



Performance Pillar

P2 – Performance Management

26 May 2010 – Wednesday Afternoon Session

**Instructions to candidates**

You are allowed three hours to answer this question paper.
You are allowed 20 minutes reading time <b>before the examination begins</b> during which you should read the question paper and, if you wish, make annotations on the question paper. However, you will <b>not</b> be allowed, <b>under any circumstances</b> , to open the answer book and start writing or use your calculator during this reading time.
You are strongly advised to carefully read ALL the question requirements before attempting the question concerned (that is all parts and/or sub-questions).
ALL answers must be written in the answer book. Answers written on the question paper will <b>not</b> be submitted for marking.
You should show all workings as marks are available for the method you use.
You will require graph paper for your answer to question 6.
ALL QUESTIONS ARE COMPULSORY.
Section A comprises 5 questions and is on pages 2 to 6.
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 19.
Write your candidate number, the paper number and examination subject title in the spaces provided on the front of the answer book. Also write your contact ID and name in the space provided in the right hand margin and seal to close.
Tick the appropriate boxes on the front of the answer book to indicate which questions you have answered.

**P2 – Performance Management**

TURN OVER

## 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

The budget for the production cost of a new product was based on the following assumptions:

- (i) Time for the 1<sup>st</sup> batch of output = 10 hours
- (ii) Learning rate = 80%
- (iii) Learning will cease after 40 batches, and thereafter the time per batch will be the same as the time of the final batch during the learning period, i.e. the 40<sup>th</sup> batch
- (iv) Standard direct labour rate per hour = \$12.00

An extract from the out-turn performance report based on the above budget is as follows:

	<i>Budget</i>	<i>Actual</i>	<i>Variance</i>
Output (batches)	60	50	10 adverse
Direct labour hours	163.53	93.65	69.88 favourable
Direct labour cost	\$1,962	\$1,146	\$816 favourable

Further analysis has shown that, due to similarities between this product and another that was developed last year, the rate of learning that should have been expected was 70% and that the learning should have ceased after 30 batches. Other budget assumptions for the new product remain valid.

#### *Required:*

- (a) Prepare a revised out-turn performance report for the new product that
  - (i) shows the flexed budgeted direct labour hours and direct labour cost based on the revised learning curve data, and
  - (ii) shows the variances that reconcile the actual results to your flexed budget in as much detail as possible.

*(7 marks)*
- (b) Explain why your report is more useful to the production manager than the report shown above.

*(3 marks)*

Note: The learning index values for an 80% and a 70% learning curve are -0.3219 and -0.5146 respectively.

*(Total for Question One = 10 marks)*

## Question Two

PQ manufactures and sells consumer electronics. It is constantly working to design the latest gadgets and “must-haves” which are unique in the market place at the time they are launched. The management of PQ are aware of the short product life cycles in this competitive market and consequently use a market skimming pricing strategy at the introduction stage.

*Required:*

Explain the changes that are likely to occur in the following items at the three later stages in the product life cycle of a typical PQ product.

- (i) Selling price
- (ii) Production costs
- (iii) Selling and marketing costs

*(Total for Question Two = 10 marks)*

*Section A continues on page 4*

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### Question Three

XY, a company that manufactures a range of timber products, is considering changing to a just-in-time (JIT) production system.

Currently XY employs staff who are contracted to work and be paid for a total of 3,937.75 hours per month. Their labour efficiency ratio is 96% and, as a result, they are able to produce 3,780 standard hours of output each month in normal working hours.

Overtime working is used to meet additional demand, though the management of XY try to avoid the need for this because it is paid at a 50% premium to the normal hourly rate of \$10 per hour. Instead, XY plan production so that in months of lower demand inventory levels increase to enable sales demand to be met in other months. XY has determined that the cost of holding inventory is \$6 per month for each standard hour of output that is held in inventory.

XY has forecast the demand for its products for the next six months as follows:

<i>Month</i>	<i>Demand (Standard hours)</i>
1	3,100
2	3,700
3	4,000
4	3,300
5	3,600
6	4,980

You may assume that all production costs (other than labour) are either fixed or are not driven by labour hours worked, and that there is zero inventory at the start of month 1 and at the end of month 6. Assume also that production and sales occur evenly during each month at present, and that the minimum contracted hours will remain the same with the JIT system.

