

Professional Level – Options Module

Advanced Financial Management

Tuesday 4 June 2013



Time allowed

Reading and planning: 15 minutes

Writing: 3 hours

This paper is divided into two sections:

Section A – This ONE question is compulsory and MUST be attempted

Section B – TWO questions ONLY to be attempted

Formulae and tables are on pages 8–12.

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

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Section A – This ONE question is compulsory and MUST be attempted

1 Mlima Co is a private company involved in aluminium mining. About eight years ago, the company was bought out by its management and employees through a leveraged buyout (LBO). Due to high metal prices worldwide, the company has been growing successfully since the LBO. However, because the company has significant debt borrowings with strict restrictive covenants and high interest levels, it has had to reject a number of profitable projects. The company has currently two bonds in issue, as follows:

A 16% secured bond with a nominal value of \$80m, which is redeemable at par in five years. An early redemption option is available on this bond, giving Mlima Co the option to redeem the bond at par immediately if it wants to; and

A 13% unsecured bond with a nominal value of \$40m, which is redeemable at par in ten years.

Mlima Co's Board of Directors (BoD) has been exploring the idea of redeeming both bonds to provide it with more flexibility when making future investment decisions. To do so, the BoD has decided to consider a public listing of the company on a major stock exchange. It is intended that a total of 100 million shares will be issued in the newly-listed company. From the total shares, 20% will be sold to the public, 10% will be offered to the holders of the unsecured bond in exchange for redeeming the bond through an equity-for-debt swap, and the remaining 70% of the equity will remain in the hands of the current owners. The secured bond would be paid out of the funds raised from the listing.

The details of the possible listing and the distribution of equity were published in national newspapers recently. As a result, potential investors suggested that due to the small proportion of shares offered to the public and for other reasons, the shares should be offered at a substantial discount of as much as 20% below the expected share price on the day of the listing.

Mlima Co, financial information

It is expected that after the listing, deployment of new strategies and greater financial flexibility will boost Mlima Co's future sales revenue and, for the next four years, the annual growth rate will be 120% of the previous two years' average growth rate. After the four years, the annual growth rate of the free cash flows to the company will be 3.5%, for the foreseeable future. Operating profit margins are expected to be maintained in the future. Although it can be assumed that the current tax-allowable depreciation is equivalent to the amount of investment needed to maintain the current level of operations, the company will require an additional investment in assets of 30c per \$1 increase in sales revenue for the next four years.

Extracts from Mlima Co's past three years' Statement of Profit or Loss

Year ended	31 May 2013	31 May 2012	31 May 2011
	\$ million	\$ million	\$ million
Sales revenue	389.1	366.3	344.7
Operating profit	58.4	54.9	51.7
Net interest costs	17.5	17.7	18.0
Profit before tax	40.9	37.2	33.7
Taxation	10.2	9.3	8.4
Profit after tax	30.7	27.9	25.3

Once listed, Mlima Co will be able to borrow future debt at an interest rate of 7%, which is only 3% higher than the risk-free rate of return. It has no plans to raise any new debt after listing, but any future debt will carry considerably fewer restrictive covenants. However, these plans do not take into consideration the Bahari project (see below).

Bahari Project

Bahari is a small country with agriculture as its main economic activity. A recent geological survey concluded that there may be a rich deposit of copper available to be mined in the north-east of the country. This area is currently occupied by subsistence farmers, who would have to be relocated to other parts of the country. When the results of the survey were announced, some farmers protested that the proposed new farmland where they would be moved to was less fertile and that their communities were being broken up. However, the protesters were intimidated and violently put down by the government, and the state-controlled media stopped reporting about them. Soon afterwards, their protests were ignored and forgotten.

In a meeting between the Bahari government and Mlima Co's BoD, the Bahari government offered Mlima Co exclusive rights to mine the copper. It is expected that there are enough deposits to last at least 15 years. Initial estimates

suggest that the project will generate free cash flows of \$4 million in the first year, rising by 100% per year in each of the next two years, and then by 15% in each of the two years after that. The free cash flows are then expected to stabilise at the year-five level for the remaining 10 years.

