Question Number	Scheme	Marks
8. **(a)**	$P(X > 168) = P\left(Z > \frac{168-160}{5}\right)$	M1
	$= P(Z > 1.6)$	A1
	$= 0.0548$ **awrt 0.0548**	A1 (3)
(b)	$P(X < w) = P\left(Z < \frac{w-160}{5}\right)$	
	$\frac{w-160}{5} = -2.3263$	M1 B1
	$w = 148.37$ **awrt 148**	A1 (3)
(c)	$\frac{160-\mu}{\sigma} = 2.3263$	M1 B1
	$\frac{152-\mu}{\sigma} = -1.2816$	B1
	$160 - \mu = 2.3263\sigma$	
	$152 - \mu = -1.2816\sigma$	
	$8 = 3.6079\sigma$	M1
	$\sigma = 2.21\ldots$ **awrt 2.22**	A1
	$\mu = 154.84\ldots$ **awrt 155**	A1 (6)
		[12]
	Notes	
(a)	M1 for an attempt to standardize 168 with 160 and 5 i.e. $\pm\left(\frac{168-160}{5}\right)$ or implied by 1.6	
	1st A1 for P(Z > 1.6) or P(Z < -1.6) ie z = 1.6 and a correct inequality or 1.6 on a shaded diagram	
	Correct answer to (a) implies all 3 marks	
(b)	M1 for attempting $\pm\left(\frac{w-160}{5}\right)$ = recognizable z value ($\|z\| > 1$)	
	B1 for $z = \pm 2.3263$ or better. Should be $z =\ldots$ or implied so: $1 - 2.3263 = \frac{w-160}{5}$ is M0B0	
	A1 for awrt 148. This may be scored for other z values so M1B0A1 is possible	
	For awrt 148 only with no working seen award M1B0A1	
(c)	M1 for attempting to standardize 160 or 152 with μ and σ (allow $\pm$) and equate to z value ($\|z\| > 1$)	
	1st B1 for awrt $\pm$ 2.33 or $\pm$ 2.32 seen	
	2nd B1 for awrt $\pm$ 1.28 seen	
	2nd M1 for attempt to solve their two linear equations in μ and σ leading to equation in just one variable	
	1st A1 for σ = awrt 2.22 . Award when 1st seen	
	2nd A1 for μ = awrt 155. Correct answer only for part (c) can score all 6 marks.	
	NB σ = 2.21 commonly comes from z = 2.34 and usually scores M1B0B1M1A0A1	
	The A marks in (c) require both M marks to have been earned	

Question Number	Scheme	Marks
2. **(a)**	awrt $\pm$ 1.40 $\frac{23-\mu}{5} = "1.40"$ (o.e) $\mu = 16$ (or awrt 16.0)	B1 M1A1ft A1 (4)
(b)	0.4192	B1 (1) **5**

Notes

(a)

B1 for awrt $\pm$ 1.40 or better seen anywhere. Condone 1.4 instead of 1.40

M1 for attempting to standardise with 23 and 5 and μ, accept $\pm$

e.g. $\frac{23-\mu}{25} = 1.40$ can score B1M0 (since using 25 not 5 for standardising)

$\frac{23-\mu}{5} = 0.9192$ can score B0M1 (since have correct standardisation)

Can accept equivalent equations e.g. $23-\mu = 5\times"1.40"$

1st A1ft for standardised expression = to a z value ($|z| > 1$). Signs must be compatible.

Follow through their z

e.g. $\frac{23-\mu}{5}$ = their z where $z > 1$ or $\frac{\mu-23}{5}$ = their z where $z < -1$

2nd A1 for 16 or awrt 16.0 if they are using a more accurate z

Correct answer only scores 4/4 but if any working is seen apply scheme

(b)

B1 for 0.4192 (but accept 3sf accuracy if 0.9192 – 0.5 is seen)

