

Professional Level – Options Module

Advanced Financial Management

September/December 2015



Time allowed

Reading and planning: 15 minutes

Writing: 3 hours

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 11–15.

Do NOT open this question 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 – This ONE question is compulsory and MUST be attempted

1 Cigno Co is a large pharmaceutical company, involved in the research and development (R&D) of medicines and other healthcare products. Over the past few years, Cigno Co has been finding it increasingly difficult to develop new medical products. In response to this, it has followed a strategy of acquiring smaller pharmaceutical companies which already have successful products in the market and/or have products in development which look very promising for the future. It has mainly done this without having to resort to major cost-cutting and has therefore avoided large-scale redundancies. This has meant that not only has Cigno Co performed reasonably well in the stock market, but it has also maintained a high level of corporate reputation.

Anatra Co is involved in two business areas: the first area involves the R&D of medical products, and the second area involves the manufacture of medical and dental equipment. Until recently, Anatra Co's financial performance was falling, but about three years ago a new chief executive officer (CEO) was appointed and she started to turn the company around. Recently, the company has developed and marketed a range of new medical products, and is in the process of developing a range of cancer-fighting medicines. This has resulted in a good performance in the stock market, but many analysts believe that its shares are still trading below their true value. Anatra Co's CEO is of the opinion that the turnaround in the company's fortunes makes it particularly vulnerable to a takeover threat, and she is thinking of defence strategies that the company could undertake to prevent such a threat. In particular, she was thinking of disposing some of the company's assets and focussing on its core business.

Cigno Co is of the opinion that Anatra Co is being held back from achieving its true potential by its equipment manufacturing business and that by separating the two business areas, corporate value can be increased. As a result, it is considering the possibility of acquiring Anatra Co, unbundling the manufacturing business, and then absorbing Anatra Co's R&D of medical products business. Cigno Co estimates that it would need to pay a premium of 35% to Anatra Co's shareholders to buy the company.

Financial information: Anatra Co

Given below are extracts from Anatra Co's latest statement of profit or loss and statement of financial position for the year ended 30 November 2015.

	2015
	\$ million
Sales revenue	21,400
Profit before interest and tax (PBIT)	3,210
Interest	720
Pre-tax profit	2,490
	2015
	\$ million
Non-current liabilities	9,000
Share capital (50c/share)	3,500
Reserves	4,520

Anatra Co's share of revenue and profits between the two business areas are as follows:

	Medical products R&D	Equipment manufacturing
Share of revenue and profit	70%	30%

Post-acquisition benefits from acquiring Anatra Co

Cigno Co estimates that following the acquisition and unbundling of the manufacturing business, Anatra Co's future sales revenue and profitability of the medical R&D business will be boosted. The annual sales growth rate is expected to be 5% and the profit margin before interest and tax is expected to be 17.25% of sales revenue, for the next four years. It can be assumed that the current tax allowable depreciation will remain equivalent to the amount of investment needed to maintain the current level of operations, but that the company will require an additional investment in assets of 40c for every \$1 increase in sales revenue.

After the four years, the annual growth rate of the company's free cash flows is expected to be 3% for the foreseeable future.

Anatra Co's unbundled equipment manufacturing business is expected to be divested through a sell-off, although other options such as a management buy-in were also considered. The value of the sell-off will be based on the medical and dental equipment manufacturing industry. Cigno Co has estimated that Anatra Co's manufacturing business should be valued at a factor of 1.2 times higher than the industry's average price-to-earnings ratio. Currently the industry's average earnings-per-share is 30c and the average share price is \$2.40.

Possible additional post-acquisition benefits

Cigno Co estimates that it could achieve further cash flow benefits following the acquisition of Anatra Co, if it undertakes a limited business re-organisation. There is some duplication of the R&D work conducted by Cigno Co and Anatra Co, and the costs related to this duplication could be saved if Cigno Co closes some of its own operations. However, it would mean that many redundancies would have to be made including employees who have worked in Cigno Co for many years. Anatra Co's employees are considered to be better qualified and more able in these areas of duplication, and would therefore not be made redundant.

Cigno Co could also move its headquarters to the country where Anatra Co is based and thereby potentially save a significant amount of tax, other than corporation tax. However, this would mean a loss of revenue for the government where Cigno Co is based.

The company is concerned about how the government and the people of the country where it is based might react to these issues. It has had a long and beneficial relationship with the country and with the country's people.

Cigno Co has estimated that it would save \$1,600 million after-tax free cash flows to the firm at the end of the first year as a result of these post-acquisition benefits. These cash flows would increase by 4% every year for the next three years.

