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Mark Scheme (Results)

January 2018

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

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

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PEARSON EDEXCEL IAL MATHEMATICS

General Instructions for Marking

1. The total number of marks for the paper is 75

2. The Edexcel Mathematics mark schemes use the following types of marks:

- **M** marks: Method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
- **A** marks: Accuracy marks can only be awarded if the relevant method (M) marks have been earned.
- **B** marks are unconditional accuracy marks (independent of M marks)
- Marks should not be subdivided.

3. Abbreviations

   These are some of the traditional marking abbreviations that will appear in the mark schemes.

   - bod – benefit of doubt
   - ft – follow through
   - the symbol $\surd$ will be used for correct ft
   - cao – correct answer only
   - cso - correct solution only. There must be no errors in this part of the question to obtain this mark
   - isw – ignore subsequent working
   - awrt – answers which round to
   - SC: special case
   - o.e. – or equivalent (and appropriate)
   - d… or dep – dependent
   - indep – independent
   - dp decimal places
   - sf significant figures
   - * The answer is printed on the paper or ag- answer given
   - ⌐ or d… The second mark is dependent on gaining the first mark

4. All A marks are 'correct answer only' (cao.), unless shown, for example, as A1 ft to indicate that previous wrong working is to be followed through. After a misread however, the subsequent A marks affected are treated as A ft, but manifestly absurd answers should never be awarded A marks.

5. For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected.

6. Ignore wrong working or incorrect statements following a correct answer.

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Question Number	Scheme	Marks
1. (a)	$[61\times15=]$ **915**	**B1** (1)
(b)	$[\text{Var}_A]=\frac{59610}{10}-77^2$ = **32** $[\text{Var}_B]=\frac{58035}{15}-61^2$ = **148**	**M1** **A1 A1** (3)
(c)	Class *B* since its variance is larger	**B1ft** (1)
(d)(i)	$\text{Mean}_{AB}=\frac{770+"915"}{25}=67.4$ or $\frac{10}{25}\times77+\frac{15}{25}\times61=$ **67.4**	**M1 A1**
(ii)	$\text{Var}_{AB}=\frac{59\,610+58\,035}{25}-"67.4"^2=163.04$ **awrt 163**	**M1 A1** (4)
(e)(i)	No effect on the variance of class *A* since addition does not change variance (Var (*X* + *b*) = Var (*X*))	**B1**
(ii)	The mean will increase since the total score has increased or mean of *A* increased but mean of *B* stayed the same	**B1**
(iii)	The variance of the entire group will increase since the mean of class *A* is now further away from the mean of class *B*	**B1** (3) **[12 marks]**

	Notes
(b)	M1 for a correct method for variance for either class. Accept s^2 and allow inside $\sqrt{...}$ 1st A1 for 1 correct answer. NB $s_A^2=35.\dot{5}$ or awrt 35.6 and $s_B^2=158.57...$ or awrt 159 2nd A1 for both correct. [ISW standard deviations following correct variances.]
(c)	B1ft for Class *B* **and** it has a larger variance/standard deviation (do not allow spread) If $\text{Var}_A > \text{Var}_B$ then allow choice of *A* since variance is larger. Ft their values if > 0
(d)(i)	M1 for a correct calculation for the mean (or weighted mean), ft their 915 from (a) A1 for 67.4 o.e.
(ii)	M1 for use of correct formula (no $\sqrt{...}$) with total $\sum x^2$ = 117 645 and their mean.NB $\frac{S_{xx}}{25}=\frac{4076}{25}$ A1 for awrt 163 [Don't ISW standard deviation]
(e)(i)	B1 for no effect/does not change **and** correct supporting reason that mentions addition or subtraction doesn't affect or only affected by multiplication/division. Comment that $(x-\bar{x})$ doesn't change is fine. Just "coding" is not sufficient.
(ii)	B1 for stating the mean will increase **and** correct supporting reason that states or implies that total (of scores) has increased. Allow new mean = $\frac{1715}{25}=68.6$
(iii)	B1 for increase **and** correct supporting reason that mentions *A* marks and *B* marks and that they are more spread out. Just saying: "marks are more varied" or "only added 3 to one class" is **not** sufficient
NB	Calc for (iii) gives new Σx^2 = 64 320 and Var_{AB} = 188.24 but no mark

