

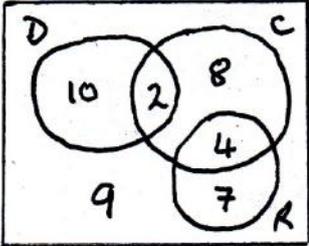
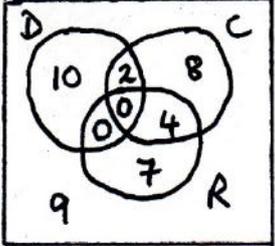


Mark Scheme (Results)

January 2020

Pearson Edexcel International Advanced Level
in Statistics S1 (WST01) Paper 01

Question Number	Scheme	Marks
1.	[Sum of probs = 1 gives] $a + b + c + 0.3 = 1$ (o.e.) [F(1) = 0.63 gives] $0.15 + a + b = 0.63$ <u>or</u> $0.63 + c + 0.15 = 1$ (o.e.) Solving $c = \underline{0.22}$ [Use of E(X) = 1 or symmetry gives] $a = c$ $a = \underline{0.22}$ Therefore $b = \underline{0.26}$	M1 M1 A1 M1 A1 [5]
Notes		
<p>Each of the 3 Ms can be awarded at any point for either the correct equation seen or clearly implied by its use e.g. choosing their b ($0 < b < 0.7$) so that $a + b + c = 0.7$ (1st M1)</p> <p>1st M1 for use of sum of probabilities to form an equation in a, b and c. Can allow the use of their value for c in the equation <u>or</u> implied by its use to find b</p> <p>2nd M1 for equation in a and b from using F(1) = 0.63 e.g. $a + b = 0.48$ <u>or</u> $c + 0.15 = 0.37$</p> <p>1st A1 for deducing $c = 0.22$</p> <p>3rd M1 for using E(X) = 1 to deduce $a = c$ fit their <u>value</u> of c (provided $0 \leq a \leq 0.35$) NB E(X) = 1 gives $-a + b + 3c = 0.7$ but only scores M1 when they state $a = c$ <u>or</u> give their value of a ($0 \leq a \leq 0.35$) = their value of c</p> <p>2nd A1 for $b = 0.26$</p> <p>All 3 correct answers only (no working) scores 5 marks (they may be seen in the table)</p> <p>If answers seen in the table contradict answers with working in the body of the script the script takes preference.</p>		

