Professional Level – Options Module

Advanced Financial Management

Tuesday 3 June 2014

Paper P4

Time allowed
Reading and planning: 15 minutes
Writing: 3 hours

This paper is divided into two sections:

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

Section B – TWO questions ONLY to be attempted

Formulae and tables are on pages 9–13.

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.

ACCA

The Association of Chartered Certified Accountants

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

1 Cocoa-Mocha-Chai (CMC) Co is a large listed company based in Switzerland and uses Swiss Francs as its currency. It imports tea, coffee and cocoa from countries around the world, and sells its blended products to supermarkets and large retailers worldwide. The company has production facilities located in two European ports where raw materials are brought for processing, and from where finished products are shipped out. All raw material purchases are paid for in US dollars (US$), while all sales are invoiced in Swiss Francs (CHF).

Until recently CMC Co had no intention of hedging its foreign currency exposures, interest rate exposures or commodity price fluctuations, and stated this intent in its annual report. However, after consultations with senior and middle managers, the company's new Board of Directors (BoD) has been reviewing its risk management and operations strategies.

The following two proposals have been put forward by the BoD for further consideration:

Proposal one

Setting up a treasury function to manage the foreign currency and interest rate exposures (but not commodity price fluctuations) using derivative products. The treasury function would be headed by the finance director. The purchasing director, who initiated the idea of having a treasury function, was of the opinion that this would enable her management team to make better decisions. The finance director also supported the idea as he felt this would increase his influence on the BoD and strengthen his case for an increase in his remuneration.

In order to assist in the further consideration of this proposal, the BoD wants you to use the following upcoming foreign currency and interest rate exposures to demonstrate how they would be managed by the treasury function:

(i) a payment of US$5,060,000 which is due in four months' time; and

(ii) a four-year CHF60,000,000 loan taken out to part-fund the setting up of four branches (see proposal two below). Interest will be payable on the loan at a fixed annual rate of 2·2% or a floating annual rate based on the yield curve rate plus 0·40%. The loan's principal amount will be repayable in full at the end of the fourth year.

Proposal two

This proposal suggested setting up four new branches in four different countries. Each branch would have its own production facilities and sales teams. As a consequence of this, one of the two European-based production facilities will be closed. Initial cost-benefit analysis indicated that this would reduce costs related to production, distribution and logistics, as these branches would be closer to the sources of raw materials and also to the customers. The operations and sales directors supported the proposal, as in addition to above, this would enable sales and marketing teams in the branches to respond to any changes in nearby markets more quickly. The branches would be controlled and staffed by the local population in those countries. However, some members of the BoD expressed concern that such a move would create agency issues between CMC Co's central management and the management controlling the branches. They suggested mitigation strategies would need to be established to minimise these issues.

Response from the non-executive directors

When the proposals were put to the non-executive directors, they indicated that they were broadly supportive of the second proposal if the financial benefits outweigh the costs of setting up and running the four branches. However, they felt that they could not support the first proposal, as this would reduce shareholder value because the costs related to undertaking the proposal are likely to outweigh the benefits.

Additional information relating to proposal one

The current spot rate is US$1·0635 per CHF1. The current annual inflation rate in the USA is three times higher than Switzerland.

The following derivative products are available to CMC Co to manage the exposures of the US$ payment and the interest on the loan:

Exchange-traded currency futures

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

3-month expiry	1·0647
6-month expiry	1·0659

Exchange-traded currency options

Contract size CHF125,000, exercise price quotation: US$ per CHF1, premium: cents per CHF1

	Call Options		Put Options	
Exercise price	3-month expiry	6-month expiry	3-month expiry	6-month expiry
1·06	1·87	2·75	1·41	2·16
1·07	1·34	2·22	1·88	2·63

It can be assumed that futures and option contracts expire at the end of the month and transaction costs related to these can be ignored.

Over-the-counter products

In addition to the exchange-traded products, Pecunia Bank is willing to offer the following over-the-counter derivative products to CMC Co:

(i) A forward rate between the US$ and the CHF of US$ 1·0677 per CHF1.

(ii) An interest rate swap contract with a counterparty, where the counterparty can borrow at an annual floating rate based on the yield curve rate plus 0·8% or an annual fixed rate of 3·8%. Pecunia Bank would charge a fee of 20 basis points each to act as the intermediary of the swap. Both parties will benefit equally from the swap contract.

Required:

(a) Advise CMC Co on an appropriate hedging strategy to manage the foreign exchange exposure of the US$ payment in four months' time. Show all relevant calculations, including the number of contracts bought or sold in the exchange-traded derivative markets. (15 marks)

(b) Demonstrate how CMC Co could benefit from the swap offered by Pecunia Bank. (6 marks)

(c) As an alternative to paying the principal on the loan as one lump sum at the end of the fourth year, CMC Co could pay off the loan in equal annual amounts over the four years similar to an annuity. In this case, an annual interest rate of 2% would be payable, which is the same as the loan's gross redemption yield (yield to maturity).

