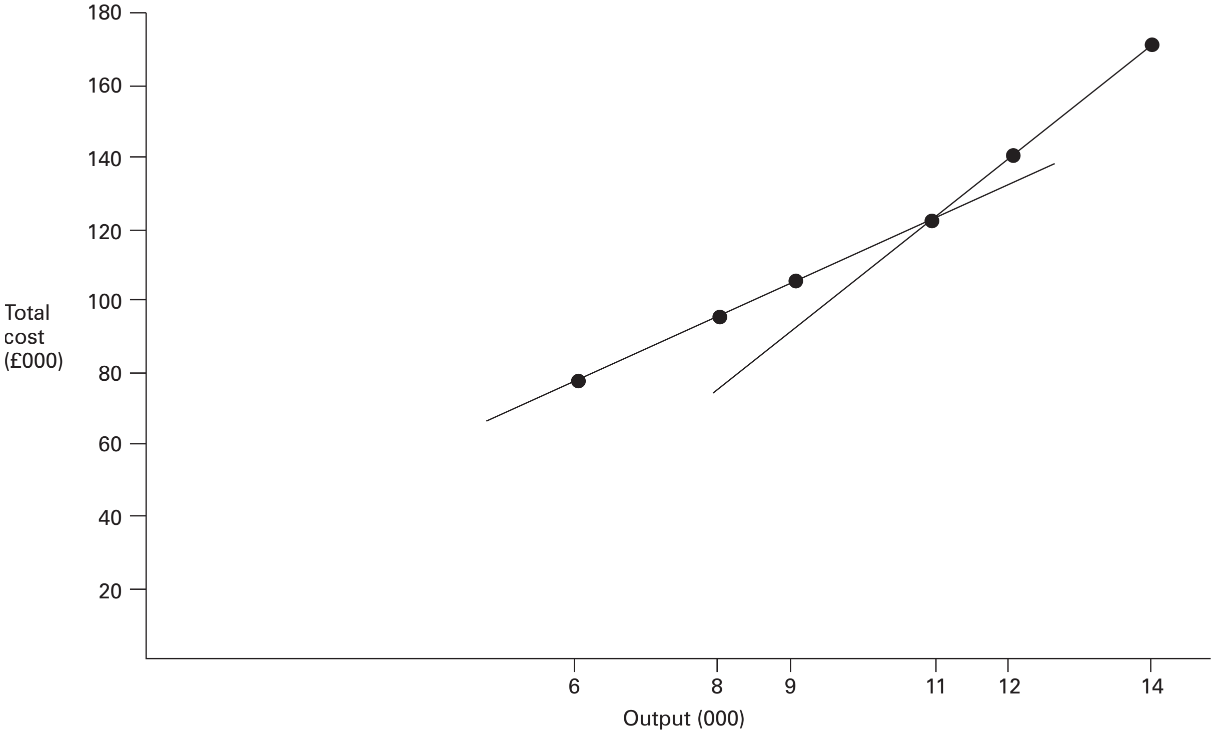


Figure Q24.12

$$b = \frac{n\Sigma xy - \Sigma x \Sigma y}{n\Sigma x^2 - (\Sigma x)^2}$$

$$b = \frac{6 \times 7655 - 60 \times 717}{6 \times 642 - (60)^2} = 11\ 5476$$

$$\bar{y} = a + b\bar{x}$$
$$a = \bar{y}\ b\bar{x} = (717/6) - 11.5476 \times (60/6) = 4.024$$

(b) The question implies that unit variable cost changes at a particular output level. Figure Q24.12 suggests that the change takes place at approximately 11 000 units of output.

The linear cost relationships for the two sections of the graph can be estimated using the high–low method, regression analysis or reading directly from the graph. Using the high–low method, the cost equations are:

$$\text{variable cost per unit below 11 000 units} = \frac{£125\ 400 - £78\ 000}{11\ 000 \text{ units} - 6000 \text{ units}} = £9.48$$

$$\text{monthly fixed costs} = £78\ 000 - (6000 \times £9.48) = £21\ 120$$

$$\text{variable cost per unit (11 000 units or more)} = \frac{£172\ 000 - £125\ 400}{14\ 000 - 11\ 000} = £15.53$$

$$\text{monthly fixed cost} = £125\ 400 - (11\ 000 \times £15.53) = -\ £45\ 467$$

The cost function for activity in excess of 11 000 units implies that fixed costs are negative. An examination of the graph suggests that fixed costs are approximately £21 000 and unit variable costs increase at 11 000 units. Assuming estimated fixed costs of £21 120 for output levels in excess of 11 000 units, the estimated unit variable cost (VC) at an output level of 12 000 units can be derived from the following equation:

total cost (£140 400) = fixed costs (£21 120) + (11 000 × £9.48) + 1000VC
VC = £15

In other words, the cost equation is:

$$y = 21\ 120 + £9.48x_1 + £15x_2$$

where x_1 = output levels up to 11 000 units
x_2 = output levels over 11 000 units − x_1

(c)

	Output (000)	Observed costs (£000)	Costs[a] (£000)	Estimated difference (£000)
January	9	105.2	106.44	(1.24)
February	14	172.0	170.40	1.6
March	11	125.4	125.40	0
April	8	96.0	96.96	(0.96)
May	6	78.0	78.00	0
June	12	140.4	140.40	0

Note
[a]Based on cost equation $21\,120 + 9.48x_1 + 15x_2$

(d) For the answer to this question see Chapter 24 (pages 964–68).

