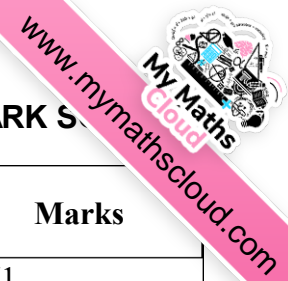
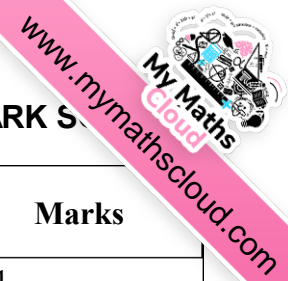


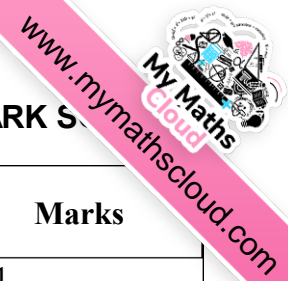
Question number	Scheme	Marks
1.	$P(X > 2.85) = 0.05$ $P(X < \frac{1}{5.67}) = 0.01$ $\therefore P(\frac{1}{5.67} < X < 2.85) = 1 - 0.05 - 0.01$ $= 0.94$	B1 B1 M1 A1 (4 marks)
2.	$H_0: \sigma^2 = 4; H_1: \sigma^2 > 4$ $\nu = 19, \chi^2_{19}(0.05) = 30.144$ $\frac{(n-1)S^2}{\sigma^2} = \frac{19 \times 6.25}{4} = 29.6875$ <p style="text-align: right;">both 30.144 use of $\frac{(n-1)S^2}{\sigma^2}$ AWRT 29.7</p> <p>Since $29.6875 < 30.144$ there is insufficient evidence to reject H_0. There is insufficient evidence to suggest that the standard deviation is greater than 2.</p>	B1 B1 M1 A1 A1 ft B1 ft (6 marks)
3.	<p>(a) $P(X \leq c_1) \leq 0.05; P(X \leq 3 \lambda = 8) = 0.0424 \Rightarrow X \leq 3$ $P(X \geq c_2) \leq 0.05; P(X \geq 4 \lambda = 8) = 0.0342 \Rightarrow X \geq 13$ $P(X \geq 13 \lambda = 8) = 0.0638$ \therefore critical region is $\{X \leq 3 \cup X \geq 13\}$</p> <p>(b) (i) $P(4 \leq X \leq 12 \lambda = 10) = P(X \leq 12) - P(X \leq 3)$ $= 0.7916 - 0.0103$ $= 0.7813$</p> <p>(ii) Power = $1 - 0.7813 = 0.2187$</p>	M1; A1 M1; A1 A1 ft (5) M1 M1 A1 B1 ft (4) (9 marks)



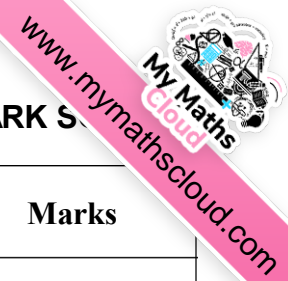
Question number	Scheme	Marks
4.	<p>$d:$ 7 2 -3 1 -1 -2 10 5</p> <p>$\Sigma d = 19; \Sigma d^2 = 193$</p> <p>$\therefore \bar{d} = \frac{19}{8} = 2.375; S_d^2 = \frac{1}{7} \left\{ 193 - \frac{19^2}{8} \right\} = 21.125$</p> <p>$H_0: \mu_D = 0; H_1: \mu_D > 0$ both</p> <p>$t = \frac{2.375 - 0}{\sqrt{\frac{21.125}{8}}} = 1.4615\dots$ AWRT 1.46</p> <p>$\nu = 7 \Rightarrow$ critical region: $t > 1.895$ 1.895</p> <p>Since 1.4915... is <u>not</u> in the critical region there is insufficient evidence to reject H_0 and we conclude that there is insufficient evidence to support the doctors' belief.</p>	<p>M1</p> <p>B1; M1 A1</p> <p>B1</p> <p>M1</p> <p>A1</p> <p>B1</p> <p>A1 ft</p> <p>(9 marks)</p>
	<p><i>Alternative:</i></p> <p>Use of 2 sample t-test \Rightarrow B0 B0 B0 M1 A1 M1 A1 B1 A1 i.e : 6/9 max</p> <p>$S_p^2 = \frac{7 \times 440.125 + 7 \times 501.357}{8 + 8 - 2} = 470.74$</p> <p>$t = \frac{216.125 - 213.75}{\sqrt{470.74 \left(\frac{1}{8} + \frac{1}{8} \right)}} = 0.0547$</p> <p>critical region: $t > 1.761$</p> <p>Conclusion as above</p>	<p>M1 A1</p> <p>M1 A1</p> <p>B1</p> <p>A1 ft</p>