Question Number	Scheme	Marks
<p>2. (a)</p> <p>(b)</p> <p>(c)</p> <p>(d)</p> <p>ALT</p> <p>(e)</p> <p>(f)</p>	<div style="display: flex; justify-content: space-around;">   </div> <p>Since no family has a dog and a rabbit a mutually exclusive pair is $\underline{D, R}$</p> $\left[\frac{2 + "4"}{40} \right] = \underline{\underline{\frac{3}{20}}}$ <p>e.g. $P(D \cap C) = \frac{2}{40} = \frac{1}{20}$ $P(D) = \frac{12}{40} = \frac{3}{10}$ $P(C) = \frac{14}{40} = \frac{7}{20}$ <u>or</u></p> $\frac{1}{20} \neq \frac{3}{10} \times \frac{7}{20} = \left[\frac{21}{200} \right]$ <p>so they are <u>not</u> independent</p> <p>$P(C) = \frac{14}{40} = \frac{7}{20}$ vs $P(C D) = \frac{2}{12} = \frac{1}{6}$ <u>or</u> $P(D) = \frac{12}{40} = \frac{3}{10}$ vs $P(D C) = \frac{2}{14} = \frac{1}{7}$</p> <p>e.g. $[P(R C) =] \frac{P(R \cap C)}{P(C)}$ or $\frac{"4"}{\frac{14}{40}}$</p> $= \frac{4}{14} = \underline{\underline{\frac{2}{7}}}$ <p>$\frac{"10"+"7"}{"10"+"7"+9}$ (o.e.) ; = $\frac{17}{\underline{\underline{26}}}$ (accept 0.6538461)</p>	<p>B1 B1 B1 B1</p> <p>(4)</p> <p>B1</p> <p>(1)</p> <p>B1ft</p> <p>(1)</p> <p>M1</p> <p>A1</p> <p>(2)</p> <p>M1</p> <p>A1ft</p> <p>(2)</p> <p>M1; A1</p> <p>(2)</p> <p>[12]</p>
Notes		
	<p>(a) 1st B1 for 3 intersecting circles with $n(D \cap R) = 0$ (either diagram) [Blank is not equiv'to 0] 2nd B1 for a box and 9 outside the circles 3rd B1 for $n(D \cap C) = 2$ and $n(D \cap C') = 10$ 4th B1 for 8, 4 and 7 correctly placed</p> <p>(b) B1 for D and R with a suitable reason (extra pairs is B0) e.g. $P(D \cap R) = 0$ Condone \emptyset for 0 <u>or</u> no intersection/overlap. Must see an attempt at a reason. Must be D, R not $P(D), P(R)$ $P(D \cup R) = P(D) + P(R)$ is <u>not</u> a suitable reason though.</p> <p style="text-align: center;">For (c) onwards if their $N \neq 40$ allow denominators of probs with 40 or N</p> <p>(c) B1ft ft their "4" (but must give a proper fraction) ft blank as 0 <u>or</u> $\frac{3}{20}$ or exact equivalent</p> <p>(d) M1 for stating <u>all</u> the probabilities (values) required for a suitable test, must be labelled. Must use D and C ft their VD. Must be clear which test they are trying to use. A1 for the correct probabilities <u>and</u> correct calculation or comparison <u>and</u> correct conclusion</p> <p>(e) M1 for a correct ratio of probabilities (ft their 4): either as an expression or values A1ft for $\frac{2}{7}$ or exact equivalent (allow ft of their 4 [$\neq 0$] provided it gives an exact fraction)</p> <p>(f) M1 for a correct ratio (possibly of probabilities) ft their 10 and their 7 [Not expression here] A1 for $\frac{17}{26}$ or exact equivalent (e.g. 0.654 will score M1A0)</p>	<p>Allow probabilities (out of 40) or decimals or integers.</p>

Question Number	Scheme	Marks
3. (a)	$S_{mp} = 32958 - \frac{1124 \times 281}{10} \quad [= 1373.6] \quad (*)$	B1cso (1)
(b)	$[r =] \frac{1373.6}{\sqrt{6046.4 \times 382.9}}$ $= 0.9027... \quad \text{awrt } \underline{0.903}$	M1 A1 (2)
(c)	In scatter diagram points are close to a line <u>or</u> r is close to (or near to) 1 It is consistent with the manager's belief	B1 (1)
(d)	$\frac{\sum m}{\sum p} = \frac{1124}{281} \quad (\text{o.e.})$ <p style="text-align: center;">So $k = \underline{4}$</p>	M1 A1 (2)
(e)	$b = \frac{1373.6}{6046.4} \quad [= 0.22717...]$ $a = 28.1 - "0.2271..." \times 112.4 \quad [= 2.5653...]$ $p = 2.565... + 0.2271...m \quad \underline{p = 2.57 + 0.227m}$	M1 M1 A1; A1 (4)
(f)	[2.565... + 0.2271... × 70 =] 18.467... accept answers in range [18, 18.6]	B1 (1)
(g)	Manager's model (when $m = 70$) estimates $p = 17.5$ So use manager's model since wants the lower estimate. (o.e.)	B1ft dB1 (2)
Notes		
(a)	B1cso for a correct expression seen (need all 4 numbers seen)	
(b)	M1 for a correct expression or an answer only of 0.90 (2sf) or 0.902 (truncation) A1 for awrt 0.903	
(c)	B1 for "points close to a line" <u>or</u> " r is close to 1" <u>or</u> "strong correlation" (o.e.) <u>but</u> "nearer to 1" is B0 <u>and</u> "consistent with manager" <u>or</u> "consistent with belief" (o.e.) <u>or</u> "yes"	
(d)	M1 for a correct calculation or equation in k A1 for $k = 4$ NB using the point (140, 35) is M0A0 despite giving $k = 4$	
(e)	1 st M1 for a correct expression for b 2 nd M1 for a correct equation in a (ft their value of b or even letter b in correct formula) 1 st A1 for $b =$ awrt 0.227 in an equation in p and m <u>or</u> allow y and x Allow a transcription error (e.g. 0.277 etc) if 0.227 is seen in earlier working. 2 nd A1 for $a =$ awrt 2.57 in an equation in p and m only	
(g)	1 st B1ft for 17.5 <u>or</u> $70 \div k$ for their value of k 2 nd dB1 (dep on 1 st B1) for therefore choosing manager's model because it has the lower estimate. (o.e.) (Must be true for their values)	

