6.

(a) 200 or 200g **B1**

(1)

(b) $P(190 < X < 210) = 0.6$ or $P(X < 210) = 0.8$ or $P(X > 210) = 0.2$ or diagram (o.e.) **M1**

Correct use of 0.8 or 0.2 **A1**

$Z = (\pm)\dfrac{210-200}{\sigma}$ **M1**

$\dfrac{10}{\sigma} = 0.8416$ 0.8416 **B1**

$\sigma = 11.882129....$ AWRT 11.9 **A1**

(5)

(c) $P(X < 180) = P\left(Z < \dfrac{180-200}{\sigma}\right)$ **M1**

$= P(Z < -1.6832)$

$= 1 - 0.9535$ **M1**

$= 0.0465$ or AWRT 0.046 **A1**

(3)

Total 9 marks

(a) "mean = 200g" is B0 but "median = 200" or just "200" alone is B1

Standardization in (b) and (c). They must use σ not σ^2 or $\sqrt{\sigma}$.

(b)
- 1st M1 for a correct probability statement (as given or eg P(200<*X*<210)=0.3 o.e.) or shaded diagram - must have values on *z*-axis and probability areas shown
- 1st A1 for correct use of 0.8 or *p* = 0.2. Need a correct probability statement. May be implied by a suitable value for *z* seen (e.g. *z* = 0.84)
- 2nd M1 for attempting to standardise. Values for *x* and μ used in formula. Don't need *z* = for this M1 nor a *z*-value, just mark standardization.
- B1 for *z* = 0.8416 (or better) [*z* = 0.84 usually just loses this mark in (a)]
- 2nd A1 for AWRT 11.9

(c)
- 1st M1 for attempting to Standardise with 200 and their sd(>0) e.g. $(\pm)\dfrac{180-200}{\text{their } \sigma}$
- 2nd M1 **NB on epen this is an A mark ignore and treat it as 2nd M1** for 1 – a probability from tables provided compatible with their probability statement.
- A1 for 0.0465 or AWRT 0.046 (Dependent on both Ms in part (c))

Question Number	Scheme	Marks
Q7 (a)	$z = \dfrac{53-50}{2}$ Attempt to standardise	**M1**
	P(X>53)=1-P(Z<1.5) 1-probability required can be implied	**B1**
	=1-0.9332	
	=0.0668	**A1**
		[3]
(b)	$P(X \le x_0) = 0.01$	**M1**
	$\dfrac{x_0 - 50}{2} = -2.3263$	**M1B1**
	$x_0 = 45.3474$ awrt 45.3 or 45.4	**M1A1**
		[5]
(c)	P(2 weigh more than 53kg and 1 less) $= 3 \times 0.0668^2 (1 - 0.0668)$	**B1M1A1ft**
	$= 0.012492487..$ awrt 0.012	**A1**
		[4]
		Total 12
	Notes: (a) M1 for using 53,50 and 2, either way around on numerator B1 1- any probability for mark A1 0.0668 cao (b) M1 can be implied or seen in a diagram or equivalent with correct use of 0.01 or 0.99 M1 for attempt to standardise with 50 and 2 numerator either way around B1 for ± 2.3263 M1 Equate expression with 50 and 2 to a z value to form an equation with consistent signs and attempt to solve A1 awrt 45.3 or 45.4 (c) B1 for 3, M1 $p^2(1-p)$ for any value of p A1ft for p is their answer to part (a) without 3 A1 awrt 0.012 or 0.0125	

Question Number	Scheme	Marks
6 (a)	$P(X < 39) = P\left(Z < \frac{39-30}{5}\right)$	M1
	$= P(Z < 1.8) = \underline{0.9641}$ (allow awrt 0.964)	A1 (2)
(b)	$P(X < d) = P\left(Z < \frac{d-30}{5}\right) = 0.1151$	
	$1 - 0.1151 = 0.8849$	M1
	$\Rightarrow \quad z = -1.2$ (allow $\pm$ 1.2)	B1
	$\therefore \frac{d-30}{5} = -1.2$ $\underline{d = 24}$	M1A1 (4)
(c)	$P(X > e) = 0.1151$ so $e = \mu + (\mu$ - their $d)$ or $\frac{e-30}{5} = 1.2$ or – their z	M1
	$\underline{e = 36}$	A1 (2)
(d)	$P(d < X < e) = 1 - 2 \times 0.1151$	M1
	$= 0.7698$ AWRT $\underline{0.770}$	A1 (2)
		[10]

