

Professional Level – Options Module

Advanced Financial Management

Thursday 9 December 2010

Time allowed

Reading and planning: 15 minutes

Writing: 3 hours

This paper is divided into two sections:

Section A – BOTH questions are compulsory and MUST be attempted

Section B – TWO questions ONLY to be attempted

Formulae and tables are on pages 9–13.

Do NOT open this paper until instructed by the supervisor.

During reading and planning time only the question paper may be annotated. You must NOT write in your answer booklet until instructed by the supervisor.

This question paper must not be removed from the examination hall.

The Association of Chartered Certified Accountants

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Paper

ACCA

Section A – BOTH questions are compulsory and MUST be attempted

1 Doric Co, a listed company, has two manufacturing divisions: parts and fridges. It has been manufacturing parts for domestic refrigeration and air conditioning systems for a number of years, which it sells to producers of fridges and air conditioners worldwide. It also sells around 30% of the parts it manufactures to its fridge production division. It started producing and selling its own brand of fridges a few years ago. After limited initial success, competition in the fridge market became very tough and revenue and profits have been declining. Without further investment there are currently few growth prospects in either the parts or the fridge divisions. Doric Co borrowed heavily to finance the development and launch of its fridges, and has now reached its maximum overdraft limit. The markets have taken a pessimistic view of the company and its share price has declined to 50c per share from a high of \$2.83 per share around three years ago.

Extracts from the most recent financial statements:

Financial position as at 30 November 2010		\$m
Assets		
Non-Current Assets		
Land and buildings		70
Machinery and equipment		50
		120
Current Assets		
Inventory		180
Receivables		40
		220
Total Assets		340
Equity and Liabilities		
Share capital (40c per share par value)		40
Reserves		20
		60
Non-Current Liabilities		
7% Unsecured bonds 2020		120
Other unsecured loans (currently 5 ¹ / ₃ % interest)		30
		150
Current Liabilities		
Payables		70
Bank overdraft (currently 10% interest)		60
		130
Total Liabilities and capital		340
Income for the year ended 30 November 2010		
		\$m
Sales revenue:	Parts division	170
	Fridge division	340
Costs prior to depreciation, interest payments and tax:	Parts division	(120)
	Fridge division	(370)
Tax allowable depreciation		(18)
Finance cost (interest)		(16)
Tax		Nil
Loss		(14)

A survey from the refrigeration and air conditioning parts market has indicated that there is potential for Doric Co to manufacture parts for mobile refrigeration units used in cargo planes and containers. If this venture goes ahead then the parts division before-tax profits are expected to grow by 5% per year. The proposed venture would need an initial one-off investment of \$50 million.

Suggested proposals

The Board of Directors has arranged for a meeting to discuss how to proceed and is considering each of the following proposals:

1. To cease trading and close down the company entirely.
2. To undertake corporate restructuring in order to reduce the level of debt and obtain the additional capital investment required to continue current operations.
3. To close the fridge division and continue the parts division through a leveraged management buy-out, involving some executive directors and managers from the parts division. The new company will then pursue its original parts business as well as the development of the parts for mobile refrigeration business, described above. All the current and long-term liabilities will be initially repaid using the proceeds from the sale of the fridge division. The finance raised from the management buy-out will pay for any remaining liabilities, the additional capital investment required to continue operations and re-purchase the shares at a premium of 20%.

The following information has been provided for each proposal:

Cease trading

Estimated realisable values of assets not sold as going concern are:

	\$ million
Land and buildings	60
Machinery and equipment	40
Inventory	90
Receivables	20

Corporate restructuring

The existing ordinary shares will be cancelled and ordinary shareholders will be issued with 40 million new \$1 ordinary shares in exchange for a cash payment at par. The existing unsecured bonds will be cancelled and replaced with 270 million of \$1 ordinary shares. The bond holders will contribute \$90 million in cash. All the shares will be listed and traded. The bank overdraft will be converted into a secured ten-year loan with a fixed annual interest rate of 7%. The other unsecured loans will be repaid. In addition to this, the directors of the restructured company will get 4 million \$1 share options for an exercise price of \$1.10, which will expire in four years.

