## Performance Pillar

## P2 - Performance Management

Thursday 2 September 2010

## Instructions to candidates

| You are allowed three hours to answer this question paper. |
| :--- |
| You are allowed 20 minutes reading time before the examination begins <br> during which you should read the question paper and, if you wish, make <br> annotations on the question paper. However, you will not be allowed, under <br> any circumstances, <br> calculator during this reading time answer book and start writing or use your |
| You are strongly advised to carefully read ALL the question requirements <br> before attempting the question concerned (that is all parts and/or sub- <br> questions). |
| ALL answers must be written in the answer book. Answers written on the <br> question paper will not be submitted for marking. |
| You should show all workings as marks are available for the method you use. |
| ALL QUESTIONS ARE COMPULSORY. |
| Section A comprises 5 questions and is on pages 2 to 7 |
| Section B comprises 2 questions and is on pages 8 to 11. |
| Maths tables and formulae are provided on pages 13 to 16. |
| The list of verbs as published in the syllabus is given for reference on page <br> 19. |
| Write your candidate number, the paper number and examination subject title <br> in the spaces provided on the front of the answer book. Also write your <br> contact ID and name in the space provided in the right hand margin and seal <br> to close. |

Tick the appropriate boxes on the front of the answer book to indicate which questions you have answered.


## SECTION A - 50 MARKS

[Note: The indicative time for answering this section is 90 minutes.]
ANSWER ALL FIVE QUESTIONS IN THIS SECTION. EACH QUESTION IS WORTH 10 MARKS. YOU SHOULD SHOW YOUR WORKINGS AS MARKS ARE AVAILABLE FOR THE METHOD YOU USE.

## Question One

A company manufactures five products in one factory. The company uses a Just-in-Time (JIT) production system. The company's budgeted fixed costs for the next year are $\$ 300,000$. The table below summarises the budgeted sales and contribution details for the five products for the next year.

| Product | $A$ | $B$ | $C$ | $D$ | $E$ |
| :--- | ---: | ---: | ---: | ---: | ---: |
| Unit selling price (\$) | 40 | 15 | 40 | 30 | 20 |
| Total sales (\$000) | 400 | 180 | 1,400 | 900 | 200 |
| Contribution/sales ratio (\%) | 45 | 30 | 25 | 20 | (10) |

The following diagram has been prepared to summarise the above budget figures:


After the diagram had been prepared, the Marketing Director has said that Products $A$ and $E$ are complementary products. The budget assumes that there are no sales of Product $A$ without also selling Product $E$ and no sales of Product $E$ without selling Product $A$.

## Required:

(a)
(i) Explain TWO reasons why the chart does not provide a useful summary of the budget data provided.
(ii) Explain the meaning of point $X$ on the chart.
(b) Calculate the breakeven revenue for the next year using the budgeted sales mix.

All workings must be shown.

## Question Two

HT manufactures and sells consumer goods. The market in which it operates is highly competitive and HT is constantly designing new products in order to maintain its market share. The life cycle of products in the market is extremely short with all of the manufacturers constantly introducing new products or variations on existing products.

Consumers consider two main factors when buying these products: price and quality. HT uses a penetration pricing policy when launching its products and is always striving to improve its quality from product design stage through to customer care. As a result it has a $15 \%$ market share, and its largest competitor has a 6\% market share with around 30 other companies sharing the remainder of the market.

## Required:

(a) Compare and contrast:

- Costs of quality conformance; and
- Costs of quality non-conformance.
(3 marks)
(b) Discuss the relationship between quality conformance costs and product selling prices in HT.
(c) Explain how Kaizen principles could be used by HT to extend the life of its products.
(Total for Question Two = 10 marks)


## Question Three

ST is a distribution company which buys a product in bulk from manufacturers, repackages the product into smaller packs and then sells the packs to retail customers. ST's customers vary in size and consequently the size and frequency of their orders also varies. Some customers order large quantities from ST each time they place an order. Other customers order only a few packs each time.

The current accounting system of ST produces very basic management information that reports only the overall company profit. ST is therefore unaware of the costs of servicing individual customers. However, the company has now decided to investigate the use of Direct Customer Profitability Analysis (DCPA).

