edexcel

Mark Scheme (Results)

January 2016

Pearson Edexcel International A Level in Statistics 1 (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.

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
   - oe – 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
   - $\llcorner$ 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. If a candidate makes more than one attempt at any question:
    - If all but one attempt is crossed out, mark the attempt which is NOT crossed out.
    - If either all attempts are crossed out or none are crossed out, mark all the attempts and score the highest single attempt.

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

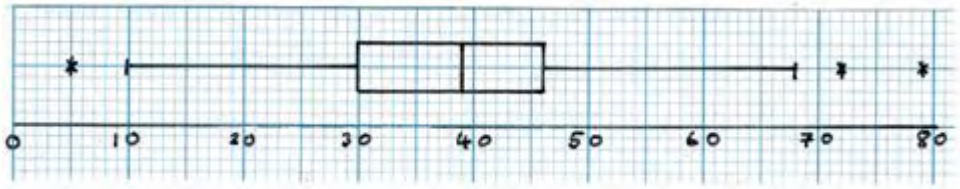
Special notes for marking Statistics exams

- If a candidate is "hedging their bets" e.g. give Attempt 1…Attempt 2…etc then please send to review.
- Any correct method should gain credit. If you cannot see how to apply the mark scheme but believe the method to be correct please send to review.

Jan2016
WST01 STATISTICS 1 International
Mark Scheme

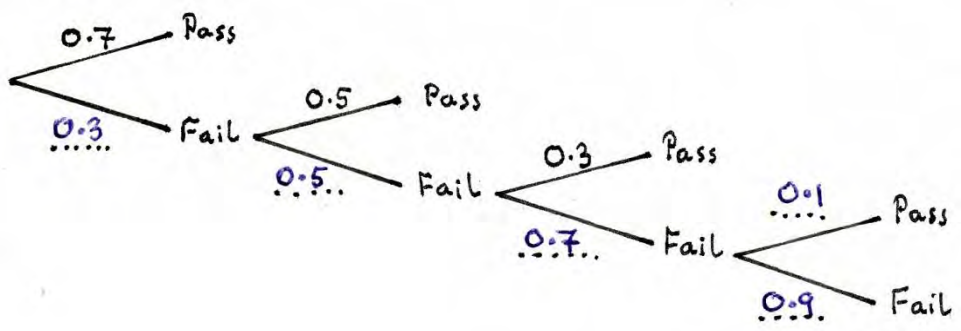
Question Number	Scheme	Marks
1.(a)	[F(5) =] $\frac{5}{6}$	B1 (1)
(b)	[E(X) =] $-2\times\frac{1}{4}+1\times\frac{1}{6}+3\times\frac{1}{3}+4\times\frac{1}{12}+6\times\frac{1}{6}$ or $\frac{1}{12}(-6+2+12+4+12)$	M1
	$= \mathbf{2}$	A1 (2)
(c)	[E(X^2) =] $(-2)^2\times\frac{1}{4}+1\times\frac{1}{6}+3^2\times\frac{1}{3}+4^2\times\frac{1}{12}+6^2\times\frac{1}{6}$ (o.e.)	M1
	or $\frac{1}{12}(12+2+36+16+72)$ or $\frac{138}{12}$ or $\frac{23}{2}$ (o.e.)	
	[Var(X) =] $"\frac{23}{2}"-"2"^2$	M1
	$= \mathbf{7.5}$ (o.e.)	A1 (3)
(d)(i)	[E(Y) = 7 – 2E(X) =] **3**	B1
(ii)	[Var(Y) =] $(-2)^2$ Var(X) or 4 Var(X)	M1
	$= \mathbf{30}$	A1
(iii)	$7-2X>X \Rightarrow 7>3X$	M1
	so $X = 1$ or -2	A1
	So [P($Y > X$) =] $\frac{5}{12}$	A1 (6)

