

A level Statistics Paper 4 **MARK SCHEME**

Question 1

Question Number	Scheme	Marks
(a)	Width = <u>0.5</u> (cm) e.g. 4 [cm^2] represents 8 babies <u>or</u> frequency densities are 8 <u>and</u> 34 Height = <u>17</u> (cm)	B1 M1 A1 (3)
(b)	$[Q_2 =] \{3\} + \frac{(25-9)}{(26-9)} \times 0.5$, <u>or</u> $\{3.5\} - \frac{(25-24)}{(41-24)} \times 0.5 =$ awrt <u>3.47</u> (allow $\frac{59}{17}$)	M1, A1 (2)
(c)(i)	$\sum fx = 1 \times 1 + 2.5 \times 8 + 3.25 \times 17 + 3.75 \times 17 + 4.5 \times 7 = 171.5$, $\bar{x} = \frac{171.5}{50} = (3.43)$ (*)	B1cso
(ii)	$\sqrt{\frac{611.375}{50} - 3.43^2}$, = 0.680147... = awrt <u>0.680</u> (Accept 0.68)	M1, A1 (3)
(d)	$[P(W < 3) = P\left(Z < \frac{-0.43}{0.65}\right)] = P(Z < -0.6615..)$ = 1 - 0.7454 (tables) = 0.2546 awrt <u>0.254-0.255</u>	M1 M1 A1 (3)
(e)	(b) and (c)(i) mean \neq med or skew <u>or</u> mean \sim median or no skew <u>and</u> comment (d) = 0.254 or 0.255 compare data = 0.18 (or 12.7 compared with 9) 0.18 different from 0.25 so normal not good <u>or</u> 0.18 similar to 0.25 so normal is OK	B1 B1 dB1 (3)
(f)(i)	No change in mean (since weight is the same)	B1
(ii)	s.d. will decrease (Extra value is at "centre" so data more concentrated) Both statements correct <u>and</u> correct reasons for <u>each</u>	B1 dB1 (3)
		[17 marks]

	Notes	
(a)	M1 for clear representation of area with frequency <u>or</u> height \times width = 8.5 A1 for 17 (cm) [Must be clear it is height not frequency] (Ans only must satisfy $h \times w = 8.5$)	
(b)	M1 for $\frac{16}{17} \times 0.5$ <u>or</u> if using $n + 1$ for $\frac{16.5}{17} \times 0.5$ May see $-\frac{1}{17} \times 0.5$ if working down A1 for awrt 3.47 (or $\frac{59}{17}$) [check from correct working] <u>or</u> (if using $(n + 1)$ for 3.485 or awrt 3.49)	
(c)(i)	B1cso for Σfx (at least 3 correct & no incorrect products seen) <u>and</u> correct $\frac{\Sigma fx}{50}$ or $\frac{171.5}{50}$	
(ii)	M1 for a correct expression including square root. Must use 3.43 no ft A1 for awrt 0.680 (accept 0.68). Allow use of $s =$ awrt 0.687 (Ans only 2/2)	
(d)	1 st M1 for an attempt to standardise with 3, 3.43 and 0.65. Allow \pm and also use of their sd 2 nd M1 for $1 - p$ where $0.74 < p < 0.75$ NB calculator gives 0.7458665... A1 for awrt 0.254 or 0.255	
(e)	1 st B1 for a statement about mean/median and compatible comment about normal 2 nd B1 for statement comparing their (d) with data (sight of 0.18 <u>or</u> 12.7 and 9 required) 3 rd dB1 dep on 2 nd B1 for conclusion about normal compatible with 2 nd statement	
(f)(i)	1 st B1 for no change in mean {send a correct argument for <u>decrease</u> to review}	
(ii)	2 nd B1 for s.d. decreases 3 rd dB1 dep on 1 st and 2 nd Bs for a correct reason for <u>both</u> mean <u>and</u> sd e.g. "new mean the same so within 1 s.d. of old mean"	

Question 2

Question Number	Scheme	Marks
(a)	$[P(B \cap R') =] \underline{0}$	B1 (1)
(b)	$P(B) = 0.27 + 0.33 = 0.6$, $P(D) = 0.27 + 0.15 + t$, $P(B \cap D) = 0.27$ $[P(B) \times P(D) = P(B \cap D) \text{ gives}] \quad 0.6 \times (0.42 + t) = 0.27$ $0.42 + t = \frac{0.27}{0.6} \quad \text{or} \quad 0.6t = 0.018$ $t = \underline{0.03}$	M1 M1 A1 A1 (4)
(c)	$[u =] \quad 1 - (0.6 + 0.15 + t)$ $u = \underline{0.22}$	M1 A1ft (2)
(d)(i)	$\left[\frac{P(D \cap R \cap B)}{P(R \cap B)} = \right] = \frac{0.27}{0.27 + 0.33} \quad \text{or} \quad P(D R \cap B) = P(D B) = P(D)$ $= \underline{0.45}$	M1 A1
(ii)	$\left[\frac{P(D \cap [R \cap B'])}{P(R \cap B')} = \right] = \frac{0.15}{0.15 + u}$ $= \frac{15}{37}$	M1 A1 (4)
(e)	$40 \times "0.45" \text{ and } 37 \times "\frac{15}{37}"$ $= \underline{33}$	M1 A1 (2)
		[13 marks]