ST would like to see the results from a small sample of customers before it decides whether to fully introduce DCPA.

The information for two customers, and for the whole company, for the previous period was as follows:

|  | Customer |  | D |
| :--- | :---: | :---: | :---: |
| Factory contribution (\$000) | 75 | 40.5 | Company |
|  |  |  | 450 |
| Number of: | 50 | 27 | 300 |
| Packs sold (000) | 24 | 12 | 200 |
| Sales visits to customers | 75 | 20 | 700 |
| Orders placed by customers | 45 | 15 | 240 |
| Normal deliveries to customers | 5 | 0 | 30 |

Activity costs: \$000s
Sales visits to customers 50
Processing orders placed by customers 70
Normal deliveries to customers 120
Urgent deliveries to customers 60

## Required

(a) Prepare a Direct Customer Profitability Analysis for each of the two customers.
(6 marks)
(b) Explain how ST could use DCPA to increase its profits.
(4 marks)
(Total for Question Three = 10 marks)

## Question Four

CW is a retail company that operates five stores. Each store has a manager and there is also a General Manager who reports directly to the Board of directors of the company.

For many years the General Manager has set the budgets for each store and the store managers' performances have been measured against their respective budgets even though they did not actively participate in their preparation. If a store manager meets his budgeted target then he is financially rewarded for his performance.

The company has recently appointed a new Finance Director who has questioned this previous practice and suggested that each store manager should be involved in the preparation of their own budget. The General Manager is very concerned about this. She thinks that the store managers will overstate their costs and resource requirements in order to make it easier for them to achieve their budget targets.

## Required:

(a) Explain the problems that could arise, for planning and decision making purposes within CW, if the store managers did overstate their budgeted costs and resource requirements.
(b) Discuss the behavioural issues that could arise if excess costs and resources are removed from the store managers' budgets.
(6 marks)
(Total for Question Four = 10 marks)

## Question Five

The following details show the direct labour requirements for the first six batches of a new product that were manufactured last month:

|  | Budget | Actual |
| :--- | ---: | ---: |
| Output (batches) | 6 | 6 |
| Labour hours | 2,400 | 1,950 |
| Total labour cost | $\$ 16,800$ | $\$ 13,650$ |

The Management Accountant reported the following variances:

| Total labour cost variance | $\$ 3,150$ favourable |
| :--- | :---: |
| Labour rate variance | Nil |
| Labour efficiency variance | $\$ 3,150$ favourable |

The Production Manager has now said that he forgot to inform the Management Accountant that he expected a $90 \%$ learning curve to apply for at least the first 10 batches.

Required:
(a) Calculate planning and operational variances that analyse the actual performance taking account of the anticipated learning effect.
(6 marks)
Note: The learning index for a $90 \%$ learning curve is -0.1520
(b) Explain the differences between standard costing and target costing.
(Total for Question Five = 10 marks)

## End of Section A

Section B starts on page 8

SECTION B - 50 MARKS
[Note: The indicative time for answering this section is 90 minutes.]
ANSWER BOTH QUESTIONS IN THIS SECTION. EACH QUESTION IS WORTH 25 MARKS. YOU SHOULD SHOW YOUR WORKINGS AS MARKS ARE AVAILABLE FOR THE METHOD YOU USE.

## Question Six

A manufacturer of electrical appliances is continually reviewing its product range and enhancing its existing products by developing new models to satisfy the demands of its customers. The company intends to always have products at each stage of the product life cycle to ensure the company's continued presence in the market.

Currently the company is reviewing three products:
Product K was introduced to the market some time ago and is now about to enter the maturity stage of its life cycle. The maturity stage is expected to last for ten weeks. Each unit has a variable cost of $\$ 38$ and takes 1 standard hour to produce. The Managing Director is unsure which of four possible prices the company should charge during the next ten weeks. The following table shows the results of some market research into the level of weekly demand at alternative prices:

| Selling price per unit | $\$ 100$ | $\$ 85$ | $\$ 80$ | $\$ 75$ |
| :--- | :---: | :---: | :---: | :---: |
| Weekly demand (units) | 600 | 800 | 1,200 | 1,400 |

Product L was introduced to the market two months ago using a penetration pricing policy and is now about to enter its growth stage. This stage is expected to last for 20 weeks. Each unit has a variable cost of $\$ 45$ and takes 1.25 standard hours to produce. Market research has indicated that there is a linear relationship between its selling price and the number of units demanded, of the form $\mathrm{P}=\mathrm{a}-\mathrm{bx}$. At a selling price of $\$ 100$ per unit demand is expected to be 1,000 units per week. For every $\$ 10$ increase in selling price the weekly demand will reduce by 200 units and for every $\$ 10$ decrease in selling price the weekly demand will increase by 200 units.

