

## A level Statistics Paper 6 **MARK SCHEME**

### Question 1

Question Number	Scheme	Marks
(a)	<p>(3 – 6) mins has width 4 and is 2cm, (11 – 15) mins has width 5 so is <u>2.5</u>(cm)</p> <p>(3 – 6) mins has frequency of 38 and area of 19 cm<sup>2</sup> so <u>2 people</u>(per cm<sup>2</sup>)(o.e.)</p> <p><u>or</u> frequency density = <math>\frac{38}{4} = 9.5 = \text{height}</math></p> <p>(11 – 15) mins has area of <math>2.5 \times h</math> cm<sup>2</sup> so <math>h = \frac{12}{2 \times 2.5} = \underline{2.4}</math> (cm) allow <math>\frac{12}{5}</math></p>	<p>B1</p> <p>M1</p> <p>A1</p> <p style="text-align: right;">(3)</p>
(b)	<p><math>Q_2 = (6.5) + \frac{12}{25} \times 2</math> <u>or</u> <math>(8.5) - \frac{13}{25} \times 2</math></p> <p style="text-align: center;">= awrt <u>7.46</u></p>	<p>M1</p> <p>A1</p> <p style="text-align: right;">(2)</p>
(c)	<p><math>\sum fx = 38 \times 4.5 + \dots + 7 \times 18 = 811.5</math> and <math>\bar{x} = \frac{811.5}{100}</math>, = awrt <u>8.12</u></p>	<p>M1, A1</p> <p style="text-align: right;">(2)</p>
(d)	<p><math>\sigma = \sqrt{\frac{8096.25}{100} - \bar{x}^2} = \sqrt{80.9625 - "65.85\dots"} = \sqrt{15.1(0)\dots}</math>, = awrt <u>3.89</u></p>	<p>M1, A1</p> <p style="text-align: right;">(2)</p>
<b>Notes</b>		
(a)	<p>B1 for width of 2.5 (cm) allow <math>\frac{5}{2}</math></p> <p>M1 for 2 people per cm<sup>2</sup> <u>or</u> a correct numerical equ'n for <math>h</math> <u>or</u> their width <math>\times</math> height = 6</p> <p>A1 for height of 2.4 (cm) [If just see 2.4 and 2.5 it must be clear which is <math>h</math> and which <math>w</math>]</p>	
(b)	<p>M1 for a correct expr'n with sign (ignoring end point). Condone 12.5 for use of <math>(n + 1)</math></p> <p>A1 for awrt 7.46 (or 7.5 if using <math>(n + 1)</math> but must see evidence of <math>(n + 1)</math> approach)</p>	
(c)	<p>M1 for an attempt at <math>\sum fx</math> (i.e. <u>full</u> expression or <math>650 &lt; \sum fx &lt; 950</math>) <u>and</u> division by 100</p> <p><math>\sum fx</math> may be in the table.</p> <p>A1 for 8.115 or awrt 8.12 (allow 8.11) [May be in (d) but must be labelled e.g. <math>\bar{x} = \dots</math>]</p>	
(d)	<p>M1 for a correct expression (ft their mean) including <math>\sqrt{\quad}</math>. Allow <math>s</math> leading to <math>\sqrt{15.26\dots}</math></p> <p>A1 for awrt 3.89 Allow use of <math>s = \text{awrt } 3.91</math> [Correct ans. only to (c) or (d) full marks]</p>	

