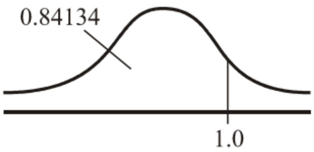
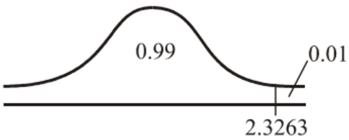
2 In order not to be late for a job interview, Anita needs to leave her house in a taxi no later than 3.00 pm. Past experience has shown that, when she telephones for a taxi from company A, the time it takes to arrive at her house may be modelled by a normal distribution with a mean of 12 minutes and a standard deviation of 3 minutes.

(a) Given that she telephones for a taxi at 2.45 pm, find the probability that she will not be late for the interview. *(3 marks)*

(b) Find, to the nearest minute, the latest time that she should telephone for a taxi in order to have a probability of 0.99 of not being late for the interview. *(3 marks)*

As well as wishing not to be late, Anita would prefer not to arrive too early, as waiting outside an interview room makes her nervous. The time taken to arrive at her house by a taxi from company B may be modelled by a normal distribution with a mean of 12 minutes and a standard deviation of 2 minutes.

(c) State, giving a reason, which taxi firm you would advise Anita to use. *(2 marks)*

Question	Solution	Marks	Total Marks	Comments
2 (a)	$z = \frac{15-12}{3} = 1.0$ $P(\text{not late}) = 0.841$ 	M1 M1 A1	**(3)**	
(b)	$12 + 2.3263 \times 3 = 18.9$ Telephone 19 minutes before 3.0 pm ie 2.41 pm 	B1 M1 A1	**(3)**	
(c)	Choose second firm because standard deviation smaller $\rightarrow$ for given risk of being late average waiting time shorter	M1 A1	**(2)**	
		TOTAL	**8**	

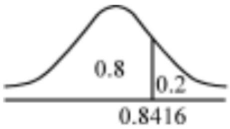
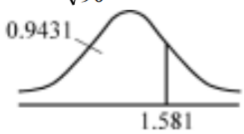
6 A study showed that the time, T minutes, spent by a customer between entering and leaving Fely's department store has a mean of 20 with a standard deviation of 6.

Assume that T may be modelled by a normal distribution.

(a) Find the value of T exceeded by 20% of customers. *(4 marks)*

(b) (i) Write down the standard deviation of the mean time spent in Fely's store by a random sample of 90 customers. *(1 mark)*

(ii) Find the probability that this mean time will exceed 21 minutes. *(4 marks)*

6(a)		B1 M1 m1 A1	4	$0.8416(0.841-0.842)$ Use of $z \times 6$ Completely correct method $25.0(25.0-25.1)$
(b)(i)	$\frac{6}{\sqrt{90}}=0.632$	B1	1	$\frac{6}{\sqrt{90}}$ acf
(ii)	$z=\frac{(21-20)}{\frac{(6)}{\sqrt{90}}}=1.581$  Probability mean exceeds 21 is $1-0.9431=0.0569$	M1 m1 m1 A1	4	Use of $\frac{6}{\sqrt{90}}$ Method for z – ignore sign Completely correct method 0.0569 (0.0568 - 0.0571)
	Total		**9**	

8 A gas supplier maintains a team of engineers who are available to deal with leaks reported by customers. Most reported leaks can be dealt with quickly but some require a long time. The time (excluding travelling time) taken to deal with reported leaks is found to have a mean of 65 minutes and a standard deviation of 60 minutes.

(a) Assuming that the times may be modelled by a normal distribution, estimate the probability that:

(i) it will take more than 185 minutes to deal with a reported leak; *(3 marks)*

(ii) it will take between 50 minutes and 125 minutes to deal with a reported leak; *(4 marks)*

(iii) the mean time to deal with a random sample of 90 reported leaks is less than 70 minutes. *(4 marks)*

(b) A statistician, consulted by the gas supplier, stated that, as the times had a mean of 65 minutes and a standard deviation of 60 minutes, the normal distribution would not provide an adequate model.