Product M is currently being tested and is to be launched in ten weeks' time. This is an innovative product which the company believes will change the entire market. The company has decided to use a market skimming approach to pricing this product during its introduction stage.

The company currently has a production facility which has a capacity of 2,000 standard hours per week. This facility is being expanded but the extra capacity will not be available for ten weeks.

## Required:

(a)
(i) Calculate which of the four selling prices should be charged for product K , in order to maximise its contribution during its maturity stage;
(3 marks)
and as a result, in order to utilise all of the spare capacity from your answer to (i) above,
(ii) Calculate the selling price of product $L$ during its growth stage.
(6 marks)
(Total for requirement (a) = 9 marks)
(b) Compare and contrast penetration and skimming pricing strategies during the introduction stage, using product M to illustrate your answer.
(6 marks)
(c) Explain with reasons, for each of the remaining stages of M's product life cycle, the changes that would be expected in the
(i) average unit production cost
(ii) unit selling price
(10 marks)
(Total for Question Six = 25 marks)

## Section B continues on page 10

## Question Seven

The Alpha group comprises two companies, X Limited and Y Limited both of which are resident in a country where company profits are subject to taxation at 30\%.

## X Limited

X Limited has two trading divisions:
Consultancy division - provides consultancy services to the engineering sector.
Production division - assembles machinery which it sells to a number of industry sectors. Many of the components used in these machines are purchased from Y Limited.

## Y Limited

Y Limited manufactures components from raw materials many of which are imported. The components are sold globally. Some of the components are sold to X Limited.

## Financial results

The financial results of the two companies for the year ended 30 September 2010 are as follows:

|  | X Limited |  | Y Limited |
| :--- | :---: | :---: | :---: |
|  | Consultancy division | Production division |  |
| External sales | $\$ 000$ | $\$ 000$ | $\$ 000$ |
| Sales to X Limited | 710 | 1,260 | 400 |
|  |  |  | $\underline{350}$ |
| Cost of sales | 240 |  | 750 |
| Administration costs | $\underline{260}$ | $\underline{210}$ | $\underline{140}$ |
| Operating profit <br> Capital employed | $\underline{800}$ | $2, \underline{000}$ | 250 |
|  |  | $\underline{130}$ |  |
|  |  | $\underline{370}$ |  |
|  |  |  | 4,000 |

* includes the cost of components purchased from Y Limited


## Required:

(a) Discuss the performance of each division of $X$ Limited and of $Y$ Limited using the following three ratios:
(i) Return on Capital Employed (ROCE)
(ii) Operating Profit Margin
(iii) Asset Turnover

## Transfer Prices

The current policy of the group is to allow the managers of each company or division to negotiate with each other concerning the transfer prices.

The manager of $Y$ Limited charges the same price internally for its components that it charges to its external customers. The manager of $Y$ argues that this is fair because if the internal sales were not made he could increase his external sales. An analysis of the market demand shows that currently Y Limited satisfies only $80 \%$ of the external demand for its components.

The manager of the Production division of $X$ Limited believes that the price being charged by $Y$ Limited for the components is too high and is restricting $X$ Limited's ability to win orders. Recently $X$ Limited failed to win a potentially profitable an order which it priced using its normal gross profit mark-up. The competitor who won the order set a price that was less than 10\% lower than X Limited's price.

An analysis of the cost structure of $Y$ Limited indicates that $40 \%$ of the cost of sales is fixed costs and the remaining costs vary with the value of sales.