	Notes
(a)	B1 for $\frac{5}{6}$ or exact equivalents e.g. $\frac{10}{12}$ or $0.8\dot{3}$
	For M1 in (b) & 1st M1 in (c) take full method leading to answer: e.g. ÷ by 5 (or n) is usually M0
(b)	M1 for an attempt at E(X) with at least 3 correct products seen. Answer only M1A1
(c)	1st M1 for an attempt at E(X^2) with at least 3 correct products seen (even if labelled Var(X)) Condone -2^2 if it later becomes + 4 but only 3 correct products are needed for M1
	2nd M1 for a correct numerical expression for Var(X) ft their E(X) and their E(X^2)
	A1 for 7.5 or any exact equivalent e.g. $\frac{15}{2}$ Answer only M1M1A1
(d)(i)	B1 for 3 only
(ii)	M1 for correct use of Var($aX+b$) formula. ft their value of Var(X) even if < 0
	A1 for 30 only
(iii)	M1 for attempt at solving a correct inequality as far as $a > bx$ (a and b both >0)
	1st A1 for identifying $X = 1$ and -2 as the required values (or $Y = 11$ and 5)[⇒ by corr ans]
	2nd A1 for $\frac{5}{12}$ or an exact equivalent
ALT	[y : 11 5 1 −1 −5] Allow M1 in (ii) for attempt at E(Y^2) = 39 (≥ 3 correct products) **and** Var(Y) = "39"−"3"^{2} ft their E(Y)
	Allow M1 in (iii) for attempt at full set of Y values with corresponding X probs (≥ 3 correct)

Question Number	Scheme	Marks
Question Number	Scheme	Marks
2.(a)	[pass for] **30** (labelled or 1st answer)	B1 (1)
(b)	[merit for] **46** (labelled or 2nd answer)	B1 (1)
(c)	$[1.5(Q_3 - Q_1) = 1.5 \times 16 = 24]$ so $c =$ **70** and $d =$ **6**	B1, B1 (2)
(d)	**68, 72, 79**	B2/1/0 (2)
(e)	$5 < d$ therefore 5 is an outlier	M1
		A1
		A1 (3)
(f)	$\frac{1}{2} \times \left(\frac{1}{4}\right)^2 \times 3$	M1M1
	$= \frac{3}{32}$	A1 (3)
		[12 marks]
	Notes	
	In (a), (b), (c) and (d) condone correct numbers with % e.g. 30% for (a)	
(c)	1st B1 for $c = 70$ 2nd B1 for $d = 6$ (Allow B1B1 for unlabelled 70 followed by 6)	
SC	Award B1B0 for $c = 6$ and $d = 70$ or 6 and 70 in the wrong order	
(d)	B2 for all 3 correct values (and no extra value) (B1 for two correct)	
(e)	**Fully correct box plot scores M1A1A1**	
	M1 for identifying or stating(e.g. on the grid) that 5 is the only outlier or lower whisker ending at 6 or 10 (May be implied by a correct diagram)	
	1st A1 for only one outlier correctly marked at 5 (whisker(s) must stop above 5)	
	2nd A1 for a single lower whisker stopping at 10 (2 whiskers is A0 here)	
	Condone 15 marked (e.g. dash or cross) on an otherwise correct whisker	
	If the outlier is at 5 and lower whisker ends at 6 award M1A1A0	
(f)	1st M1 for $\frac{1}{2} \times \left(\frac{1}{4}\right)^2$	
	2nd M1 for an expression of the form $pq^2 \times 3$ where p and q are probabilities $(p \neq q)$	
	NB $\frac{3}{4} \times \left(\frac{1}{4}\right)^2 \times 3 = \frac{9}{64} = 0.140625$ is a common incorrect answer and scores M0M1A0	
SC	Can award M0M1A0 if just $\frac{9}{64}$ (o.e.) is seen.	
	A1 for $\frac{3}{32}$ or exact equivalent. Allow 0.0937 or 0.0938 following a correct expression.	
Warning	$2 \times (0.25)^2 \times (0.75)$ or $2 \times \left(\frac{1}{4}\right)^2 \times \frac{3}{4}$ gives the correct answer but is M0M0A0	