Answer to question 24.3

(a)

$$\begin{aligned} 5000 &= 10 \times 5000^{-0.3} \\ &= 10 \times 0.07768 \\ &= 0.7768 \end{aligned}$$

The average time taken to produce 1 unit is 0.7768 hours. Therefore 3884 hours (5000 × 0.7768) will be required to produce 5000 units. It is assumed that 3884 hours per annum will be available for years 2 and 3. Hence the cumulative hours for years 1 and 2 will be 7768 (3884 × 2). It is therefore necessary to determine the number of units of output that will require 7768 hours.

Let y_t = total number of hours. Then the average time (y) required to produce 1 unit of output is y_t/x, where x represents the number of units of output. Applying the learning-curve formula:

$$\begin{aligned} y &= ax^b \\ y_t/x &= ax^b \\ y_t &= ax^{b+1} \\ 7768 &= 10x^{0.7} \\ x^{0.7} &= 776.8 \\ x &= 776.8^{1/0.7} \\ &= 776.8^{1.428\,57} \\ &= 13\,460 \end{aligned}$$

Thus the output for year 2 will be 8460 units (13 460 − 5000). For years 1–3 there are 11 652 hours (3884 × 3) available. Applying the above approach:

$$\begin{aligned} 11\,652 &= 10x^{0.7} \\ x^{0.7} &= 1165.2 \\ x &= 1165.2^{1.428\,57} \\ &= 24\,020 \end{aligned}$$

Thus the output for year 3 will be 10 560 units (24 020 − 13 460).

Instead of applying the above method, we can use a trial-and-error approach to determine the output for years 2 and 3. For year 2:

$$13\,000 \text{ units} = 10 \times 13\,000^{-0.3} = 0.5832 \times 13\,000 = 7581 \text{ hrs}$$
$$14\,000 \text{ units} = 10 \times 14\,000^{-0.3} = 0.5704 \times 14\,000 = 7986 \text{ hrs}$$

By trial and error, the learning-curve formula is applied to output levels between 13 000 and 14 000 units until the time required is equal to 7768 hours.

NPV calculations

Years	1	2	3
Output	5 000	8 460	10 560
	(£)	(£)	(£)
Sales (× £42)	210 000	355 320	443 520
Less costs:			
Labour (3884 × £6)	23 304	23 304	23 304
Material (× £30)	150 000	253 800	316 800
Overheads	25 000	25 000	25 000
Total costs	198 304	302 104	365 104
Net cash flows	+ 11 696	+ 53 216	+ 78 416

Discount factor	0.8696	0.7561	0.6575
Present values	10 171	40 237	51 559

NPV £101 967 − £50 000 = £51 967

The contract should be undertaken on the basis of the NPV decision rule.

(b) The answer should include a discussion of the following points:

(i) A discussion of the assumptions relating to the learning curve. The learning rate based on past experience may not apply to this product. The learning effect may not continue over the whole range of the curve, and the 'steady state' may occur at a different point from that implied by the learning-curve formula.

(ii) The impact of inflation has been ignored.

(iii) The company cost of capital has been used. This rate is appropriate only if this project has the same risk as the average risk of the firm's existing assets.

(iv) Presumably all of the skilled labour capacity is used to meet the requirements of a single customer. It may be unwise to be committed to a single customer. The financial position of the customer should be investigated before acceptance of the order.

(v) The alternative use of the scarce labour should be explored and the present values from the alternative uses compared with the NPV calculated in (a).

(vi) The impact on customer goodwill if the demand from existing customers cannot be met.

Answer to question 24.4

(a) See 'Cost estimation when the learning effect is present' for the answer to this question.

(b) The answer to this question requires the calculation of sales revenues and costs for output and sales volumes at various levels in order to prepare a graph and identify the approximate volume level at which profits are maximized. The following are calculations of total costs and total revenues in increments of 100 units:

Labour cost

$y = ax^b$

$y_{100} = 60 \times 100^{-0.269} = 60 \times 0.2897 = 17.382$ average hours per unit giving 1738.2 hours for 100 units

$y_{200} = 60 \times 200^{-0.269} = 60 \times 0.2404 = 14.424$ average hours per unit giving 2884.8 hours for 200 units

$y_{300} = 60 \times 300^{-0.269} = 60 \times 0.2156 = 12.936$ average hours per unit giving 3880.8 hours for 300 units

$y_{400} = 60 \times 400^{-0.269} = 60 \times 0.1995 = 11.97$ average hours per unit giving 4788 hours for 400 units

$y_{500} = 60 \times 500^{0.269} = 60 \times 0.1879 = 11.274$ average hours per unit giving 5637 = hours for 500 units