Question number	Scheme	Marks
5. (a)(i)	$E(\hat{\theta}) = \theta$	B1
(ii)	$E(\hat{\theta}) = \theta$ or $E(\hat{\theta}) \rightarrow \theta$	B1
	and $\text{Var}(\hat{\theta}) \rightarrow 0$ as $n \rightarrow \infty$ where n is the sample size	B1 (3)
(b)	$E(\hat{p}_1) = p, \therefore \text{Bias} = 0$	B1
	$E(\hat{p}_2) = \frac{5p}{6}, \therefore \text{Bias} = \frac{1}{6}p$	B1 B1
	$E(\hat{p}_3) = p, \therefore \text{Bias} = 0$	B1 (4)
(c)	$\text{Var}(\hat{p}_1) = \frac{1}{9n^2} \{npq + npq + npq\}$	M1
	$= \frac{pq}{3n}$	A1
	$\text{Var}(\hat{p}_2) = \frac{1}{36n^2} \{npq + 9npq + npq\} = \frac{11pq}{36n}$	A1
	$\text{Var}(\hat{p}_3) = \frac{1}{36n^2} \{4npq + 9npq + npq\} = \frac{7pq}{18n}$	A1 (4)
(d) (i)	\hat{p}_1 ; unbiased and smallest variance	B1 dep; B1
(ii)	\hat{p}_2 ; biased	B1 dep; B1 (4)
(15 marks)		



Question number	Scheme	Marks
6. (a)	$\bar{x} = 123.1$	B1
	$s = 5.87745\dots$	B1
	(NB: $\Sigma x = 1231$; $\Sigma x^2 = 151847$)	
(i)	95% confidence interval is given by	
	$123.1 \pm 2.262 \times \frac{5.87745\dots}{\sqrt{10}}$	M1
	2.262	B1
	i.e: (118.8958..., 127.30418...)	A1 ft
	AWRT (119, 127)	A1 A1
(ii)	95% confidence interval is given by	
	$\frac{9 \times 5.87745\dots^2}{19.023} < \sigma^2 < \frac{9 \times 5.87745\dots^2}{2.700}$	use of $\frac{(n-1)s^2}{\sigma^2}$ M1
	19.023	B1
	2.700	B1
	i.e; (16.34336..., 115.14806...)	A1ft
	AWRT (16.3, 115)	A1 A1 (13)
(b)	130 is just outside confidence interval	B1
	16 is just outside confidence interval	B1
	Thus supervisor should be concerned about the speed of the new typist	B1 (3)
		(16 marks)



Question number	Scheme	Marks
7. (a)	$S_A^2 = \frac{1}{10} \left\{ 3960540 - \frac{6600^2}{11} \right\} = 54.0$ $S_B^2 = \frac{1}{12} \left\{ 7410579 - \frac{9815^2}{13} \right\} = 21.1\dot{6}$ $H_0: \sigma_A^2 = \sigma_B^2; H_1: \sigma_A^2 \neq \sigma_B^2$ $CR: F_{10, 12} > 2.75$ $S_A^2 / S_B^2 = \frac{54.0}{21.1\dot{6}} = 2.55118\dots$ <p>Since 2.55118... is not in the critical region we can assume that the variances are equal.</p>	B1 B1 B1 M1 A1 B1 (6)
(b)	$H_0: \mu_B = \mu_A + 150; H_1: \mu_B > \mu_A + 150$ $CR: t_{22}(0.05) > 1.717$ $S_p^2 = \frac{10 \times 54.0 + 12 \times 21.1\dot{6}}{22} = 36.090\dot{9}$ $t = \frac{1755 - 6001 - 150}{\sqrt{36.0909\dots \left(\frac{1}{11} + \frac{1}{13} \right)}} = 2.03157$ <p style="text-align: right;">AWRT 2.03</p> <p>Since 2.03... is in the critical region we reject H_0 and conclude that the mean weight of cauliflowers from B exceeds that from A by at least 50g.</p>	both B1 1.717 B1 M1 A1 M1 A1 A1 A1 ft (8)
(c)	Samples from normal populations Equal variances Independent samples	Any two sensible verifications B1 B1 (2) (16 marks)