Required:

Calculate the modified duration of the loan if it is repaid in equal amounts and explain how duration can be used to measure the sensitivity of the loan to changes in interest rates. (7 marks)

(d) Prepare a memorandum for the Board of Directors (BoD) of CMC Co which:

(i) Discusses proposal one in light of the concerns raised by the non-executive directors; and (9 marks)

(ii) Discusses the agency issues related to proposal two and how these can be mitigated. (9 marks)

Professional marks will be awarded in part (d) for the presentation, structure, logical flow and clarity of the memorandum. (4 marks)

(50 marks)

Section B – TWO questions ONLY to be attempted

2 You have recently commenced working for Burung Co and are reviewing a four-year project which the company is considering for investment. The project is in a business activity which is very different from Burung Co's current line of business.

The following net present value estimate has been made for the project:

All figures are in $ million

Year	0	1	2	3	4
Sales revenue		23·03	36·60	49·07	27·14
Direct project costs		(13·82)	(21·96)	(29·44)	(16·28)
Interest		(1·20)	(1·20)	(1·20)	(1·20)
Profit		8·01	13·44	18·43	9·66
Tax (20%)		(1·60)	(2·69)	(3·69)	(1·93)
Investment/sale	(38·00)				4·00
Cash flows	(38·00)	6·41	10·75	14·74	11·73
Discount factors (7%)	1	0·935	0·873	0·816	0·763
Present values	(38·00)	5·99	9·38	12·03	8·95

Net present value is negative $1·65 million, and therefore the recommendation is that the project should not be accepted.

In calculating the net present value of the project, the following notes were made:

(i) Since the real cost of capital is used to discount cash flows, neither the sales revenue nor the direct project costs have been inflated. It is estimated that the inflation rate applicable to sales revenue is 8% per year and to the direct project costs is 4% per year.

(ii) The project will require an initial investment of $38 million. Of this, $16 million relates to plant and machinery, which is expected to be sold for $4 million when the project ceases, after taking any taxation and inflation impact into account.

(iii) Tax allowable depreciation is available on the plant and machinery at 50% in the first year, followed by 25% per year thereafter on a reducing balance basis. A balancing adjustment is available in the year the plant and machinery is sold. Burung Co pays 20% tax on its annual taxable profits. No tax allowable depreciation is available on the remaining investment assets and they will have a nil value at the end of the project.

(iv) Burung Co uses either a nominal cost of capital of 11% or a real cost of capital of 7% to discount all projects, given that the rate of inflation has been stable at 4% for a number of years.

(v) Interest is based on Burung Co's normal borrowing rate of 150 basis points over the 10-year government yield rate.

(vi) At the beginning of each year, Burung Co will need to provide working capital of 20% of the anticipated sales revenue for the year. Any remaining working capital will be released at the end of the project.

(vii) Working capital and depreciation have not been taken into account in the net present value calculation above, since depreciation is not a cash flow and all the working capital is returned at the end of the project.

It is anticipated that the project will be financed entirely by debt, 60% of which will be obtained from a subsidised loan scheme run by the government, which lends money at a rate of 100 basis points below the 10-year government debt yield rate of 2·5%. Issue costs related to raising the finance are 2% of the gross finance required. The remaining 40% will be funded from Burung Co's normal borrowing sources. It can be assumed that the debt capacity available to Burung Co is equal to the actual amount of debt finance raised for the project.

Burung Co has identified a company, Lintu Co, which operates in the same line of business as that of the project it is considering. Lintu Co is financed by 40 million shares trading at $3·20 each and $34 million debt trading at $94 per $100. Lintu Co's equity beta is estimated at 1·5. The current yield on government treasury bills is 2% and it is estimated that the market risk premium is 8%. Lintu Co pays tax at an annual rate of 20%.

Both Burung Co and Lintu Co pay tax in the same year as when profits are earned.

Required:

(a) Calculate the adjusted present value (APV) for the project, correcting any errors made in the net present value estimate above, and conclude whether the project should be accepted or not. Show all relevant calculations. (15 marks)

(b) Comment on the corrections made to the original net present value estimate and explain the APV approach taken in part (a), including any assumptions made. (10 marks)

(25 marks)

3 Vogel Co, a listed engineering company, manufactures large scale plant and machinery for industrial companies. Until ten years ago, Vogel Co pursued a strategy of organic growth. Since then, it has followed an aggressive policy of acquiring smaller engineering companies, which it feels have developed new technologies and methods, which could be used in its manufacturing processes. However, it is estimated that only between 30% and 40% of the acquisitions made in the last ten years have successfully increased the company's shareholder value.

