

Professional Level – Options Module

Advanced Financial Management

September/December 2017 – Sample Questions



Time allowed: 3 hours 15 minutes

This question 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 10–14.

Do NOT open this question paper until instructed by the supervisor.

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

Think Ahead

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Paper

The Association of
Chartered Certified
Accountants

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

- 1 Conejo Co is a listed company based in Ardilla and uses the \$ as its currency. The company was formed around 20 years ago and was initially involved in cybernetics, robotics and artificial intelligence within the information technology industry. At that time due to the risky ventures Conejo Co undertook, its cash flows and profits were very varied and unstable. Around 10 years ago, it started an information systems consultancy business and a business developing cyber security systems. Both these businesses have been successful and have been growing consistently. This in turn has resulted in a stable growth in revenues, profits and cash flows. The company continues its research and product development in artificial intelligence and robotics, but this business unit has shrunk proportionally to the other two units.

Just under eight years ago, Conejo Co was successfully listed on Ardilla's national stock exchange, offering 60% of its share capital to external equity holders, whilst the original founding members retained the remaining 40% of the equity capital. The company remains financed largely by equity capital and reserves, with only a small amount of debt capital. Due to this, and its steadily growing sales revenue, profits and cash flows, it has attracted a credit rating of A from the credit rating agencies.

At a recent board of directors (BoD) meeting, the company's chief financial officer (CFO) argued that it was time for Conejo Co to change its capital structure by undertaking a financial reconstruction, and be financed by higher levels of debt. As part of her explanation, the CFO said that Conejo Co is now better able to bear the increased risk resulting from higher levels of debt finance; would be better protected from predatory acquisition bids if it was financed by higher levels of debt; and could take advantage of the tax benefits offered by increased debt finance. She also suggested that the expected credit migration from a credit rating of A to a credit rating of BBB, if the financial reconstruction detailed below took place, would not weaken Conejo Co financially.

Financial reconstruction

The BoD decided to consider the financial reconstruction plan further before making a final decision. The financial reconstruction plan would involve raising \$1,320 million (\$1.32 billion) new debt finance consisting of bonds issued at their face value of \$100. The bonds would be redeemed in five years' time at their face value of \$100 each. The funds raised from the issue of the new bonds would be used to implement one of the following two proposals:

- (i) Proposal 1: Either buy back equity shares at their current share price, which would be cancelled after they have been repurchased; or
- (ii) Proposal 2: Invest in additional assets in new business ventures.

Conejo Co, Financial information

Extract from the forecast financial position for next year

	\$m
Non-current assets	1,735
Current assets	530
Total assets	<u>2,265</u>
Equity and liabilities	
Share capital (\$1 per share par value)	400
Reserves	1,700
Total equity	<u>2,100</u>
Non-current liabilities	120
Current liabilities	45
Total liabilities	<u>165</u>
Total liabilities and capital	<u>2,265</u>

Conejo Co's forecast after-tax profit for next year is \$350 million and its current share price is \$11 per share.

The non-current liabilities consist solely of 5.2% coupon bonds with a face value of \$100 each, which are redeemable at their face value in three years' time. These bonds are currently trading at \$107.80 per \$100. The bond's covenant stipulates that should Conejo Co's borrowing increase, the coupon payable on these bonds will increase by 37 basis points.

Conejo Co pays tax at a rate of 15% per year and its after-tax return on the new investment is estimated at 12%.

Other financial information

Current government bond yield curve

Year	1	2	3	4	5
	1.5%	1.7%	1.9%	2.2%	2.5%

Yield spreads (in basis points)

	1 year	2 years	3 years	4 years	5 years
A	40	49	59	68	75
BBB	70	81	94	105	112
BB	148	167	185	202	218

The finance director wants to determine the percentage change in the value of Conejo Co's current bonds, if the credit rating changes from A to BBB. Furthermore, she wants to determine the coupon rate at which the new bonds would need to be issued, based on the current yield curve and appropriate yield spreads given above.

Conejo Co's chief executive officer (CEO) suggested that if Conejo Co paid back the capital and interest of the new bond in fixed annual repayments of capital and interest through the five-year life of the bond, then the risk associated with the extra debt finance would be largely mitigated. In this case, it was possible that credit migration, by credit rating companies, from A rating to BBB rating may not happen. He suggested that comparing the duration of the new bond based on the interest payable annually and the face value in five years' time with the duration of the new bond where the borrowing is paid in fixed annual repayments of interest and capital could be used to demonstrate this risk mitigation.