Question Number	Scheme	Marks
<p>4. (a)</p> <p>(b)</p> <p>(c)</p> <p>(d)</p> <p>(e)</p> <p>(f)(i)</p> <p>(ii)</p>	<p>Width = <u>0.5</u> (cm) 1cm² rep's 4 babies <u>or</u> 0.25cm² rep's 1 baby <u>or</u> their $h \times w = 3.5$ <u>or</u> area = 3.5 cm² Height = $\frac{14}{16} \times 4 \div 0.5 = \underline{7}$ (cm)</p> <p>Lower Quartile = $[2.5] + \frac{\frac{98}{4} - 16}{24} \times 0.5 = [2.5] + \frac{8.5}{24} \times 0.5$ = 2.50 + 0.177... = awrt <u>2.68</u></p> <p>$Q_2 - Q_1 = 3.14 - 2.68 = \underline{0.46} > \underline{0.41} = 3.55 - 3.14 = Q_3 - Q_2$ So <u>negative skew</u></p> <p>$\bar{w} = \frac{311.5}{98} = 3.17857... = \text{awrt } \underline{3.18}$</p> <p>$\sigma_w = \sqrt{\frac{1051.125}{98} - \bar{w}^2} = \sqrt{0.622448...} ; = 0.78895... = \text{awrt } \underline{0.789}$</p> <p>$\frac{3(3.18 - 3.14)}{0.789} = 0.152... \quad \text{awrt } \underline{0.15}$</p> <p>49th value now 3.25 [<u>or</u> median in group $3.25 \leq w < 3.50$] so median increases more higher values <u>or</u> Σfx increases ... so mean increases</p>	<p>B1 M1 A1 (3)</p> <p>M1 A1 (2)</p> <p>M1 A1 (2)</p> <p>B1 M1 A1 (3)</p> <p>M1A1 (2)</p> <p>B1 B1 (2)</p> <p>[14]</p>
Notes		
<p>(a)</p> <p>(b)</p> <p>(c)</p> <p>(d)</p> <p>(e)</p> <p>(f)(i)</p> <p>(ii)</p>	<p>B1 0.5 only M1 may be implied by correct height A1 correct height of 7(cm)</p> <p>M1 for any correct equation leading to correct fraction as part of $m = \dots$ or $(m - [2.5]) = \dots$ Ignore incorrect end point and watch out for "working down" Using 25 for 24.5 is M0 A1 awrt 2.68 allow exact fraction e.g. $\frac{257}{96}$ (allow 8.75 for 8.5 [or $\frac{515}{192}$] if $n + 1$ used)</p> <p>M1 for use of $Q_2 - Q_1$ and $Q_3 - Q_2$ (o.e.) ft their Q_1 [<u>or</u> correct inequality and -ve skew] <u>or</u> a correct quartile inequality and statement that negative skew A1 for correctly concluding negative skew from their values. Their ft calc should be correct.</p> <p>B1 for awrt 3.18 (allow $\frac{89}{28}$) M1 for a correct expression (including square root) ft their mean ($\frac{\sqrt{122}}{14}$ scores M1) A1 for awrt 0.789 (accept $s = 0.79301... = \text{awrt } 0.793$)</p> <p>M1 for correct substitution (ft their values and condone missing 3) A1 for awrt 0.15</p> <p>1st B1 for median increases with a suitable reason to support this (must mention the 3.25) 2nd B1 for mean increases with a suitable reason to support this (Recalc of $\bar{x} = 3.196... is B0)$</p>	