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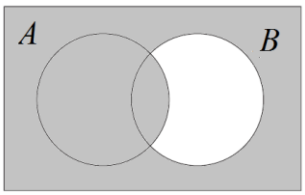
Question Number	Scheme	Marks
2. (a)		**B1** **(1)**
(b)	$[\,P(C \cap D) = 0\,]$	**B1**
(i)	$P(C \cup D) = P(C) + P(D) = \frac{1}{2}$	**B1**
(ii)	$P(C \mid D)[= \frac{P(C \cap D)}{P(D)}] = 0$	**B1** **(3)**
(c)(i)	$P(F \cup G) = P(F) + P(G) - P(F \cap G)$	
	$\frac{3}{8} = \frac{1}{6} + P(G) - \frac{1}{6} \times P(G)$	**M1 M1**
	$P(G) = \frac{1}{4}$	**A1**
(ii)	$P(F \mid G')[= P(F)] = \frac{1}{6}$	**B1** **(4)** **[8 marks]**

	Notes
(a)	If a 2nd diagram is drawn then award B0 unless the incorrect diagram is crossed out
(b)	1st B1 for writing or using $P(C \cap D) = 0$ anywhere in (b)(may be implied by correct $P(C \mid D)$) $P(C \cup D) = P(C) + P(D) - P(C \cap D) = \left[\frac{1}{5} + \frac{3}{10}\right] = \frac{1}{2}$ does imply 1st B1 2nd B1 for $P(C \cup D) = 0.5$ (o.e.) (may just be labelled (b)(i) $\frac{1}{2}$) This does <u>not</u> imply 1st B1 3rd B1 for $P(C \mid D) = 0$…this <u>will</u> imply 1st B1 too
(c)(i)	1st M1 for use of addition formula (3 terms) with correct substitution of at least one term Assuming or stating $P(F \cap G) = 0$ scores M0 2nd M1 for <u>use</u> of independence $P(F \cap G) = P(F) \times P(G) = \frac{1}{6} \times P(G)$ (i.e. must be used) Use of e.g. x for $P(G)$ is fine. NB $\frac{3}{8} = \frac{1}{6} \times P(G)$ is M0M0
ALT	Let $y =$ $P(F \cap G)$ then $P(G) = y + \frac{3}{8} - \frac{1}{6}$ scores 1st M1 and $y = \frac{1}{6}(y + \frac{3}{8} - \frac{1}{6})$ o.e. gets 2nd M1 A1 for $\frac{1}{4}$ o.e.
(ii)	B1 for $P(F \mid G') = \frac{1}{6}$ (may be labelled (c)(ii) $\frac{1}{6}$) Accept exact equivalents.

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Question Number	Scheme	Marks
3. (a)	[It supports because:] r is close to –1 <u>or</u> there is strong correlation.	**B1** **(1)**
(b)	e.g. The dependent variable. The variable being studied.	**B1** **(1)**
(c)	$[b = \frac{S_{ch}}{S_{cc}} =] \frac{-3034.6}{303448} = -0.01[000...\text{hours/mg}]$	**M1 A1**
	So the data support the statement. (o.e.)	**dA1** **(3)**
(d)	$a = \bar{h} - b\bar{c} = \frac{126}{20} - "-0.01.." \times \frac{3660}{20} = 6.3 - "-0.01..." \times 183 = 8.13\ldots$ **awrt <u>8.1</u>**	**M1 A1ft** **A1** **(3)**
		[8 marks]

	Notes
(b)	B1 Allow equivalent definitions e.g. the variable you can't control in an experiment. <u>or</u> the amount of sleep <u>depends</u> on the amount of caffeine <u>or</u> is affected by (changes according to) another variable BUT "can't be measured" is B0 **Mark (c) and (d) together. Gradient: M1 & 1st A1 in (c) Intercept: M1 & 1st A1 in (d)**
(c)	M1 for calculation of gradient (correct expression) 1st A1 for awrt -0.01 must be seen to come from gradient (can be part of whole equation) 2nd dA1 dependent on M1 and 1st A1 for "claim is supported" <u>or</u> "Martin is correct" <u>or</u> "reduces by 1 hour"
2nd A1 **2nd A1**	If whole equation is seen before 2nd A1 attempted they must refer to just gradient <u>or</u> May use equation to calculate h for some c and then c + 100 to show loss of 1 hour If they use the intercept and c = 100, must see a clear subtraction (e.g. 8.13 – 7.13) to score
(d)	M1 for attempt to find a for linear regression model (Use of letter b or ft their value of b but a correctly placed $\bar{h}$ or $\bar{c}$ needed) 1st A1ft for correct expression for a (follow through their value for b) 2nd A1 for awrt 8.1 (hours) (or 8 hours and awrt 8 minutes) [Allow 8.1.. – 0]

