Professional Level – Options Module

Advanced Financial Management

March/June 2018 – Sample Questions

P4 ACCA

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.

Paper P4

Think Ahead

ACCA

The Association of Chartered Certified Accountants

Section A – This question is compulsory and MUST be attempted

1 Chikepe Co is a large listed company operating in the pharmaceutical industry with a current market value of equity of $12,600 million and a debt to equity ratio of 30:70, in market value terms. Institutional investors hold most of its equity shares. The company develops and manufactures antibiotics and anti-viral medicines. Both the company and its products have an established positive reputation among the medical profession, and its products are used widely. However, its rate of innovation has slowed considerably in the last few years and it has fewer new medical products coming into the market.

At a recent meeting of the board of directors (BoD), it was decided that the company needed to change its current strategy of growing organically to one of acquiring companies, in order to maintain the growth in its share price in the future. The members of the BoD had different opinions on the type of acquisition strategy to pursue.

Director A was of the opinion that Chikepe Co should follow a strategy of acquiring companies in different business sectors. She suggested that focusing on just the pharmaceutical sector was too risky and acquiring companies in different business sectors will reduce this risk.

Director B was of the opinion that Director A's suggestion would not result in a reduction in risk for shareholders. In fact, he suggested that this would result in agency related issues with Chikepe Co's shareholders reacting negatively and as a result, the company's share price would fall. Instead, Director B suggested that Chikepe Co should focus on its current business and acquire other established pharmaceutical companies. In this way, the company will gain synergy benefits and thereby increase value for its shareholders.

Director C agreed with Director B, but suggested that Chikepe Co should consider relatively new pharmaceutical companies, as well as established businesses. In her opinion, newer companies might be involved in research and development of innovative products, which could have high potential in the future. She suggested that using real options methodology with traditional investment appraisal methods such as net present value could help establish a more accurate estimate of the potential value of such companies.

The company has asked its finance team to prepare a report on the value of a potential target company, Foshoro Co, before making a final decision.

Foshoro Co

Foshoro Co is a non-listed pharmaceutical company established about 10 years ago. Initially Foshoro Co grew rapidly, but this rate of growth slowed considerably three years ago, after a venture capital equity backer exited the company by selling its stake back to the founding directors. The directors had to raise substantial debt capital to buy back the equity stake. The company's current debt to equity ratio is 60:40. This high level of gearing means that the company will find it difficult to obtain funds to develop its innovative products in the future.

The following financial information relates to Foshoro Co:

Extract from the most recent statement of profit or loss

	$ million
Sales revenue	878·1
Profit before interest and tax	192·3
Interest	78·6
Tax	22·7
Profit after tax	91·0

In arriving at the profit before interest and tax, Foshoro Co deducted tax allowable depreciation and other non-cash expenses totalling $112·0 million. It requires a cash investment of $98·2 million in non-current assets and working capital to continue its operations at the current level.

Three years ago, Foshoro Co's profit after tax was $83·3 million and this has been growing steadily to their current level. Foshoro Co's profit before interest and tax and its cash flows grew at the same growth rate as well. It is likely that this growth rate will continue for the foreseeable future if Foshoro Co is not acquired by Chikepe Co. Foshoro Co's cost of capital has been estimated at 10%.

Combined company: Chikepe Co and Foshoro Co

Once Chikepe Co acquires Foshoro Co, it is predicted that the combined company's sales revenue will be $4,200 million in the first year, and its operating profit margin on sales revenue will be 20% for the foreseeable future.

After the first year, the sales revenue is expected to grow at 7% per year for the following three years. It is anticipated that after the first four years, the growth rate of the combined company's free cash flows will be 5·6% per year.

The combined company's tax allowable depreciation is expected to be equivalent to the amount of investment needed to maintain the current level of operations. However, as the company's sales revenue increases over the four-year period, the combined company will require an additional investment in assets of $200 million in the first year and then $0·64 per $1 increase in sales revenue for the next three years.

It can be assumed that the asset beta of the combined company is the weighted average of the individual companies' asset betas, weighted in proportion of the individual companies' value of equity. It can also be assumed that the capital structure of the combined company remains at Chikepe Co's current capital structure level, a debt to equity ratio of 30:70. Chikepe Co pays interest on borrowings at a rate of 5·3% per annum.

Chikepe Co estimates that it will be able to acquire Foshoro Co by paying a premium of 30% above its estimated equity value to Foshoro Co's shareholders.

Other financial information

	Equity beta	Asset beta
Chikepe Co	1·074	0·800
Foshoro Co	2·090	0·950

The current annual government borrowing base rate is 2% and the annual market risk premium is estimated at 7%.