Sales revenue

$$y = ax^n$$

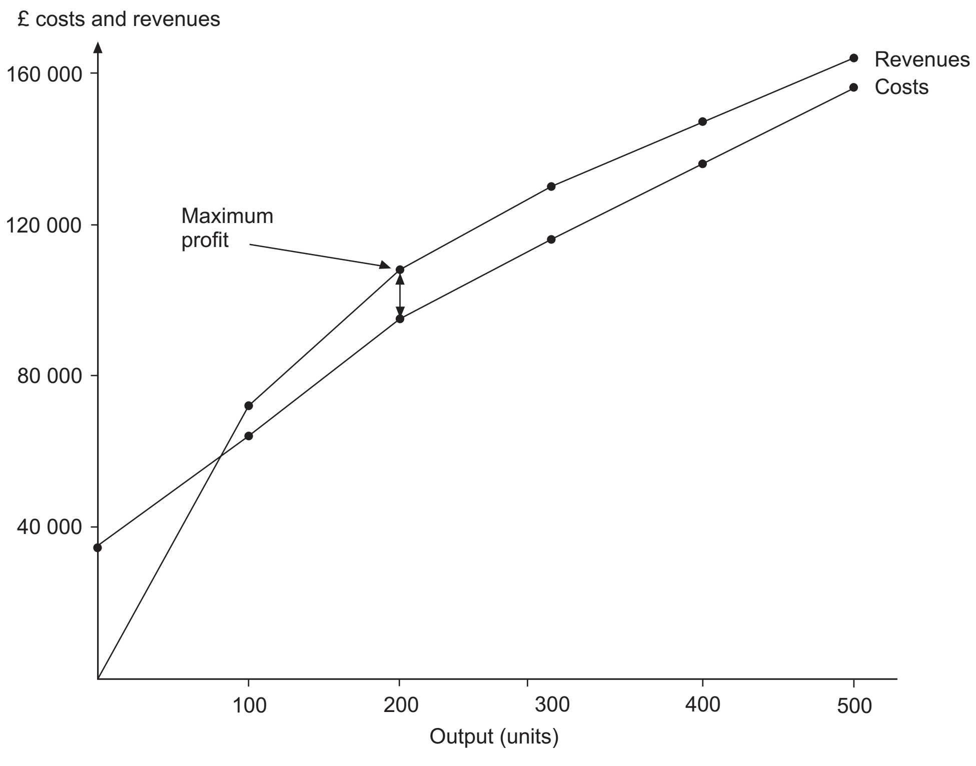


Figure Q24.17

where y = average selling price for x units
a = the selling price for the first unit of output
x = the number of units of output under consideration
n = exponent function

$$£327.80 = £10\,000 \times 500^n$$
$$£327.80/£10\,000 = 500^n$$
$$0.03278 = 500^n$$

^{n} = log 0.03278 / log 500 = −3.1479 / 6.2146 = −0.55
y_{100} = £10 000 × 100$^{-0.55}$ = £10 000 × 0.07943 = £794.30 selling price giving £79 430 for 100 units
y_{200} = £10 000 × 200$^{-0.55}$ = £10 000 × 0.05425 = £542.50 selling price giving £108 500 for 200 units
y_{300} = £10 000 × 300$^{-0.55}$ = £10 000 × 0.04341 = £434.10 selling price giving £130 233 for 300 units
y_{400} = £10 000 × 400$^{-0.55}$ = £10 000 × 0.03706 = £370.60 selling price giving £148 240 for 400 units
y_{500} = £10 000 × 500$^{-0.55}$ = £10 000 × 0.03278 = £327.80 selling price giving £163 900 for 500 units

Projected cost, revenues and profits

Output (units)	Labour hours	Labour cost (£)	Other variable costs (£)	Fixed costs (£)	Total cost (£)	Total revenues (£)	Profit/(loss) (£)
0				35 000	35 000		(35 000)
100	1738.2	34 764	2 000	35 000	71 764	79 430	7 666
200	2884.8	57 696	4 000	35 000	96 696	108 500	11 804
300	3880.8	77 616	6 000	35 000	118 616	130 233	11 617
400	4788.0	95 760	8 000	35 000	138 760	148 240	9 480
500	5637.0	112 740	10 000	35 000	157 740	163 900	6 160

The above information is plotted on the graph shown in Figure Q24.17.

(c) It is apparent from the graph and the schedule shown in part (b) that profit maximizing output level is around an output level of 200 units but that profit is not very sensitive to output changes between 200 and 300 units.

Answers to questions for Chapter 25 Quantitative models for the planning and control of stocks

Answer to question 25.1

(a) (i) Continuous stocktaking refers to a situation where a sample of stores items are counted regularly on, say, a daily basis. Sufficient items should be checked each day so that during a year all items are checked at least once. The alternative system of stocktaking is a complete physical stockcount where all the stock items are counted at one point in time. Continuous stocktaking is preferable because production is not disrupted and any discrepancies and losses are revealed earlier.
(ii) A perpetual inventory system is a stock recording system whereby the balance is shown for a stock item after each receipt or issue. In a non-computerized system the records are maintained on bin cards or stores ledger cards. A separate record is maintained for each item of materials in stores. Therefore the stock balance for each stores item is available at any point in time.
(iii) For an explanation of ABC inventory analysis see 'Control of stocks through classification' in Chapter 25.
(b) For the answer to this question you should refer to Chapter 25 ('Relevant costs for quantitative models under conditions of certainty' and 'Determining the economic order quantity').
(c) Normal control levels are the reorder level, minimum level, and maximum level.

Reorder level = maximum usage × maximum lead time
= 800 kg × 14 days
= 11 200 kg

Minimum level = re-order level − average usage in average lead time
= 11 200 kg − (600 kg × 12 days)
= 4000 kg

Maximum level = re-order level + EOQ – minimum usage in minimum lead time
= 11 200 kg + 12 000 kg − (400 kg × 10 days)
= 19 200 kg

Answer to question 25.2

(a) *Item A32: storage and ordering cost schedule*

No. of orders per year	4	5	6	7	8	9	10	11	12
Order size (boxes)	1250	1000	833	714	625	556	500	455	417
Average stock (boxes)	625	500	417	357	313	278	250	228	208
	(£)	(£)	(£)	(£)	(£)	(£)	(£)	(£)	(£)
Storage costs (average stock x 25% of £2)	312.5	250.0	208.5	178.5	156.5	139.0	125.0	114.0	104.0
Ordering costs (£12.5 per order)	50.0	62.5	75.0	87.5	100.0	112.5	125.0	137.5	150.0
Total cost	£362.5	£312.5	£283.5	£266.0	£256.5	£251.5	£250.0	£251.5	£254.0

(b) The number of orders which should be placed in a year to minimize costs is 10.

(c)
$$\text{EOQ} = \sqrt{\left(\frac{2DO}{H}\right)}$$

where D = total demand for period, O = ordering cost per order, H = holding cost per unit.