An additional one-off capital investment of \$80 million in machinery and equipment is necessary to increase sales revenue for both divisions by 7%, with no change to the costs. After the one-off 7% growth, sales will continue at the new level for the foreseeable future.

It is expected that the Doric's cost of capital rate will reduce by 550 basis points following the restructuring from the current rate.

Management buy-out

The parts division is half the size of the fridge division in terms of the assets and liabilities attributable to it. If the management buy-out proposal is chosen, a pro rata additional capital investment will be made to machinery and equipment on a one-off basis to increase sales revenue of the parts division by 7%. Sales revenue will then continue at the new level for the foreseeable future.

All liabilities categories have equal claim for repayment against the company's assets.

It is expected that Doric's cost of capital rate will decrease by 100 basis points following the management buy-out from the current rate.

The following additional information has been provided:

Redundancy and other costs will be approximately \$54 million if the whole company is closed, and pro rata for individual divisions that are closed. These costs have priority for payment before any other liabilities in case of closure. The taxation effects relating to this may be ignored.

Corporation tax on profits is 20% and losses cannot be carried forward for tax purposes. Assume that tax is payable in the year incurred.

All the non-current assets, including land and buildings, are eligible for tax allowable depreciation of 15% annually on the book values. The annual reinvestment needed to keep operations at their current levels is roughly equivalent to the tax allowable depreciation. The \$50 million investment in the mobile refrigeration business is not eligible for any tax allowable depreciation.

Doric's current cost of capital is 12%.

Required:

Prepare a report for the Board of Directors, evaluating the financial and non-financial impact of all the three proposals to Doric Co's main stakeholder groups, that includes:

- (i) An estimate of the return the debt holders and shareholders would receive in the event that Doric Co ceases trading and is closed down. (3 marks)**
- (ii) An estimate of the income position and the value of Doric Co in the event that the restructuring proposal is selected. State any assumptions made. (8 marks)**
- (iii) An estimate of the amount of additional finance needed and the value of Doric Co if the management buy-out proposal is selected. State any assumptions made. (8 marks)**
- (iv) A discussion of the impact of each proposal on the existing shareholders, the unsecured bond holders, and the executive directors and managers involved in the management buy-out. Suggest which proposal is likely to be selected. (12 marks)**

Professional marks will be awarded in question 1 for the appropriateness and format of the report. (4 marks)

(35 marks)

2 Fubuki Co, an unlisted company based in Megaera, has been manufacturing electrical parts used in mobility vehicles for people with disabilities and the elderly, for many years. These parts are exported to various manufacturers worldwide but at present there are no local manufacturers of mobility vehicles in Megaera. Retailers in Megaera normally import mobility vehicles and sell them at an average price of \$4,000 each. Fubuki Co wants to manufacture mobility vehicles locally and believes that it can sell vehicles of equivalent quality locally at a discount of 37·5% to the current average retail price.

Although this is a completely new venture for Fubuki Co, it will be in addition to the company's core business. Fubuki Co's directors expect to develop the project for a period of four years and then sell it for \$16 million to a private equity firm. Megaera's government has been positive about the venture and has offered Fubuki Co a subsidised loan of up to 80% of the investment funds required, at a rate of 200 basis points below Fubuki Co's borrowing rate. Currently Fubuki Co can borrow at 300 basis points above the five-year government debt yield rate.

A feasibility study commissioned by the directors, at a cost of \$250,000, has produced the following information.