Question Number	Scheme	Marks
<p>5. (a)</p> <p>(b)</p> <p>(c)</p>	$P(X < 7) = P\left(Z < \frac{7-10}{6}\right) = P(Z < -0.5)$ $= 1 - 0.6915 \quad ; = 0.308537... \quad \text{awrt } \underline{0.309}$ $\frac{10+k-10}{6} = 0.8416$ $k = 5.0496 \quad \text{awrt } \underline{5.05}$ Area of rectangle is $X(X-3)$ Need $X(X-3) > 40$ $X^2 - 3X - 40 > 0 \Rightarrow (X-8)(X+5) > 0$ So critical values are 8 and -5 Need $P(X > 8) + P(X < -5)$ or $1 - P(-5 < X < 8)$ So $P(Z > -0.33) + P(Z < -2.5)$ $= 0.6293 + 0.0062$ $= 0.6355 \quad [0.6355 \sim 0.637]$	<p>M1</p> <p>M1; A1 (3)</p> <p>M1 B1</p> <p>A1 (3)</p> <p>M1</p> <p>M1</p> <p>M1</p> <p>A1</p> <p>M1</p> <p>M1</p> <p>dM1</p> <p>A1</p> <p>(8)</p> <p>[14]</p>
Notes		
<p>(a)</p> <p>(b)</p> <p>Ans only</p> <p>Ans only</p> <p>(c)</p> <p>Ans only</p>	<p>1st M1 for standardising 7 (or 13) with 10 and 6 (allow \pm)</p> <p>2nd M1 for $1-p$ (where $0.68 < p < 0.70$)</p> <p>A1 for awrt 0.309 (calc. 0.3085375.....) (Ans only scores 3/3)</p> <p>M1 Standardising $10 \pm k$ with 10 and 6 and setting equal to z value $0.8 < z < 0.9$</p> <p>B1 for $z = \pm 0.8416$ or better (calc gives 0.8416212.....) <u>used</u> in a linear equation for k</p> <p>A1 $k = 5.05$ or better (or use of $z = 0.84$ and answer of 5.04)</p> <p>awrt 5.04 scores M1B0A1</p> <p>Answer in the range 5.049 ~ 5.0499 scores M1B1A1 but answer only of 5.05 is M1B0A1</p> <p>1st M1 for a suitable expression for the area of the rectangle (in x or X) [\Rightarrow by 2nd or 3rd M1]</p> <p>2nd M1 for a correct quadratic inequality (accept $x(x-3) > 40$ [o.e.]</p> <p>3rd M1 for an attempt to solve their 3TQ to find critical values (allow = 0) (e.g. factorise)</p> <p>Allow $(X+8)(X-5)$ <u>or</u> use of formula with ≤ 1 sign error <u>or</u> $(X - \frac{3}{2})^2 - k - 40$ ($k > 0$)</p> <p>1st A1 for the correct critical values (cvs) of 8 and -5</p> <p>4th M1 for solving their quadratic inequality - taking the “outside” region (ft their cvs) [P(..) not required]</p> <p>5th M1 for standardising at least one of their values (with 10 and 6) correctly (ft their cvs)</p> <p>6th dM1 for an attempt at both probabilities: one ≈ 0.006 and one > 0.6 and adding <u>or</u> for $1-q$ where $q = 0.36$ or better This mark is dependent on all the other 5 M marks being scored</p> <p>2nd A1 for answer in range [0.6355, 0.637] with clear attempt at both probabilities used (calc 0.636768...)</p> <p>If 6th M1 is not explicitly seen then must have an answer awrt 0.636 or 0.637</p>	

