

Professional Level – Options Module

Advanced Financial Management

Thursday 5 June 2008

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 tables are on pages 11–15.

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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The question paper begins on page 3.**

Section A – BOTH questions are compulsory and MUST be attempted

- 1 Mercury Training was established in 1999 and since that time it has developed rapidly. The directors are considering either a flotation or an outright sale of the company.

The company provides training for companies in the computer and telecommunications sectors. It offers a variety of courses ranging from short intensive courses in office software to high level risk management courses using advanced modelling techniques. Mercury employs a number of in-house experts who provide technical materials and other support for the teams that service individual client requirements. In recent years, Mercury has diversified into the financial services sector and now also provides computer simulation systems to companies for valuing acquisitions. This business now accounts for one third of the company's total revenue.

Mercury currently has 10 million, 50c shares in issue. Jupiter is one of the few competitors in Mercury's line of business. However, Jupiter is only involved in the training business. Jupiter is listed on a small company investment market and has an estimated beta of 1.5. Jupiter has 50 million shares in issue with a market price of 580c. The average beta for the financial services sector is 0.9. Average market gearing (debt to total market value) in the financial services sector is estimated at 25%.

Other summary statistics for both companies for the year ended 31 December 2007 are as follows:

	Mercury	Jupiter
Net assets at book value (\$million)	65	45
Earnings per share (c)	100	50
Dividend per share (c)	25	25
Gearing (debt to total market value)	30%	12%
Five year historic earnings growth (annual)	12%	8%

Analysts forecast revenue growth in the training side of Mercury's business to be 6% per annum, but the financial services sector is expected to grow at just 4%.

Background information:

The equity risk premium is 3.5% and the rate of return on short-dated government stock is 4.5%.

Both companies can raise debt at 2.5% above the risk free rate.

Tax on corporate profits is 40%.

Required:

- (a) **Estimate the cost of equity capital and the weighted average cost of capital for Mercury Training. Explain the circumstances where each of the two rates would be used.** (10 marks)
- (b) **Advise the owners of Mercury Training on a range of likely issue prices for the company.** (10 marks)
- (c) **Discuss the advantages and disadvantages, to the directors of Mercury Training, of a public listing versus private equity finance as a means of disposing of their interest in the company.** (8 marks)

(28 marks)

- 2 Venus Systems, a publicly quoted company, is a specialist manufacturer of mechanical control units for both the defence and civil aviation industries. Its principal customers are the defence procurement agencies of a number of western governments and European Aerospace Co, an aeroplane manufacturer. Over recent years the company has suffered a collapse in profitability and has attempted to respond by reducing its defence related business and focusing on its civil aviation business.

On the civil side, long delays at European Aerospace Co in the development of a new large-bodied passenger aeroplane, the European Aircoach, have severely impacted upon suppliers such as Venus Systems. As a result Venus's share price has declined over the last three years, in line with movements in the sector index. However, market valuations have not followed the general decline in earnings across the sector. Market analysts attribute this to the high level of advance orders by airlines for the Aircoach and the confident expectation that full production will commence in mid 2009.

Orders for defence components have fallen rapidly over the last three years and the company has taken the decision to scale down its defence division and switch production resources to the civil side of the business. Wherever possible the company has redeployed and retrained its workforce. Indeed, its commitment to its workforce has helped maintain good industrial relations and the redeployment has been successfully matched against its natural labour turnover in the civil division.

During 2007 the company commenced the decommissioning of its defence manufacturing site and began rationalising both defence and civil production to one site.

The summary financial statements for the company over the last three years are as follows:

Venus Systems

Accounts for the year ended 30 April:

	2008 \$m	2007 \$m	2006 \$m
Income statements			
Revenue	72.6	88.2	90.0
Cost of Sales	44.0	50.5	58.0
	<hr/>	<hr/>	<hr/>
Gross Profit	28.6	37.7	32.0
<i>less other operating costs</i>	27.0	25.2	24.0
	<hr/>	<hr/>	<hr/>
Operating profit	1.6	12.5	8.0
Finance Costs	1.4	1.4	2.5
	<hr/>	<hr/>	<hr/>
Profit before tax	0.2	11.1	5.5
Income tax expense (at 30%)	0.1	3.3	1.7
	<hr/>	<hr/>	<hr/>
Profit for the period	<u>0.1</u>	<u>7.8</u>	<u>3.8</u>