## Question 2

Question Number	Scheme	Marks
(a)	$P(G_1) + P(R_1 \cap G_2) + P(Y_1 \cap G_2)$ <u>or</u> $P(GY) + P(GR) + P(RG) + P(YG)$ (o.e.) $= \frac{1}{64} + \frac{r}{64} \times \frac{1}{63} + \frac{y}{64} \times \frac{1}{63} = \frac{1}{64} + \frac{r+y}{64 \times 63}$ <u>or</u> $2 \times \frac{r+y}{64 \times 63}$ $= \frac{1}{64} + \frac{63}{64 \times 63}$ <u>or</u> $\frac{2 \times 63}{64 \times 63}$ <u>or</u> $\frac{1}{64} + \frac{1}{64}$ <u>or</u> $= \frac{1}{32}$ or 0.03125	M1 A1 M1 A1 (4)
(b)	$P(R_1 \cap R_2) = \frac{r}{64} \times \frac{r-1}{63} = \frac{5}{84}$ $r(r-1) = 5 \times 64 \times 63 \div 84 = 240$ hence $r^2 - r - 240 = 0$ or $r^2 - r = 240$ (*)	M1A1 A1cso (3)
(c)	$r^2 - r - 240 = (r-16)(r+15) \{= 0\}$ <u>or</u> $16^2 - 16 - 240 = 256 - 256$ <u>or</u> $\frac{16}{64} \times \frac{15}{63} = \frac{5}{84}$ so $r = 16$ <u>and</u> rejecting $-15$ (*)	M1 A1cso (2)
(d)	$P(\geq 1 \text{ red}) = P(RG) + P(GR) + P(RY) + P(YR) + P(RR)$ <u>or</u> $\frac{2}{252} + \frac{2y}{252} + \frac{15}{252}$ (o.e.) <u>or</u> $P(R_1) + P(R'_1 \cap R_2)$ <u>or</u> $\frac{16}{64} + \frac{48}{64} \times \frac{16}{63}$ <u>or</u> $1 - \frac{48}{64} \times \frac{47}{63}$ , $= \frac{37}{84}$ Require: $\frac{P(R_1 \cap R_2)}{P(\text{at least one red})} = \frac{\frac{5}{84}}{\frac{37}{84}}$ , $= \frac{5}{37}$ or 0.135	M1, A1 M1, A1 (4)
		<b>[Total 13]</b>

Notes	
(a)	1 <sup>st</sup> M1 for at least 2 correct cases. May be in symbols or probs. May be in tree diagram Use of $r = 16$ or $y = 47$ can score maximum of 1 <sup>st</sup> M1 then A0M0A0 1 <sup>st</sup> A1 for all cases and their associated probs added 2 <sup>nd</sup> M1 for combining probabilities and using $r + y = 63$ 2 <sup>nd</sup> A1 for $\frac{1}{32}$ or an exact equivalent (correct answer only 4/4)
(b)	M1 for $\frac{r}{64} \times g(r) = \dots$ where $g(r)$ is any linear function of $r$ 1 <sup>st</sup> A1 for any correct equation in $r$ 2 <sup>nd</sup> A1cso for correctly simplifying to the given equation with no incorrect working seen. There should be at least 1 intermediate step seen
(c)	M1 for correct factors <u>or</u> completing square <u>or</u> use of formula <u>or</u> substitution A1cso for concluding $r = 16$ <u>and</u> rejecting $-15$ (e.g. crossing out etc)
(d)	1 <sup>st</sup> M1 for a correct expression for at least one red. May be in symbols or probs. or in a tree 1 <sup>st</sup> A1 for $\frac{37}{84}$ (o.e.) as a single fraction <u>or</u> awrt 0.440 [May be implied by correct answer] 2 <sup>nd</sup> M1 for a ratio of probabilities (denom may be in symbols) with numerator of $\frac{5}{84}$ (o.e.) 2 <sup>nd</sup> A1 for $\frac{5}{37}$ or an exact equivalent

### Question 3

Question Number	Scheme	Marks
(a)	Only 2 outcomes <b>Heads and Tails</b> oe	
	Constant probability of <b>spinning a Head/Tail</b> oe	
	Coin is <b>spun</b> a fixed number of times oe	
	Each <b>spin</b> of the coin is independent oe	B1 B1
		(2)
(b)	$T \sim B(6, 0.5)$	
	$P(T \leq 5) - P(T \leq 4) = 0.9844 - 0.8906$ or $6\left(\frac{1}{2}\right)^5\left(\frac{1}{2}\right)$ oe	M1
	$= 0.09375$ or $\frac{3}{32}$ oe	awrt 0.0938
		A1
		(2)
(c)	$P(T = 4, 5, 6) = 1 - P(T \leq 3)$	M1
	$= 1 - 0.6563$	
	$= 0.3437$ or $\frac{11}{32}$	awrt 0.344
		A1
		(2)
(d)	$P(H = 3, 4, 5, 6) = 1 - P(H \leq 2)$	B1M1d
	$= 1 - 0.8306$	
	$= 0.1694$ or $\frac{347}{2048}$	awrt 0.169
		A1
		(3)
		<b>Total 9</b>