1. Initial cost of acquiring suitable premises will be \$11 million, and plant and machinery used in the manufacture will cost \$3 million. Acquiring the premises and installing the machinery is a quick process and manufacturing can commence almost immediately.
2. It is expected that in the first year 1,300 units will be manufactured and sold. Unit sales will grow by 40% in each of the next two years before falling to an annual growth rate of 5% for the final year. After the first year the selling price per unit is expected to increase by 3% per year.
3. In the first year, it is estimated that the total direct material, labour and variable overheads costs will be \$1,200 per unit produced. After the first year, the direct costs are expected to increase by an annual inflation rate of 8%.
4. Annual fixed overhead costs would be \$2·5 million of which 60% are centrally allocated overheads. The fixed overhead costs will increase by 5% per year after the first year.
5. Fubuki Co will need to make working capital available of 15% of the anticipated sales revenue for the year, at the beginning of each year. The working capital is expected to be released at the end of the fourth year when the project is sold.

Fubuki Co's tax rate is 25% per year on taxable profits. Tax is payable in the same year as when the profits are earned. Tax allowable depreciation is available on the plant and machinery on a straight-line basis. It is anticipated that the value attributable to the plant and machinery after four years is \$400,000 of the price at which the project is sold. No tax allowable depreciation is available on the premises.

Fubuki Co uses 8% as its discount rate for new projects but feels that this rate may not be appropriate for this new type of investment. It intends to raise the full amount of funds through debt finance and take advantage of the government's offer of a subsidised loan. Issue costs are 4% of the gross finance required. It can be assumed that the debt capacity available to the company is equivalent to the actual amount of debt finance raised for the project.

Although no other companies produce mobility vehicles in Megaera, Haizum Co, a listed company, produces electrical-powered vehicles using similar technology to that required for the mobility vehicles. Haizum Co's cost of equity is estimated to be 14% and it pays tax at 28%. Haizum Co has 15 million shares in issue trading at \$2·53 each and \$40 million bonds trading at \$94·88 per \$100. The five-year government debt yield is currently estimated at 4·5% and the market risk premium at 4%.

Required:

(a) Evaluate, on financial grounds, whether Fubuki Co should proceed with the project. (17 marks)

(b) Discuss the appropriateness of the evaluation method used and explain any assumptions made in part (a) above. (8 marks)

(25 marks)

Section B – TWO questions ONLY to be attempted

3 The treasury division of Marengo Co, a large quoted company, holds equity investments in various companies around the world. One of the investments is in Arion Co, in which Marengo holds 200,000 shares, which is around 2% of the total number of Arion Co's shares traded on the stock market. Over the past year, due to the general strength in the equity markets following optimistic predictions of the performance of world economies, Marengo's investments have performed well. However, there is some concern that the share price of Arion Co may fall in the coming two months due to uncertainty in its markets. It is expected that any fall in share prices will be reversed following this period of uncertainty.

The treasury division managers in Marengo, Wenyu, Lola and Sam, held a meeting to discuss what to do with the investment in Arion Co and they each made a different suggestion as follows:

1. Wenyu was of the opinion that Marengo's shareholders would benefit most if no action were taken. He argued that the courses of action proposed by Lola and Sam, below, would result in extra costs and possibly increase the risk to Marengo Co.
2. Lola proposed that Arion Co's shares should be sold in order to eliminate the risk of a fall in the share price.
3. Sam suggested that the investment should be hedged using an appropriate derivative product.

Although no exchange-traded derivative products exist on Arion Co's shares, a bank has offered over-the-counter (OTC) option contracts at an exercise price of 350 cents per share in a contract size of 1,000 shares each, for the appropriate time period. Arion Co's current share price is 340 cents per share, although the volatility of the share prices could be as high as 40%.

It can be assumed that Arion Co will not pay any dividends in the coming few months and that the appropriate inter-bank lending rate will be 4% over that period.

Required:

(a) Estimate the number of OTC put option contracts that Marengo Co will need to hedge against any adverse movement in Arion Co's share price. Provide a brief explanation of your answer.