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Question Number	Scheme	Marks
4. (a)	$E(X) = -4a + (-3b) + a + 2b + 5\times 0.2 [= -3a - b + 1]$	**B1** **(1)**
(b)(i)	$E(X) = 0$	**B1**
(ii)	$a + b + a + b + 0.2 = 1$ $-3a - b + 1 = 0$ Solving simultaneously to give $\underline{a = 0.3}$ $\underline{b = 0.1}$	**B1** **M1** **A1 A1** **(5)**
(c)	$\text{Var}(1-3X) = 9\text{Var}(X)$ $E(X^2) = (-4)^2 a + (-3)^2 b + a + (2^2)b + 25\times 0.2 [= 11.4]$ $\text{Var}(1-3X) = 102.6$ **awrt <u>103</u>**	**M1** **M1** **A1** **(3)**
(d)(i)	$[P(Y < 0) = P(1 - X < 0) =]$ $P(X > 1) = b + 0.2 = 0.3$	**M1 A1ft**
(ii)	$[P(Y < k) = P(1 - X < k)] =$ $P(X > (1-k)) = 0.2 \Rightarrow 1 - k = 2$ $\underline{\boldsymbol{k = -1}}$	**M1** **A1** **(4)** **[13 marks]**

Notes

(a) B1 for a correct expression for $E(X)$ (need not be simplified)

(b)(i) B1 $E(X) = 0$ <u>or</u> $-3a - b + 1 = 0$ <u>or</u> (b)(i) 0
(must be explicitly stated in (b) before values for a and b found)

(ii) B1 for using sum of probabilities = 1 to form a correct equation in a and b
M1 for attempting to eliminate one variable (correct processes on 2 indep' linear equations)
1st A1 for $a = 0.3$ or $b = 0.1$
2nd A1 for both $a = 0.3$ and $b = 0.1$

(c) 1st M1 for $3^2\text{Var}(X)$ <u>or</u> $3^2 E(X^2)$
2nd M1 for a correct algebraic expression for $E(X^2)$ e.g. $17a + 13b + 5$
<u>or</u> numerical expression and can ft a and b if probabilities
May see $E(X^2) = \ldots$ or $\text{Var}(X) = \ldots$ in part (b) and can then award this mark

Dis (1 – 3*X*)

13	10	– 2	–5	–14
0.3	0.1	0.3	0.1	0.2

1st M1 for prob distribution, ft their a and b if probabilities. All $(1 - 3X)$ values correct.
2nd M1 for correct expression for $\text{Var}(1 - 3X)$ including the -1^2 for $[E(1 - 3X)]^2$

A1 for awrt 103

(d)(i) If $a = b = 0.2$ then can only score M1A0 if correct values for X or Y are seen.
Just 0.2+0.2 is M0A0
M1 for $P(X > 1)$ <u>or</u> for $X = 2$ and $X = 5$ only **<u>or</u>** for $Y = -1$ and $Y = -4$ only **<u>or</u>** "b" + 0.2
A1ft for their b + 0.2 **if M1 scored** (where b and b + 0.2 are probabilities)

Ans only M1A1 for 0.3 **only if** $b = 0.1$ in part (b). Answer only $\neq$ 0.3 is M0A0

(ii) M1 for $P(X > (1-k)) = 0.2$ <u>or</u> $1 - k = 2$ <u>or</u> $P(Y < -1) = 0.2$
A1 for $k = -1$

Dis of *Y* An attempt at the distribution for Y will get 1st M1 in (i) when the correct values are chosen.