	2008	2007	2006
Statements of financial position (Balance Sheets)	\$m	\$m	\$m
Non-current assets			
Buildings, plant and machinery	17.0	42.0	84.0
Current Assets			
Inventories	11.7	6.7	8.1
Receivables	36.3	22.1	17.5
Cash	56.1	54.8	26.6
Total Current Assets	<u>104.1</u>	<u>83.6</u>	<u>52.2</u>
Total Assets	<u>121.1</u>	<u>125.6</u>	<u>136.2</u>
Equity and Liabilities			
Paid up share capital			
Ordinary shares (25¢)	25.0	25.0	20.0
Other reserves	12.0	12.0	10.0
Retained earnings	39.7	39.6	36.8
less dividends payable	0.0	0.0	-5.0
	<u>39.7</u>	<u>39.6</u>	<u>31.8</u>
Total equity	<u>76.7</u>	<u>76.6</u>	<u>61.8</u>
Current Liabilities			
Trade payables	2.7	2.9	3.5
Deferred income and accrued expenses	6.1	7.3	7.8
Tax payable	3.2	1.6	6.1
Dividends payable	0.0	0.0	5.0
Interest payable	1.4	1.4	2.5
Total current liabilities	<u>13.4</u>	<u>13.2</u>	<u>24.9</u>
Non-current liabilities			
Loans	25.0	25.0	45.0
Provisions (deferred tax)	6.0	10.8	4.5
Total non-current liabilities	<u>31.0</u>	<u>35.8</u>	<u>49.5</u>
Total liabilities	<u>44.4</u>	<u>49.0</u>	<u>74.4</u>
Total Equity and Liabilities	<u>121.1</u>	<u>125.6</u>	<u>136.2</u>
Notes	2008	2007	2006
	\$m	\$m	\$m
Non-current assets at start of year	170.0	220.0	190.0
additions	0.0	0.0	30.0
less disposals	-20.0	-50.0	0.0
	<u>150.0</u>	<u>170.0</u>	<u>220.0</u>
Accumulated depreciation at start of the year	128.0	136.0	114.0
less depreciation on disposals	-10.0	-25.0	0.0
depreciation charge for the year	15.0	17.0	22.0
Accumulated depreciation at the end of the year	<u>133.0</u>	<u>128.0</u>	<u>136.0</u>
Net book value of non-current assets	<u>17.0</u>	<u>42.0</u>	<u>84.0</u>

Summary statements of cash flows	2008	2007	2006
	\$m	\$m	\$m
Operating cash flow	-4.0	25.4	35.0
less interest	-1.4	-2.5	-2.5
less taxation	-3.3	-1.7	-6.5
Free cash flow before reinvestment	-8.7	21.2	26.0
Dividend paid	0.0	-5.0	-12.0
Capital expenditure	10.0	25.0	-30.0
Financing	0.0	-13.0	0.0
Net cash flow	1.3	28.2	-16.0
Market value of equity (\$ million)	40.0	97.0	105.0

The board believes that it can reverse the decline in the company's profitability with the following turnaround strategy:

1. By cost saving and other measures, it can return to its 2007 level of operating profit on its existing business.
2. By investment in new fabrication equipment at a cost of \$35 million, it can increase the value of the company by \$20.2 million.
3. Through the introduction of just-in-time manufacturing systems, it anticipates that it can reduce its inventories by 10 days in each of the next three years. Its current receivables can be brought back to the 2007 level by improvements in its credit control but, because of the nature of its business, it does not anticipate being able to improve beyond that.
4. The company is also considering a scheme whereby 10% of the equity shares will be repurchased at the current price of 40c per share plus a premium of 10c.