Note: You may assume that the delta of a put option is equivalent to $N(-d_1)$ (7 marks)

(b) Discuss possible reasons for the suggestions made by each of the three managers. (13 marks)

(20 marks)

- 4 Lamri Co (Lamri), a listed company, is expecting sales revenue to grow to \$80 million next year, which is an increase of 20% from the current year. The operating profit margin for next year is forecast to be the same as this year at 30% of sales revenue. In addition to these profits, Lamri receives 75% of the after-tax profits from one of its wholly owned foreign subsidiaries – Magnolia Co (Magnolia), as dividends. However, its second wholly owned foreign subsidiary – Strymon Co (Strymon) does not pay dividends.

Lamri is due to pay dividends of \$7.5 million shortly and has maintained a steady 8% annual growth rate in dividends over the past few years. The company has grown rapidly in the last few years as a result of investment in key projects and this is likely to continue.

For the coming year it is expected that Lamri will require the following capital investment.

1. An investment equivalent to the amount of depreciation to keep its non-current asset base at the present productive capacity. Lamri charges depreciation of 25% on a straight-line basis on its non-current assets of \$15 million. This charge has been included when calculating the operating profit amount.
2. A 25% investment in additional non-current assets for every \$1 increase in sales revenue.
3. \$4.5 million additional investment in non-current assets for a new project.

Lamri also requires a 15% investment in working capital for every \$1 increase in sales revenue.

Strymon produces specialist components solely for Magnolia to assemble into finished goods. Strymon will produce 300,000 specialist components at \$12 variable cost per unit and will incur fixed costs of \$2.1 million for the coming year. It will then transfer the components to Magnolia at full cost price, where they will be assembled at a cost of \$8 per unit and sold for \$50 per unit. Magnolia will incur additional fixed costs of \$1.5 million in the assembly process.

Tax-Ethic (TE) is a charitable organisation devoted to reducing tax avoidance schemes by companies operating in poor countries around the world. TE has petitioned Lamri's Board of Directors to reconsider Strymon's policy of transferring goods at full cost. TE suggests that the policy could be changed to cost plus 40% mark-up. If Lamri changes Strymon's policy, it is expected that Strymon would be asked to remit 75% of its after-tax profits as dividends to Lamri.

Other Information

1. Lamri's outstanding non-current liabilities of \$35 million, on which it pays interest of 8% per year, and its 30 million \$1 issued equity capital will not change for the coming year.
2. Lamri's, Magnolia's and Strymon's profits are taxed at 28%, 22% and 42% respectively. A withholding tax of 10% is deducted from any dividends remitted from Strymon.
3. The tax authorities where Lamri is based charge tax on profits made by subsidiary companies but give full credit for tax already paid by overseas subsidiaries.
4. All costs and revenues are in \$ equivalent amounts and exchange rate fluctuations can be ignored.

Required:

- (a) Calculate Lamri's dividend capacity for the coming year prior to implementing TE's proposal and after implementing the proposal. (14 marks)
- (b) Comment on the impact of implementing TE's proposal and suggest possible actions Lamri may take as a result. (6 marks)

(20 marks)

5 Prospice Mentis University (PMU) is a prestigious private institution and a member of the Holly League, which is made up of universities based in Rosinante and renowned worldwide as being of the highest quality. Universities in Rosinante have benefited particularly from students coming from Kantaka, and PMU has been no exception. However, PMU has recognised that Kantaka has a large population of able students who cannot afford to study overseas. Therefore it wants to investigate how it can offer some of its most popular degree programmes in Kantaka, where students will be able to study at a significantly lower cost. It is considering whether to enter into a joint venture with a local institution or to independently set up its own university site in Kantaka.

Offering courses overseas would be a first from a Holly League institution and indeed from any academic institution based in Rosinante. However, there have been less renowned academic institutions from other countries which have formed joint ventures with small private institutions in Kantaka to deliver degree programmes. These have been of low quality and are not held in high regard by the population or the government of Kantaka.