Answer only scores all marks in each section BUT check (b) and (c) are in correct order

(a)

M1 for standardising with σ, $z = \pm\frac{39-30}{5}$ is OK

A1 for 0.9641 or awrt 0.964 but if they go on to calculate 1 – 0.9641 they get M1A0

(b)

1st M1 for attempting 1- 0.1151. Must be seen in (b) in connection with finding d

B1 for $z = \pm 1.2$. They must state $z = \pm 1.2$ or imply it is a z value by its use. This mark is only available in part (b).

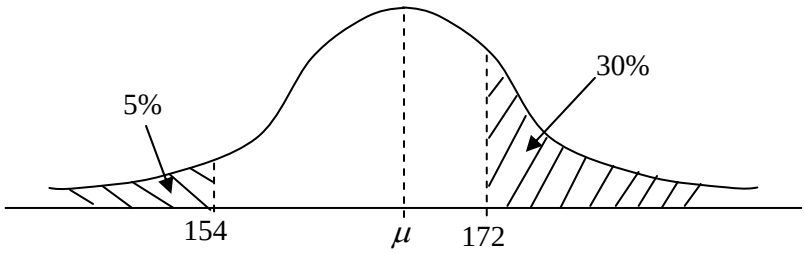
2nd M1 for $\left(\frac{d-30}{5}\right) =$ their negative z value (or equivalent)

(c) M1 for a full method to find e. If they used $z = 1.2$ in (b) they can get M1 for $z = \pm 1.2$ here
If they use symmetry about the mean $\mu + (\mu$ - their $d)$ then ft their d for M1
Must explicitly see the method used unless the answer is correct.

(d) M1 for a complete method or use of a correct expression e.g. "their 0.8849" - 0.1151
or **If their *d* < their *e*** using their values with $P(X < e) - P(X < d)$
If their $d \geq$ their e then they can only score from an argument like 1 – 2x0.1151
A negative probability or probability > 1 for part (d) scores M0A0

Question Number	Scheme	Marks
Q8 (a)	Let the random variable X be the lifetime in hours of bulb	
	$P(X < 830) = P(Z < \frac{\pm(830-850)}{50})$ Standardising with 850 and 50	M1
	$= P(Z < -0.4)$	
	$= 1 - P(Z < 0.4)$ Using 1-(probability>0.5)	M1
	$= 1 - 0.6554$	
	$= 0.3446$ or 0.344578 by calculator awrt 0.345	A1
		(3)
(b)	0.3446×500 Their (a) x 500	M1
	$= 172.3$ Accept 172.3 or 172 or 173	A1
		(2)
(c)	Standardise with 860 and σ and equate to z value $\frac{\pm(818-860)}{\sigma} = z$ value	M1
	$\frac{818-860}{\sigma} = -0.84(16)$ or $\frac{860-818}{\sigma} = 0.84(16)$ or $\frac{902-860}{\sigma} = 0.84(16)$ or equiv.	A1
	$\pm 0.8416(2)$	B1
	$\sigma = 49.9$ 50 or awrt 49.9	A1
		(4)
(d)	Company Y as the ***mean*** is greater for Y. both	B1
	They have (approximately) the same ***standard deviation*** or ***sd***	B1
		(2)
		[11]

Notes
8(a) If 1-z used e.g. 1-0.4=0.6 then award second M0
8(c) M1 can be implied by correct line 2
A1 for completely correct statement or equivalent.
Award B1 if 0.8416(2) seen
Do not award final A1 if any errors in solution e.g. negative sign lost.
8(d) Must use statistical terms as underlined.