Vogel Co is currently considering acquiring Tori Co, an unlisted company, which has three departments. Department A manufactures machinery for industrial companies, Department B produces electrical goods for the retail market, and the smaller Department C operates in the construction industry. Upon acquisition, Department A will become part of Vogel Co, as it contains the new technologies which Vogel Co is seeking, but Departments B and C will be unbundled, with the assets attached to Department C sold and Department B being spun off into a new company called Ndege Co.

Given below are extracts of financial information for the two companies for the year ended 30 April 2014.

	Vogel Co $ million	Tori Co $ million
Sales revenue	790·2	124·6
Profit before depreciation, interest and tax (PBDIT)	244·4	37·4
Interest	13·8	4·3
Depreciation	72·4	10·1
Pre-tax profit	158·2	23·0

	Vogel Co $ million	Tori Co $ million
Non-current assets	723·9	98·2
Current assets	142·6	46·5
7% unsecured bond	–	40·0
Other non-current and current liabilities	212·4	20·2
Share capital (50c/share)	190·0	20·0
Reserves	464·1	64·5

Share of current and non-current assets and profit of Tori Co's three departments:

	Department A	Department B	Department C
Share of current and non-current assets	40%	40%	20%
Share of PBDIT and pre-tax profit	50%	40%	10%

Other information

(i) It is estimated that for Department C, the realisable value of its non-current assets is 100% of their book value, but its current assets' realisable value is only 90% of their book value. The costs related to closing Department C are estimated to be $3 million.

(ii) The funds raised from the disposal of Department C will be used to pay off Tori Co's other non-current and current liabilities.

(iii) The 7% unsecured bond will be taken over by Ndege Co. It can be assumed that the current market value of the bond is equal to its book value.

(iv) At present, around 10% of Department B's PBDIT come from sales made to Department C.

(v) Ndege Co's cost of capital is estimated to be 10%. It is estimated that in the first year of operation Ndege Co's free cash flows to firm will grow by 20%, and then by 5·2% annually thereafter.

(vi) The tax rate applicable to all the companies is 20%, and Ndege Co can claim 10% tax allowable depreciation on its non-current assets. It can be assumed that the amount of tax allowable depreciation is the same as the investment needed to maintain Ndege Co's operations.

(vii) Vogel Co's current share price is $3 per share and it is estimated that Tori Co's price-to-earnings (PE) ratio is 25% higher than Vogel Co's PE ratio. After the acquisition, when Department A becomes part of Vogel Co, it is estimated that Vogel Co's PE ratio will increase by 15%.

(viii) It is estimated that the combined company's annual after-tax earnings will increase by $7 million due to the synergy benefits resulting from combining Vogel Co and Department A.

Required:

(a) Discuss the possible reasons why Vogel Co may have switched its strategy of organic growth to one of growing by acquiring companies. (4 marks)

(b) Discuss the possible actions Vogel Co could take to reduce the risk that the acquisition of Tori Co fails to increase shareholder value. (7 marks)

(c) Estimate, showing all relevant calculations, the maximum premium Vogel Co could pay to acquire Tori Co, explaining the approach taken and any assumptions made. (14 marks)

(25 marks)

4 The chief executive officer (CEO) of Faoilean Co has just returned from a discussion at a leading university on the 'application of options to investment decisions and corporate value'. She wants to understand how some of the ideas which were discussed can be applied to decisions made at Faoilean Co. She is still a little unclear about some of the discussion on options and their application, and wants further clarification on the following:

(i) Faoilean Co is involved in the exploration and extraction of oil and gas. Recently there have been indications that there could be significant deposits of oil and gas just off the shores of Ireland. The government of Ireland has invited companies to submit bids for the rights to commence the initial exploration of the area to assess the likelihood and amount of oil and gas deposits, with further extraction rights to follow. Faoilean Co is considering putting in a bid for the rights. The speaker leading the discussion suggested that using options as an investment assessment tool would be particularly useful to Faoilean Co in this respect.

(ii) The speaker further suggested that options were useful in determining the value of equity and default risk, and suggested that this was why companies facing severe financial distress could still have a positive equity value.

(iii) Towards the end of the discussion, the speaker suggested that changes in the values of options can be measured in terms of a number of risk factors known as the 'greeks', such as the 'vega'. The CEO is unclear why option values are affected by so many different risk factors.

Required:

(a) With regard to (i) above, discuss how Faoilean Co may use the idea of options to help with the investment decision in bidding for the exploration rights, and explain the assumptions made when using the idea of options in making investment decisions. (11 marks)

(b) With regard to (ii) above, discuss how options could be useful in determining the value of equity and default risk, and why companies facing severe financial distress still have positive equity values. (9 marks)

(c) With regard to (iii) above, explain why changes in option values are determined by numerous different risk factors and what 'vega' determines. (5 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

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