Estimating the combined company's weighted average cost of capital

Cigno Co is of the opinion that as a result of acquiring Anatra Co, the cost of capital will be based on the equity beta and the cost of debt of the combined company. The asset beta of the combined company is the individual companies' asset betas weighted in proportion of the individual companies' market value of equity. Cigno Co has a market debt to equity ratio of 40:60 and an equity beta of 1.10.

It can be assumed that the proportion of market value of debt to market value of equity will be maintained after the two companies combine.

Currently, Cigno Co's total firm value (market values of debt and equity combined) is \$60,000 million and Anatra Co's asset beta is 0.68.

Additional information

- The estimate of the risk free rate of return is 4.3% and of the market risk premium is 7%.
- The corporation tax rate applicable to all companies is 22%.
- Anatra Co's current share price is \$3 per share, and it can be assumed that the book value and the market value of its debt are equivalent.
- The pre-tax cost of debt of the combined company is expected to be 6.0%.

Important note

Cigno Co's board of directors (BoD) does not require any discussion or computations of currency movements or exposure in this report. All calculations are to be presented in \$ millions. Currency movements and their management will be considered in a separate report. The BoD also does not expect any discussion or computations relating to the financing of acquisition in this report, other than the information provided above on the estimation of the cost of capital.

Required:

- (a) Distinguish between a divestment through a sell-off and a management buy-in as forms of unbundling. (4 marks)
- (b) Prepare a report for the board of directors (BoD) of Cigno Co which:
- (i) Estimates the value attributable to Cigno Co's shareholders from the acquisition of Anatra Co before taking into account the cash benefits of potential tax savings and redundancies, and then after taking these into account; (18 marks)
 - (ii) Assesses the value created from (b)(i) above, including a discussion of the estimations made and methods used; (8 marks)
 - (iii) Advises the BoD on the key factors it should consider in relation to the redundancies and potential tax savings. (4 marks)
- Professional marks will be awarded in part (b) for the format, structure and presentation of the report. (4 marks)
- (c) Discuss whether the defence strategy suggested by Anatra Co's CEO of disposing assets is feasible. (6 marks)
- (d) Takeover regulation, where Anatra Co is based, offers the following conditions aimed at protecting shareholders: the mandatory-bid condition through sell out rights, the principle of equal treatment, and squeeze-out rights.

Required:

Explain the main purpose of each of the three conditions. (6 marks)

(50 marks)

Section B – TWO questions ONLY to be attempted

2 The Armstrong Group is a multinational group of companies. Today is 1 September. The treasury manager at Massie Co, one of Armstrong Group’s subsidiaries based in Europe, has just received notification from the group’s head office that it intends to introduce a system of netting to settle balances owed within the group every six months. Previously inter-group indebtedness was settled between the two companies concerned.

The predicted balances owing to, and owed by, the group companies at the end of February are as follows:

Owed by	Owed to	Local currency million (m)
Armstrong (USA)	Horan (South Africa)	US \$12.17
Horan (South Africa)	Massie (Europe)	SA R42.65
Giffen (Denmark)	Armstrong (USA)	D Kr21.29
Massie (Europe)	Armstrong (USA)	US \$19.78
Armstrong (USA)	Massie (Europe)	€1.57
Horan (South Africa)	Giffen (Denmark)	D Kr16.35
Giffen (Denmark)	Massie (Europe)	€1.55

The predicted exchange rates, used in the calculations of the balances to be settled, are as follows:

	D Kr	US\$	SA R	€
1 D Kr =	1.0000	0.1823	1.9554	0.1341
1 US \$ =	5.4855	1.0000	10.7296	0.7358
1 SA R =	0.5114	0.0932	1.0000	0.0686
1 € =	7.4571	1.3591	14.5773	1.0000

Settlement will be made in dollars, the currency of Armstrong Group, the parent company. Settlement will be made in the order that the company owing the largest net amount in dollars will first settle with the company owed the smallest net amount in dollars.

Note: D Kr is Danish Krone, SA R is South African Rand, US \$ is United States dollar and € is Euro.

Required:

- (a) (i) Calculate the inter-group transfers which are forecast to occur for the next period. (8 marks)
- (ii) Discuss the problems which may arise with the new arrangement. (3 marks)

The most significant transaction which Massie Co is due to undertake with a company outside the Armstrong Group in the next six months is that it is due to receive €25 million from Bardsley Co on 30 November. Massie Co’s treasury manager intends to invest this money for the six months until 31 May, when it will be used to fund some major capital expenditure. However, the treasury manager is concerned about changes in interest rates. Predictions in the media range from a 0.5% rise in interest rates to a 0.5% fall.

Because of the uncertainty, the treasury manager has decided to protect Massie Co by using derivatives. The treasury manager wishes to take advantage of favourable interest rate movements. Therefore she is considering options on interest rate futures or interest rate collars as possible methods of hedging, but not interest rate futures. Massie Co can invest at LIBOR minus 40 basis points and LIBOR is currently 3.6%.