Question Number	Scheme	Marks
Q7 (a)	 bell shaped, must have inflexions 154,172 on axis 5% and 30%	B1 B1 B1 (3)
(b)	$P(X < 154) = 0.05$ $\frac{154-\mu}{\sigma} = -1.6449$ or $\frac{\mu-154}{\sigma} = 1.6449$ $\mu = 154 + 1.6449\sigma$ **given**	M1 B1 A1 cso (3)
(c)	$172 - \mu = 0.5244\sigma$ or $\frac{172-\mu}{\sigma} = 0.5244$ (allow $z = 0.52$ or better here but must be in an equation) Solving gives $\sigma = 8.2976075$ (**awrt 8.30)** and $\mu = 167.64873$ (**awrt 168**)	B1 M1 A1 A1 (4)
(d)	$P(\text{Taller than 160cm}) = P\left(Z > \frac{160-\mu}{\sigma}\right)$ $= P(Z < 0.9217994)$ $= 0.8212$ **awrt 0.82**	M1 B1 A1 (3) **Total [13]**

(a) 2nd B1 for 154 and 172 marked but 154 must be < μ and 172 > μ. But μ need not be marked.
Allow for $\frac{154-\mu}{\sigma}$ and $\frac{172-\mu}{\sigma}$ marked on appropriate sides of the peak.
3rd B1 the 5% and 30% should be clearly indicated in the correct regions i.e. LH tail and RH tail.

(b) M1 for $\pm\frac{(154-\mu)}{\sigma} = z$ value (z must be recognizable e.g. 1.64, 1.65, 1.96 but NOT 0.5199 etc)
B1 for $\pm$ 1.6449 seen in a line before the final answer.
A1cso for no incorrect statements (in μ, σ) equating a z value and a probability or incorrect signs
e.g. $\frac{154-\mu}{\sigma} = 0.05$ or $\frac{154-\mu}{\sigma} = 1.6449$ or $P(Z < \frac{\mu-154}{\sigma}) = 1.6449$

(c) B1 for a correct 2nd equation (NB $172 - \mu = 0.525\sigma$ is B0, since z is incorrect)
M1 for solving their two linear equations leading to $\mu = ...$ or $\sigma = ...$
1st A1 for σ = awrt 8.30, 2nd A1 for μ = awrt 168 [NB the 168 can come from false working.
These A marks require use of correct equation from (b), and a z value for "0.5244" in (c)]
NB use of $z = 0.52$ will typically get σ=8.31 and μ = 167.67… and score B1M1A0A1
No working and both correct scores 4/4, only one correct scores 0/4
Provided the M1 is scored the A1s can be scored even with B0 (e.g. for z =0.525)

(d) M1 for attempt to standardise with 160, their μ and their σ (> 0). Even allow with symbols μ and σ.
B1 for z = awrt $\pm$ 0.92
No working and a correct answer can score 3/3 provided σ and μ are correct to 2sf.

Question Number	Scheme	Marks
Q7 (a)	$P(D > 20) = P\left(Z > \frac{20-30}{8}\right)$	M1
	$= P(Z > -1.25)$	A1
	$=$ **0.8944** **awrt 0.894**	A1 (3)
(b)	$P(D < Q_3) = 0.75$ so $\frac{Q_3 - 30}{8} = 0.67$	M1 B1
	$Q_3 =$ **awrt 35.4**	A1 (3)
(c)	35.4 - 30= 5.4 so $Q_1 = 30 - 5.4$ = **awrt 24.6**	B1ft (1)
(d)	$Q_3 - Q_1 = 10.8$ so $1.5(Q_3 - Q_1) = 16.2$ so $Q_1 - 16.2 = h$ or $Q_3 + 16.2 = k$	M1
	h=**8.4 to 8.6** and k= **51.4 to 51.6** both	A1 (2)
(e)	$2P(D > 51.6) = 2P(Z > 2.7)$	M1
	$= 2[1 - 0.9965]$ = awrt **0.007**	M1 A1 (3)
		Total 12

(a) M1 for an attempt to standardise 20 or 40 using 30 and 8.
1st A1 for $z = \pm 1.25$
2nd A1 for awrt 0.894

(b) M1 for $\frac{Q_3 - 30}{8}$ = to a z value
M0 for 0.7734 on RHS.
B1 for (z value) between 0.67~0.675 seen.
M1B0A1 for use of $z = 0.68$ in correct expression with awrt 35.4

(c) Follow through using their of quartile values.

(d) M1 for an attempt to calculate 1.5(IQR) and attempt to add or subtract using one of the formulae given in the question - follow through their quartiles

(e) 1st M1 for attempting $2P(D >$ their $k)$ or ($P(D >$their $k) + P(D <$ their $h)$)
2nd M1 for standardising their h or k (may have missed the 2) so allow for standardising $P(D > 51.6)$ or $P(D < 8.4)$
Require boths Ms to award A mark.