Qu No.	Scheme	Marks														
6. (a)	[Sum of probs = 1 gives] $k \left[1 + \frac{1}{2} + \frac{1}{3} + \frac{1}{4} + \frac{1}{5} + \frac{1}{6} \right] \{=1\}$ <u>or</u> $\frac{147k}{60} = 1$ $k = \frac{20}{49}$	M1 A1 cso (2)														
(b)	$E(S) = \frac{1}{147} \left(60 \times \frac{1}{2} + 120 \times \frac{1}{3} + 180 \times \frac{1}{4} + 240 \times \frac{1}{5} + 300 \times \frac{1}{6} \right)$ <u>or</u> $3.55k$ $= \frac{71}{49}$	M1A1 A1 (3)														
(c)	Expected profit = $260P(S=5) - 10$ <u>or</u> $-10 \times P(S \neq 5) + 250 \times P(S=5)$ $= \left[260 \times \frac{10}{147} - 10 \right] = 7.68707\dots = \text{awrt } (\$) \underline{7.69}$	M1M1 A1 (3)														
(d)	p^2 because Roger must win 1 st and 2 nd round (accept “wins 2 rounds”) ($1-p$) because Roger loses in 3 rd round match	B1 B1 (2)														
(e)	<table border="1" style="width: 100%; border-collapse: collapse; text-align: center;"> <tr> <td>[r]</td> <td>0</td> <td>1</td> <td>2</td> <td>3</td> <td>4</td> <td>5</td> </tr> <tr> <td>[P(R=r)]</td> <td>$1-p$</td> <td>$p(1-p)$</td> <td>$[p^2(1-p)]$</td> <td>$p^3(1-p)$</td> <td>$p^4(1-p)$</td> <td>p^5</td> </tr> </table>	[r]	0	1	2	3	4	5	[P(R=r)]	$1-p$	$p(1-p)$	$[p^2(1-p)]$	$p^3(1-p)$	$p^4(1-p)$	p^5	B1 M1A1 (3)
[r]	0	1	2	3	4	5										
[P(R=r)]	$1-p$	$p(1-p)$	$[p^2(1-p)]$	$p^3(1-p)$	$p^4(1-p)$	p^5										
(f)	E (profit) = $260 \times p^5 - 10$ $[E(\text{profit}) \geq 7.69] \Rightarrow p^5 \geq \frac{17.69}{260}$ so $p \geq 0.58418\dots$	M1 A1 M1; A1 (4)														
[17]																

Notes

(a)	M1 for clear attempt to find sum of probs. (Condone $\frac{147k}{60} = 1$) A1cso for the correct answer with M1 clearly scored and no incorrect working seen. Need to see all 6 probs added and = 1 for M1 and a comment (e.g. therefore $k = \dots$) for A1	
Verify		
(b)	M1 for an attempt at $E(S)$ – at least 4 correct products (allow use of k or $k = 0.408$ or better) 1 st A1 for a fully correct expression (allow $3.55k$) 2 nd A1 for $\frac{71}{49}$ (accept 1.45 or better [calc:1.44897...]) (Ans only 3/3)	
(c)	1 st M1 for $260 \times P(S=5)$ <u>or</u> $250 \times P(S=5)$ 2 nd M1 for $N \times P(S=5) - 10$ <u>or</u> $N \times P(S=5) - 10 \times P(S \neq 5)$ ($N \in \mathbb{N}$) A1 for awrt (\$)7.69	Probabilities can be in terms of k or ft their values
(d)	1 st B1 for an explanation of the p^2 term (e.g. use of tree diagram) 2 nd B1 for an explanation that must lose the 3 rd round match	WWL alone scores 1 st B1 <u>but</u> WWL <u>and</u> $pp(1-p)$ will get B1B1
(e)	B1 for correct set of values for R (in a table or a list) M1 for at least 3 correct values [apart from $P(R=2)$] for R and correct probabilities A1 for a fully correct probability distribution	
(f)	1 st M1 for $260 \times P(R=5)$ (ft their $P(R=5)$ implied by 2 nd M1) 1 st A1 for $260 \times p^5 - 10$ <u>or</u> $p^5 \geq \frac{10}{147}$ 2 nd M1 for forming a correct ft of $P(R=5) \geq P(S=5)$ (accept $>$ or allow $=$) [ft their (c)] 2 nd A1 for awrt 0.58 <u>or</u> 0.59 [If equals sign is used we need to see awrt 0.59 for the A1]	
ALT	$260p^5 - 10 \geq 260 \times \frac{10}{147} - 10$ (M1A1) $\Rightarrow p^5 \geq \frac{10}{147}$ (M1) etc (A1)	