The cost of the project, payable at the start, is expected to be \$150 million, comprising machinery, working capital and the mining rights fee payable to the Bahari government. None of these costs is expected to be recoverable at the end of the project's 15-year life.

The Bahari government has offered Mlima Co a subsidised loan over 15 years for the full \$150 million at an interest rate of 3% instead of Mlima Co's normal borrowing rate of 7%. The interest payable is allowable for taxation purposes. It can be assumed that Mlima Co's business risk is not expected to change as a result of undertaking the Bahari project.

At the conclusion of the meeting between the Bahari government and Mlima Co's BoD, the president of Bahari commented that working together would be like old times when he and Mlima Co's chief executive officer (CEO) used to run a business together.

Other Information

Mlima Co's closest competitor is Ziwa Co, a listed company which mines metals worldwide. Mlima Co's directors are of the opinion that after listing Mlima Co's cost of capital should be based on Ziwa Co's ungeared cost of equity. Ziwa Co's cost of capital is estimated at 9.4%, its geared cost of equity is estimated at 16.83% and its pre-tax cost of debt is estimated at 4.76%. These costs are based on a capital structure comprising of 200 million shares, trading at \$7 each, and \$1,700 million 5% irredeemable bonds, trading at \$105 per \$100. Both Ziwa Co and Mlima Co pay tax at an annual rate of 25% on their taxable profits.

It can be assumed that all cash flows will be in \$ instead of the Bahari currency and therefore Mlima Co does not have to take account of any foreign exchange exposure from this venture.

Required:

(a) Prepare a report for the Board of Directors (BoD) of Mlima Co that:

- (i) Explains why Mlima Co's directors are of the opinion that Mlima Co's cost of capital should be based on Ziwa Co's ungeared cost of equity and, showing relevant calculations, estimate an appropriate cost of capital for Mlima Co;** (7 marks)
- (ii) Estimates Mlima Co's value without undertaking the Bahari project and then with the Bahari project. The valuations should use the free cash flow methodology and the cost of capital calculated in part (i). Include relevant calculations;** (14 marks)
- (iii) Advises the BoD whether or not the unsecured bond holders are likely to accept the equity-for-debt swap offer. Include relevant calculations;** (5 marks)
- (iv) Advises the BoD on the listing and the possible share price range, if a total of 100 million shares are issued. The advice should also include:**
 - **A discussion of the assumptions made in estimating the share price range;**
 - **In addition to the reasons mentioned in the scenario above, a brief explanation of other possible reasons for changing its status from a private company to a listed one; and**
 - **An assessment of the possible reasons for issuing the share price at a discount for the initial listing;** (12 marks)

Professional marks will be awarded in part (a) for the format, structure and presentation of the report.

(4 marks)

(b) Discuss the possible impact on, and response of, Mlima Co to the following ethical issues, with respect to the Bahari project:

- (i) The relocation of the farmers; and**
- (ii) The relationship between the Bahari president and Mlima Co's chief executive officer.**

Note: The total marks will be split equally between each part.

(8 marks)

(50 marks)

Section B – TWO questions ONLY to be attempted

2 Hav Co is a publicly listed company involved in the production of highly technical and sophisticated electronic components for complex machinery. It has a number of diverse and popular products, an active research and development department, significant cash reserves and a highly talented management who are very good in getting products to market quickly.

A new industry that Hav Co is looking to venture into is biotechnology, which has been expanding rapidly and there are strong indications that this recent growth is set to continue. However, Hav Co has limited experience in this industry. Therefore it believes that the best and quickest way to expand would be through acquiring a company already operating in this industry sector.

Strand Co is a private company operating in the biotechnology industry and is owned by a consortium of business angels and company managers. The owner-managers are highly skilled scientists who have developed a number of technically complex products, but have found it difficult to commercialise them. They have also been increasingly constrained by the lack of funds to develop their innovative products further.

Discussions have taken place about the possibility of Strand Co being acquired by Hav Co. Strand Co's managers have indicated that the consortium of owners is happy for the negotiations to proceed. If Strand Co is acquired, it is expected that its managers would continue to run the Strand Co part of the larger combined company.