## Required:

(b)
(i) Discuss how the present transfer pricing policy is affecting the overall performance of the group.
(ii) Explain, including appropriate calculations, the transfer price or prices at which the components should be supplied by $Y$ Limited to X Limited.
(c) The group Managing Director is considering relocating Y Limited to a country that has a much lower rate of company taxation than that in its current location.

## Required:

Explain the potential tax consequences of the internal transfer pricing policy if Y Limited were to relocate.

Maths tables and formulae are on pages 13 to 16

## PRESENT VALUE TABLE

Present value of 1 unit of currency, that is $(1+r)^{-n}$ where $r=$ interest rate; $n=$ number of periods until payment or receipt.

| Periods | Interest rates (r) |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| ( $n$ ) | 1\% | 2\% | 3\% | 4\% | 5\% | 6\% | 7\% | 8\% | 9\% | 10\% |
| 1 | 0.990 | 0.980 | 0.971 | 0.962 | 0.952 | 0.943 | 0.935 | 0.926 | 0.917 | 0.909 |
| 2 | 0.980 | 0.961 | 0.943 | 0.925 | 0.907 | 0.890 | 0.873 | 0.857 | 0.842 | 0.826 |
| 3 | 0.971 | 0.942 | 0.915 | 0.889 | 0.864 | 0.840 | 0.816 | 0.794 | 0.772 | 0.751 |
| 4 | 0.961 | 0.924 | 0.888 | 0.855 | 0.823 | 0.792 | 0.763 | 0.735 | 0.708 | 0.683 |
| 5 | 0.951 | 0.906 | 0.863 | 0.822 | 0.784 | 0.747 | 0.713 | 0.681 | 0.650 | 0.621 |
| 6 | 0.942 | 0.888 | 0.837 | 0.790 | 0.746 | 0705 | 0.666 | 0.630 | 0.596 | 0.564 |
| 7 | 0.933 | 0.871 | 0.813 | 0.760 | 0.711 | 0.665 | 0.623 | 0.583 | 0.547 | 0.513 |
| 8 | 0.923 | 0.853 | 0.789 | 0.731 | 0.677 | 0.627 | 0.582 | 0.540 | 0.502 | 0.467 |
| 9 | 0.914 | 0.837 | 0.766 | 0.703 | 0.645 | 0.592 | 0.544 | 0.500 | 0.460 | 0.424 |
| 10 | 0.905 | 0.820 | 0.744 | 0.676 | 0.614 | 0.558 | 0.508 | 0.463 | 0.422 | 0.386 |
| 11 | 0.896 | 0.804 | 0.722 | 0.650 | 0.585 | 0.527 | 0.475 | 0.429 | 0.388 | 0.350 |
| 12 | 0.887 | 0.788 | 0.701 | 0.625 | 0.557 | 0.497 | 0.444 | 0.397 | 0.356 | 0.319 |
| 13 | 0.879 | 0.773 | 0.681 | 0.601 | 0.530 | 0.469 | 0.415 | 0.368 | 0.326 | 0.290 |
| 14 | 0.870 | 0.758 | 0.661 | 0.577 | 0.505 | 0.442 | 0.388 | 0.340 | 0.299 | 0.263 |
| 15 | 0.861 | 0.743 | 0.642 | 0.555 | 0.481 | 0.417 | 0.362 | 0.315 | 0.275 | 0.239 |
| 16 | 0.853 | 0.728 | 0.623 | 0.534 | 0.458 | 0.394 | 0.339 | 0.292 | 0.252 | 0.218 |
| 17 | 0.844 | 0.714 | 0.605 | 0.513 | 0.436 | 0.371 | 0.317 | 0.270 | 0.231 | 0.198 |
| 18 | 0.836 | 0.700 | 0.587 | 0.494 | 0.416 | 0.350 | 0.296 | 0.250 | 0.212 | 0.180 |
| 19 | 0.828 | 0.686 | 0.570 | 0.475 | 0.396 | 0.331 | 0.277 | 0.232 | 0.194 | 0.164 |
| 20 | 0.820 | 0.673 | 0.554 | 0.456 | 0.377 | 0.312 | 0.258 | 0.215 | 0.178 | 0.149 |