(d)
$$\text{EOQ} = \sqrt{\left(\frac{2 \times 5000 \times 12.5}{0.5}\right)}$$

$$= 500 \text{ units}$$

(e) The maximum saving that could be made if the authority process four orders per year would be:

$$\frac{£362.50 - £250}{£362.50} = 31\%$$

(f) (i) Reducing the number of stock items by eliminating slow moving and obsolete stocks.
(ii) Standardization of stock items thus reducing the total number of items in stock.

Answer to question 25.3

(a) (i)
$$\text{EOQ} = \sqrt{\left(\frac{2DO}{H}\right)}$$

where D = annual demand, O = ordering cost per order, H = holding cost per unit. Therefore:

$$\text{EOQ} = \sqrt{\left(\frac{2 \times 48\,000 \times £0.60}{10\% \times £10}\right)}$$

$$= 240$$

(ii) Number of orders required per year is:

$$\frac{\text{annual requirements}}{\text{EOQ}} = \frac{48\,000}{240} = 200 \text{ orders per year}$$

(iii) Total cost = holding costing + ordering cost

$$= \frac{240\ (£1)}{2} + \frac{48\,000}{240}(£0.60)$$

$$= £240$$

(b) Usage per day = 133.33 (48 000/360 days)
Number of days' usage in closing stock = 3 (400/133.33)
Lead time = 3 days
Therefore the next order should be placed immediately.

(c) Some problems when attempting to apply the EOQ formula are:
(i) Inventory is not always used at a constant rate, and the constant usage assumption is implicit in the EOQ formula.
(ii) The EOQ formula requires estimates of (a) annual sales, (b) ordering costs, (c) purchase price per unit and (d) cost of carrying inventories. These items may be extremely difficult to estimate in practice.

Answer to question 25.4

(a) (i) The cost of sales expressed as a percentage of total sales is 100 − Gross Margin %. Product A = 58% (100 − 42%), Product B = 54%, Product C = 63%.

Weekly cost of sales (£000s)

	Minimum	Maximum
14/363	$26 \times 0.58 = 15.08$	$30 \times 0.58 = 17.40$
11/175	$130 \times 0.54 = 70.20$	$160 \times 0.55 = 86.40$
14/243	$60 \times 0.63 = 37.80$	$128 \times 0.63 = 80.64$

Weekly sales (units)

	Minimum	Maximum
14/363	15.08/2.25 = 6702	17.40/2.25 = 7733
11/175	70.20/0.36 = 195 000	86.40/0.36 = 240 000
14/243	37.80/0.87 = 43 448	80.64/0.87 = 92 690

(ii) Re-order level = Maximum usage × maximum lead time
14/363 = 7733 × 2 = 15 466 units
11/175 = 240 000 × 2 = 480 000 units
14/243 = 92 690 × 2 = 185 380 units

(iii) Maximum stock control level
= Re-order level + EOQ (Minimum usage in minimum lead time)
14/363 = 15 466 + 25 000 − (6 702 × 2) = 27 062 units
11/175 = 480 000 + 500 000 − (195 000 × 2) = 590 000 units
14/243 = 185 380 + 250 000 − (43 448 × 2) = 348 484 units

(b) 1. Excessive stocks of item 14/363 are being held since stock exceeds the maximum stock level;
2. Stock is below the re-order level for item 11/175 and there are no outstanding orders. An order should have been raised;
3. The order for item 14/243 has been placed too early since stock exceeds the re-order level.

Answer to question 25.5

(a)

$$\text{EOQ} = \sqrt{\left(\frac{2DO}{H}\right)} = \sqrt{\left(\frac{2 \times 50\,000 \times 100}{0.40}\right)} = 5000$$

(b)

	(£)
Savings in purchase price (50 000 × £0.02)	= 1000
Saving in ordering cost[a]	
$\frac{DO}{Q_d} - \frac{DO}{Q} = \frac{50\,000 \times 100}{10\,000} - \frac{50\,000 \times 100}{5000}$	= 500
Total savings	1500

Note

[a]Q_d represents quantity ordered to obtain discount and Q represents EOQ. The additional holding cost if the larger quantity is purchased is calculated as follows:

$$\frac{(Q_d - Q)H}{2} = \frac{(10\,000 - 5000) \times 0.40}{2} = £1000$$

As the total savings exceed the total cost increase, the company should take advantage of the quantity discount.

Answer to question 25.6

(a) Annual material costs are £9m (30% 3 £30m) and conversion costs are £7.5m (25% 3 £30m).

Current stock levels are:			(£)
Raw materials (10% × £9m)			900 000
Work in progress:			
Materials element	£1 350 000	(15% × £9m)	
Conversion cost	675 000	(15% × £7.5 m × 60%)	2 025 000
Finished goods:			
Materials element	£1 080 000	(12% × £900 000)	
Conversion cost	900 000	(12% × £7.5m)	1 980 000

The stockholding costs for each category of stocks are as follows:

	Existing (£)	Revised (£)
Raw material stock:		
Fixed holding and acquisition costs	100 000	20 000
Variable holding and acquisition costs	90 000 (10%)	12 600 (20% × £900 000 × £0.07)
Financial charges	180 000 (20%)	36 000 [20% × (20% × £900 000)]
	370 000	68 600
Work in progress:		
Fixed movement and control costs	140 000	56 000 (40% × £140 000)
Variable movement and control costs	67 500 (5% × £1.35 m)	8 100 [£0.03 × (20% × £1.35m)]
Financial charges	405 000 (20% × £2025 m)	81 000 [20% × (20% × £2.025m)]
	612 500	145 100
Finished goods:		
Fixed holding and control costs	180 000	72 000 (40% × £180 000)
Variable holding and control costs	39 600 (2% × £1.98m)	4 950 [0.01 × (25% × £1.98m)]
Financial charges	396 000 (20% × £1.98m)	99 000 [20% × (25% × £1.98m)]
	615 600	175 950