Strand Co is of the opinion that most of its value is in its intangible assets, comprising intellectual capital. Therefore, the premium payable on acquisition should be based on the present value to infinity of the after tax excess earnings the company has generated in the past three years, over the average return on capital employed of the biotechnological industry. However, Hav Co is of the opinion that the premium should be assessed on synergy benefits created by the acquisition and the changes in value, due to the changes in the price-to-earnings (PE) ratio before and after the acquisition.

Given below are extracts of financial information for Hav Co for 2013 and Strand Co for 2011, 2012 and 2013:

Year ended 30 April	Hav Co	Strand Co		
	2013	2013	2012	2011
	\$ million	\$ million	\$ million	\$ million
Earnings before tax	1,980	397	370	352
Non-current assets	3,965	882	838	801
Current assets	968	210	208	198
Share capital (25c/share)	600	300	300	300
Reserves	2,479	183	166	159
Non-current liabilities	1,500	400	400	400
Current liabilities	354	209	180	140

The current average PE ratio of the biotechnology industry is 16.4 times and it has been estimated that Strand Co's PE ratio is 10% higher than this. However, it is thought that the PE ratio of the combined company would fall to 14.5 times after the acquisition. The annual after tax earnings will increase by \$140 million due to synergy benefits resulting from combining the two companies.

Both companies pay tax at 20% per annum and Strand Co's annual cost of capital is estimated at 7%. Hav Co's current share price is \$9.24 per share. The biotechnology industry's pre-tax return on capital employed is currently estimated to be 20% per annum.

Hav Co has proposed to pay for the acquisition using one of the following three methods:

- (i) A cash offer of \$5.72 for each Strand Co share; or
- (ii) A cash offer of \$1.33 for each Strand Co share plus one Hav Co share for every two Strand Co shares; or
- (iii) A cash offer of \$1.25 for each Strand Co share plus one \$100 3% convertible bond for every \$5 nominal value of Strand Co shares. In six years, the bond can be converted into 12 Hav Co shares or redeemed at par.

Required:

- (a) Distinguish between the different types of synergy and discuss possible sources of synergy based on the above scenario. (9 marks)
- (b) Based on the two different opinions expressed by Hav Co and Strand Co, calculate the maximum acquisition premium payable in each case. (6 marks)
- (c) Calculate the percentage premium per share that Strand Co's shareholders will receive under each acquisition payment method and justify, with explanations, which payment method would be most acceptable to them. (10 marks)

(25 marks)

- 3 Kenduri Co is a large multinational company based in the UK with a number of subsidiary companies around the world. Currently, foreign exchange exposure as a result of transactions between Kenduri Co and its subsidiary companies is managed by each company individually. Kenduri Co is considering whether or not to manage the foreign exchange exposure using multilateral netting from the UK, with the Sterling Pound (£) as the base currency. If multilateral netting is undertaken, spot mid-rates would be used.

The following cash flows are due in three months between Kenduri Co and three of its subsidiary companies. The subsidiary companies are Lakama Co, based in the United States (currency US\$), Jaia Co, based in Canada (currency CAD) and Gochiso Co, based in Japan (currency JPY).

Owed by	Owed to	Amount
Kenduri Co	Lakama Co	US\$ 4.5 million
Kenduri Co	Jaia Co	CAD 1.1 million
Gochiso Co	Jaia Co	CAD 3.2 million
Gochiso Co	Lakama Co	US\$ 1.4 million
Jaia Co	Lakama Co	US\$ 1.5 million
Jaia Co	Kenduri Co	CAD 3.4 million
Lakama Co	Gochiso Co	JPY 320 million
Lakama Co	Kenduri Co	US\$ 2.1 million

Exchange rates available to Kenduri Co

	US\$/£1	CAD/£1	JPY/£1
Spot	1.5938–1.5962	1.5690–1.5710	131.91–133.59
3-month forward	1.5996–1.6037	1.5652–1.5678	129.15–131.05

Currency options available to Kenduri Co

Contract size £62,500, Exercise price quotation: US\$/£1, Premium: cents per £1

Exercise price	Call Options		Put Options	
	3-month expiry	6-month expiry	3-month expiry	6-month expiry
1.60	1.55	2.25	2.08	2.23
1.62	0.98	1.58	3.42	3.73

