## Performance Pillar

## P2 - Performance Management

## 24 November 2010 - Wednesday Afternoon Session

## 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, to open the answer book and start writing or use your <br> calculator during this reading time. <br> 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). <br> ALL answers must be written in the answer book. Answers written on the <br> question paper will not be submitted for marking. <br> You should show all workings as marks are available for the method you use. <br> ALL QUESTIONS ARE comPULSORY. <br> Section A comprises 5 questions and is on pages 2 to 6. <br> Section B comprises 2 questions and is on pages 8 to 11. <br> Maths tables and formulae are provided on pages 13 to 16. <br> The list of verbs as published in the syllabus is given for reference on page <br> 19. <br> 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. <br> Tick the appropriate boxes on the front of the answer book to indicate which <br> questions you have answered. |

SECTION A - 50 MARKS
[You are advised to spend no longer than 18 minutes on each question in this section.]

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

The following variances have been calculated in respect of a new product:
Direct labour efficiency variance
Direct labour rate variance

## \$14,700 Favourable <br> \$ 5,250 Adverse

The variances were calculated using standard cost data which showed that each unit of the product was expected to take 8 hours to produce at a cost of $\$ 15$ per hour. Actual output of the product was 560 units and actual time worked in the manufacture of the product totalled 3,500 hours at a cost of $\$ 57,750$.

However, the production manager now realises that the standard time of 8 hours per unit was the time taken to produce the first unit and that a learning rate of $90 \%$ should have been anticipated for the first 600 units.

## Required:

(a) Calculate planning and operating variances following the recognition of the learning curve effect.
(6 marks)
(b) Explain the importance of learning curves in the context of Target Costing.

Note: The learning index for a $90 \%$ learning curve is -0.1520
(Total for Question One = 10 marks)

## Question Two

CAL manufactures and sells solar panels for garden lights. Components are bought in and assembled into metal frames that are machine manufactured by CAL. There are a number of alternative suppliers of these solar panels. Some of CAL's competitors charge a lower price, but supply lower quality panels; whereas others supply higher quality panels than CAL but for a much higher price.
CAL is preparing its budgets for the coming year and has estimated that the market demand for its type of solar panels will be 100,000 units and that its share will be 20,000 units (i.e. $20 \%$ of the available market). The standard cost details of each solar panel are as follows:

## Selling price

Bought - in components (1 set)
Assembly \& machining cost
Delivery cost
Contribution
\$ per unit
60
15
25
5

## 45

15

An analysis of CAL's recent performance revealed that 2\% of the solar panels supplied to customers were returned for free replacement, because the customer found that they were faulty. Investigation of these returned items shows that the components had been damaged when they had been assembled into the metal frame. These returned panels cannot be repaired and have no scrap value. If the supply of faulty solar panels to customers could be eliminated then, due to improved customer perception, CAL's market share would increase to 25\%.

## Required:

(a) Explain, with reference to CAL, quality conformance costs and quality nonconformance costs and the relationship between them.
(b) Assuming that CAL continues with its present systems and that the percentage of quality failings is as stated above:
(i) Calculate, based on the budgeted figures and sales returns rate, the total relevant costs of quality for the coming year.
(4 marks)
(ii) Calculate the maximum saving that could be made by implementing an inspection process for the solar panels, immediately before the goods are delivered.

## Question Three

QW is a company that manufactures machine parts from sheet metal to specific customer order for industrial customers. QW is considering diversification into the production of metal ornaments. The ornaments would be produced at a constant rate throughout the year. It then plans to sell these ornaments from inventory through wholesalers and via direct mail to consumers.
Presently, each of the machine parts is specific to a customer's order. Consequently, the company does not hold an inventory of finished items but it does hold the equivalent of one day's production of sheet metal so as to reduce the risk of being unable to produce goods demanded by customers at short notice. There is a one day lead time for delivery of sheet metal to QW from its main supplier though additional supplies could be obtained at less competitive prices.
Demand for these industrial goods is such that delivery is required almost immediately after the receipt of the customer order. QW is aware that if it is unable to meet an order immediately the industrial customer would seek an alternative supplier, despite QW having a reputation for high quality machine parts.
The management of QW is not aware of the implications of the diversification for its production and inventory policies.