Question Number	Scheme	Marks
3.(a)	$[S_{vs}] = 177.311 - \frac{36.8 \times 29}{8}$ = 43.911 = awrt **43.9**	A1
		M1
	$[S_{ss}] = 209.72 - \frac{36.8^2}{8}$ = 40.44 = awrt **40.4**	A1
		(3)
(b)	$r = \frac{"43.911"}{\sqrt{55.275 \times "40.44"}}$, = 0.92875… = awrt **0.929**	M1, A1
		(2)
(c)	r is close to 1 so there is support for the publisher's belief [if $1 > \lvert r \rvert$ … 0.5] (Allow "yes" because "strong corr." but "yes" & "positive corr." is B0)	B1ft
		(1)
(d)	$b = \frac{"43.911"}{55.275}$, = 0.7944… = awrt 0.79	M1, A1
	$a = \bar{s} - b\bar{v} = 4.6 - "0.7944..." \times 3.625$ [= 1.720…]	M1
	s =1.72 + 0.794v	A1
		(4)
(e)	$\frac{y}{1000} = "1.72" + "0.794" \times \left(\frac{x+50}{200} \right)$	M1
	y = 1920 + 3.97x	A1 A1ft
		(3)
(f)	Gradient of textbooks is greater	B1ft
	spend more advertising on textbooks	dB1ft
		(2)
		[15 marks]

	Notes	
(a)	M1 for one correct expression 1st A1 for $[S_{vs} =]$ awrt 43.9 2nd A1 for $[S_{ss} =]$ awrt 40.4	For correct answer with no working award M1 and the appropriate A1 Condone missing labels
(b)	M1 for a correct expr' for r, ft their 43.911 (but not 177.311) and their 40.44 (not 209.72) A1 for awrt 0.929 (correct ans only scores 2/2 and ans only of 0.93 scores M1A0)	
(c)	B1ft for saying it does support the belief or a linear model/relationship is suitable **and** giving a suitable reason e.g. strong correlation [If $\lvert r \rvert < 0.5$ allow "r close to 0" so "does not support" o.e.]	
(d)	**In (d) and (e) a correct answer with no working is awarded the M marks by implication** 1st M1 for a correct expression for b, ft their 43.911 and allow 3sf values to be used 1st A1 for awrt 0.79 or allow an exact fraction from the 3sf values e.g. $\frac{439}{553}$ 2nd M1 for a correct method for a, ft their value of b NB $\bar{s} = 4.6 = \frac{3.6}{8}$ and $\bar{v} = 3.625 = \frac{29}{8}$ 2nd A1 for equation for s in terms of v with a = awrt 1.72 and b = awrt 0.794	
(e)	M1 for correct sub. in their equation giving an equation in y and x. Allow 1 slip e.g. $\frac{y}{100}$ 1st A1 for c = 1920 (to 3 sf) 2nd A1ft for d = awrt 3.97 or $5 \times$(their b correct to 2 sig. figs.)	
ALT	Using coding formulae to get values for x, y requires a full method. Allow 1 slip but correct $d \Rightarrow$ M1	
(f)	1st B1ft for a suitable reason based on gradients (o.e. in words e.g. rate of increase...) 2nd dB1ft for recommending spend more on advertising textbooks	
ft	If gradient in (e) < 1.2 then a comparison of grads leading to spending on novels is B1B1	