In Kantaka, government run universities and a handful of large private academic institutions, none of which have entered into joint ventures, are held in high regard. However, the demand for places in these institutions far outstrips the supply of places and many students are forced to go to the smaller private institutions or to study overseas if they can afford it.

After an initial investigation the following points have come to light:

1. The Kantaka government is keen to attract foreign direct investment (FDI) and offer tax concessions to businesses which bring investment funds into the country. It is likely that PMU would need to borrow a substantial amount of money if it were to set up independently. However, the investment funds required would be considerably smaller if it went into a joint venture.
2. Given the past experiences of poor quality education offered by joint ventures between small local private institutions and overseas institutions, the Kantaka government has been reluctant to approve degrees from such institutions. Also the government has not allowed graduates from these institutions to work in national or local government, or in nationalised organisations.
3. Over the past two years the Kantaka currency has depreciated against other currencies, but economic commentators believe that this may not continue for much longer.
4. A large proportion of PMU's academic success is due to innovative teaching and learning methods, and high quality research. The teaching and learning methods used in Kantaka's educational institutions are very different. Apart from the larger private and government run universities, little academic research is undertaken elsewhere in Kantaka's education sector.

Required:

Discuss the benefits and disadvantages of PMU entering into a joint venture instead of setting up independently in Kantaka. As part of your discussion, consider how the disadvantages can be mitigated and the additional information PMU needs in order to make its decision.

(20 marks)

Formulae

Modigliani and Miller Proposition 2 (with tax)

$$k_e = k_e^i + (1 - T)(k_e^i - k_d) \frac{V_d}{V_e}$$

Two asset portfolio

$$s_p = \sqrt{w_a^2 s_a^2 + w_b^2 s_b^2 + 2w_a w_b r_{ab} s_a s_b}$$

The Capital Asset Pricing Model

$$E(r_i) = R_f + \beta_i (E(r_m) - R_f)$$

The asset beta formula

$$\beta_a = \left[\frac{V_e}{(V_e + V_d(1 - T))} \beta_e \right] + \left[\frac{V_d(1 - T)}{(V_e + V_d(1 - T))} \beta_d \right]$$

The Growth Model

$$P_0 = \frac{D_0(1 + g)}{(r_e - g)}$$

Gordon's growth approximation

$$g = br_e$$

The weighted average cost of capital

$$WACC = \left[\frac{V_e}{V_e + V_d} \right] k_e + \left[\frac{V_d}{V_e + V_d} \right] k_d (1 - T)$$

The Fisher formula

$$(1 + i) = (1 + r)(1 + h)$$

Purchasing power parity and interest rate parity

$$S_1 = S_0 \times \frac{(1 + h_c)}{(1 + h_b)} \quad F_0 = S_0 \times \frac{(1 + i_c)}{(1 + i_b)}$$

The Put Call Parity relationship

$$p = c - P_a + P_e e^{-rt}$$

Modified Internal Rate of Return

$$MIRR = \left[\frac{PV_R}{PV_I} \right]^{\frac{1}{n}} (1 + r_e) - 1$$

The Black-Scholes option pricing model	The FOREX modified Black-Scholes option pricing model
$c = P_a N(d_1) - P_e N(d_2) e^{-rt}$ <p>Where:</p> $d_1 = \frac{\ln(P_a / P_e) + (r + 0.5s^2)t}{s\sqrt{t}}$ $d_2 = d_1 - s\sqrt{t}$	$c = e^{-rt} [F_0 N(d_1) - X N(d_2)]$ <p>Or</p> $p = e^{-rt} [X N(-d_2) - F_0 N(-d_1)]$ <p>Where:</p> $d_1 = \frac{\ln(F_0 / X) + s^2 T / 2}{s\sqrt{T}}$ <p>and</p> $d_2 = d_1 - s\sqrt{T}$