Required:

- (a) Discuss the possible reasons for the finance director's suggestions that Conejo Co could benefit from higher levels of debt with respect to risk, from protection against acquisition bids, and from tax benefits. (7 marks)
- (b) Prepare a report for the board of directors of Conejo Co which:
- Estimates, and briefly comments on, the change in value of the current bond and the coupon rate required for the new bond, as requested by the CFO; (6 marks)
 - Estimates the Macaulay duration of the new bond based on the interest payable annually and face value repayment, and the Macaulay duration based on the fixed annual repayment of the interest and capital, as suggested by the CEO; (6 marks)
 - Estimates the impact of the two proposals on how the funds may be used on next year's forecast earnings, forecast financial position, forecast earnings per share and on forecast gearing; (11 marks)
 - Using the estimates from (b)(i), (b)(ii) and (b)(iii), discusses the impact of the proposed financial reconstruction and the proposals on the use of funds on:
 - Conejo Co;
 - Possible reaction(s) of credit rating companies and on the expected credit migration, including the suggestion made by the CEO;
 - Conejo Co's equity holders;
 - Conejo Co's current and new debt holders. (16 marks)

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

(4 marks)

(50 marks)

Section B – TWO questions ONLY to be attempted

- 2 Eview Cinemas Co is a long-established chain of cinemas in the country of Taria. Twenty years ago Eview Cinemas Co's board decided to convert some of its cinemas into sports gyms, known as the EV clubs. The number of EV clubs has expanded since then. Eview Cinemas Co's board brought in outside managers to run the EV clubs, but over the years there have been disagreements between the clubs' managers and the board. The managers have felt that the board has wrongly prioritised investment in, and refurbishment of, the cinemas at the expense of the EV clubs.

Five years ago, Eview Cinemas Co undertook a major refurbishment of its cinemas, financing this work with various types of debt, including loan notes at a high coupon rate of 10%. Shortly after the work was undertaken, Taria entered into a recession which adversely affected profitability. The finance cost burden was high and Eview Cinemas Co was not able to pay a dividend for two years.

The recession is now over and Eview Cinemas Co has emerged in a good financial position, as two of its competitors went into insolvency during the recession. Eview Cinemas Co's board wishes to expand its chain of cinemas and open new, multiscreen cinemas in locations which are available because businesses were closed down during the recession.

In two years' time Taria is due to host a major sports festival. This has encouraged interest in sport and exercise in the country. As a result, some gym chains are looking to expand and have contacted Eview Cinemas Co's board to ask if it would be interested in selling the EV clubs. Most of the directors regard the cinemas as the main business and so are receptive to selling the EV clubs.

The finance director has recommended that the sales price of the EV clubs be based on predicted free cash flows as follows:

1. The predicted free cash flow figures in \$millions for EV clubs are as follows:

Year	1	2	3	4
	390	419	455	490

2. After Year 4, free cash flows should be assumed to increase at 5.2% per annum.
3. The discount rate to be used should be the current weighted average cost of capital, which is 12%.
4. The finance director believes that the result of the free cash flow valuation will represent a fair value of the EV clubs' business, but Eview Cinemas Co is looking to obtain a 25% premium on the fair value as the expected sales price.

Other information supplied by the finance director is as follows:

1. The predicted after-tax profits of the EV clubs are \$454 million in Year 1. This can be assumed to be 40% of total after-tax profits of EV Cinemas Co.
2. The expected proceeds which Eview Cinemas Co receives from selling the EV clubs will be used firstly to pay off the 10% loan notes. Part of the remaining amount from the sales proceeds will then be used to enhance liquidity by being held as part of current assets, so that the current ratio increases to 1.5. The rest of the remaining amount will be invested in property, plant and equipment. The current net book value of the non-current assets of the EV clubs to be sold can be assumed to be \$3,790 million. The profit on the sale of the EV clubs should be taken directly to reserves.
3. Eview Cinemas Co's asset beta for the cinemas can be assumed to be 0.952.
4. Eview Cinemas Co currently has 1,000 million \$1 shares in issue. These are currently trading at \$15.75 per share. The finance director expects the share price to rise by 10% once the sale has been completed, as he thinks that the stock market will perceive it to be a good deal.
5. Tradeable debt is currently quoted at \$96 per \$100 for the 10% loan notes and \$93 per \$100 for the other loan notes. The value of the other loan notes is not expected to change once the sale has been completed. The overall pre-tax cost of debt is currently 9% and can be assumed to fall to 8% when the 10% loan notes are redeemed.
6. The current tax rate on profits is 20%.
7. Additional investment in current assets is expected to earn a 7% pre-tax return and additional investment in property, plant and equipment is expected to earn a 12% pre-tax return.
8. The current risk-free rate is 4% and the return on the market portfolio is 10%.