The non-executive directors have questioned the continuing viability of the company in the short to medium term and whether a more aggressive strategy than that proposed by management is necessary. As a result, you have been appointed as a financial advisor to the board. The board has requested that you provide a report evaluating the position thoroughly but not one that is 'full of figures'. The executive directors, whilst concerned about the company's position, are very keen to reassure the non-executive members of the board about the continuing viability of the business and have given you full access to the company's information and its planning processes. However, the non-executive directors are concerned about the company's prospect of survival in the short to medium term. As part of your review of the risk of failure, you believe that it will be necessary to calculate a current Z-score for the company.

In the calculation of ratios using figures in the statement of financial position, you may use year-end figures throughout.

Retail price inflation stands at 3% per annum and has been at that rate for the last three years.

Note:

The Altman Z-score is calculated as follows:

$$Z = 1.2X_1 + 1.4X_2 + 3.3X_3 + 0.6X_4 + 1.0X_5$$

Where:

X_1 = working capital/total assets

X_2 = retained earnings/total assets

X_3 = earnings before interest and tax/total assets

X_4 = market value of equity/book value of total debt

X_5 = sales/total assets

In Altman's model, a Z-score of 3 or more indicates a high likelihood of non-failure, 1.8 or less indicates a high likelihood of failure.

Required:

Prepare a report for the board of directors containing an analysis of the company's position. Your report should include:

- (a) An introduction outlining the principal causes of financial distress in any business. (5 marks)**
- (b) An appraisal of the impact of the proposed turnaround strategy on the company's performance, efficiency, risk and liquidity. Your appraisal of the company's exposure to risk should include an assessment of the risk of failure using Altman's Z-score and any other risk measures you consider appropriate. (17 marks)**
- (c) Advice on any corporate governance and ethical issues that the company should consider when reviewing its turnaround strategy. (6 marks)**

Appropriateness of the format and presentation of the report and the effectiveness with which its advice is communicated. (4 marks)

(32 marks)

Section B – TWO questions ONLY to be attempted

3 Asteroid Systems is a German-based company with a subsidiary in Switzerland. The company’s financial manager expects the Swiss business will remit the equivalent of Euros 1·5 million in two months. Her expectations of the future remittance are based upon the current SFr/Euro forward rate.

The current spot and forward rates for Swiss francs against the Euro are extracted from the Financial Times and are shown in the table below.

	Closing mid-point	Change on day	Bid/offer spread	Days mid		One month Rate	annual %	Three month Rate	annual %
				high	low				
Switzerland (SFr/€)	1·6242	0·0107	239–244	1·6261	1·6147	1·6223	1·4	1·6176	1·6

In the Euro money market the company can make fixed interest deposits at LIBOR and can borrow at LIBOR plus 20 basis points for terms of greater than one month but up to six months. The company can borrow at fixed rates in the Swiss money market. LIBOR rates, as quoted in the Financial Times, are as follows:

	EUR	CHF
spot	3·56688	2·06000
1 week	3·57300	2·06000
2 week	3·58438	2·07000
1 month	3·60900	2·08000
2 month	3·72538	2·17000
3 month	3·78238	2·20000

The company’s financial manager is keen to eliminate transaction risk. However, because of the margin requirements and their impact upon the firm’s cash flow, she would prefer not to use exchange traded derivatives. Swiss franc borrowing or lending rates would need to be negotiated with the bank.

Required:

- (a) **Estimate the lowest acceptable Swiss borrowing or lending rate for a money market hedge maturing in two months.** (10 marks)
- (b) **Discuss the relative advantages and disadvantages of the use of a money market hedge compared with using exchange traded derivatives for hedging a foreign exchange exposure.** (6 marks)
- (c) **Discuss the extent to which currency hedging can reduce a firm’s cost of capital.** (4 marks)

(20 marks)

4 Mr Moon is the CEO of Saturn Systems, a very large listed company in the telecommunications business. The company is in a very strong financial position, having developed rapidly in recent years through a strategy based upon growth by acquisition. Currently, earnings and earnings growth are at all time highs although the company's cash reserves are at a low level following a number of strategic investments in the last financial year. The previous evening Mr Moon gave a speech at a business dinner and during questions made some remarks that Pluto Limited was an attractive company with 'great assets' and that he would be a 'fool' if he did not consider the possibility 'like everyone else' of acquiring the company. Pluto is a long established supplier to Saturn Systems and if acquired would add substantially to the market capitalisation of the business.