| Periods |  |  |  |  |  |  |  |  |  |  |  |  |
| :---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | ---: | :---: | :---: |
| $(n)$ | Interest rates $(r)$ |  |  |  |  |  |  |  |  |  |  |  |
|  | $11 \%$ | $12 \%$ | $13 \%$ | $14 \%$ | $15 \%$ | $16 \%$ | $17 \%$ | $18 \%$ | $19 \%$ | $20 \%$ |  |  |
| 1 | 0.901 | 0.893 | 0.885 | 0.877 | 0.870 | 0.862 | 0.855 | 0.847 | 0.840 | 0.833 |  |  |
| 2 | 0.812 | 0.797 | 0.783 | 0.769 | 0.756 | 0.743 | 0.731 | 0.718 | 0.706 | 0.694 |  |  |
| 3 | 0.731 | 0.712 | 0.693 | 0.675 | 0.658 | 0.641 | 0.624 | 0.609 | 0.593 | 0.579 |  |  |
| 4 | 0.659 | 0.636 | 0.613 | 0.592 | 0.572 | 0.552 | 0.534 | 0.516 | 0.499 | 0.482 |  |  |
| 5 | 0.593 | 0.567 | 0.543 | 0.519 | 0.497 | 0.476 | 0.456 | 0.437 | 0.419 | 0.402 |  |  |
| 6 | 0.535 | 0.507 | 0.480 | 0.456 | 0.432 | 0.410 | 0.390 | 0.370 | 0.352 | 0.335 |  |  |
| 7 | 0.482 | 0.452 | 0.425 | 0.400 | 0.376 | 0.354 | 0.333 | 0.314 | 0.296 | 0.279 |  |  |
| 8 | 0.434 | 0.404 | 0.376 | 0.351 | 0.327 | 0.305 | 0.285 | 0.266 | 0.249 | 0.233 |  |  |
| 9 | 0.391 | 0.361 | 0.333 | 0.308 | 0.284 | 0.263 | 0.243 | 0.225 | 0.209 | 0.194 |  |  |
| 10 | 0.352 | 0.322 | 0.295 | 0.270 | 0.247 | 0.227 | 0.208 | 0.191 | 0.176 | 0.162 |  |  |
| 11 | 0.317 | 0.287 | 0.261 | 0.237 | 0.215 | 0.195 | 0.178 | 0.162 | 0.148 | 0.135 |  |  |
| 12 | 0.286 | 0.257 | 0.231 | 0.208 | 0.187 | 0.168 | 0.152 | 0.137 | 0.124 | 0.112 |  |  |
| 13 | 0.258 | 0.229 | 0.204 | 0.182 | 0.163 | 0.145 | 0.130 | 0.116 | 0.104 | 0.093 |  |  |
| 14 | 0.232 | 0.205 | 0.181 | 0.160 | 0.141 | 0.125 | 0.111 | 0.099 | 0.088 | 0.078 |  |  |
| 15 | 0.209 | 0.183 | 0.160 | 0.140 | 0.123 | 0.108 | 0.095 | 0.084 | 0.079 | 0.065 |  |  |
| 16 | 0.188 | 0.163 | 0.141 | 0.123 | 0.107 | 0.093 | 0.081 | 0.071 | 0.062 | 0.054 |  |  |
| 17 | 0.170 | 0.146 | 0.125 | 0.108 | 0.093 | 0.080 | 0.069 | 0.060 | 0.052 | 0.045 |  |  |
| 18 | 0.153 | 0.130 | 0.111 | 0.095 | 0.081 | 0.069 | 0.059 | 0.051 | 0.044 | 0.038 |  |  |
| 19 | 0.138 | 0.116 | 0.098 | 0.083 | 0.070 | 0.060 | 0.051 | 0.043 | 0.037 | 0.031 |  |  |
| 20 | 0.124 | 0.104 | 0.087 | 0.073 | 0.061 | 0.051 | 0.043 | 0.037 | 0.031 | 0.026 |  |  |