Both companies pay tax at an annual rate of 20%.

Chikepe Co estimates equity values in acquisitions using the free cash flow to firm method.

Future acquisitions

The BoD agreed that in the future it is likely that Chikepe Co will target both listed and non-listed companies for acquisition. It is aware that when pursuing acquisitions of listed companies, the company would need to ensure that it complied with regulations such as the mandatory bid rule and the principle of equal treatment to protect shareholders. The BoD is also aware that some listed companies may attempt to defend acquisitions by employing anti-takeover measures such as poison pills and disposal of crown jewels.

Required:

(a) Compare and contrast the reasons for the opinions held by Director A and by Director B, and discuss the types of synergy benefits which may arise from the acquisition strategy suggested by Director B. (9 marks)

(b) Discuss how using real options methodology in conjunction with net present value could help establish a more accurate estimate of the potential value of companies, as suggested by Director C. (5 marks)

(c) Prepare a report for the board of directors of Chikepe Co which:

(i) Estimates the current equity value of Foshoro Co; (6 marks)

(ii) Estimates the equity value arising from combining Foshoro Co with Chikepe Co; (11 marks)

(iii) Evaluates whether the acquisition of Foshoro Co would be beneficial to Chikepe Co's shareholders and discusses the limitations of the valuation method used in (c)(i) and (c)(ii) above. (7 marks)

Professional marks will be awarded in part (c) for the format, structure and presentation of the report. (4 marks)

(d) Discuss how the mandatory bid rule and the principle of equal treatment protects shareholders in the event of their company facing a takeover bid, and discuss the effectiveness of poison pills and disposal of crown jewels as defensive tactics against hostile takeover bids. (8 marks)

(50 marks)

Section B – TWO questions ONLY to be attempted

2 Tippletine Co is based in Valliland. It is listed on Valliland's stock exchange but only has a small number of shareholders. Its directors collectively own 45% of the equity share capital.

Tippletine Co's growth has been based on the manufacture of household electrical goods. However, the directors have taken a strategic decision to diversify operations and to make a major investment in facilities for the manufacture of office equipment.

Details of investment

The new investment is being appraised over a four-year time horizon. Revenues from the new investment are uncertain and Tippletine Co's finance director has prepared what she regards as cautious forecasts. She predicts that it will generate $2 million operating cash flows before marketing costs in Year 1 and $14·5 million operating cash flows before marketing costs in Year 2, with operating cash flows rising by the expected levels of inflation in Years 3 and 4.

Marketing costs are predicted to be $9 million in Year 1 and $2 million in each of Years 2 to 4.

The new investment will require immediate expenditure on facilities of $30·6 million. Tax allowable depreciation will be available on the new investment at an annual rate of 25% reducing balance basis. It can be assumed that there will either be a balancing allowance or charge in the final year of the appraisal. The finance director believes the facilities will remain viable after four years, and therefore a realisable value of $13·5 million can be assumed at the end of the appraisal period.

The new facilities will also require an immediate initial investment in working capital of $3 million. Working capital requirements will increase by the rate of inflation for the next three years and any working capital at the start of Year 4 will be assumed to be released at the end of the appraisal period.

Tippletine Co pays tax at an annual rate of 30%. Tax is payable with a year's time delay. Any tax losses on the investment can be assumed to be carried forward and written off against future profits from the investment.

Predicted inflation rates are as follows:

Year	1	2	3	4
	8%	6%	5%	4%

Financing the investment

Tippletine Co has been considering two choices for financing all of the $30·6 million needed for the initial investment in the facilities:

– A subsidised loan from a government loan scheme, with the loan repayable at the end of the four years. Issue costs of 4% of the gross finance would be payable. Interest would be payable at a rate of 30 basis points below the risk free rate of 2·5%. In order to obtain the benefits of the loan scheme, Tippletine Co would have to fulfil various conditions, including locating the facilities in a remote part of Valliland where unemployment is high.

– Convertible loan notes, with the subscribers for the notes including some of Tippletine Co's directors. The loan notes would have issue costs of 4% of the gross finance. If not converted, the loan notes would be redeemed in six years' time. Interest would be payable at 5%, which is Tippletine Co's normal cost of borrowing. Conversion would take place at an effective price of $2·75 per share. However, the loan note holders could enforce redemption at any time from the start of Year 3 if Tippletine Co's share price fell below $1·50 per share. Tippletine Co's current share price is $2·20 per share.

Issue costs for the subsidised loan and convertible loan notes would be paid out of available cash reserves. Issue costs are not allowable as a tax-deductible expense.