It can be assumed that option contracts expire at the end of the relevant month

Annual interest rates available to Kenduri Co and subsidiaries

	Borrowing rate	Investing rate
UK	4.0%	2.8%
United States	4.8%	3.1%
Canada	3.4%	2.1%
Japan	2.2%	0.5%

Required:

- (a) Advise Kenduri Co on, and recommend, an appropriate hedging strategy for the US\$ cash flows it is due to receive or pay in three months, from Lakama Co. Show all relevant calculations to support the advice given. (12 marks)
- (b) Calculate, using a tabular format (transactions matrix), the impact of undertaking multilateral netting by Kenduri Co and its three subsidiary companies for the cash flows due in three months. Briefly discuss why some governments allow companies to undertake multilateral netting, while others do not. (10 marks)
- (c) When examining different currency options and their risk factors, it was noticed that a long call option had a high gamma value. Explain the possible characteristics of a long call option with a high gamma value. (3 marks)

(25 marks)

- 4 Limni Co is a large company manufacturing hand-held electronic devices such as mobile phones and tablet computers. The company has been growing rapidly over the last few years, but it also has high research and development expenditure. It is involved in a number of projects worldwide, developing new and innovative products and systems in a rapidly changing industry. Due to the nature of the industry, this significant growth in earnings has never been stable, but has depended largely on the success of the new innovations and competitor actions. However, in the last two years it seems that the rapid period of growth is slowing, with fewer products coming to market compared to previous years.

Limni Co has never paid dividends and has financed projects through internally generated funds and with occasional rights issues of new share capital. It currently has insignificant levels of debt. The retained cash reserves have recently grown because of a drop in the level of investment in new projects.

The company has an active treasury division which invests spare funds in traded equities, bonds and other financial instruments; and releases the funds when required for new projects. The division also manages cash flow risk using money and derivative markets. The treasury division is currently considering investing in three companies with the following profit after tax (PAT) and dividend history:

Year	Company Theta		Company Omega		Company Kappa	
	PAT	Dividends	PAT	Dividends	PAT	Dividends
	\$000	\$000	\$000	\$000	\$000	\$000
2013	57,100	22,840	93,300	60,560	162,400	44,100
2012	54,400	21,760	90,600	57,680	141,500	34,200
2011	52,800	21,120	88,000	54,840	108,900	26,300
2010	48,200	19,280	85,400	52,230	105,700	20,250
2009	45,500	18,200	82,900	49,740	78,300	15,700

All of the three companies' share capital has remained largely unchanged since 2009.

Recently, Limni Co's Board of Directors (BoD) came under pressure from the company's larger shareholders to start returning some of the funds, currently retained by the company, back to the shareholders. The BoD thinks that the shareholders have a strong case to ask for repayments. However, it is unsure whether to pay a special, one-off large dividend from its dividend capacity and retained funds, followed by small annual dividend payments; or to undertake a periodic share buyback scheme over the next few years.

Limni Co is due to prepare its statement of profit or loss shortly and estimates that the annual sales revenue will be \$600 million, on which its profit before tax is expected to be 23% of sales revenue. It charges depreciation of 25% on a straight-line basis on its non-current assets of \$220 million. It estimates that \$67 million investment in current and non-current assets was spent during the year. It is due to receive \$15 million in dividends from its subsidiary companies, on which annual tax of 20% on average has been paid. Limni Co itself pays annual tax at 26%, and the tax authorities where Limni Co is based charge tax on dividend remittances made by overseas subsidiary companies, but give full credit on tax already paid on those remittances. In order to fund the new policy of returning funds to shareholders, Limni Co's BoD wants to increase the current estimated dividend capacity by 10%, by asking the overseas subsidiary companies for higher repatriations.