Mr Moon's comments were widely reported in the following morning's financial newspapers and, by 10 am, the share price of Pluto had risen 15% in out-of-hours and early trading. The first that you, Saturn's chief financial officer, heard about the issue was when you received an urgent call from Mr Moon's office. You have just completed a background investigation of Pluto, along with three other potential targets instigated at Saturn's last board meeting in May. Following that investigation, you have now commenced a review of the steps required to raise the necessary debt finance for a bid and the procedure you would need to follow in setting up a due diligence investigation of each company.

On arriving at Mr Moon's office you are surprised to see the chairman of the board in attendance. Mr Moon has just put down the telephone and is clearly very agitated. They tell you about the remarks made by Mr Moon the previous evening and that the call just taken was from the Office of the Regulator for Public Companies. The regulator had wanted to know if a bid was to be made and what announcement the company intended to make. They had been very neutral in their response pending your advice but had promised to get back to the regulator within the hour. They knew that if they were forced to admit that a bid was imminent and then withdrew that they would not be able to bid again for another six months. Looking at you they ask as one: 'what do we do now?' After a short discussion you returned to your office and began to draft a memorandum with a recommendation about how to proceed.

Required:

- (a) **Assess the regulatory, financial and ethical issues in this case.** (15 marks)
- (b) **Propose a course of action that the company should now pursue, including a draft of any announcement that should be made, given that the board of Saturn Systems wishes to hold open the option of making a bid in the near future.** (5 marks)

(20 marks)

- 5 Neptune is a listed company in the telecommunications business. You are a senior financial management advisor employed by the company to review its capital investment appraisal procedures and to provide advice on the acceptability of a significant new capital project – the Galileo.

The project is a domestic project entailing immediate capital expenditure of \$800 million at 1 July 2008 and with projected revenues over five years as follows:

	30 June 2009	30 June 2010	30 June 2011	30 June 2012	30 June 2013
Revenue (\$ million)	680·00	900·00	900·00	750·00	320·00

Direct costs are 60% of revenues and indirect, activity based costs are \$140 million for the first year of operations, growing at 5% per annum over the life of the project. In the first two years of operations, acceptance of this project will mean that other work making a net contribution before indirect costs of \$150 million for each of the first two years will not be able to proceed. The capital expenditure of \$800 million is to be paid immediately and the equipment will have a residual value after five years' operation of \$40 million. The company depreciates plant and equipment on a straight-line basis and, in this case, the annual charge will be allocated to the project as a further indirect charge. Preconstruction design and contracting costs incurred over the previous three years total \$50 million and will be charged to the project in the first year of operation.

The company pays tax at 30% on its taxable profits and can claim a 50% first year allowance on qualifying capital expenditure followed by a writing down allowance of 40% applied on a reducing balance basis. Given the timing of the company's tax payments, tax credits and charges will be paid or received twelve months after they arise. The company has sufficient other profits to absorb any capital allowances derived from this project.

The company currently has \$7,500 million of equity and \$2,500 million of debt in issue quoted at current market values. The current cost of its debt finance is \$LIBOR plus 180 basis points. \$LIBOR is currently 5·40%, which is 40 basis points above the one month Treasury bill rate. The equity risk premium is 3·5% and the company's beta is 1·40. The company wishes to raise the additional finance for this project by a new bond issue. Its advisors do not believe that this will alter the company's bond rating. The new issue will incur transaction costs of 2% of the issue value at the date of issue.

Required:

- (a) Estimate the adjusted present value of the project resulting from the new investment and from the refinancing proposal and justify the use of this technique. (14 marks)
- (b) Estimate the modified internal rate of return generated by the project cash flows, excluding the effects of refinancing. (6 marks)

(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> $d_1 = \frac{\ln(P_a / P_e) + (r + 0.5s^2)t}{s\sqrt{t}}$ $d_2 = d_1 - s\sqrt{t}$	$c = e^{-rt} F_0 N(d_1) - XN(d_2)$ <p>Or</p> $p = e^{-rt} (XN(-d_2) - F_0 N(-d_1))$ <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>											
(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	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
(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	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	0·49987	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