#### *Required*

- (a) With the current production system,
- (i) Calculate for each of the six months and the period in total, the total inventory holding costs.
  - (ii) Calculate the total production cost savings made by changing to a JIT production system.

*(6 marks)*

- (b) Explain TWO other factors that should be considered by XY before changing to a JIT production system.

*(4 marks)*

*(Total for Question Three = 10 marks)*

#### Question Four

A firm of solicitors is using budgetary control during 2010. The senior partner estimated the demand for the year for each of the firm's four divisions: Civil, Criminal, Corporate, and Property. A separate partner is responsible for each division.

Each divisional partner then prepared a cost budget based on the senior partner's demand estimate for the division. These budgets were then submitted to the senior partner for his approval. He then amended them as he thought appropriate before issuing each divisional partner with the final budget for the division. He did not discuss these amendments with the respective divisional partners. Actual performance is then measured against the final budgets for each month and each divisional partner's performance is appraised by asking the divisional partner to explain the reasons for any variances that occur.

The Corporate partner has been asked to explain why her staff costs exceeded the budgeted costs for last month while the chargeable time was less than budgeted. Her reply is below:

"My own original estimate of staff costs was higher than the final budgeted costs shown on my divisional performance report. In my own cost budget I allowed for time to be spent developing new services for the firm's corporate clients and improving the clients' access to their own case files. This would improve the quality of our services to clients and therefore increase client satisfaction. The trouble with our present system is that it focuses on financial performance and ignores the other performance indicators found in modern performance management systems."

*Required:*

- (a) Discuss the present budgeting system and its likely effect on divisional partner motivation.

*(6 marks)*

- (b) Explain two non-financial performance indicators (other than client satisfaction and service quality) that could be used by the firm.

*(4 marks)*

*(Total for Question Four = 10 marks)*

*Section A continues on page 6*

### Question Five

LMN comprises three trading divisions plus a Head Office. There is a director for each trading division and, in addition, there is a Managing Director who is based in Head Office. Divisional directors are empowered to make decisions concerning the day to day operations of their division and investment decisions requiring an initial investment up to \$100,000. Investment decisions involving greater initial expenditure must be authorised by the Managing Director. Inter-divisional trading occurs between all of the trading divisions. The transfer prices are determined by Head Office. Head Office provides services and facilities to each of the trading divisions.

At the end of each month, the actual costs of Head Office are apportioned to the trading divisions. Each Head Office cost is apportioned to the trading divisions using an appropriate basis. The bases used are: number of employees; value of sales; capital invested; and standard hours of service delivered.

The Head Office costs, together with the costs and revenues generated at divisional level, are summarised in a divisional performance statement each month. The divisional directors are not happy with the present performance statement and how it is used to appraise their performance.

*Required:*

- (a) Explain, using examples from the scenario, three issues that LMN should consider when designing a new divisional performance statement.

*(6 marks)*

LMN is thinking of introducing Activity Based Costing at its Head Office to help with the apportionment of all its costs to the divisions.

- (b) Discuss the advantages of applying Activity Based Costing to apportion all of the Head Office costs.

*(4 marks)*

*(Total for Question Five = 10 marks)*

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*(Total for Section A = 50 marks)*

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*End of Section A*

*Section B starts on page 8*

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TURN OVER

## 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.

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### Question Six

RT 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 the products are shown below:

Product	R	T
Unit selling price (\$)	130	160
Resources per unit:		
Direct labour (\$8 per hour)	3 hours	5 hours
Material A (\$3 per kg)	5 kgs	4 kgs
Material B (\$7 per litre)	2 litres	1 litre
Machine hours (\$10 per hour)	3 hours	4 hours

Market research shows that the maximum demand for products R and T during June 2010 is 500 units and 800 units respectively. This does not include an order that RT has agreed with a commercial customer for the supply of 250 units of R and 350 units of T at selling prices of \$100 and \$135 per unit respectively. Although the customer will accept part of the order, failure by RT to deliver the order in full by the end of June will cause RT to incur a \$10,000 financial penalty.