## Required

(a) Compare and contrast QW's present production and inventory policy and practices with a traditional production system that uses constant production levels and holds inventory to meet peaks of demand.
(b) Discuss the importance of a Total Quality Management (TQM) system in a just-in-time (JIT) environment. Use QW to illustrate your discussion.
(5 marks)
(Total for Question Three = 10 marks)

## Question Four

DW, a transport company, operates three depots. Each depot has a manager who reports directly to the Operations Director.

For many years the depot managers have been asked by the Operations Director to prepare a budget for their depot as part of the company's annual budgeting process. A new depot manager has been appointed to the Southern region and he has concerns about the validity of these annual budgets. He argues that they soon become out of date as operational circumstances change. At a recent manager's meeting he said, "They are restrictive. They do not permit the depot managers to make decisions in response to operational changes, or change working practices for next year until that year's budget has been approved."

## Required:

(a) Explain the differences between the above annual budgeting system and a rolling budget system.
(b) Discuss how the Southern region depot manager could use a rolling budget system to address his concerns.

Section A continues on page 6

## Question Five

XY provides accountancy services and has three different categories of client: limited companies, self employed individuals, and employed individuals requiring taxation advice. XY currently charges its clients a fee by adding a 20\% mark-up to total costs. Currently the costs are attributed to each client based on the hours spent on preparing accounts and providing advice.
XY is considering changing to an activity based costing system. The annual costs and the causes of these costs have been analysed as follows:

|  | $\$$ |
| :--- | ---: |
| Accounts preparation and advice | 580,000 |
| Requesting missing information | 30,000 |
| Issuing fee payment reminders | 15,000 |
| Holding client meetings | 60,000 |
| Travelling to clients | 40,000 |

The following details relate to three of $X Y$ 's clients and to $X Y$ as a whole:

|  | Client |  |  | $\boldsymbol{X Y}$ |
| :--- | ---: | ---: | ---: | ---: |
|  | $A$ | $B$ | $C$ |  |
| Hours spent on preparing accounts and <br> providing advice | 1,000 | 250 | 340 | $\mathbf{1 8 , 0 0 0}$ |
| Requests for missing information | 4 | 10 | 6 | $\mathbf{2 5 0}$ |
| Payment reminders sent | 2 | 8 | 10 | $\mathbf{4 0 0}$ |
| Client meetings held | 4 | 1 | 2 | $\mathbf{2 5 0}$ |
| Miles travelled to meet clients | 150 | 600 | 0 | $\mathbf{1 0 , 0 0 0}$ |

## Required:

Prepare calculations to show the effect on fees charged to each of these three clients of changing to the new costing system.
(10 marks)
(Total for Question Five = 10 marks)
(Total for Section A = 50 marks)

## End of Section A

Section B starts on page 8

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## SECTION B - 50 MARKS

[You are advised to spend no longer than 45 minutes on each question in this section.]

## 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

LM produces two products from different quantities of the same resources using a just-in-time (JIT) production system. The selling price and resource requirements of each of these two products are as follows:

| Product | $L$ | $M$ |
| :--- | :--- | ---: |
| Unit selling price (\$) | 70 | 90 |
| Variable costs per unit: |  |  |
| $\quad$ Direct labour (\$7 per hour) | 28 | 14 |
| $\quad$ Direct material (\$5 per kg) | 10 | 45 |
| $\quad$ Machine hours (\$10 per hour) | 10 | 20 |
| Fixed overheads absorbed | 12 | 6 |
| Profit per unit | 10 | 5 |

Fixed overheads are absorbed at the rate of $\$ 3$ per direct labour hour.
Market research shows that the maximum demand for products $L$ and $M$ during December 2010 will be 400 units and 700 units respectively.

At a recent meeting of the purchasing and production managers to discuss the company's production plans for December 2010, the following resource availability for December 2010 was identified:

| Direct labour | 3,500 hours |
| :--- | :--- |
| Direct material | $6,000 \mathrm{~kg}$ |
| Machine hours | 2,000 hours |

## Required:

(a) Prepare calculations to show, from a financial perspective, the optimum production plan for December 2010 and the contribution that would result from adopting your plan.
(b) You have now presented your optimum plan to the purchasing and production managers of LM. During the presentation, the following additional information became available:
(i) The company has agreed to an order for 250 units of product $M$ for a selling price of $\$ 90$ per unit from a new overseas customer. This order is in addition to the maximum demand that was previously predicted and must be produced and delivered in December 2010;
(ii) The originally predicted resource restrictions were optimistic. The managers now agree that the availability of all resources will be 20\% lower than their original predictions.