Required:

- (a) **Discuss Limni Co's current dividend, financing and risk management policies, and suggest how the decision to return retained funds back to the shareholders will affect these policies.** (8 marks)
- (b) **Evaluate the dividend policies of each of the three companies that Limni Co is considering investing in, and discuss which company Limni Co might select.** (8 marks)
- (c) **Calculate, and briefly comment on, how much the dividends from overseas companies need to increase by, to increase Limni Co's dividend capacity by 10%.** (6 marks)
- (d) **Discuss the benefits to Limni Co's shareholders of receiving repayments through a share buyback scheme as opposed to the dividend scheme described above.** (3 marks)

(25 marks)

Formulae

Modigliani and Miller Proposition 2 (with tax)

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

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

$$g = b r_e$$

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

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

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

$$c = P_a N(d_1) - P_e N(d_2) e^{-rt}$$

Where:

$$d_1 = \frac{\ln(P_a / P_e) + (r + 0.5s^2)t}{s\sqrt{t}}$$

$$d_2 = d_1 - s\sqrt{t}$$

The Put Call Parity relationship

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

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>		1%	2%	3%	4%	5%	6%	7%	8%	9%	10%	
(n)												
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		0.914	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	0.350	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)		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	0.909	1
2	1.970	1.942	1.913	1.886	1.859	1.833	1.808	1.783	1.759	1.736	1.736	2
3	2.941	2.884	2.829	2.775	2.723	2.673	2.624	2.577	2.531	2.487	2.487	3
4	3.902	3.808	3.717	3.630	3.546	3.465	3.387	3.312	3.240	3.170	3.170	4
5	4.853	4.713	4.580	4.452	4.329	4.212	4.100	3.993	3.890	3.791	3.791	5
6	5.795	5.601	5.417	5.242	5.076	4.917	4.767	4.623	4.486	4.355	4.355	6
7	6.728	6.472	6.230	6.002	5.786	5.582	5.389	5.206	5.033	4.868	4.868	7
8	7.652	7.325	7.020	6.733	6.463	6.210	5.971	5.747	5.535	5.335	5.335	8
9	8.566	8.162	7.786	7.435	7.108	6.802	6.515	6.247	5.995	5.759	5.759	9
10	9.471	8.983	8.530	8.111	7.722	7.360	7.024	6.710	6.418	6.145	6.145	10
11	10.368	9.787	9.253	8.760	8.306	7.887	7.499	7.139	6.805	6.495	6.495	11
12	11.255	10.575	9.954	9.385	8.863	8.384	7.943	7.536	7.161	6.814	6.814	12
13	12.134	11.348	10.635	9.986	9.394	8.853	8.358	7.904	7.487	7.103	7.103	13
14	13.004	12.106	11.296	10.563	9.899	9.295	8.745	8.244	7.786	7.367	7.367	14
15	13.865	12.849	11.938	11.118	10.380	9.712	9.108	8.559	8.061	7.606	7.606	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	0.833	1
2	1.713	1.690	1.668	1.647	1.626	1.605	1.585	1.566	1.547	1.528	1.528	2
3	2.444	2.402	2.361	2.322	2.283	2.246	2.210	2.174	2.140	2.106	2.106	3
4	3.102	3.037	2.974	2.914	2.855	2.798	2.743	2.690	2.639	2.589	2.589	4
5	3.696	3.605	3.517	3.433	3.352	3.274	3.199	3.127	3.058	2.991	2.991	5
6	4.231	4.111	3.998	3.889	3.784	3.685	3.589	3.498	3.410	3.326	3.326	6
7	4.712	4.564	4.423	4.288	4.160	4.039	3.922	3.812	3.706	3.605	3.605	7
8	5.146	4.968	4.799	4.639	4.487	4.344	4.207	4.078	3.954	3.837	3.837	8
9	5.537	5.328	5.132	4.946	4.772	4.607	4.451	4.303	4.163	4.031	4.031	9
10	5.889	5.650	5.426	5.216	5.019	4.833	4.659	4.494	4.339	4.192	4.192	10
11	6.207	5.938	5.687	5.453	5.234	5.029	4.836	4.656	4.486	4.327	4.327	11
12	6.492	6.194	5.918	5.660	5.421	5.197	4.988	4.793	4.611	4.439	4.439	12
13	6.750	6.424	6.122	5.842	5.583	5.342	5.118	4.910	4.715	4.533	4.533	13
14	6.982	6.628	6.302	6.002	5.724	5.468	5.229	5.008	4.802	4.611	4.611	14
15	7.191	6.811	6.462	6.142	5.847	5.575	5.324	5.092	4.876	4.675	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