Present Value Table

Present value of 1 i.e. $(1 + r)^{-n}$

Where r = discount rate
 n = number of periods until payment

<i>Discount rate (r)</i>											
<i>Periods</i>											
(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	1
2	0.980	0.961	0.943	0.925	0.907	0.890	0.873	0.857	0.842	0.826	2
3	0.971	0.942	0.915	0.889	0.864	0.840	0.816	0.794	0.772	0.751	3
4	0.961	0.924	0.888	0.855	0.823	0.792	0.763	0.735	0.708	0.683	4
5	0.951	0.906	0.863	0.822	0.784	0.747	0.713	0.681	0.650	0.621	5
6	0.942	0.888	0.837	0.790	0.746	0.705	0.666	0.630	0.596	0.564	6
7	0.933	0.871	0.813	0.760	0.711	0.665	0.623	0.583	0.547	0.513	7
8	0.923	0.853	0.789	0.731	0.677	0.627	0.582	0.540	0.502	0.467	8
9	0.941	0.837	0.766	0.703	0.645	0.592	0.544	0.500	0.460	0.424	9
10	0.905	0.820	0.744	0.676	0.614	0.558	0.508	0.463	0.422	0.386	10
11	0.896	0.804	0.722	0.650	0.585	0.527	0.475	0.429	0.388	0.305	11
12	0.887	0.788	0.701	0.625	0.557	0.497	0.444	0.397	0.356	0.319	12
13	0.879	0.773	0.681	0.601	0.530	0.469	0.415	0.368	0.326	0.290	13
14	0.870	0.758	0.661	0.577	0.505	0.442	0.388	0.340	0.299	0.263	14
15	0.861	0.743	0.642	0.555	0.481	0.417	0.362	0.315	0.275	0.239	15
(n)	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	1
2	0.812	0.797	0.783	0.769	0.756	0.743	0.731	0.718	0.706	0.694	2
3	0.731	0.712	0.693	0.675	0.658	0.641	0.624	0.609	0.593	0.579	3
4	0.659	0.636	0.613	0.592	0.572	0.552	0.534	0.516	0.499	0.482	4
5	0.593	0.567	0.543	0.519	0.497	0.476	0.456	0.437	0.419	0.402	5
6	0.535	0.507	0.480	0.456	0.432	0.410	0.390	0.370	0.352	0.335	6
7	0.482	0.452	0.425	0.400	0.376	0.354	0.333	0.314	0.296	0.279	7
8	0.434	0.404	0.376	0.351	0.327	0.305	0.285	0.266	0.249	0.233	8
9	0.391	0.361	0.333	0.308	0.284	0.263	0.243	0.225	0.209	0.194	9
10	0.352	0.322	0.295	0.270	0.247	0.227	0.208	0.191	0.176	0.162	10
11	0.317	0.287	0.261	0.237	0.215	0.195	0.178	0.162	0.148	0.135	11
12	0.286	0.257	0.231	0.208	0.187	0.168	0.152	0.137	0.124	0.112	12
13	0.258	0.229	0.204	0.182	0.163	0.145	0.130	0.116	0.104	0.093	13
14	0.232	0.205	0.181	0.160	0.141	0.125	0.111	0.099	0.088	0.078	14
15	0.209	0.183	0.160	0.140	0.123	0.108	0.095	0.084	0.074	0.065	15