Question Number	Scheme	Marks
4. **(a)**	$(z = \pm)\dfrac{15-16.12}{1.6}(=-0.70)$	M1
	P(Z < -0.70) = 1 - 0.7580	M1
	= <u>0.2420</u> **(awrt 0.242)**	A1 (3)
(b)	[P($T < t$)=0.30 implies] $z = \dfrac{t-16.12}{1.6} = -0.5244$	M1 A1
	$\dfrac{t-16.12}{1.6} = -0.5244 \Rightarrow t = 16.12 - 1.6 \times "0.5244"$	M1
	t = awrt <u>15.28</u> (allow awrt 15.28/9)	A1 (4)
		7

	Notes
	Allow slips e.g. 16.2 for 16.12 for 1st M1 in (a) and (b)
(a)	1st M1 for standardising expression with 15, 16.12 and 1.6 - allow <u>±</u>
	2nd M1 for 1 - a probability (> 0.5) from tables or calculator based on their standardised value
	Correct answer only scores 3/3
	In part (b) they can use any letter or symbol instead of *t*
(b)	1st M1 for standardising with *t* (o.e.), 16.12 and 1.6, allow <u>±</u>, and setting equal to a *z* value
	1st A1 for an equation with $z = \pm 0.5244$ or better
	e.g. $\dfrac{t-16.12}{1.6} = \pm 0.52$ (or 0.525) scores M1 (but A0)
	2nd M1 for solving <u>their</u> linear equation as far as $t = a \pm b \times 1.6$. Not dependent on 1st M1
	e.g. solving $\dfrac{t-16.12}{1.6} = 0.3$ to give $t = 16.12 + 1.6 \times 0.3$ scores this M1
	Allow $\dfrac{t-16.12}{1.6^2} = 0.3$ to give $t = 16.12 + 1.6^2 \times 0.3$ to score M1 too
	2nd A1 dependent on both M marks. Allow awrt 15.28 or awrt 15.29
	Condone awrt 15.3 if a correct expression for t = ... is seen.
	Answers with no working:
	15.28 is M1A1M1A1, 15.29 is M1A0M1A1, 15.3 is M1A0M1A0

Question Number	Scheme	Marks
7 (a)	$P(W < 224) = P\left(z < \frac{224-232}{5}\right)$ $= P(z < -1.6)$	M1
	$= 1 - 0.9452$	M1
	$= 0.0548$ awrt 0.0548	A1
		(3)
(b)	$0.5 - 0.2 = 0.3$ 0.3 or 0.7 seen	M1
	$\frac{w-232}{5} = 0.5244$ 0.5244 seen	B1; M1
	$w = 234.622$ awrt 235	A1
		(4)
(c)	$0.2 \times (1-0.2)$	M1
	$2 \times 0.8 \times (1-0.8) = 0.32$	M1 A1
		(3)
		Total 10

NOTES

(a)

M1 for standardising with 232 and 5. (i.e. not 5^2 or $\sqrt{5}$) . Accept $\pm\frac{w-232}{5}$.

M1 for finding (1- a probability > 0.5)

A1 awrt 0.0548

(b)

M1 Can be implied by use of ± 0.5244 or $\pm$ (0.52 to 0.53)

B1 for ± 0.5244 only.

Second M1 standardise with 232 and 5 and equate to *z* value of (0.52 to 0.53) or (0.84 to 0.85)

1 – z used award second M0.

Require consistent signs i.e. $\frac{232-w}{5} = -0.5244$ or negative z value for M1.

A1 dependent upon second M mark for awrt 235 but see note below.

Common errors involving probabilities and not z values:

P(*Z*<0.2) = 0.5793 used instead of *z* value gives awrt 235 but award M0B0M0A0

P(*Z*<0.8) = 0.7881 used instead of *z* value award M0B0M0A0.