In initial discussions, the majority of the board favoured using the subsidised loan. The appraisal of the investment should be prepared on the basis that this method of finance will be used. However, the chairman argued strongly in favour of the convertible loan notes, as, in his view, operating costs will be lower if Tippletine Co does not have to fulfil the conditions laid down by the government of Valliland. Tippletine Co's finance director is sceptical, however, about whether the other shareholders would approve the issue of convertible loan notes on the terms suggested. The directors will decide which method of finance to use at the next board meeting.

Other information

Humabuz Co is a large manufacturer of office equipment in Valliland. Humabuz Co's geared cost of equity is estimated to be 10·5% and its pre-tax cost of debt to be 5·4%. These estimates are based on a capital structure comprising $225 million 6% irredeemable bonds, trading at $107 per $100, and 125 million $1 equity shares, trading at $3·20 per share. Humabuz Co also pays tax at an annual rate of 30% on its taxable profits.

Required:

(a) Calculate the adjusted present value for the investment on the basis that it is financed by the subsidised loan and conclude whether the project should be accepted or not. Show all relevant calculations. (17 marks)

(b) Discuss the issues which Tippletine Co's shareholders who are not directors would consider if its directors decided that the new investment should be financed by the issue of convertible loan notes on the terms suggested.

Note: You are not required to carry out any calculations when answering part (b). (8 marks)

(25 marks)

3 Arthuro Co group

Arthuro Co is based in Hittyland and is listed on Hittyland's stock exchange. Arthuro Co has one wholly-owned subsidiary, Bowerscots Co, based in the neighbouring country of Owlia. Hittyland and Owlia are in a currency union and the currency of both countries is the $.

Arthuro Co purchased 100% of Bowerscots Co's share capital three years ago. Arthuro Co has the power under the acquisition to determine the level of dividend paid by Bowerscots Co. However, Arthuro Co's board decided to let Bowerscots Co's management team have some discretion when making investment decisions. Arthuro Co's board decided that it should receive dividends of 60% of Bowerscots Co's post-tax profits and has allowed Bowerscots Co to use its remaining retained earnings to fund investments chosen by its management. A bonus linked to Bowerscots Co's after-tax profits is a significant element of Bowerscots Co's managers' remuneration.

Bowerscots Co operates in a very competitive environment. Recently, a senior member of its management team has left to join a competitor.

Arthuro Co's dividend policy

Until three months ago, Arthuro Co had 90 million $2 equity shares in issue and $135 million 8% bonds. Three months ago it made a 1 for 3 rights issue. A number of shareholders did not take up their rights, but sold them on, so there have been changes in its shareholder base. Some shareholders expressed concern about dilution of their dividend income as a result of the rights issue. Therefore, Arthuro Co's board felt it had to promise, for the foreseeable future, at least to maintain the dividend of $0·74 per equity share, which it paid for the two years before the rights issue.

Arthuro Co's board is nevertheless concerned about whether it will have sufficient funds available to fulfil its promise about the dividend. It has asked the finance director to forecast its dividend capacity based on assumptions about what will happen in a 'normal' year. The finance director has made the following assumptions in the forecast:

1. Sales revenue can be assumed to be 4% greater than the most recent year's of $520 million.
2. The operating profit margin can be assumed to be 20%.
3. Operating profit can be assumed to be reported after charging depreciation of $30 million and profit on disposal of non-current assets of $5·9 million. The cost of the non-current assets sold can be assumed to be $35 million and its accumulated depreciation to be $24·6 million. Depreciation is allowable for tax and the profit on disposal is fully chargeable to tax.
4. The net book value of non-current assets at the year end in the most recent accounts was $110 million. To maintain productive capacity, sufficient investment to increase this net book value figure 12 months later by 4% should be assumed, in line with the increase in sales. The calculation of investment required for the year should take into account the depreciation charged of $30 million, and net book value of the non-current assets disposed of during the year.
5. A $0·15 investment in working capital can be assumed for every $1 increase in sales revenue.
6. Bowerscots Co's pre-tax profits can be assumed to be $45 million.

Arthuro Co's directors have decided that if there is a shortfall of dividend capacity, compared with the dividends required to maintain the current dividend level, the percentage of post-tax profits of Bowerscots Co paid as dividend should increase, if necessary up to 100%.

Taxation

Arthuro Co pays corporation tax at 30% and Bowerscots Co pays corporation tax at 20%. A withholding tax of 5% is deducted from any dividends remitted by Bowerscots Co. There is a bilateral tax treaty between Hittyland and Owlia. Corporation tax is payable by Arthuro Co on profits declared by Bowerscots Co, but Hittyland gives full credit for corporation tax already paid in Owlia. Hittyland gives no credit for withholding tax paid on dividends in Owlia.