Annuity Table

Present value of an annuity of 1 i.e. $\frac{1 - (1 + r)^{-n}}{r}$

Where r = discount rate
 n = number of periods

		<i>Discount rate (r)</i>										
<i>Periods</i>		1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	
(n)		11%	12%	13%	14%	15%	16%	17%	18%	19%	20%	
1	0.990	0.980	0.971	0.962	0.952	0.943	0.935	0.926	0.917	0.909	1	
2	1.970	1.942	1.913	1.886	1.859	1.833	1.808	1.783	1.759	1.736	2	
3	2.941	2.884	2.829	2.775	2.723	2.673	2.624	2.577	2.531	2.487	3	
4	3.902	3.808	3.717	3.630	3.546	3.465	3.387	3.312	3.240	3.170	4	
5	4.853	4.713	4.580	4.452	4.329	4.212	4.100	3.993	3.890	3.791	5	
6	5.795	5.601	5.417	5.242	5.076	4.917	4.767	4.623	4.486	4.355	6	
7	6.728	6.472	6.230	6.002	5.786	5.582	5.389	5.206	5.033	4.868	7	
8	7.652	7.325	7.020	6.733	6.463	6.210	5.971	5.747	5.535	5.335	8	
9	8.566	8.162	7.786	7.435	7.108	6.802	6.515	6.247	5.995	5.759	9	
10	9.471	8.983	8.530	8.111	7.722	7.360	7.024	6.710	6.418	6.145	10	
11	10.37	9.787	9.253	8.760	8.306	7.887	7.499	7.139	6.805	6.495	11	
12	11.26	10.58	9.954	9.385	8.863	8.384	7.943	7.536	7.161	6.814	12	
13	12.13	11.35	10.63	9.986	9.394	8.853	8.358	7.904	7.487	7.103	13	
14	13.00	12.11	11.30	10.56	9.899	9.295	8.745	8.244	7.786	7.367	14	
15	13.87	12.85	11.94	11.12	10.38	9.712	9.108	8.559	8.061	7.606	15	
1	0.901	0.893	0.885	0.877	0.870	0.862	0.855	0.847	0.840	0.833	1	
2	1.713	1.690	1.668	1.647	1.626	1.605	1.585	1.566	1.547	1.528	2	
3	2.444	2.402	2.361	2.322	2.283	2.246	2.210	2.174	2.140	2.106	3	
4	3.102	3.037	2.974	2.914	2.855	2.798	2.743	2.690	2.639	2.589	4	
5	3.696	3.605	3.517	3.433	3.352	3.274	3.199	3.127	3.058	2.991	5	
6	4.231	4.111	3.998	3.889	3.784	3.685	3.589	3.498	3.410	3.326	6	
7	4.712	4.564	4.423	4.288	4.160	4.039	3.922	3.812	3.706	3.605	7	
8	5.146	4.968	4.799	4.639	4.487	4.344	4.207	4.078	3.954	3.837	8	
9	5.537	5.328	5.132	4.946	4.772	4.607	4.451	4.303	4.163	4.031	9	
10	5.889	5.650	5.426	5.216	5.019	4.833	4.659	4.494	4.339	4.192	10	
11	6.207	5.938	5.687	5.453	5.234	5.029	4.836	4.656	4.486	4.327	11	
12	6.492	6.194	5.918	5.660	5.421	5.197	4.988	4.793	4.611	4.439	12	
13	6.750	6.424	6.122	5.842	5.583	5.342	5.118	4.910	4.715	4.533	13	
14	6.982	6.628	6.302	6.002	5.724	5.468	5.229	5.008	4.802	4.611	14	
15	7.191	6.811	6.462	6.142	5.847	5.575	5.324	5.092	4.876	4.675	15	

