1	$E(X) = \frac{10}{3}$ oe $\quad$ $Var(X) = \frac{25}{9}$ oe	**B1**		For $E(X)$ and $Var(X)$
	$E(Y) = 10$ $\quad$ $Var(Y) = 5$	**B1**		For $E(Y)$ and $Var(Y)$ OR For $E(X)$ and $E(Y)$ For $Var(X)$ and $Var(Y)$
	$E(X + Y) = \frac{40}{3}$ oe $\quad$ or 13.3 (3 sf)	**B1**		
	Var $(X + Y) =$ "$\frac{25}{9}$" + "5"	**M1**		For adding 2 (appropriate) variances
	sd = $\frac{\sqrt{70}}{3}$ oe $\quad$ or 2.79 (3 sf)	**A1**	[5]	or sd = or $\sqrt{2} \times \frac{5}{3}$
2	H_0: P(hit target) = 0.65			Allow $p = 0.65$
	H_1: P(hit target) > 0.65	**B1**		Allow $p > 0.65$
	$^{20}C_2 \times 0.35^2 \times 0.65^{18} + 19 \times 0.35 \times 0.65^{19} + 0.65^{20}$	**M1**		Allow one end error. Allow p/q mix. Allow (1–) for **M** mark
	= 0.0121 (3 sf)	**A1**		**A** mark recovered following valid comparison
	Comp 0.01	**M1**		For valid comparison
	There is no evidence (at the 1% level) that she has improved	**A1**√	[5]	She has probably not improved. No contradictions. (SR Use of Normal **M0**, but **M1A1** for valid comparison could be awarded)
3 (i)	H_0: pop mean journey time = 35.2 mins			Allow "μ". Not "mean journey time"
	H_1: pop mean journey time < 35.2 mins	**B1**		
	$\frac{34.7-35.2}{5.6/\sqrt{25}}$ $\quad$ (= –0.446)	**M1**		For standardising (√25 needed)
	$\Phi(<$ "–0.446") = 1 – Φ("0.446")	**M1**		For correct area consistent with their working
	= 0.328 (3 sf)	**A1**	[4]	As final answer
(ii)	H_0 *is* rejected but Type II error can only be made if H_0 is *not* rejected	**B1**	[1]	Allow just "H_0 is rejected." oe
4	$X - 2Y \sim N(0.1, 0.2^2 + 4 \times 0.1^2)$ soi (= N(0.1, 0.08))	**B1 B1**		**B1** for ± 0.1 **B1** for $0.2^2 + 4 \times 0.1^2$
	$\frac{0-0.1}{\sqrt{"0.08"}}$ $\quad$ (= –0.354)	**M1**		For standardising. Allow without √ sign
	Φ("–0.354 ") = 1 – Φ("0.354")	**M1**		For correct area consistent with their working
	= 0. 362 (3 sf)	**A1**	[5]	
5 (i)	Est(μ) = $\frac{14\,910}{150}$ $\quad$ (= 99.4)	**B1**		
	Est(σ^2) = $\frac{150}{149}(\frac{1525000}{150} - "99.4"^2)$	**M1**		Allow **M1** if $\frac{150}{149}$ omitted
	= 288.228	**A1**		
	$z = 2.576$	**B1**		Accept 2.574–2.579
	"99.4" ± $z \times \sqrt{288.228 \div 150}$	**M1**		Any z
	CI = 95.8 to 103 (3 sf)	**A1**	[6]	(NB Use of biased Var can score 5/6 max)
(ii)	100 lies within this CI			
	Hence yes	**B1**√	[1]	Both needed, ft their CI

(iii)	To avoid bias or Necessary to enable statistical inference	**B1**	[1]	Or any equivalent
6 (i)	$\lambda = 3.3 \times \frac{25}{30} = 2.75$	**B1**		
	$e^{-2.75}(1 + 2.75 + \frac{2.75^2}{2})$	**M1**		Allow any λ Allow one end error
	$= 0.481$ (3 sf)	**A1**	[3]	As final answer. Accept 0.482
(ii) (a)	$\lambda\ (= 3.3 \times \frac{365}{30}) = 40.15$	**B1**		Accept 40.1 or 40.2
	$(X \sim \text{Po}(40.15) \Rightarrow X \sim \text{N}(40.15, 40.15))$ $\frac{50.5-"40.15"}{\sqrt{"40.15"}}$ $(= 1.633)$	**M1**		Allow with incorrect or no cc OR no √ sign
	$1 - \Phi("1.633")$	**M1**		For correct area consistent with their working
	$= 0.0513$ (3 sf)	**A1**	[4]	Accept 0.0512
(b)	$\lambda > 15$	**B1**	[1]	or similar
(iii)	$\lambda = \frac{73}{30}$ oe or $1.1+1.33= 2.43$ (3 sf)	**B1**		
	$1 - e^{-2.43}(1 + 2.43 + \frac{2.43^2}{2} + \frac{2.43^3}{3!})$	**M1**		Allow any λ. Allow one end error
	$= 0.228$ (3 sf)	**A1**	[3]	
7 (a) (i)	$E(X) = 1.5$	**B1**		
	$\frac{2}{9}\int_0^3 (3x^3 - x^4)dx$	**M1**		Attempt integ $x^2f(x)$ ignore limits
	$= \frac{2}{9}\left[\frac{3x^4}{4} - \frac{x^5}{5}\right]_0^3$			
	$= \frac{2}{9}\left[\frac{243}{4} - \frac{243}{5}\right]$ $(= 2.7)$	**M1**		Sub correct limits into correct integral
	$\text{Var}(X)\ (= 2.7 - 1.5^2) = 0.45$ oe	**A1**√	[4]	Ft their $E(X)$, but no ft for –ve Var.
(ii)	0.5	**B1**	[1]	
(iii)	$(1 - \frac{13}{27}) \div 2$	**M1**		or $\frac{2}{9}\int_2^3 (3x - x^2)\ dx$ oe
	$= \frac{7}{27}$ or 0.259	**A1**	[2]	As final answer
(b)	$\frac{1}{2} \times 2 \times 2a = \frac{1}{2}$ or $\int_0^2 ax dx = \frac{1}{2}$	**M1**		Attempt correct equation in 'a'
	$a = \frac{1}{4}$	**A1**		
	$\frac{1}{2} \times b \times \frac{1}{4}b = 1$ or $\int_0^b \frac{1}{4}x dx = 1$ or $b = 2 \times \sqrt{2}$	**M1**		or $\frac{1}{2} \times b \times ab = 1$ or $\int_0^b ax dx = 1$ attempt correct equation in (a and) b
	$b = 2\sqrt{2}$	**A1**√	[4]	Allow $b = \sqrt{8}$ or 2.83 (3 sf) Ft incorrect a, both **M**s needed
		Total for paper 50		