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Question Number	Scheme	Marks
5. (a)	$[-2\times1000+20000]=$ (£)18000	**B1** **(1)**
(b)	$S_{wy}=2490-\frac{81\times405}{9}$ or $2490-3645$ [$=-1155$]	**B1**
	$r=\frac{"-1155"}{\sqrt{660\times2500}}$ or $\frac{"-1155"}{\sqrt{1650000}}=-0.899$ **(*)**	**M1 A1cso** **(3)**
(c)	–0.899 (or "same"); as (linear) coding does not have any effect on correlation	**B1** **(1)**
(d)	$y = 60.75 - 1.75\frac{(x-20000)}{1000}$	**M1**
	$y = 95.75 - 0.00175x$	**A1A1** **(3)**
(e)	$y = 95.75 - 0.00175(21000)$ or $y = 60.75 - 1.75(1)$	**M1**
	$y = 59$ awrt **59**	**A1** **(2)**
(f)	**Data:** x = (£)18000 to x = (£)45000 or **Franca:** $w = 5$ to $w = 20$	**M1**
	As this is interpolation, the estimates are reliable.	**A1** **(2)** **[12 marks]**

Notes

(b)
B1 for a correct numerical expression for S_{wy} (this must be seen (may be on numerator of r))
M1 for a correct expression for r (may ft their $S_{wy} \neq 2490$)
A1cso for – 0.899 or better (calc: – 0.89916628…)[B1 and M1 scored and all correct]

(d)
M1 for substituting $w = (x – 20000)/1000$ into the linear equation
1st A1 a = awrt 95.8 or exact fraction equivalent to $\frac{383}{4}$
2nd A1 $b = –0.00175$ o.e. e.g. $\frac{-1.75}{1000}$ or -1.75×10^{-3} or $-\frac{7}{4000}$ in an equation $y = a + bx$

(e)
M1 for substituting $x = 21000$ into their equation in (d) provided "changed"
or substituting $w = 1$ into the given equation
A1 for awrt 59 (minutes) [ignore units even if incorrect e.g. "hours" or "km"]

(f)
M1 for showing that x = £25000 to x = £40000 gives $w = 5$ to $w = 20$ (both correct w values needed)
or for showing that $w = –2$ is x = 18 000 and $w = 25$ is x = 45 000 (both correct x values needed)
A1 for mentioning interpolation or "within range" so reliable
provided two suitable values stated for M1

Question Number	Scheme	Marks
6. (a)	[P(S = 1) =] **0**	**B1** **(1)**
(b)	P(S > 2) = 1 − P(S = 2) or 1 − P($S \leqslant 2$) or P(S = 3) + P(S = 4) + P(S = 5) $= 1-\left(\frac{2}{5}\times\frac{1}{4}\right), = \frac{9}{10}$ or e.g. $\frac{2}{5}\times\frac{3}{4} + \frac{3}{5}$, = **0.9**	**M1** **M1 A1** **(3)**
(c)	$P(S=3)=\left(\frac{3}{5}\times\frac{2}{4}\times\frac{1}{3} + \frac{2}{5}\times\frac{3}{4}\times\frac{1}{3}\right), = \frac{1}{5}$	**M1, A1** **(2)**
(d)	$P(S=3 \mid \text{2nd is blue}) = \frac{P(S=3 \cap \text{2nd is blue})}{P(\text{2nd is blue})} = \frac{\frac{3}{5}\times\frac{2}{4}\times\frac{1}{3}}{\frac{3}{5}\times\frac{2}{4}+\frac{2}{5}\times\frac{1}{4}} = \frac{1}{4}$	**M1 A1** **(2)**
(e)	$P(S=5) = 4\times\left(\frac{3}{5}\times\frac{2}{4}\times\frac{1}{3}\times\frac{2}{2}\times\frac{1}{1}\right) = \frac{2}{5}$	**B1** **M1 A1** **(3)** **[11 marks]**

Notes

(b) 1st M1 for writing or using $1-P(S=2)$ etc or identifying cases for $S > 2$ e.g. BB' or B'
This mark may be implied by a fully correct numerical expression for the probability
2nd M1 for correct expression for P(S = 2) or for P(S > 2) e.g. $0.4\times0.75 + 0.6$ **Ans of 0.9 3/3**

(c) M1 for both correct products (or 2 × ….)