Cumulative present value of 1 unit of currency per annum, Receivable or Payable at the end of each year for $n$ years $\frac{1-(1+r)^{-n}}{r}$

| Periods | Interest rates (r) |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| ( $n$ ) | 1\% | 2\% | 3\% | 4\% | 5\% | 6\% | 7\% | 8\% | 9\% | 10\% |
| 1 | 0.990 | 0.980 | 0.971 | 0.962 | 0.952 | 0.943 | 0.935 | 0.926 | 0.917 | 0.909 |
| 2 | 1.970 | 1.942 | 1.913 | 1.886 | 1.859 | 1.833 | 1.808 | 1.783 | 1.759 | 1.736 |
| 3 | 2.941 | 2.884 | 2.829 | 2.775 | 2.723 | 2.673 | 2.624 | 2.577 | 2.531 | 2.487 |
| 4 | 3.902 | 3.808 | 3.717 | 3.630 | 3.546 | 3.465 | 3.387 | 3.312 | 3.240 | 3.170 |
| 5 | 4.853 | 4.713 | 4.580 | 4.452 | 4.329 | 4.212 | 4.100 | 3.993 | 3.890 | 3.791 |
| 6 | 5.795 | 5.601 | 5.417 | 5.242 | 5.076 | 4.917 | 4.767 | 4.623 | 4.486 | 4.355 |
| 7 | 6.728 | 6.472 | 6.230 | 6.002 | 5.786 | 5.582 | 5.389 | 5.206 | 5.033 | 4.868 |
| 8 | 7.652 | 7.325 | 7.020 | 6.733 | 6.463 | 6.210 | 5.971 | 5.747 | 5.535 | 5.335 |
| 9 | 8.566 | 8.162 | 7.786 | 7.435 | 7.108 | 6.802 | 6.515 | 6.247 | 5.995 | 5.759 |
| 10 | 9.471 | 8.983 | 8.530 | 8.111 | 7.722 | 7.360 | 7.024 | 6.710 | 6.418 | 6.145 |
| 11 | 10.368 | 9.787 | 9.253 | 8.760 | 8.306 | 7.887 | 7.499 | 7.139 | 6.805 | 6.495 |
| 12 | 11.255 | 10.575 | 9.954 | 9.385 | 8.863 | 8.384 | 7.943 | 7.536 | 7.161 | 6.814 |
| 13 | 12.134 | 11.348 | 10.635 | 9.986 | 9.394 | 8.853 | 8.358 | 7.904 | 7.487 | 7.103 |
| 14 | 13.004 | 12.106 | 11.296 | 10.563 | 9.899 | 9.295 | 8.745 | 8.244 | 7.786 | 7.367 |
| 15 | 13.865 | 12.849 | 11.938 | 11.118 | 10.380 | 9.712 | 9.108 | 8.559 | 8.061 | 7.606 |
| 16 | 14.718 | 13.578 | 12.561 | 11.652 | 10.838 | 10.106 | 9.447 | 8.851 | 8.313 | 7.824 |
| 17 | 15.562 | 14.292 | 13.166 | 12.166 | 11.274 | 10.477 | 9.763 | 9.122 | 8.544 | 8.022 |
| 18 | 16.398 | 14.992 | 13.754 | 12.659 | 11.690 | 10.828 | 10.059 | 9.372 | 8.756 | 8.201 |
| 19 | 17.226 | 15.679 | 14.324 | 13.134 | 12.085 | 11.158 | 10.336 | 9.604 | 8.950 | 8.365 |
| 20 | 18.046 | 16.351 | 14.878 | 13.590 | 12.462 | 11.470 | 10.594 | 9.818 | 9.129 | 8.514 |