Summary of cost savings

	Existing situation (£)	Revised situation (£)	Savings (£)
Raw material stock	370 000	68 600	301 400
Work in progress	612 500	145 100	467 400
Finished goods	615 600	175 950	439 650
	1 598 100	389 650	1 208 450

(b) Possible reasons for the reduction in costs for each item of stock are as follows:

Raw material stock

(i) Reduction in insurance and clerical costs
(ii) Reduction in number of staff required
(iii) Savings arising from reduction in warehouse space
(iv) Reduction in materials handling cost
(v) Reduced financing costs

Work in progress

(i) Reduction in losses arising from moving WIP from one department to another
(ii) Reduction in materials handling equipment and staff
(iii) Savings or additional cash flows arising from reduced storage space
(iv) Reduced financing costs

Finished goods stock

(i) Reduction in insurance costs
(ii) Savings arising from reduction in warehouse space and staff
(iii) Reduction in finished goods handling costs
(iv) Reduced financing costs

(c) For just-in-time purchasing it is essential that reliable suppliers can be found who will deliver to match the company's production demands. Any later deliveries may result in stockout costs. Suppliers may increase purchase costs to compensate for synchronizing their delivery and production schedules to the JIT production requirements of Prodco.

Alternatively, savings might arise from negotiating large long-term contracts with fewer suppliers. Dealing with fewer suppliers should result in a significant reduction in administrative costs. The reduction in stocks should create excess storage space which might be used to increase production capacity. Alternatively, it may be possible to sub-let the space.

The move to a cell layout should enable the company to respond quickly to changes in sales demand or to meet special orders. Thus additional sales might be generated. Additional training costs will be necessary to train the workers to operate different types of machines and carry out routine maintenance. Set-up costs may increase as the company moves from producing large batches using batch production techniques to producing small or single unit batches using flow production techniques.

JIT manufacturing should reduce finished goods stocks since the aim is to produce the required quantities at the precise time they are required. This should result in improved customer goodwill if production is more sensitive to meeting customer delivery requirements. The reduction in finished goods stock requirements will create additional storage space which might generate additional rental income from sub-letting.

Answer to question 25.7

(a) The re-order point based on the expected usage and lead time is calculated as follows:

Total demand during lead time	Joint probability	Expected value (usage)
75 000 (15 × 5000)	0.1	7 500
105 000 (15 × 7000)	0.1	10 500
100 000 (20 × 5000)	0.25	25 000
140 000 (20 × 7000)	0.25	35 000
125 000 (25 × 5000)	0.15	18 750
175 000 (25 × 7000)	0.15	26 250
	1.00	123 000

With a re-order level of 150 000 units, the safety stock (buffer stock) is 27 000 units (150 000 – 123 000).

(b) The probability of a stockout (i.e. demand in excess of 150 000 units) is 0.15.

(c)
$$\text{EOQ} = \sqrt{\left[\frac{2 \times (6000 \times 240) \times 1000}{0.15}\right]} = 138\,564 \text{ units}$$

Note that the expected daily demand of 6000 units is calculated as follows:

$$(0.5 \times 5000) + (0.5 \times 7000)$$

The average number of orders per annum is:

$$\frac{6000 \times 240}{138\,564} = 10.39$$

The expected annual stockouts in units per annum is:

$$0.15 \times (175\,000 - 150\,000) \times 10.39 = 38\,962 \text{ units}$$

(d) The additional annual holding cost if the re-order level is increased to 175 000 units is £3750 (25 000 × £0.15).

At a re-order level of 150 000 units, the expected value of the stockouts per annum is 38 962 units.

Therefore the increase in stock is justified where the stockout cost per unit is greater than 9.6 pence (£3750/38 962 units).

(e) Many companies are now giving increasing attention to reducing stocks to a minimum by adopting just-in-time (JIT purchasing and production techniques. For a description of JIT techniques you should refer to Chapter 22. The main disadvantage of JIT purchasing is that a successful JIT philosophy depends on finding suppliers who can provide a reliable delivery service at frequent intervals. With the absence of stocks, the system is dependent on a reliable service being maintained with no delay in deliveries. JIT companies therefore become very dependent upon the reliability of the supplier, and any failure by the latter to meet delivery schedules could have a serious impact on a whole production process.

Answers to questions for Chapter 26 The application of linear programming to management accounting

Answer to question 26.1

(a)

	W		B	
	(£)		(£)	
Materials	24.00	(8 kg at £3)	42.75	(14.25 kg at £3)
Labour	69.76	(21.8 hrs at £3.20)	24.00	(7.5 hrs at £3.20)
	93.76		66.75	
Selling price	128.00		95.00	
Contribution	34.24		28.25	

Let W = number of units of Product W produced
B = number of units of Product B produced
The linear programming model is as follows:

Maximize $34.24W + 28.25B$ subject to:
$4W + 3B \leqslant 1200$ kg processing hours
$8W + 14.25B \leqslant 4000$ kg (materials)
$21.8W + 7.5B \leqslant 6000$ labour hours

The above constraints are plotted on the graph shown in Figure Q26.2 as follows:
Processing hours: Line from $W = 300$, $B = 0$ to $B = 400$, $W = 0$
Materials: Line from $W = 500$, $B = 0$ to $B = 281$, $W = 0$
Labour hours: Line from $W = 275$, $B = 0$ to $B = 800$, $W = 0$

The feasible region is area ABCD. The objective function line drawn on the graph is based on an arbitrary selected contribution of £6848 (the contribution if only 200 units of Product W is produced). This contribution can also be obtained if just 242 units (£6848/£28.25 per unit) of Product B are produced.