At a recent meeting of the purchasing and production managers to discuss the production plans of RT for June, the following resource restrictions for June were identified:

Direct labour hours	7,500 hours
Material A	8,500 kgs
Material B	3,000 litres
Machine hours	7,500 hours



*Required:*

- (a) Assuming that RT completes the order with the commercial customer, prepare calculations to show, from a financial perspective, the optimum production plan for June 2010 and the contribution that would result from adopting this plan.  
*(6 marks)*
- (b) Prepare calculations to show, from a financial perspective, whether RT should complete the order from the commercial customer  
*(3 marks)*

You have now presented your optimum production plan to the purchasing and production managers of RT. During your presentation it became clear that the predicted resource restrictions were rather optimistic. In fact the managers agreed that the availability of all of the resources could be as much as 10% lower than their original predictions.

- (c) Assuming that RT completes the order with the commercial customer, and using graphical linear programming, prepare a graph to show the optimum production plan for RT for June 2010 on the basis that the availability of all resources is 10% lower than originally predicted.  
*(11 marks)*
- (d) Discuss how the graph in your solution to (c) above can be used to help to determine the optimum production plan for June 2010 if the actual resource availability lies somewhere between the managers' optimistic and pessimistic predictions.  
*(5 marks)*

*(Total for Question Six = 25 marks)*

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*Section B continues on page 10*

## Question Seven

H manufactures perfumes and cosmetics by mixing various ingredients in different processes, before the items are packaged and sold to wholesalers. H uses a divisional structure with each process being regarded as a separate division with its own manager who is set performance targets at the start of each financial year which begins on 1 January. Performance is measured using Return on Investment (ROI) based on net book value of capital equipment at the start of the year. The company depreciates its capital equipment at the rate of 20% per annum on a reducing balance basis. The annual depreciation is calculated at the start of the financial year and one-twelfth of this annual amount is included as monthly depreciation in the fixed overhead costs of each process. Output transferred from one process to another is valued using transfer prices based on the total budgeted costs of the process plus a mark-up of 15%.

### Process B

This is the first process. Raw materials are blended to produce three different outputs, two of which are transferred to Processes C and D respectively. The third output is accounted for as a by-product and sold in the external market without further processing. The equipment used to operate this process originally cost \$800,000 on 1 January 2005.

The Process B account for April 2010 was as follows:

	<i>Litres</i>	<i>\$</i>		<i>Litres</i>	<i>\$</i>
Opening WIP	NIL	NIL	Normal Loss	3,000	3,000
Material W	10,000	25,000	By-product	5,000	5,000
Material X	5,000	10,000	Output to C	9,000	82,800
Material Y	12,000	24,000	Output to D	10,000	92,000
Direct labour		30,000	Closing WIP	NIL	NIL
Overhead		75,000			
Profit & Loss		18,800			
Totals	27,000	182,800	Totals	27,000	182,800

The material costs are variable per unit of input and direct labour costs are fixed in the short term because employees' contracts provide them with a six month notice period. Overhead costs include a share of Head Office costs, and of the remaining overhead costs some vary with the input volume of the process. The level of activity in April 2010 was typical of the monthly volumes processed by the company.

### Process C

This process receives input from Process B to which is added further materials to produce a finished product that is sold in the external market at the budgeted selling price of \$20 per litre. The equipment used to operate this process originally cost \$500,000 on 1 January 2008.

The Process C account for April 2010 was as follows:

	<i>Litres</i>	<i>\$</i>		<i>Litres</i>	<i>\$</i>
Opening WIP	1,000	11,200	Normal Loss	3,000	1,500
Input from B	9,000	82,800	Abnormal Loss	1,500	750
Material Z	3,000	15,000	Output	7,500	150,000
Direct labour		20,000	Closing WIP	1,000	11,200
Overhead		50,000			
			Profit & Loss		15,550
Totals	13,000	179,000	Totals	13,000	179,000

The material costs are variable per unit of input and direct labour costs are fixed in the short term because employees' contracts provide them with a six month notice period. Overhead costs include a share of Head Office costs, and of the remaining overhead costs some vary with the input volume of the process. The level of activity that occurred in April 2010 was typical of the monthly volumes processed by the company, and the opening and closing work in process are identical in every respect. The process is regarded as an investment centre and completed output and losses are valued at their selling prices. The manager of Process C is concerned at the level of output achieved from the input volume and is considering

investing in new equipment that should eliminate the abnormal loss. This would involve investing \$1,000,000 in new processing equipment on 1 January 2011; the existing equipment would be sold on the same date at a price equal to its net book value.