| Periods |  |  |  |  |  |  |  |  |  |  |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $(n)$ | Interest rates $(r)$ |  |  |  |  |  |  |  |  |  |
|  | $11 \%$ | $12 \%$ | $13 \%$ | $14 \%$ | $15 \%$ | $16 \%$ | $17 \%$ | $18 \%$ | $19 \%$ | $20 \%$ |
| 1 | 0.901 | 0.893 | 0.885 | 0.877 | 0.870 | 0.862 | 0.855 | 0.847 | 0.840 | 0.833 |
| 2 | 1.713 | 1.690 | 1.668 | 1.647 | 1.626 | 1.605 | 1.585 | 1.566 | 1.547 | 1.528 |
| 3 | 2.444 | 2.402 | 2.361 | 2.322 | 2.283 | 2.246 | 2.210 | 2.174 | 2.140 | 2.106 |
| 4 | 3.102 | 3.037 | 2.974 | 2.914 | 2.855 | 2.798 | 2.743 | 2.690 | 2.639 | 2.589 |
| 5 | 3.696 | 3.605 | 3.517 | 3.433 | 3.352 | 3.274 | 3.199 | 3.127 | 3.058 | 2.991 |
| 6 | 4.231 | 4.111 | 3.998 | 3.889 | 3.784 | 3.685 | 3.589 | 3.498 | 3.410 | 3.326 |
| 7 | 4.712 | 4.564 | 4.423 | 4.288 | 4.160 | 4.039 | 3.922 | 3.812 | 3.706 | 3.605 |
| 8 | 5.146 | 4.968 | 4.799 | 4.639 | 4.487 | 4.344 | 4.207 | 4.078 | 3.954 | 3.837 |
| 9 | 5.537 | 5.328 | 5.132 | 4.946 | 4.772 | 4.607 | 4.451 | 4.303 | 4.163 | 4.031 |
| 10 | 5.889 | 5.650 | 5.426 | 5.216 | 5.019 | 4.833 | 4.659 | 4.494 | 4.339 | 4.192 |
| 11 | 6.207 | 5.938 | 5.687 | 5.453 | 5.234 | 5.029 | 4.836 | 4.656 | 4.486 | 4.327 |
| 12 | 6.492 | 6.194 | 5.918 | 5.660 | 5.421 | 5.197 | 4.988 | 7.793 | 4.611 | 4.439 |
| 13 | 6.750 | 6.424 | 6.122 | 5.842 | 5.583 | 5.342 | 5.118 | 4.910 | 4.715 | 4.533 |
| 14 | 6.982 | 6.628 | 6.302 | 6.002 | 5.724 | 5.468 | 5.229 | 5.008 | 4.802 | 4.611 |
| 15 | 7.191 | 6.811 | 6.462 | 6.142 | 5.847 | 5.575 | 5.324 | 5.092 | 4.876 | 4.675 |
| 16 | 7.379 | 6.974 | 6.604 | 6.265 | 5.954 | 5.668 | 5.405 | 5.162 | 4.938 | 4.730 |
| 17 | 7.549 | 7.120 | 6.729 | 6.373 | 6.047 | 5.749 | 5.475 | 5.222 | 4.990 | 4.775 |
| 18 | 7.702 | 7.250 | 6.840 | 6.467 | 6.128 | 5.818 | 5.534 | 5.273 | 5.033 | 4.812 |
| 19 | 7.839 | 7.366 | 6.938 | 6.550 | 6.198 | 5.877 | 5.584 | 5.316 | 5.070 | 4.843 |
| 20 | 7.963 | 7.469 | 7.025 | 6.623 | 6.259 | 5.929 | 5.628 | 5.353 | 5.101 | 4.870 |

## PROBABILITY

$A \cup B=A$ or $B . \quad A \cap B=\boldsymbol{A}$ and $\boldsymbol{B}$ (overlap).
$P(B \mid A)=$ probability of $B$, given $A$.

## Rules of Addition

If $A$ and $B$ are mutually exclusive:
If $A$ and $B$ are not mutually exclusive:

$$
\begin{aligned}
& P(A \cup B)=P(A)+P(B) \\
& P(A \cup B)=P(A)+P(B)-P(A \cap B)
\end{aligned}
$$

## Rules of Multiplication

If $A$ and $B$ are independent::
$P(A \cap B)=P(A) * P(B)$
If $A$ and $B$ are not independent:
$P(A \cap B)=P(A) * P(B \mid A)$
$E(X)=\sum$ (probability * payoff)

## DESCRIPTIVE STATISTICS

Arithmetic Mean

$$
\bar{x}=\frac{\sum x}{n} \quad \bar{x}=\frac{\sum f x}{\sum f} \quad \text { (frequency distribution) }
$$

Standard Deviation

$$
S D=\sqrt{\frac{\sum(x-\bar{x})^{2}}{n}} \quad S D=\sqrt{\frac{\sum \mathrm{fx}^{2}-\overline{x^{2}}}{\sum \mathrm{f}}} \text { (frequency distribution) }
$$