Required:

(a) (i) Estimate Arthuro Co's forecast dividend capacity for a 'normal' year; (11 marks)

(ii) Estimate the level of dividend required from Bowerscots Co to give Arthuro Co sufficient dividend capacity to maintain its dividend level of $0·74 per equity share. (3 marks)

(b) Arthuro Co has decided to increase its level of dividend from Bowerscots Co if its dividend capacity is insufficient.

Required:

(i) From Arthuro Co's viewpoint, discuss the financial benefits of, and problems with, this decision; (5 marks)

(ii) Discuss the agency problems, and how they might be resolved, with this decision. (6 marks)

(25 marks)

4 The Adverane Group is a multinational group of companies with its headquarters in Switzerland. The Adverane Group consists of a number of fully-owned subsidiaries and Elted Co, an associate company based in the USA in which Adverane Group owns 30% of the ordinary equity share capital. Balances owing between the parent, Adverane Co, and its subsidiaries and between subsidiaries are settled by multilateral netting. Transactions between the parent and Elted Co are settled separately.

Transactions with Elted Co

Adverane Co wishes to hedge transactions with Elted Co which are due to be settled in four months' time in US$. Adverane Co will owe Elted Co US$3·7 million for a major purchase of supplies and Elted Co will owe Adverane Co US$10·15 million for non-current assets. Adverane Group's treasury department is considering whether to use money markets or exchange-traded currency futures for hedging.

Annual interest rates available to Adverane Co

	Investing rate	Borrowing rate
Switzerland	2·7%	3·9%
USA	2·5%	3·7%

Exchange traded currency futures

Contract size CHF125,000, price quotation US$ per CHF1

Three-month expiry: 1·1213

Six-month expiry: 1·1204

Netting

The balances owed to and owed by members of Adverane Group when netting is to take place are as follows:

Owed by	Owed to	Local currency m
Adverane (Switzerland)	Bosha (Eurozone)	CHF15·90
Adverane (Switzerland)	Diling (Brazil)	CHF4·46
Bosha (Eurozone)	Cogate (USA)	€24·89
Bosha (Eurozone)	Diling (Brazil)	€18·57
Cogate (USA)	Adverane (Switzerland)	US$27·08
Cogate (USA)	Diling (Brazil)	US$5·68
Diling (Brazil)	Adverane (Switzerland)	BRL38·80
Diling (Brazil)	Bosha (Eurozone)	BRL51·20

Spot rates are currently as follows:

	CHF	€	US$	BRL
1 CHF =	1·0000	0·9347–0·9369	1·1196–1·1222	3·1378–3·1760

The group members will make settlement in Swiss francs. Spot mid-rates will be used in calculations. Settlement will be made in the order that the company owing the largest net amount in Swiss francs will first settle with the company owed the smallest net amount in Swiss francs.

Transfer price arrangements

The Adverane Group board has been reviewing the valuation of inter-group transactions, as it is concerned that the current system is not working well. Currently inter-group transfer prices are mostly based on fixed cost plus a mark-up negotiated by the buying and selling divisions. If they cannot agree a price, either the sale does not take place or the central treasury department determines the margin. The board has the following concerns:

– Both selling and buying divisions have claimed that prices are unfair and distort the measurement of their performance.

– Significant treasury department time is being taken up dealing with disputes and then dealing with complaints that the price it has imposed is unfair on one or the other division.

– Some parts of the group are choosing to buy from external suppliers rather than from suppliers within the group.

As a result of the review, the Adverane Group board has decided that transfer prices should in future be based on market prices, where an external market exists.

Note: CHF is Swiss Franc, € is Euro, US$ is United States dollar and BRL is Brazilian Real.

Required:

(a) Advise Adverane Co on, and recommend, an appropriate hedging strategy for the US$ cash flows it is due to receive from, or pay to, Elted Co. (9 marks)

(b) (i) Calculate the inter-group transfers which are forecast to take place. (7 marks)

(ii) Discuss the advantages of multilateral netting by a central treasury function within the Adverane Group. (3 marks)

(c) Evaluate the extent to which changing to a market-price system of transfer pricing will resolve the concerns of the Adverane Group board. (6 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

$$P_o = \frac{D_o(1+g)}{(r_e - g)}$$

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

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

Modified Internal Rate of Return

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

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

Discount rate (r)

Periods (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

Discount rate (r)

Periods (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

[P.T.O.

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