If the contribution line is extended outwards the optimum point is B on the graph. At this point the output is 155 units of Product W and 194 units of Product B. The optimum point can be determined mathematically by solving the simultaneous equations for the constraints that intersect at point B:

$$8W + 14.25B = 4000$$
$$4W + 3B = 1200$$

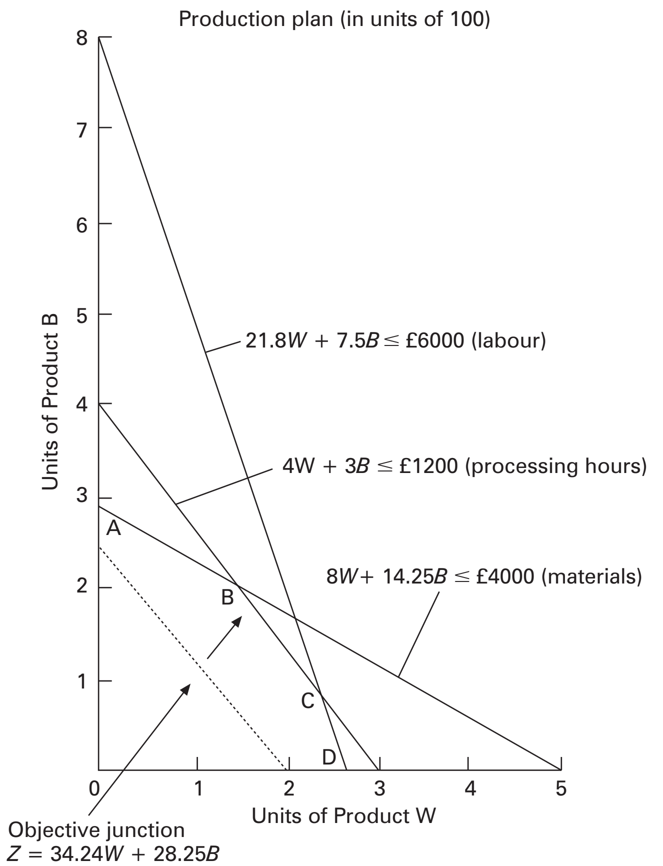


Figure Q26.2

The values of W and B when the above equations are solved are 155 for W and 194 for B. This will yield a total contribution of £10 788.

(b) The answer should also include the following points:
   (i) Few production resources are entirely fixed in the short term apart from machine capacity. Steps can often be taken to remove the constraints, such as obtaining materials from alternative sources or increasing machine capacity by working longer hours;
   (ii) A narrow focus has been adopted. Consideration should be given to increasing selling prices to the point where demand is equal to maximum output arising from the current production considerations;
   (iii) The approach ignores marketing considerations. Long-term profits might be maximized by concentrating production on one of the products to capture a large market share so that market dominance can be established and more substantial profits obtained;
   (iv) Linear programming tends to focus on the short term whereas the emphasis should be on maximizing long-run profits.

Answer to question 26.2

(a) The calculations of the product contributions are:

	Private (£)	Commercial (£)
Selling price	2400	3200
Material[a]	(200)	(250)
Direct labour	(90)	(108)
Variable production costs	(250)	(312)
Contribution	1860	2530

Note

[a]The contribution should reflect the additional cash flow contribution from selling an extra roll. The material costs given in the question represent sunk costs and are not relevant costs to be included in the contribution calculation. The relevant cost of materials is the lost sales value of £1 per lb of wool or nylon (that is, 200 lb at £1 for private use and 250 × £1 for commercial use).

Let X = number of rolls of private use
Let Y = number of rolls of commercial use

Then the linear programming formulation is:

Maximize $1860X + 2530Y$ subject to

$$40X + 200Y \leqslant 24\,000 \quad \text{(wool constraint)}$$
$$160X + 50Y \leqslant 25\,000 \quad \text{(nylon constraint)}$$
$$30X + 36Y \leqslant 6600 \quad \text{(machine time constraint)}$$
$$X \geqslant 0$$
$$Y \geqslant 0$$

The above constraints are plotted on the graph in Figure Q26.6 as follows:

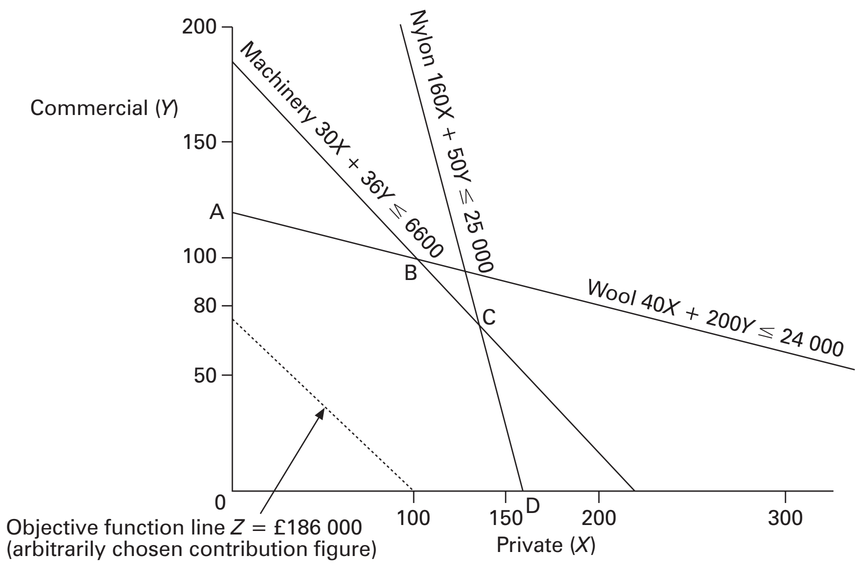


Figure Q26.6

Wool constraint: line from $X = 600, Y = 0$ to $Y = 120, X = 0$
Nylon constraint: line from $X = 156.25, Y = 0$ to $Y = 500, X = 0$
Capacity constraint: line from $X = 220$, $Y = 0$ to $Y= 183.33$, $X = 0$