## INDEX NUMBERS

Price relative $=100 * P_{1} / P_{0} \quad$ Quantity relative $=100 * Q_{1} / Q_{0}$
Price: $\quad \frac{\sum w *\left(\frac{P_{1}}{P_{0}}\right)}{\sum w} \times 100$
Quantity: $\quad \frac{\sum w *\left(\frac{Q_{1}}{Q_{0}}\right)}{\sum w} \times 100$

## TIME SERIES

Additive Model

$$
\text { Series }=\text { Trend }+ \text { Seasonal + Random }
$$

Multiplicative Model

$$
\text { Series }=\text { Trend * Seasonal * Random }
$$

## FINANCIAL MATHEMATICS

## Compound Interest (Values and Sums)

Future Value $S$, of a sum of $X$, invested for $n$ periods, compounded at $r \%$ interest

$$
S=X[1+r]^{n}
$$

## Annuity

Present value of an annuity of $£ 1$ per annum receivable or payable for $n$ years, commencing in one year, discounted at $r \%$ per annum:

$$
\mathrm{PV}=\frac{1}{r}\left[1-\frac{1}{[1+r]^{n}}\right]
$$

## Perpetuity

Present value of $£ 1$ per annum, payable or receivable in perpetuity, commencing in one year, discounted at $r \%$ per annum:

$$
\mathrm{PV}=\frac{1}{r}
$$

## LEARNING CURVE

$$
Y_{x}=a X^{b}
$$

where:
$Y_{X}=$ the cumulative average time per unit to produce $X$ units;
$a=$ the time required to produce the first unit of output;
$X=$ the cumulative number of units;
$b=$ the index of learning.
The exponent $b$ is defined as the log of the learning curve improvement rate divided by $\log 2$.

## INVENTORY MANAGEMENT

Economic Order Quantity

$$
\mathrm{EOQ}=\sqrt{\frac{2 C_{0} D}{C_{h}}}
$$

where: $\mathrm{C}_{0}=$ cost of placing an order
$C_{h} \quad=\quad$ cost of holding one unit in inventory for one year
D $=$ annual demand

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## LIST OF VERBS USED IN THE QUESTION REQUIREMENTS

A list of the learning objectives and verbs that appear in the syllabus and in the question requirements for each question in this paper.

It is important that you answer the question according to the definition of the verb.

| LEARNING OBJECTIVE | VERBS USED | DEFINITION |
| :---: | :---: | :---: |
| Level 1 - KNOWLEDGE |  |  |
| What you are expected to know. | List | Make a list of |
|  | State | Express, fully or clearly, the details/facts of |
|  | Define | Give the exact meaning of |
| Level 2 - COMPREHENSION |  |  |
| What you are expected to understand. | Describe | Communicate the key features |
|  | Distinguish | Highlight the differences between |
|  | Explain | Make clear or intelligible/State the meaning or purpose of |
|  | Identify | Recognise, establish or select after consideration |
|  | Illustrate | Use an example to describe or explain something |
| Level 3 - APPLICATION |  |  |
| How you are expected to apply your knowledge. | Apply | Put to practical use |
|  | Calculate | Ascertain or reckon mathematically |
|  | Demonstrate | Prove with certainty or to exhibit by practical means |
|  | Prepare | Make or get ready for use |
|  | Reconcile | Make or prove consistent/compatible |
|  | Solve | Find an answer to |
|  | Tabulate | Arrange in a table |
| Level 4 - ANALYSIS |  |  |
| How are you expected to analyse the detail of what you have learned. |  |  |
|  | Categorise | Place into a defined class or division |
|  | Compare and contrast | Show the similarities and/or differences between |
|  | Construct | Build up or compile |
|  | Discuss | Examine in detail by argument |
|  | Interpret | Translate into intelligible or familiar terms |
|  | Prioritise | Place in order of priority or sequence for action |
|  | Produce | Create or bring into existence |
| Level 5 - EVALUATION |  |  |
| How are you expected to use your learning to evaluate, make decisions or recommendations. |  |  |
|  | Evaluate | Appraise or assess the value of |
|  | Recommend |  |

## Performance Pillar

## Management Level Paper

P2 - Performance Management

## September 2010

