



Question Number	Scheme	Marks
1. (a)	$b = 2.75, a = \frac{1}{2.91} = 0.344$ 2.75, reciprocal, 0.344	B1, M1, A1 (3 marks)
2.	$d: 5, 13, -8, 2, -3, 4, 11, -1$ at least 2 correct $(\Sigma d = 23, \Sigma d^2 = 409) \bar{d} = 2.875, sd = 6.9987 (\approx 7.00)$ $H_0: \mu_d = 0, H_1: \mu_d > 0$ both $t = \frac{2.875\sqrt{8}}{6.9987} = 1.1618... (\approx 1.16)$ formula and substitution, 1.16 Critical value $t_7(10\%) = 1.415$ (1 tail) Not significant. Insufficient evidence to support the chemist's claim.	M1 A1, A1 B1 M1, A1 B1 A1 ft (8 marks)
3. (a)	$E(A_1) = E(X_1) E(X_2) = \mu^2$ $A_2 = \bar{X}^2, \bar{X} \sim N\left(\mu, \frac{\sigma^2}{2}\right) \therefore E(\bar{X}^2) = E(A_2) = \mu^2 + \frac{\sigma^2}{2}$ (b) A_1 is unbiased, bias for A_2 is $\frac{\sigma^2}{2}$ (c) Used A_1 since it is unbiased (d) $E(\bar{X}^2) = \mu^2 + \frac{\sigma^2}{2}$; as $n \rightarrow \infty, E(\bar{X}^2) \rightarrow \mu^2$ $\text{Var}(\bar{X}^2) = \frac{2\sigma^4}{n^2} + \frac{4\sigma^2\mu^2}{n}$; as $n \rightarrow \infty, \text{Var}(\bar{X}^2) \rightarrow 0$ \bar{X}^2 is a consistent estimator of μ^2	B1 M1, M1, A1 (4) B1, B1 (2) B1 (1) M1 M1 A1 (3) (10 marks)

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4.	<p>(a) $H_0: \mu = 150.9$ [accept ≥ 150.9], $H_1: \mu < 150.9$ both</p> $s^2 = \frac{1}{29} \left(646904.1 - \frac{(4400.7)^2}{30} \right) = \frac{1365.727}{29} = 47.1$ <p>test statistic $t = \frac{30}{s/\sqrt{30}} = -3.36$ M1 A1</p> <p>critical value $t_{29}(5\%) = (-)1.669$ B1</p> <p>significant, evidence to confirm doctor's statement A1 ft (6)</p> <p>(b) $H_0: \sigma^2 = 36$, $H_1: \sigma^2 \neq 36$ both B1</p> <p>test statistic $\frac{(n-1)s^2}{\sigma^2} = \frac{1365.727}{36} = 37.9$ M1, A1</p> <p>critical values $\chi_{29}^2(5\%)$ upper tail = 45.722 not significant B1, B1 $\chi_{29}^2(5\%)$ lower tail = 16.047</p> <p>Insufficient evidence that variance of the heights of female Indians is different from that of females in the UK A1 ft (6)</p> <p style="text-align: right;">(12 marks)</p>	
5.	<p>(a) $H_0: \sigma_G^2 = \sigma_B^2$, $H_1: \sigma_G^2 \neq \sigma_B^2$, B1</p> $s_B^2 = \frac{1}{6} (56130 - 7 \times 88.9^2) = \frac{807.53}{6} = 134.6$ M1 A1 $s_G^2 = \frac{1}{7} (55746 - 8 \times 83.1^2) = \frac{501.12}{7} = 71.58$ A1 $\frac{s_B^2}{s_G^2} = 1.880\dots$ M1 <p>critical value $F_{6,7} = 3.87$ B1</p> <p>not significant, variances are the same A1 ft (7)</p> <p>(b) $H_0: \mu_B = \mu_G$, $H_1: \mu_B > \mu_G$ B1</p> <p>pooled estimate of variance $s^2 = \frac{6 \times 134.6 + 7 \times 71.58}{13} = 100.6653\dots$ M1</p> <p>test statistic $t = \frac{88.9 - 83.1}{s \sqrt{\frac{1}{7} + \frac{1}{8}}}$ M1 A1</p> <p>critical value $t_{13}(5\%) = 1.771$ B1</p> <p>Insufficient evidence to support parent's claim A1 ft (6)</p> <p style="text-align: right;">(13 marks)</p>	

ft = follow through mark

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6.	<p>(a) 95% confidence interval for μ is 2.064</p> $1.68 \pm t_{24}(2.5\%) \sqrt{\frac{1.79}{25}} = 1.68 \pm 2.064 \sqrt{\frac{1.79}{25}} = (1.13, 2.23)$ <p>(b) 95% confidence interval for σ^2 is</p> $12.401, < \frac{24 \times 1.79}{\sigma^2} <, 39.364$ $\sigma^2 > 1.09, \sigma^2 > 3.46$ <p>(c) Require $P(X > 2.5) = P\left(Z > \frac{2.5 - \mu}{\sigma}\right)$ to be as small as possible OR</p> $\frac{25 - \mu}{\sigma} \text{ to be as large as possible; both imply lowest } \sigma \text{ and } \mu.$ $\frac{25 - 1.13}{\sqrt{1.09}} = 1.31$ $P(Z > 1.31) = 1 - 0.9049 = 0.0951$	<p>B1</p> <p>M1 A1 A1 (4)</p> <p>B1, M1, B1</p> <p>A1, A1 (5)</p> <p>M1 M1</p> <p>M1</p> <p>A1 (4)</p> <p>(13 marks)</p>
7.	<p>(a) X is the number of defectives, $X \sim B(5, p)$</p> <p>size = $P(\text{reject } H_0 \mid p = 0.1) = P(X > 2 \mid p = 0.1)$</p> $= 1 - 0.9914 = 0.0086$ <p>(b) $r = P(X > 2 \mid p = 0.2), 1 - 0.9421, = 0.0579$</p> <p>(c) Y is the number of defectives, $Y \sim B(10, p)$</p> <p>$P(\text{Type I error}) = P(Y > 4 \mid p = 0.1) = 1 - 0.9984 = 0.0016$</p> <p>(d) $s = P(Y > 4 \mid p = 0.4) = 1 - 0.6331 = 0.3669$</p> <p>(e) Graph</p> <p>(f) (i) Intersection 0.32 – 0.33</p> <p>(ii) $p > 0.32$; Assistant's test is more powerful (sensible comment)</p> <p>(g) Consider costs – smaller sample so test is cheaper</p> <p>More powerful for $p < 0.32$ and $p > 0.32$ is unlikely</p>	<p>M1</p> <p>A1 (2)</p> <p>M1, M1, A1 (3)</p> <p>M1 A1 (2)</p> <p>B1 (1)</p> <p>G4 (4)</p> <p>B1</p> <p>B1 (2)</p> <p>B1</p> <p>B1 (2)</p> <p>(16 marks)</p>