M1B0M0A0 for 0.6179, M1B0M0A0 for 0.7580

(c)

M1 for 0.16 seen

M1 for '$2\times p(1-p)$'

A1 0.32 correct answer only

Question	Scheme	Marks
6. (a)	$[z =] \pm\left(\frac{150-162}{7.5}\right)$	M1
	$[z =] -1.6$	A1
	$[\mathrm{P}(F > 150) = \mathrm{P}(Z > -1.6) =]$ = 0.9452(0071…) **awrt <u>0.945</u>**	A1 (3)
(b)	z = ± 0.2533 (or better seen)	B1
	$(\pm)\frac{s-162}{7.5} = 0.2533(47\ldots)$	M1
	s = 163.9 **awrt <u>164</u>**	A1 (3)
(c)	z = ± 1.2816 (or better seen)	B1
	$\frac{162-\mu}{9} = -1.2815515...$	M1 A1
	μ = 173.533… **awrt <u>174</u>**	A1 (4)
		[10]

	Notes
(a)	M1 for attempting to standardise with 150, 162 and 7.5. Accept ± Allow use of symmetry and therefore 174 instead of 150 1st A1 for –1.6 seen. Allow 1.6 seen if 174 used or awrt 0.945 is seen. Sight of 0.945(2) is A1. 2nd A1 for awrt 0.945 Do not apply ISW, if 0.9452 is followed by 1 – 0.9452 then award A0 Correct answer only 3/3
(b)	B1 for (z =) ± 0.2533 (or better) seen. Giving z = ± 0.25 or ± 0.253 scores B0 here but may get M1A1 M1 for standardising with s (o.e.), 162 and 7.5, allow ±, and setting equal to a z value Only allow $0.24 \leq z \leq 0.26$ Condone e.g. 160 for 162 etc A1 for awrt 164 (Correct answer only scores B0M1A1)
(c)	B1 for (z =) ± 1.2816 (or better) seen. Allow awrt ± 1.28 if B0 scored in (b) for z = awrt± 0.25 M1 for attempting to standardise with 162, 9 and μ, and setting equal to a z value where $1.26 < \lvert z\rvert < 1.31$. Allow ± here so signs don't have to be compatible. 1st A1 for a correct equation with compatible signs and $1.26 < \lvert z\rvert < 1.31$ 2nd A1 for awrt 174 (Correct answer only scores B0M1A1A1). **Dependent on 1st A1**
NB	An equation $\frac{162-\mu}{9} = 1.2816$ leading to an answer of μ = 174 is A0A0 unless there is clear correct working such as: $\frac{162-x}{9} = 1.2816 \Rightarrow x = \ldots \therefore \mu = 162 + (162 - x) = 174$ then award A1A1 A common error is: $\frac{162-\mu}{9} = 1.2816$ followed by $\mu = 162 + 9 \times 1.2816$ = awrt 174 It gets A0A0

Question Number	Scheme	Marks
4.		
(a)	$\frac{127-100}{15}$	M1
	So P(L > 127) = P(Z > 1.8) or $1-$P(Z < 1.8) o.e.	A1
	= 1 – 0.9641 = **0.0359** (awrt **0.0359**)	A1
		(3)
(b)	$\frac{d-100}{15} = -1.2816$ (Calculator gives $-1.2815515\ldots$)	M1, B1
	d = 80.776 (awrt **80.8**)	A1
		(3)
(c)	Require P(L > 133 | L > 127)	M1
	$= \left[\frac{\text{P}(L>133)}{\text{P}(L>127)}\right] = \frac{\text{P}(Z>2.2)}{\text{P}(L>127)}$	dM1
	$= \left[\frac{1-0.9861}{1-0.9641}\right] = \frac{0.0139}{[0.0359]}$	A1
	= 0.3871... = awrt **0.39**	A1
		(4)
S.C.	An attempt at P(L < 133| L > 127) that leads to awrt 0.61 (M0M1A0A0)	
		10

