Normal Distribution

1 (i) $1.282 = (5130 - \mu)/40.6$

B1 — For ± 1.282 seen, or 1.28, 1.281, not 1.29 or 1.30
M1 — For standardising, with or without sq rt, squared, no cc

$\mu = 5080$ (5078) rounding to 5080

A1 | **3** | For correct answer

(ii) $P(<5000) = \Phi[(5000-5078)/40.6]$
$= \Phi(-1.921)$
$= 1 - 0.9727$
$= 0.0273$ or 2.73%

M1 — For standardising, criteria as above, can include cc
M1 — For correct area found using tables ie < 0.5ft on wrong (i)
A1 | **3** | For correct answer, accept 0.0274

(iii) $\mu = 60$, var $= 54$
$P(\text{fewer than } 65) = \Phi\,(64.5 - 60)/\sqrt{54}$
$= \Phi(0.6123)$

B1 — For 60 and 54 seen (could be sd or variance)
M1 — For using 64.5 or 65.5 in a standardising process
M1 — For standardising, must have $\sqrt{(\text{their } 54)}$ in denom

$= 0.730$ accept 0.73

A1 | **4** | For correct answer

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2 (i) $z = 0.674$ or 0.675
allow 0.67 to 0.675

B1 — For correct z, can be + or −

$\dfrac{52 - \mu}{5} = 0.674$

M1 — For an equation relating 52, 5, μ and any $z \neq 0.5987$ or 0.7734 ish

$\mu = 48.6$

A1 — For correct answer

3 — For standardising 40 or 46, 5 or 5^2 with their

(ii) $z_1 = \dfrac{40 - 48.63}{5} = -1.726$

M1 — For standardising 40 or 46, 5 or 5^2 with their mean, no cc

$z_2 = \dfrac{46 - 48.63}{5} = 0.526$

prob $= 0.9578 - 0.7005 = 0.2573$

M1 — For subtracting two probs consistent with their mean ie

usually $\Phi_{-1}\ \Phi_2$ or
$(1 - \Phi) - (1\ \ \Phi_2)$ but could be
of type $\Phi_1 - (1\ \ \Phi_2)$ if their
mean is in between 40 and 46

$(0.2573)^4$

M1 — For raising their answer above to a power 4

$= 0.00438$ or 4.38×10^{-3} accept 0.00449×10^{-3}
NB 0.0045 gets A0 and RE #1

A1 ft | **4** | For correct answer

3	$28 - \mu = 0.496\sigma$ (accept 0.495 or in between)	M1	For any equation with μ and σ and a reasonable z value not a prob. Allow cc, $\sqrt{\sigma}$, σ^2, or $-$ and give M1 A0A1ft for these four cases
	$35 - \mu = 1.282\sigma$ (accept 1.281 or in between, but not 1.28)	A1 A1	For 2 correct equations
		M1	For solving their two equations by elim 1 variable sensibly
	$\sigma = 8.91$ (accept 8.89 to 8.92 incl)	A1	For correct answer
	$\mu = 23.6$	A1 6	For correct answer

4(i)	$z = \pm\dfrac{40-35.0}{11.6} = \pm0.431$	M1	For standardising ($\sqrt{11.6}$ in denom M1, ccM0 11.6^2 M0)
		M1	For subtracting two relevant probabilities or equivalent
	$\Phi(0.431) - \{1 - \Phi(0.431)\} = 0.334$	A1 3	For correct answer
(ii)	$z = \pm 1.282$ or ±1.281 only	B1	For stating z
	$1.282 = \dfrac{x-35.0}{11.6}$	M1	For solving an equation for x with some z value from tables, allow cc, $\sqrt{11.6}$, 35-x, not 11.6^2
	$x = 49.9$ or 49.8 on $z = 1.28$	A1 3	For correct answer

5	$P(x < 3.273) = 0.5 - 0.475 = 0.025$	M1	Attempt to find z-value using tables in reverse
	$z = -1.96$	A1	±1.96 seen
	$\dfrac{3.2 - \mu}{0.714} = -1.96$	M1	Solving their standardised equation z-value not ne
	$\mu = 4.60s$	A1 [4]	Correct ans accept 4.6

6	(a	(i)	$\text{prob} = p\left(z < \dfrac{30 - 35.2}{4.7}\right)$		M1		Standardising no sq rt no cc no sq
			$= P(z < -1.106)$		M1		$1 - \Phi$
			$= 1 - 0.8655 = 0.1345$		A1		Correct ans rounding to 0.13
			$0.1345 \times 52 = 6.99$		A1	4	Correct final answer accept 6 or 7 if 6.99 not seen but previous prob 0,1345 correct
	(ii)		$\Phi(t) = 0.648 \qquad z = 0.380$		B1		0.648 seen
			$0.380 = \dfrac{t - 35.2}{4.7}$		M1		standardising allow cc, sq rt,sq, need use of tables not 0.148, 0.648, 0.352, 0.852
			$t = 37.0$		A1	3	correct answer rounding to 37.0
	(b)		$\dfrac{7 - \mu = -0.8\sigma}{\sigma} \qquad \text{so} \quad 7 - \mu = -0.8\sigma$		B1		± 0.8 seen
					B1		± 0.44 seen
			$\dfrac{10 - \mu}{\sigma} = 0.44 \quad \text{so} \; 10 - \mu = 0.44\sigma$		M1		An eqn with z-value, μ and σ no sq rt no cc no sq
					M1		Sensible attempt to eliminate μ or σ by subst or subtraction, need at least one value
			$\mu = 8.94 \qquad \sigma = 2.42$		A1	5	Correct answers