(i) Explain the reason for the statistician's statement. *(2 marks)*

(ii) Give a reason why, despite the statistician's statement, your answer to part (a)(iii) is still valid. *(2 marks)*

8(a)(i)	$z = (185 - 65)/60 = 2.0$ probability < 185 = 1 – 0.97725 = 0.02275	M1 M1 A1	3	method for z completely correct method 0.0227 – 0.023
(ii)	$z_1 = (50 - 65)/60 = -0.25$ $z_2 = (125 - 65)/60 = 1.0$	M1		method for both z's including correct sign
	Probability between 50 and 125 minutes = 0.84134 – (1 – 0.59871) = 0.440	M1 M1 A1	4	any correct use of normal tables completely correct method 0.439 – 0.441
(iii)	$z = (70 - 65)/(60/\sqrt{90}) = 0.791$ Probability mean of 90 < 60 = 0.786	M1 M1 M1 A1	4	attempted use of $60/\sqrt{90}$ correct method for z completely correct method 0.78 – 0.79
(b)(i)	Mean only just over one standard deviation above zero. Normal distribution would give a substantial chance of negative time which is impossible.	B2	2	allow both marks if point clearly made
(ii)	Large sample → mean normally distributed by central limit theorem.	B1 B1	2	
	Total		**15**	

8 The weights, in grams, of the contents of tins of mackerel fillets are normally distributed with mean μ and standard deviation 2.5. The value of μ may be adjusted as required.

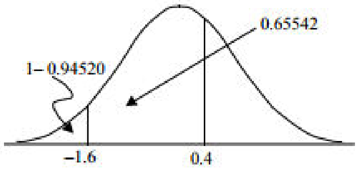
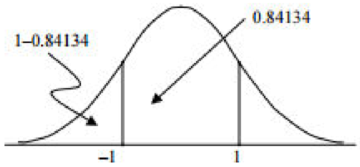
(a) Find the proportion of tins with contents weighing between 125.0 grams and 130.0 grams when $\mu = 129.0$. *(5 marks)*

(b) (i) State, without proof, the value of μ which would maximise the proportion of tins with contents weighing between 125.0 grams and 130.0 grams. *(1 mark)*

(ii) Find the proportion of tins with contents weighing between 125.0 grams and 130.0 grams when μ is equal to the value you have specified in part (b)(i). *(3 marks)*

(c) Find, to one decimal place, the value of μ such that 99% of the tins have contents weighing more than 125.0 grams. *(4 marks)*

(d) The normal distribution provides a good model for many continuous distributions which arise in production processes or in nature. Explain why the Central Limit Theorem provides another reason for the importance of the normal distribution. *(2 marks)*

Question Number and part	Solution	Marks	Total	Comments
8(a)	$z_1 = \frac{125-129}{2.5} = -1.6$	M1		Method for z ignore sign; ignore attempt at continuing correction
	$z_2 = \frac{130-129}{2.5} = 0.4$	m1		both z's correct sign
		M1		A correct use of normal distribution – generous. Allow method marks for 'correct' continuity correction (ie **not** 124.5)
	Probability between 125 and 130 = 0.65542 – (1 – 0.94520) = 0.601	m1		Completely correct method
		A1	5	0.601 (0.6 – 0.601)
(b)(i)	127.5	B1	1	127.5 or 127 or 128 only
(ii)	$z_1 = \frac{130-127.5}{2.5} = 1$ $z_2 = \frac{125-127.5}{2.5} = -1$			
		M1		Their mean
	Probability between 125 and 130			
	= 0.84134 – (1 – 0.84134) = 0.683	m1		Completely correct method (dependent on M1 and 127.5)
		A1	3	0.683 (0.68 – 0.685)
(c)	$125 + 2.3263 \times 2.5 = 130.8$	B1		2.3263 (2.32 – 2.33)
		M1		their $z \times 2.5$
		m1		m1 correct method
		A1	4	130.8 (130.8 – 130.82) or 131
(d)	Mean of large samples is approximately normally distributed for any parent distribution.	E1		Mean normal
		E1	2	Large sample
	Total		**15**	