The treasury manager has obtained the following information on Euro futures and options. She is ignoring margin requirements.

Three-month Euro futures, €1,000,000 contract, tick size 0.01% and tick value €25.

September	95.94
December	95.76
March	95.44

Options on three-month Euro futures, €1,000,000 contract, tick size 0.01% and tick value €25. Option premiums are in annual %.

September	Calls		Strike	Puts		
	December	March		September	December	March
0.113	0.182	0.245	96.50	0.002	0.123	0.198
0.017	0.032	0.141	97.00	0.139	0.347	0.481

It can be assumed that settlement for the contracts is at the end of the month. It can also be assumed that basis diminishes to zero at contract maturity at a constant rate and that time intervals can be counted in months.

Required:

- (b) **Based on the choice of options on futures or collars which Massie Co is considering and assuming the company does not face any basis risk, recommend a hedging strategy for the €25 million receipt. Support your recommendations with appropriate comments and relevant calculations.** (14 marks)

(25 marks)

- 3 Five years ago the Patel family invested in a new business, Flufftort Co, which manufactures furniture. Some family members became directors of Flufftort Co, others have not been actively involved in management. A venture capital firm, Gupte VC, also made a 20% investment in Flufftort Co. A representative of Gupte VC was appointed to Flufftort Co's board. Flufftort Co also took out a long-term 8.5% bank loan.

Sales have generally been disappointing. As a result, members of the Patel family have been reluctant to invest further in Flufftort Co. Over the last year Gupte VC has taken a tougher attitude towards Flufftort Co. Gupte VC pressurised Flufftort Co to pay a dividend of \$2 million for the year ended 30 June 2015. Gupte VC has also said that if Flufftort Co's financial results do not improve, Gupte VC may exercise its right to compel Flufftort Co to buy back its shares at par on 30 June 2016.

However, Flufftort Co's most recent product, the Easicushion chair, has been a much bigger success than expected. In order to produce enough Easicushion chairs to affect its results substantially, Flufftort Co will need to make significant expenditure on manufacturing facilities and additional working capital.

Extracts from statement of profit or loss for year ended 30 June 2015 and forecast statement of profit or loss for year ended 30 June 2016

	2015	2016 Forecast
	\$m	\$m
Operating profit	8.0	6.0
Finance cost	(3.0)	(3.0)
Profit before tax	5.0	3.0
Tax on profits (20%)	(1.0)	(0.6)
Profit for the period	4.0	2.4
Dividends	(2.0)	–
Retained earnings	2.0	2.4

Note

The forecast statement of profit or loss for the year ended 30 June 2016 is not affected by the proposed investment. This can be assumed only to affect results after 30 June 2016. The figure shown for retained earnings in the 2016 forecast can be assumed to be the net increase in cash for the year ended 30 June 2016.

Summarised statement of financial position as at 30 June 2015

	\$m
Assets	
Non-current assets	69.0
Current assets excluding cash	18.0
Cash	7.6
Total assets	94.6
Equity and liabilities	
Share capital (\$1 shares)	50.0
Retained earnings	2.6
Total equity	52.6
Long-term liabilities	
8.5% Bank loan	30.0
9% Loan note	5.0
Total long-term liabilities	35.0
Current liabilities	7.0
Total liabilities	42.0
Total equity and liabilities	94.6

Notes

1. 55% of shares are owned by the members of the Patel family who are directors, 25% by other members of the Patel family and 20% by Gupte VC.
2. The bank loan is secured on the non-current assets of Flufftort and is due for repayment on 31 December 2019. The loan is subject to a covenant that the ratio of equity to non-current liabilities should be greater than 1·3 on a book value basis. Flufftort has also been granted an overdraft facility of up to \$5 million by its bank.
3. The loan note is held by Rajiv Patel, a member of the Patel family who is not a director. The loan note is unsecured, is subordinated to the bank loan and has no fixed date for repayment.
4. If no finance is available for investment in manufacturing facilities, non-current assets, current assets excluding cash, the bank loan, loan note and current liabilities can be assumed to be the same at 30 June 2016 as at 30 June 2015.

However, the chief executive and finance director of Flufftort Co intend to propose that the company should be refinanced to fund the expanded production of the Easicushion chair. They have not yet consulted anyone else about their proposals.