Eview Cinemas Co's current summarised statement of financial position is shown below. The CEO wants to know the impact the sale of the EV clubs would have immediately on the statement of financial position, the impact on the Year 1 forecast earnings per share and on the weighted average cost of capital.

	\$m
Assets	
Non-current assets	15,621
Current assets	2,347
Total assets	<u>17,968</u>
Equity and liabilities	
Called-up share capital	1,000
Retained earnings	7,917
Total equity	<u>8,917</u>
Non-current liabilities	
10% loan notes	3,200
Other loan notes	2,700
Bank loans	985
Total non-current liabilities	<u>6,885</u>
Current liabilities	2,166
Total equity and liabilities	<u>17,968</u>

Required:

(a) Calculate the expected sales price of the EV clubs and demonstrate its impact on Eview Cinemas Co's statement of financial position, forecast earnings per share and weighted average cost of capital. (17 marks)

(b) Evaluate the decision to sell the EV clubs. (8 marks)

(25 marks)

3 High K Co is one of the three largest supermarket chains in the country of Townia. Its two principal competitors, Dely Co and Leminster Co, are of similar size to High K Co. In common with its competitors (but see below), High K Co operates three main types of store:

- Town centre stores – these sell food and drink and a range of small household items. High K Co's initial growth was based on its town centre stores, but it has been shutting them over the last decade, although the rate of closure has slowed in the last couple of years.
- Convenience stores – these are smaller and sell food and drink and very few other items. Between 2003 and 2013, High K Co greatly expanded the number of convenience stores it operated. Their performance has varied, however, and since 2013, High K Co has not opened any new stores and closed a number of the worst-performing stores.
- Out-of-town stores – these sell food and drink and a full range of household items, including large electrical goods and furniture. The number of out-of-town stores which High K Co operated increased significantly until 2010, but has only increased slightly since.

The majority of town centre and out-of-town stores premises are owned by High K Co, but 85% of convenience stores premises are currently leased.

High K Co also sells most of its range of products online, either offering customers home delivery or 'click and collect' (where the customer orders the goods online and picks them up from a collection point in one of the stores).

High K Co's year end is 31 December. When its 2016 results were published in April 2017, High K Co's chief executive emphasised that the group was focusing on:

- Increasing total shareholder return by improvements in operating efficiency and enhancement of responsiveness to customer needs
- Ensuring competitive position by maintaining flexibility to respond to new strategic challenges
- Maintaining financial strength by using diverse sources of funding, including making use in future of revolving credit facilities

Since April 2017, Dely Co and Leminster Co have both announced that they will be making significant investments to boost online sales. Dely Co intends to fund its investments by closing all its town centre and convenience stores, although it also intends to open more out-of-town stores in popular locations.

The government of Townia was re-elected in May 2017. In the 18 months prior to the election, it eased fiscal policy and consumer spending significantly increased. However, it has tightened fiscal policy since the election to avoid the economy overheating. It has also announced an investigation into whether the country's large retail chains treat their suppliers unfairly.

Extracts from High K Co's 2016 financial statements and other information about it are given below:

High K Co statement of profit or loss extracts

Year ending 31 December (all amounts in \$m)

	2014	2015	2016
Sales revenue	23,508	23,905	24,463
Gross profit	1,018	1,211	1,514
Operating profit	204	407	712
Finance costs	(125)	(115)	(100)
Profit after tax	52	220	468
Dividends	150	170	274

High K Co statement of financial position extracts

Year ending 31 December (all amounts in \$m)

Non-current assets	10,056	9,577	8,869
Cash and cash equivalents	24	709	1,215
Other current assets	497	618	747
Total non-current and current assets	10,577	10,904	10,831
Equity			
Ordinary shares (\$1)	800	800	800
Reserves	7,448	7,519	7,627
Total equity	8,248	8,319	8,427
Non-current liabilities	1,706	1,556	1,246
Current liabilities	623	1,029	1,158