At the optimum point (B in the graph) the output mix is 100 rolls for private use and 100 rolls for business use. The optimum point can be determined mathematically by solving the simultaneous equations for the constraints that intersect at point B:

$$30X + 36Y = 6\,600$$
$$40X + 200Y = 24\,000$$

The values of X and Y when the above equations are solved are 100 for X and 100 for Y. The optimum output requires 24 000 lb of wool to be used but only 21 000 lb of nylon. Therefore 4000 lb of nylon will be sold off at £1 per lb. The total contribution for the quarter is:

	(£)
Rolls for private use (100 × £1600)	160 000
Rolls for commercial use (100 × £1980)	198 000
Loss on sale of nylon [4000 × (£2 − £1)]	(4 000)
	354 000

The above calculation reflects the contribution that would be shown in the accounting statements using accrual accounting. Alternatively, the contribution can be calculated using the relevant cost approach. This alternative contribution calculation reflects the additional contribution over and above that which would be obtained from the alternative use of materials.

(b) If the variable costs increase then the contribution will decline by £110 for private sales and £40 for commercial sales. The revised contribution will be:

$$Z = 1750X + 2490Y$$

You will find that the gradient of the revised objective function line is such that the optimal point remains unchanged, and therefore the optimal output remains the same.

(c) The scarce resources are machine hours and wool. This is because these two constraints intersect at the optimum point B. If an additional machine hour were obtained, the binding constraints would become:

Wool	$40X + 200Y = 24\,000$
Machine capacity	$30X + 36Y = 6\,601$

The value of X and Y when the above equations are solved are 100.04 for X and 99.99 for Y. Therefore X increases by 0.04 rolls and Y decreases by 0.01 rolls, and the change in contribution will be as follows:

	(£)
Increase in contribution of X (0.04 × £1860)	74.40
Decrease in contribution of Y (0.01 × £2530)	25.30
Increase in contribution	49.10

If an additional lb of wool were obtained, the optimal solution would change such that X should be decreased by 0.01 rolls and Y increased by 0.01 rolls. Contribution would increase by £6.70.

(d) The answer should stress the advantages of valuing variances at opportunity cost (i.e. relevant cost) rather than acquisition cost. For a detailed explanation of the opportunity cost approach see 'Variance analysis and the opportunity cost of scarce resources' in Chapter 19. The answer should also include a discussion of the limitation placed on opportunity costs because of the limitations of linear programming. The limitations include:

(i) Linearity is assumed. In practice, stepped fixed costs might exist or resources might not be used at a constant rate throughout the entire output range. Selling prices might have to be reduced to increase volume.
(ii) The output of the model is dependent on the accuracy of the estimates used. In practice, it is difficult to segregate costs into their fixed and variable elements.
(iii) The objective function must be quantifiable and not of a qualitative nature.
(iv) Constraints are unlikely to be as completely fixed and precise as implied in the mathematical model. Some constraints can be removed at an additional cost.

Answer to question 26.3

(a) It is assumed that sales demand for Alpha is restricted to 200 units.

$$\begin{aligned} &\text{Maximize } 400x_1 + 200x_2 + 300x_3 \\ &\text{Subject to: } 2x_1 + 3x_2 + 2.5x_3 \leqslant 1920 \text{ (Process 1)} \\ &3x_1 + 2x_2 + 2x_3 \leqslant 2200 \text{ (Process 2)} \\ &x_1 \leqslant 200 \text{ (Alpha sales)} \\ &x_1, x_2, x_3 \geqslant 0 \text{ (Minimum sales constraint)} \end{aligned}$$

(b)

	x_1	x_2	x_3
x_4 = 1920	−2	−3	−2.5
x_5 = 2200	−3	−2	−2
x_6 = 200	−1	0	0
Z = 0	+400	+200	+300

Slack variables represent unused resources and unused sales potential.

(c) There are several ways of formulating the tableau for a linear programming model. The tableau given in the question can be reproduced as follows:

		x_3	x_4	x_6
x_2	506.7	−0.83	−0.33	0.67
x_5	586.7	−0.33	0.67	1.67
x_1	200	0	0	−1
Z	181 333.3	−66.67	−66.67	266.7

In Chapter 26 the approach adopted was to formulate the first tableau with positive contribution signs and negative signs for the slack variable equations. The optimal solution occurs when the signs in the contribution row are all negative. The opposite procedure has been applied with the tableau presented in the question. Therefore the signs have been reversed in the above tableau in order to ensure that it is in the same format as that presented in Chapter 26. Note that an entry of 1 in the tableau presented in the question signifies the product or slack variable that is to be entered in each row of the above tableau.

The total contribution is £181 333.3, consisting of 200 units of Alpha and 506.7 units of Beta. Process 1 (x_4) is fully utilized, but 586.7 hours (x_5) of Process 2 are unused. There is no unused sales demand for Alpha. The Z row (contribution row) indicates the shadow prices. The shadow price of £66.67 for Gamma (x_3) indicates that contribution will decline by £66.67 for each unit of Gamma produced. The shadow price of £66.67 for Process 1 (x_4) indicates that for each additional hour of Process 1 contribution would increase by £66.67. This would be achieved by increasing output of Beta by 0.33 units, and the effect of this would be to reduce Process 2 capacity by 0.67 hrs. The shadow price of £266.7 for Alpha (i.e. the slack variable) implies that for every Alpha sale above 200 units contribution would increase by £266.7. In order to produce one unit of Alpha, output of Beta will be reduced by 0.67 units, thus releasing the 2 hrs (0.67 × 3 hrs) required for Alpha in Process 1. This substitution process will result in a decline of 1.67 hrs in Process 2.