	Notes
(a)	M1 for attempting to standardise with 127, 100 and 15 . Allow $\pm$
	1st A1 for Z > 1.8. Allow a diagram but must have 1.8 and correct area indicated. Must have the Z so P(L > 127) with or without a diagram is insufficient. May be implied by 0.0359
	2nd A1 for awrt 0.0359 (calc. gives 0.035930266…). Correct ans only 3/3. M1A0A1 not poss.
(b)	M1 for an attempt to standardise with 100 and 15 and set = $\pm$ any z value ($\|z\| > 1$)
	B1 for $z = \pm$ 1.2816 (or better) seen anywhere [May be implied by 80.776(72…) or better seen]
	A1 for awrt 80.8 (can be scored for using 1.28 but then they get M1B0A1) The 80.8 must follow from correct working.
Calc	If answer is awrt 80.8 **and** awrt 80.777 or 80.776… or better seen then award M1B1A1
	If answer is awrt 80.8 or 80.77 then award M1B0A1 (unless of course z = 1.2816 is seen)
(c)	1st M1 for clear indication of correct conditional probability or attempt at correct ratio
	So clear attempt at $\frac{\text{P}(L>133)}{\text{P}(L>127)}$ is sufficient for the 1st M1
	2nd dM1 dependent on 1st M1 for P(L > 133) leading to P(Z > 2.2).
	1st A1 for 0.0139 or better seen coming from P(Z > 2.20). Dependent on both Ms
	2nd A1 for awrt 0.39. Both Ms required
ALT	If they assume Alice did not check that the phone was working you may see: [P(L< 127).0] + P(L > 127).P(L > 133| L > 127) Provided the conditional probability is seen as part of this calculation the 1st M1 can be scored and their final answer will be 0.0139(4/4) An answer of 0.0139 without sight of the conditional probability is 0/4.

Question	Scheme	Marks
6. (a)	[Let X be the amount of beans in a tin. P(X < 200) = 0.1]	
	$\frac{200-\mu}{7.8} = -1.2816$ [calc gives 1.28155156…]	M1 B1
	μ = 209.996…. awrt 210	A1
		(3)
(b)	$P(X > 225) = P\left(Z > \frac{225-"210"}{7.8}\right)$	M1
	$= P(Z > 1.92)$ or $1 - P(Z < 1.92)$ (allow 1.93)	A1
	= 1 – 0.9726 = 0.0274 (or better) [calc gives 0.0272037…]	
	= 0.0274	
	= awrt **2.7%** allow **0.027**	A1
		(3)
(c)	[Let Y be the new amount of beans in a tin]	
	$\frac{210-205}{\sigma} = 2.3263$ or $\frac{200-205}{\sigma} = -2.3263$ [calc gives 2.3263478…]	M1 B1
	$\sigma = \frac{5}{2.3263}$	dM1
	$\sigma = 2.15$ (2.14933…)	A1
		(4)
		(10 marks)

	Notes
	Condone poor handling of notation if answers are correct but A marks must have correct working.
(a)	M1 for an attempt to standardise (allow ±) with 200 and 7.8 and set = ± any z value ($\|z\| > 1$)
	B1 for z = ± 1.2816 (or better used as a z)[May be implied by 209.996(102…) or better seen]
	A1 for awrt 210 (can be scored for using 1.28 but then they get M1B0A1)
	The 210 must follow from correct working – sign scores A0
	If answer is awrt 210 **and** 209.996… or better seen then award M1B1A1
	z = 1.28 gives 209.984 and z = 1.282 gives 209.9996 and both score M1B0A1
	If answer is awrt 210 or awrt 209.996 then award M1B0A1 (unless of course z = 1.2816 is seen)
(b)	M1 for attempting to standardise with 225, their mean and 7.8 . Allow ±
	1st A1 for Z > awrt 1.92/3. Allow a diagram but must have 1.92/3 and correct area indicated.
	Must have the Z so P(X > 225) with or without a diagram is not sufficient.
	Award for 1 – 0.9726 or 1 – 0.9732
	2nd A1 for 2.7 % or better (calculator gives 2.72…) Allow awrt 0.027. Correct ans scores 3/3
(c)	1st M1 for an attempt to standardise with 200 or 210, 205 and σ and set = ± any z value ($\|z\| > 2$)
	B1 for z = 2.3263 (or better) **and** compatible signs.
	If B0 in (a) for using a value in [1.28, 1.29) but not using 1.2816: allow awrt 2.33 here
	2nd dM1 **Dependent on the first M1** for correctly rearranging to make σ = ... May be implied
	e.g. $\frac{5}{\sigma} = 2.32 \rightarrow \sigma = 2.16$ (M1A0) BUT must have $\sigma > 0$
	A1 for awrt 2.15 . Must follow from correct working but a range of possible z values will do.
	NB $2.320 < z \leq 2.331$ will give an answer of awrt 2.15