	Notes	
(a)	B1 A correct statement – does not need to be in context B1 A second correct statement in context include coin or heads or tails(do not allow H and T ) or spins/flip oe.	
(b)	M1 [writing or using $B(6, 0.5)$ and writing or using $P(T \leq 5) - P(T \leq 4)$ ] or $\left[6\left(\frac{1}{2}\right)^5\right]$ oe]	
(c)	M1 for realising they need find $P(T = 4, 5 \text{ or } 6)$ eg $1 - P(T \leq 3)$ or $P(T \geq 4)$	
(d)	B1	writing/using $B(6, 0.25)$ and $P(H \geq 3)$ oe
		writing/using $B(6, 0.75)$ and $P(T \leq 3)$
	M1d	dep on B1 $(0.25)^6 + 6(0.75)(0.25)^5$ $+ 15(0.75)^2(0.25)^4 + 20(0.75)^3(0.25)^3$
	A1	awrt 0.169
	NB	Only accept correct use of H and T in the probability statement unless their variable is correctly defined
	NB	awrt 0.169 with no incorrect working gains B1M1A1

#### Question 4

Question Number	Scheme	Marks
(a)	$H_0 : p = 0.35 \quad H_1 : p > 0.35$	B1
	$V \sim B(40, 0.35) \quad P(V \geq 18) = 1 - P(V \leq 17)$ or $P(V \geq 19) = 0.0699$	M1
	$= 1 - 0.8761$	$P(V \geq 20) = 0.0363$
	$= 0.1239$	CR $V \geq 20$
	Accept $H_0$ or not Significant or 18 does not lie in the critical region	M1d
	There is insufficient evidence that the <b>proportion/amount/number/percentage</b> of customers who bought organic vegetables has increased.	A1cso (5)
(b)	$E \sim B(50, 0.35)$	M1
	$P(E \leq 10) = 0.0160$	$P(E \geq 25) = 0.0207$
	$P(E \leq 11) = 0.0342$	$P(E \geq 24) = 0.0396$
	CR $E \leq 10$	$E \geq 25$ A1A1 (3)
(c)	The <b>manager's claim</b> is supported or there is sufficient evidence that the proportion of customers buying organic eggs is different from those buying organic vegetables.	B1ft (1)
(d)	$0.016 + 0.0207 = 0.0367$ or 3.67% awrt 0.0367 or 3.67%	B1 (1)

	Notes	
(a)	B1 both hypotheses correct with $p$ or $\pi$ M1 writing or using $V \sim B(40, 0.35)$ and $1 - P(V \leq 17)$ or $P(V \leq 17) = 0.8761$ or awrt 0.124 <b>OR</b> writing $P(V \geq 19) = 0.0699$ or $P(V \geq 20) = 0.0363$ leading to a CR. Implied by correct CR A1 awrt 0.124 or $V \geq 20$ or $V > 19$ allow any letter M1d dep on previous M being awarded. ft their CR or probability. A correct statement – do not allow contradicting non-contextual comments A1 cso all previous marks must be awarded. A correct statement in context. Need <b>Bold words</b> . NB award M1A1 for a correct contextual statement on its own. If there are no hypotheses or they are the wrong way around, then M0A0	
(b)	M1 writing $E \sim B(50, 0.35)$ or a correct probability or one tail of the CR correct A1 $E \leq 10$ oe A1 $E \geq 25$ oe, allow any letter. Condone missing letter NB If CR written as probabilities and both are correct or CR written as $10 \geq E \geq 25$ oe award M1A1A0. If just give CV 10 and 25 given award M1A0A0	
(c)	B1 A correct statement including the words <b>managers claim</b> or <b>eggs</b> and <b>vegetable(s)</b> (or veg) ft their 2 tail CR. Cannot be awarded if no CR given in (b)	



## Question 5

Q5	Scheme	Marks
a	$r = 0.937$ (3 s.f.)	A1
b	$H_0: \rho = 0$ , $H_1: \rho \neq 0$ , critical value = $\pm 0.6319$ . Reject $H_0$ . There is evidence that there is a correlation between the age of a machine and its maintenance costs.	M1 A1 A1
		(4 marks)