Standard normal distribution table

	0·00	0·01	0·02	0·03	0·04	0·05	0·06	0·07	0·08	0·09
0·0	0·0000	0·0040	0·0080	0·0120	0·0160	0·0199	0·0239	0·0279	0·0319	0·0359
0·1	0·0398	0·0438	0·0478	0·0517	0·0557	0·0596	0·0636	0·0675	0·0714	0·0753
0·2	0·0793	0·0832	0·0871	0·0910	0·0948	0·0987	0·1026	0·1064	0·1103	0·1141
0·3	0·1179	0·1217	0·1255	0·1293	0·1331	0·1368	0·1406	0·1443	0·1480	0·1517
0·4	0·1554	0·1591	0·1628	0·1664	0·1700	0·1736	0·1772	0·1808	0·1844	0·1879
0·5	0·1915	0·1950	0·1985	0·2019	0·2054	0·2088	0·2123	0·2157	0·2190	0·2224
0·6	0·2257	0·2291	0·2324	0·2357	0·2389	0·2422	0·2454	0·2486	0·2517	0·2549
0·7	0·2580	0·2611	0·2642	0·2673	0·2704	0·2734	0·2764	0·2794	0·2823	0·2852
0·8	0·2881	0·2910	0·2939	0·2967	0·2995	0·3023	0·3051	0·3078	0·3106	0·3133
0·9	0·3159	0·3186	0·3212	0·3238	0·3264	0·3289	0·3315	0·3340	0·3365	0·3389
1·0	0·3413	0·3438	0·3461	0·3485	0·3508	0·3531	0·3554	0·3577	0·3599	0·3621
1·1	0·3643	0·3665	0·3686	0·3708	0·3729	0·3749	0·3770	0·3790	0·3810	0·3830
1·2	0·3849	0·3869	0·3888	0·3907	0·3925	0·3944	0·3962	0·3980	0·3997	0·4015
1·3	0·4032	0·4049	0·4066	0·4082	0·4099	0·4115	0·4131	0·4147	0·4162	0·4177
1·4	0·4192	0·4207	0·4222	0·4236	0·4251	0·4265	0·4279	0·4292	0·4306	0·4319
1·5	0·4332	0·4345	0·4357	0·4370	0·4382	0·4394	0·4406	0·4418	0·4429	0·4441
1·6	0·4452	0·4463	0·4474	0·4484	0·4495	0·4505	0·4515	0·4525	0·4535	0·4545
1·7	0·4554	0·4564	0·4573	0·4582	0·4591	0·4599	0·4608	0·4616	0·4625	0·4633
1·8	0·4641	0·4649	0·4656	0·4664	0·4671	0·4678	0·4686	0·4693	0·4699	0·4706
1·9	0·4713	0·4719	0·4726	0·4732	0·4738	0·4744	0·4750	0·4756	0·4761	0·4767
2·0	0·4772	0·4778	0·4783	0·4788	0·4793	0·4798	0·4803	0·4808	0·4812	0·4817
2·1	0·4821	0·4826	0·4830	0·4834	0·4838	0·4842	0·4846	0·4850	0·4854	0·4857
2·2	0·4861	0·4864	0·4868	0·4871	0·4875	0·4878	0·4881	0·4884	0·4887	0·4890
2·3	0·4893	0·4896	0·4898	0·4901	0·4904	0·4906	0·4909	0·4911	0·4913	0·4916
2·4	0·4918	0·4920	0·4922	0·4925	0·4927	0·4929	0·4931	0·4932	0·4934	0·4936
2·5	0·4938	0·4940	0·4941	0·4943	0·4945	0·4946	0·4948	0·4949	0·4951	0·4952
2·6	0·4953	0·4955	0·4956	0·4957	0·4959	0·4960	0·4961	0·4962	0·4963	0·4964
2·7	0·4965	0·4966	0·4967	0·4968	0·4969	0·4970	0·4971	0·4972	0·4973	0·4974
2·8	0·4974	0·4975	0·4976	0·4977	0·4977	0·4978	0·4979	0·4979	0·4980	0·4981
2·9	0·4981	0·4982	0·4982	0·4983	0·4984	0·4984	0·4985	0·4985	0·4986	0·4986
3·0	0·4987	0·4987	0·4987	0·4988	0·4988	0·4989	0·4989	0·4989	0·4990	0·4990

This table can be used to calculate $N(d)$, the cumulative normal distribution functions needed for the Black-Scholes model of option pricing. If $d_i > 0$, add 0·5 to the relevant number above. If $d_i < 0$, subtract the relevant number above from 0·5.

End of Question Paper