Other information

Market price per share (in \$, \$3.89 at end of 2013, \$3.17 currently)	3.54	3.34	3.23
Staff working in shops ('000)	78	75	72

Segment information

Revenue (\$m)

Town centre stores	5,265	5,189	5,192
Convenience stores	3,786	3,792	3,833
Out-of-town stores	10,220	10,340	10,547
Store revenue	19,271	19,321	19,572
Online sales	4,237	4,584	4,891

Number of stores

Town centre stores	165	157	153
Convenience stores	700	670	640
Out-of-town stores	220	224	227

Required:

- (a) Evaluate High K Co's financial performance. You should indicate in your discussion areas where further information about High K Co would be helpful. Provide relevant calculations for ratios and trends to support your evaluation.

Note: Up to 10 marks are available for calculations.

(21 marks)

- (b) Discuss how High K Co may seek to finance an investment programme.

(4 marks)

(25 marks)

4 Wardegul Co, a company based in the Eurozone, has expanded very rapidly over recent years by a combination of acquiring subsidiaries in foreign countries and setting up its own operations abroad. Wardegul Co's board has found it increasingly difficult to monitor its activities and Wardegul Co's support functions, including its treasury function, have struggled to cope with a greatly increased workload. Wardegul Co's board has decided to restructure the company on a regional basis, with regional boards and appropriate support functions. Managers in some of the larger countries in which Wardegul Co operates are unhappy with reorganisation on a regional basis, and believe that operations in their countries should be given a large amount of autonomy and be supported by internal functions organised on a national basis.

Assume it is now 1 October 2017. The central treasury function has just received information about a future transaction by a newly-acquired subsidiary in Euria, where the local currency is the dinar (D). The subsidiary expects to receive D27,000,000 on 31 January 2018. It wants this money to be invested locally in Euria, most probably for five months until 30 June 2018.

Wardegul Co's treasury team is aware that economic conditions in Euria are currently uncertain. The central bank base rate in Euria is currently 4.2% and the treasury team believes that it can invest funds in Euria at the central bank base rate less 30 basis points. However, treasury staff have seen predictions that the central bank base rate could increase by up to 1.1% or fall by up to 0.6% between now and 31 January 2018.

Wardegul Co's treasury staff normally hedge interest rate exposure by using whichever of the following products is most appropriate:

- Forward rate agreements (FRAs)
- Interest rate futures
- Options on interest rate futures

Treasury function guidelines emphasise the importance of mitigating the impact of adverse movements in interest rates. However, they also allow staff to take into consideration upside risks associated with interest rate exposure when deciding which instrument to use.

A local bank in Euria, with which Wardegul Co has not dealt before, has offered the following FRA rates:

4-9: 5.02%
5-10: 5.10%

The treasury team has also obtained the following information about exchange traded Dinar futures and options:

Three-month D futures, D500,000 contract size

Prices are quoted in basis points at 100 – annual % yield:

December 2017: 94.84
March 2018: 94.78
June 2018: 94.66

Options on three-month D futures, D500,000 contract size, option premiums are in annual %

December	Calls		Strike price	Put		
	March	June		December	March	June
0.417	0.545	0.678	94.25	0.071	0.094	0.155
0.078	0.098	0.160	95.25	0.393	0.529	0.664

It can be assumed that futures and options contracts are settled at the end of each month. Basis can be assumed to diminish to zero at contract maturity at a constant rate, based on monthly time intervals. It can also be assumed that there is no basis risk and there are no margin requirements.

Required:

- (a) Recommend a hedging strategy for the D27,000,000 investment, based on the hedging choices which treasury staff are considering, if interest rates increase by 1·1% or decrease by 0·6%. Support your answer with appropriate calculations and discussion. (18 marks)
- (b) Discuss the advantages of operating treasury activities through regional treasury functions compared with:
- Each country having a separate treasury function.
 - Operating activities through a single global treasury function. (7 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

$$g = br_e$$

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

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

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>											
(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	10.368	9.787	9.253	8.760	8.306	7.887	7.499	7.139	6.805	6.495	11
12	11.255	10.575	9.954	9.385	8.863	8.384	7.943	7.536	7.161	6.814	12
13	12.134	11.348	10.635	9.986	9.394	8.853	8.358	7.904	7.487	7.103	13
14	13.004	12.106	11.296	10.563	9.899	9.295	8.745	8.244	7.786	7.367	14
15	13.865	12.849	11.938	11.118	10.380	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	0·4987	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