### Process D

This process receives input from Process B which is further processed to produce a finished product that is sold in the external market at the budgeted selling price of \$16 per litre. The equipment used to operate this process originally cost \$300,000 on 1 January 2000.

### The Process D account for April 2010 was as follows:

	<i>Litres</i>	<i>\$</i>		<i>Litres</i>	<i>\$</i>
Opening WIP	1,000	5,500	Normal Loss	1,000	3,000
Input from B	10,000	92,000	Output	9,000	144,000
Direct labour		30,000	Closing WIP	1,000	5,500
Overhead		30,000	Profit & Loss		5,000
Totals	11,000	157,500	Totals	11,000	157,500

Direct labour costs are fixed in the short term because employees' contracts provide them with a six month notice period. Overhead costs include a share of Head Office costs, and of the remaining overhead costs some vary with the input volume of the process. The level of activity in April 2010 was typical of the monthly volumes processed by the company, and the opening and closing work in process are identical in every respect. The process is regarded as an investment centre and completed output and losses are valued at their selling prices. The manager of Process D believes that the transfer price from Process B is unfair because the equivalent material could be purchased in the open market at a cost of \$7.50 per litre.

### *Required*

#### *(a)*

- (i) Calculate the annualised Return on Investment (ROI) achieved by each of the process divisions during April 2010. *(4 marks)*
- (ii) Discuss the suitability of this performance measure in the context of the data provided for each process division. *(4 marks)*

#### *(b)*

- (i) Calculate the effect on the annualised Return on Investment in 2011 of Process Division C investing in new capital equipment. *(4 marks)*
- (ii) Discuss the conflict that may arise between the use of NPV and ROI in this investment decision. *(4 marks)*

#### *(c)*

- Discuss the transfer pricing policy being used by H from the viewpoints of the managers of Process Division B and Process Division D. *(9 marks)*

*(Total for Question Seven = 25 marks)*

*(Total for Section B = 50 marks)*

*End of question paper*

*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 ( $n$ )	Interest rates ( $r$ )									
	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	0.705	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 ( $n$ )	Interest rates ( $r$ )									
	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	4.793	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

## FORMULAE

### PROBABILITY

$A \cup B = \mathbf{A \text{ or } B}$ .       $A \cap B = \mathbf{A \text{ and } B}$  (overlap).  
 $P(B | A)$  = probability of  $B$ , **given**  $A$ .

#### Rules of Addition

If  $A$  and  $B$  are mutually exclusive:       $P(A \cup B) = P(A) + P(B)$   
If  $A$  and  $B$  are not mutually exclusive:       $P(A \cup B) = P(A) + P(B) - P(A \cap B)$

#### Rules of Multiplication

If  $A$  and  $B$  are *independent*::       $P(A \cap B) = P(A) * P(B)$   
If  $A$  and  $B$  are **not independent**:       $P(A \cap B) = P(A) * P(B | A)$

$$E(X) = \sum (\text{probability} * \text{payoff})$$

### DESCRIPTIVE STATISTICS

Arithmetic Mean

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

Standard Deviation

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

### INDEX NUMBERS

Price relative =  $100 * P_1/P_0$       Quantity relative =  $100 * Q_1/Q_0$

Price: 
$$\frac{\sum w * \left(\frac{P_1}{P_0}\right)}{\sum w} * 100$$

Quantity: 
$$\frac{\sum w * \left(\frac{Q_1}{Q_0}\right)}{\sum w} * 100$$

### TIME SERIES

Additive Model

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

Multiplicative Model

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

## 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:

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

### Perpetuity

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

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

## LEARNING CURVE

$$Y_x = aX^b$$

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

$$EOQ = \sqrt{\frac{2C_o D}{C_h}}$$

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

*Performance Pillar*

*Management Level Paper*

*P2 – Performance Management*

*May 2010*

*Wednesday Afternoon Session*