	Notes	
(b)	<p>1st M1 for attempting 3 suitable probabilities, one involving t (at least 2 correct) e.g. sight of 0.6, 0.27, $0.42 + t$ correctly labelled in terms of B, D, R <u>or</u> in a correct equation. May see e.g. $P(B D) = \frac{0.27}{0.42+t}$</p> <p>2nd M1 for using the independence to form a linear equation in t. ft their probs if stated.</p> <p>1st A1 for solving leading to a correct equation as far as $p + t = q$ <u>or</u> $pt = q$</p> <p>2nd A1 for 0.03 or exact equivalent</p>	
(c)	<p>M1 for a correct expression for u. Allow their t or just letter t in a correct expression A1ft for 0.22 (or exact equivalent) <u>or</u> ft their t. i.e. $u = 0.25 - t$ provided u & t are probs Can score M1A1ft provided their $u + t = 0.25$ where u and t are both in $[0, 1]$</p>	
(d)(i)	<p>M1 for a correct numerical ratio of probabilities A1 for 0.45 or exact equivalent (Answer only 2/2)</p>	
(ii)	<p>M1 for a correct numerical ratio of probabilities, ft their u, provided u is a probability A1 for $\frac{15}{37}$ or 0.405 <u>or</u> allow awrt 0.41 following a correct expression (Ans only 2/2)</p>	
(e)	<p>M1 for a correct method for <u>both</u> 18 and 15 ft their 0.45 and their $\frac{15}{37}$ provided both in $[0, 1]$ NB $P(D) \times 77$ is M0 A1 for 33 only NB $\frac{27}{33} \times 40 = 32.7...$ which rounds to 33 but scores M0A0. (Ans only send to review)</p>	

Question 3

Question Number	Scheme		Marks
(a)	$0.05n = 3$	M1: using $0.05n$	M1
	$n = 60$	A1: cao NB: for 60 with no incorrect working award M1A1	A1 (2)
(b)	$R \sim B(20, 0.05)$	B1: using or writing $B(20, 0.05)$ in (i) or (ii)	B1
(i)	$P(R = 4) = {}^{20}C_4 (0.05)^4 (0.95)^{16}$ OR $P(R = 4) = P(R \leq 4) - P(R \leq 3)$ $= 0.9974 - 0.9841$ $= 0.0133$	M1 writing or using $P(R \leq 4) - P(R \leq 3)$ or using ${}^{20}C_4 (p)^4 (1-p)^{16}$	M1
		A1: awrt 0.0133	A1
(ii)	$P(R \geq 4) = 1 - P(R \leq 3)$ $= 1 - 0.9841$ $= 0.0159$	M1: writing or using $1 - P(R \leq 3)$	M1
		A1: awrt 0.0159	A1 (5)

(c)	$H_0: p = 0.05 \quad H_1: p > 0.05$	B1: Both hypotheses correct and labelled H_0 and H_1 , must use p or π Do not allow $p(x)$	B1
	$P(R \geq 4) = 1 - P(R \leq 3)$	M1: Writing or using $B(50, 0.05)$ AND writing or using $1 - P(R \leq 3)$ or $P(R \leq 3) = 0.7604$ on its own or one of the following 4 statements leading to a CR. $P(R \geq 7) = 0.0118$ $P(R \leq 6) = 0.9882$ $P(R \geq 8) = 0.0032$ $P(R \leq 7) = 0.9968$ May be implied by correct CR. Allow any letter	M1
	$= 0.2396 \quad \text{CR } R \geq 8$	A1: awrt 0.240 or 0.24 or $R \geq 8$ or 0.7604	A1
	Insufficient evidence to reject H_0 . Not Significant. Accept H_0 . 4 does not lie in the Critical region.	M1: dependent on the previous M being awarded. A correct statement – do not allow contradictory non contextual statements. Follow through their Probability/CR and H_1 . If no H_1 seen then M0. Ignore their comparison in all cases Then mentally compare their probability as follows: For prob < 0.5 statement must be correct compared to 0.01 for 1 tail test and 0.005 for 2 tailed test. For prob > 0.5 statement must be correct compared to 0.99 for 1 tail test and 0.995 for 2 tailed test. NB: If there is no non-contextual statement given you may award the M1 for a correct contextual statement	M1d
	No evidence to support <u>Patrick's</u> claim. Or no evidence that people in <i>Reddman</i> have a probability greater than 5% of having <u>red hair</u>	A1: cso fully correct solution and correct contextual statement containing the word Patrick if writing about the claim Or red hair if full context	A1cso (5)
			Total 12

Question 4

Question Number	Scheme	Marks
a	<p>'tr' should interpreted as a trace, which means a small amount</p> <p>The critical value is the first value to fall inside of the critical region</p>	A1
b	R=-0.473 (3 s.f), treating 'tr' values as zero	A1 A1
c	<p>The data show a weak negative correlation so a liner model may not be best;</p> <p>there may be other variable affecting the relationship or a different model might be a better fit</p>	A1 A1

Question 5

Q5	Scheme	Marks
a	$r = 0.340$ (3 s.f)	(1)
b	$H_0 : \rho = 0, H_1 : \rho \neq 0$ Critical value = ± 0.6319 So the critical region is $r < -0.6319$ and $r > 0.6319$ $0.340 < 0.6319$ so do not reject H_0 . There is not sufficient evidence, at the 5% level of significance, of correlation between age and salary. This means that an older person in this profession does not necessarily earn more than a younger person.	B1 M1 A1 (3)
		(4 marks)