Details of the proposed refinancing are as follows:

1. The members of the Patel family who are directors would subscribe to an additional 15 million \$1 shares at par.
2. Gupte VC would subscribe to an additional 20 million \$1 shares at par.
3. The 8·5% bank loan would be renegotiated with the bank and the borrowing increased to \$65 million, to be repaid on 30 June 2022. The expected finance cost of the loan would be 10% per annum.
4. Rajiv Patel's loan note would be replaced by 5 million \$1 shares.
5. The refinancing would mean non-current assets would increase to \$125 million, current assets other than cash would increase to \$42 million and current liabilities would increase to \$12 million.
6. Operating profits would be expected to increase to \$20 million in the first full year after the facilities are constructed (year ended 30 June 2017) and \$25 million in the second year (year ended 30 June 2018). No dividends would be paid for these two years, as cash surpluses would be used for further investment as required. Tax on company profits can be assumed to remain at 20%.

Required:

- (a) (i) **Prepare a projected statement of financial position as at 30 June 2016, on the assumption that Gupte VC exercises its rights and Gupte VC's shares are repurchased and cancelled by Flufftort Co.** (4 marks)
- (ii) **Prepare a projected statement of financial position as at 30 June 2016 on the assumption that the proposed refinancing and investment take place.** (4 marks)
- (iii) **Prepare projected statements of profit or loss for the years ended 30 June 2017 and 30 June 2018 on the basis that the profit forecasts are correct.** (4 marks)
- (b) **Evaluate whether the suggested refinancing scheme is likely to be agreed by all finance providers. State clearly any assumptions which you make.** (13 marks)

(25 marks)

- 4 Moonstar Co is a property development company which is planning to undertake a \$200 million commercial property development. Moonstar Co has had some difficulties over the last few years, with some developments not generating the expected returns and the company has at times struggled to pay its finance costs. As a result Moonstar Co's credit rating has been lowered, affecting the terms it can obtain for bank finance. Although Moonstar Co is listed on its local stock exchange, 75% of the share capital is held by members of the family who founded the company. The family members who are shareholders do not wish to subscribe for a rights issue and are unwilling to dilute their control over the company by authorising a new issue of equity shares. Moonstar Co's board is therefore considering other methods of financing the development, which the directors believe will generate higher returns than other recent investments, as the country where Moonstar Co is based appears to be emerging from recession.

Securitisation proposals

One of the non-executive directors of Moonstar Co has proposed that it should raise funds by means of a securitisation process, transferring the rights to the rental income from the commercial property development to a special purpose vehicle. Her proposals assume that the leases will generate an income of 11% per annum to Moonstar Co over a ten-year period. She proposes that Moonstar Co should use 90% of the value of the investment for a collateralised loan obligation which should be structured as follows:

- 60% of the collateral value to support a tranche of A-rated floating rate loan notes offering investors LIBOR plus 150 basis points
- 15% of the collateral value to support a tranche of B-rated fixed rate loan notes offering investors 12%
- 15% of the collateral value to support a tranche of C-rated fixed rate loan notes offering investors 13%
- 10% of the collateral value to support a tranche as subordinated certificates, with the return being the excess of receipts over payments from the securitisation process

The non-executive director believes that there will be sufficient demand for all tranches of the loan notes from investors. Investors will expect that the income stream from the development to be low risk, as they will expect the property market to improve with the recession coming to an end and enough potential lessees to be attracted by the new development.

The non-executive director predicts that there would be annual costs of \$200,000 in administering the loan. She acknowledges that there would be interest rate risks associated with the proposal, and proposes a fixed for variable interest rate swap on the A-rated floating rate notes, exchanging LIBOR for 9.5%.

However the finance director believes that the prediction of the income from the development that the non-executive director has made is over-optimistic. He believes that it is most likely that the total value of the rental income will be 5% lower than the non-executive director has forecast. He believes that there is some risk that the returns could be so low as to jeopardise the income for the C-rated fixed rate loan note holders.

Islamic finance

Moonstar Co's chief executive has wondered whether Sukuk finance would be a better way of funding the development than the securitisation.

Moonstar Co's chairman has pointed out that a major bank in the country where Moonstar Co is located has begun to offer a range of Islamic financial products. The chairman has suggested that a Mudaraba contract would be the most appropriate method of providing the funds required for the investment.

Required:

- (a) Calculate the amounts in \$ which each of the tranches can expect to receive from the securitisation arrangement proposed by the non-executive director and discuss how the variability in rental income affects the returns from the securitisation. (11 marks)
- (b) Discuss the benefits and risks for Moonstar Co associated with the securitisation arrangement that the non-executive director has proposed. (6 marks)
- (c) (i) Discuss the suitability of Sukuk finance to fund the investment, including an assessment of its appeal to potential investors. (4 marks)
- (ii) Discuss whether a Mudaraba contract would be an appropriate method of financing the investment and discuss why the bank may have concerns about providing finance by this method. (4 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>											
(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	0.914	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	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