## Required:

Construct the revised resource constraints and the objective function to be used to identify, given the additional information above, the revised optimum production plan for December 2010.
(6 marks)
(c) The resource constraints and objective function requested in part (b) above have now been processed in a simplex linear programming model and the following solution has been printed:

| Product L | 400 | Product L other value | $\mathbf{0}$ |
| :--- | :---: | :--- | ---: |
| Product M | 194 | Product M other value | $\mathbf{5 0 6}$ |
| Direct labour | 312 |  |  |
| Direct material (\$) | $\mathbf{1 . 2 2}$ |  |  |
| Machine hours | $\mathbf{3 1 2}$ |  |  |
| Contribution (\$) | $\mathbf{1 0 , 9 3 4 . 0 0}$ |  |  |

## Required:

Analyse the meaning of each of the above eight values in the solution to the problem. Your answer should include a proof of the five individual values highlighted in bold.
(13 marks)
(Total for Question Six = 25 marks)

## Section B continues on page 10

## Question Seven

SWZ is a manufacturing company that has many trading divisions. Return on Investment (ROI) is the main measure of each division's performance. Each divisional manager's salary is linked only to their division's ROI.

The following information summarises the financial performance of the S division of SWZ over the last three years:

| Year ending 31 October | 2008 | 2009 | 2010 |
| :--- | ---: | ---: | ---: |
| Turnover | $\$ 000$ | $\$ 000$ | $\$ 000$ |
| Cost of sales | 400 | 400 | 400 |
| Gross profit | 240 | 240 | 240 |
| Other operating costs | 160 | 160 | 160 |
| Pre-tax operating profit | 120 | 104 | 98 |
|  | 40 | 56 | 62 |
| Capital invested as at the end of the year | 400 | 320 | 256 |

Other operating costs include asset depreciation calculated at the rate of $20 \%$ per annum on a reducing balance basis.

The figures shown in the above table for the capital invested as at the end of the year is the net book value of the division's fixed assets.

All of the above values have been adjusted to remove the effects of inflation. There have been no additions or disposals of fixed assets within the $S$ division during this period.

## Required

(a) Discuss the performance of the $S$ division over the three year period.
(9 marks)

The manager of the $S$ division is now considering investing in a replacement machine. The machine that would be replaced would be sold for its net book value which was \$40,000 at 31 October 2010 and the new machine would cost $\$ 100,000$. The new machine would have an expected life of five years and would be depreciated using the same depreciation rates as the existing machinery. The new machine would reduce the division's cost of sales by $10 \%$. At the end of five years it would be sold for its net book value.

The divisional cost of capital is $8 \%$ per annum. The company has evaluated the investment and correctly determined that it has a positive Net Present Value (NPV) of \$24,536.

## Required

(b) Prepare calculations to show why the manager of the S division is unlikely to go ahead with the investment.

Ignore taxation.
(c) Prepare calculations to show how the use of Residual Income (RI) as the performance measure would have led to a goal congruent decision by the manager of the $S$ division in relation to the purchase of the replacement machine.

Ignore taxation.

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:

$$
\begin{aligned}
& P(A \cap B)=P(A) * P(B) \\
& P(A \cap B)=P(A) * P(B \mid A)
\end{aligned}
$$

If $A$ and $B$ are not independent:
$E(X)=\sum$ (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

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

where: $\mathrm{C}_{0}=$ cost of placing an order
$C_{h}=$ cost of holding one unit in inventory for one year
D $\quad=\quad$ 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 $\mathbf{1}$ - KNOWLEDGE <br> What you are expected to know. | Make a list of |  |
|  | List | Express, fully or clearly, the details/facts of |
| Level 2 - COMPREHENSION | Give the exact meaning of |  |

## Performance Pillar

## Management Level Paper

P2 - Performance Management

November 2010

## Wednesday Afternoon Session