(d) The optimal responses are indicated in the final tableau:

(i) Increase output of Beta by 6.66 units (20 × 0.33) at a contribution of £200 per unit. Therefore total contribution will increase by £1332 to £182 665.7. Alternatively, the change in contribution can be obtained by multiplying the 20 additional hours by the shadow price of £66.67.

(ii) This will increase total contribution by £2667 (10 units × £266.7 shadow price). In order to produce an additional unit of Alpha, the output of Beta must be reduced by 6.7 units (10 × 0.67). This will release 20 hours (6.7 units × 3 hrs for Beta) in Process 1, which are required to produce the 10 units of Alpha (10 × 2 hrs). This substitution process requires 16.7 Process 2 hours, and results in a £2667 increase in total contribution (10 units of Alpha at £400 per unit less 6.7 units of Beta at £200 per unit).

(iii) Total contribution will be reduced by £666.7 (10 units × £66.7 shadow price). In order to obtain the hours required to produce Gamma in Process 1, the output of Beta must be reduced by 8.3 units (0.83 × 10 units required for Gamma). This will release 25 hrs (8.3 × 3 hrs) in Process 1, which is required to produce 10 units (10 × 2.5 hrs) of Gamma. This substitution process will reduce Process 2 unused capacity by 3.3 hrs and reduce total contribution by £666.7 (10 units of Gamma at £100 per unit less 8.3 units of Beta at £200 per unit).

Answer to question 26.4

(a) Let x_1 = proportion of project A undertaken
x_2 = proportion of project B undertaken
x_3 = proportion of project C undertaken
x_4 = proportion of project D undertaken
x_5 = proportion of project E undertaken
x_6 = cash unused at time 1 and carried forward to time 2
x_7 = cash unused at time 2 and carried forward to time 3

The linear programming model is as follows:

Maximize $x_1 + 0.8x_2 - 0.6x_3 + 3x_4 + 0.7x_5$
subject to

$$7x_1 + 6x_2 + 2x_3 \leqslant 12 \text{ (time 0 cash available)}$$
$$-1.5x_1 - 2x_2 - 4x_3 + 8x_4 + x_6 \leqslant 2 \text{ (time 1 cash available)}^a$$
$$-2x_1 - x_2 + 0.5x_3 + 2x_4 + 3x_5 + x_7 \leqslant 1.08x_6 \text{ (time 2 cash available)}^b$$
$$-2x_1 - x_2 + 2x_3 + x_4 - x_5 \leqslant 1.08x_7 \text{ (time 3 cash available)}^c$$
$$0.6x_1 + 0.8x_2 - 0.1x_3 + 10 \geqslant 11 \text{ (year 1 profit constraint)}^d$$
$$0.6x_1 + 0.3x_2 - 0.2x_3 - 0.3x_4 + 12 \geqslant (0.6x_1 + 0.8x_2 - 0.1x_3 + 10) \times 1.1 \text{ (year 2 profit constraint: year 1 profit plus 10\%)}$$
$$1.4x_1 + 0.8x_2 - 0.3x_3 - 0.2x_4 + 1.5x_5 + 11 \geqslant (0.6x_1 + 0.3x_2 - 0.2x_3 - 0.3x_4 + 12) \times 1.1 \text{ (year 3 profit constraint: year 2 profit + 10\%)}$$
$$x_1, x_2, x_3, x_4, x_5, x_6, x_7 \geqslant 0 \text{ (non-negativity constraint)}$$
$$x_1, x_2, x_3, x_4, x_5 \leqslant 1 \text{ (maximum investment constraint)}$$

An alternative presentation is to transfer the negative items that are listed to the left of the $\leqslant$ sign to the right of the sign. These variables will now be entered as positive items.

Notes

		(£m)
[a]Time 1 cash available =	New equity	7.5
	Less loan repayment	5.5
		2.0

[b]Time 2 cash available = unused cash at time 1 plus interest.
[c]Time 3 cash available = unused cash at time 2 plus interest.
[d]Minimum profit target = £10m + 10% = £11m.

(b) It may be rational in the following circumstances to undertake a project with a negative NPV:
   (i) Where the qualitative factors outweigh the negative NPV. For example, the building of a works canteen or the provision of recreational facilities for employees.
   (ii) A project with a negative NPV that provides large cash inflows in the early years, thus enabling an additional project to be accepted with an NPV in excess of the negative NPV of the first project.

(c) *Merits of mathematical programming*
   (i) Ability to solve complex problems incorporating the effects of complex interactions.
   (ii) Speed in solving the problem using computer facilities.
   (iii) The output from the model can highlight the key constraints to which attention should be directed.
   (iv) Sensitivity analysis can be applied. The effects of changes in the variables can be speedily tested.

   Limitations of mathematical programming
   (i) Divisibility of projects may not be realistic and integer programming may have to be used.
   (ii) Constraints are unlikely to be completely fixed and as precise as implied in the mathematical models.
   (iii) Not all the relevant information can be quantified.
   (iv) All the information for the model may not be available. For example, it may not be possible precisely to specify the constraints of future periods.
   (v) All the relationships contained within the formulation may not be linear.
   (vi) All the potential investment opportunities may not be identified and included in the analysis.
   (vii) The linear programming formulation assumes that all the project's cash flows are certain and therefore it cannot incorporate uncertainty. The solution produced can only be considered optimal given this restrictive assumption.