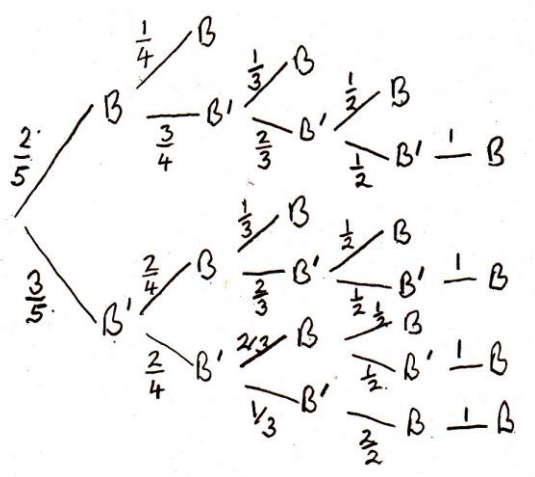
(d) M1 for a correct ratio of probabilities or a correct expression with correct substitution of either numerator or denominator (num<denom)

(e) B1 for ×4 or the sum of 4 identical (or equivalent) products. Allow "replacement" here
M1 for any one product correct (don't need to see all $\frac{2}{2}$ or $\frac{1}{1}$ terms)
A1 for 0.4 o.e. Some may write it down so score B1 and M1 by implication.

NB

s	2	3	4	5
P(S = s)	$\frac{1}{10}$	$\frac{1}{5}$	$\frac{3}{10}$	$\frac{2}{5}$

7 socks **Allow MR for using 5 + 2 socks. Deduct upto 2 A1 marks.**



This may be useful!

Question Number	Scheme	Marks
7. (a)	$P(G > 174) = P(Z > \frac{174-180}{15}) = P(Z > -0.4)$, = 0.6554 **awrt <u>0.655</u>**	**M1, A1** **(2)**
(b)	$P(k < G < 174) = P(G < 174) - P(G < k)$	
	$P(G < k) = (1 - '0.6554') - 0.3196$ or P($G > k$) = '0.6554' + 0.3196 [=0.975]	**M1**
	$P(Z < \frac{k-180}{15}) = 0.025 \Rightarrow \frac{k-180}{15} = -1.96$	**M1 B1**
	awrt <u>150.6</u>	**A1** **(4)**
(c)(i)	$P(G > w) = P(B < w) \Rightarrow \frac{w-180}{15} = -\frac{w-216}{30}$	**M1 A1**
	$\Rightarrow 45w = 8640 \Rightarrow$ ***w* =<u>192</u>**	**A1**
(ii)	$P(G > w) = P\left(Z > \frac{"192"-180}{15}\right)$ or $P(B < w) = P\left(Z < \frac{"192"-216}{30}\right)$	**M1**
	P($Z > 0.8$) = 1 – 0.7881 = 0.2119 ***p* = awrt <u>0.212</u>**	**A1** **(5)** **[11 marks]**

	Notes
(a)	M1 for standardising 174 with 180 and 15 and selecting correct region i.e. P(…> – 0.4) o.e. Just $Z = -0.4$ is M0 unless indicate with > or diagram which region(use of tables may be wrong) A1 awrt 0.655 do not isw [Final answer of awrt 0.655 scores M1A1]
(b)	1st M1 for a correct expression for P($G < k$) (may be seen in diagram or implied) <u>or</u> a correct expression for P($G > k$) ft their "0.6554" from (a). Probability for G may be standardised 2nd M1 for standardising k with 180 and 15 and equating to a z-value $\|z\| > 1.5$ B1 for (<u>+</u>) 1.96 or better (used as their z value) NB $\frac{k-180}{15} = -1.96$ will imply M1M1B1 A1 for awrt 150.6 (must come from a correct equation)
(c)(i)	M1 for standardising w with 180 and 15 **<u>and</u>** 216 and 30 (allow <u>+</u>) 1st A1 for equating standardisations with correct signs 2nd A1 for 192
(ii)	M1 for correct standardisation of $G > w$ with '192', 180 and 15 <u>or</u> $B < w$ with '192', 216 and 30 A1 for awrt 0.212

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