Question Number	Scheme	Marks
4.(a)		B1 B1 (2)
(b)	$1-0.3\times0.5\times0.7\times0.9$ or $0.7+(0.3\times0.5)+(0.3\times0.5\times0.3)+(0.3\times0.5\times0.7\times0.1)$ $=$ **0.9055**	M1 A1 (2)
(c)	$[\mathrm{P}(P_1\cup P_2 \mid \text{Pass})=]$ $\dfrac{0.7+"0.3"\times0.5}{(b)}$, $=\dfrac{0.85}{"0.9055"}$ $=0.938707\ldots=$ awrt **0.939**	M1, A1ft A1 (3)
(d)	$p+(1-p)(p-0.2)$ or $1-(1-p)(1.2-p)$ (o.e.) e.g. $p+p-p^2+0.2p-0.2=0.95 \rightarrow p^2-2.2p+1.15=0$ **(*)**	M1 dM1A1cso (3)
(e)	$p=\dfrac{2.2\pm\sqrt{2.2^2-4\times1.15}}{2}$ or Complete the sq: $(p-1.1)^2-1.1^2+1.15=0$ $=\dfrac{2.2\pm0.4898...}{2}$ or $\dfrac{2.2\pm\sqrt{0.24}}{2}$ or $1.1\pm\sqrt{0.06}$ or (1.34…), 0.855… p = 0.85505102… p = **0.855**	M1 A1 A1 (3)

	Notes
(a)	1st B1 for correctly placing 0.3 and 0.5 2nd B1 for correctly placing 0.7, 0.1 and 0.9
	Apart from (d), a correct answer with no incorrect working scores full marks.
(b)	M1 for a correct expression (ft from their tree diagram) A1 for 0.9055 or exact equivalent e.g. $\frac{1811}{2000}$ Accept 0.906 only if correct expr' seen
(c)	M1 for a correct ratio of probs ft their 0.3 and their answer to (b)[if < 1]. Num > Den M0 A1ft for correct numerator and their part (b) on denominator A1 for awrt 0.939 or accept exact fraction eg $\frac{1700}{1811}$
(d)	1st M1 for a correct expression for P(pass) in terms of p[condone $p-(p-1)(p-0.2)$ etc] 2nd dM1 dep. on 1st M1 for expanding brackets and forming an equation in p Allow one slip A1cso correct processing leading to printed answer. No incorrect working seen.
(e)	M1 for attempt to solve **given** equation, correct expression. Condone just + not ± 1st A1 for correct expression and simplified square root or 1.34… and 0.855… 2nd A1 for p = 0.855 only (penalise any extra value > 1) Correct ans only scores 3/3
Ans. only	For $\frac{1}{10}\left(11-\sqrt{6}\right)$ or 0.855... score M1A1A0 (not to 3dp) but for 0.855 can score M1A1A1

Question Number	Scheme	Marks
5.(a)	$[\mathrm{P}(H<18)=]\ \mathrm{P}\left(Z<\frac{18-22}{10}\right)=\mathrm{P}(Z<-0.4)$	M1
	$=1-0.6554$	dM1
	$=0.3446$ or awrt **0.345**	A1
		(3)
(b)	$\mathrm{P}(H>50)=\mathrm{P}(Z>2.8)=1-0.9974=0.0026$	M1 A1
	$\mathrm{P}(H>39)=\mathrm{P}(Z>1.7)=1-0.9554=0.0446$	M1 A1
	$\mathrm{P}(H>50\mid H>39)=\frac{\mathrm{P}(H>50)}{\mathrm{P}(H>39)}$ or $\frac{"0.0026"}{"0.0446"}$	M1
	= **0.057~0.0585**	A1
		(5)
(c)	$\frac{18-\mu}{\sigma}=-0.8416$ $\quad$ $\frac{28-\mu}{\sigma}=1$	M1B1A1
	Solving: $10=1.8416\sigma$	M1
	$\sigma=$ awrt **5.43**	A1
	$\mu=$ awrt **22.57**	A1
		(6)
		[14 marks]

	Notes
(a)	1st M1 for standardising with 18, 22 and 10. Allow $\pm\frac{18-22}{10}$
	2nd dM1 dependent on 1st M1 for $1-p$ where $0.6<p<0.7$
	A1 for 0.3446 or better or awrt 0.345. NB Calculator gives 0.3445783…Ans only 3/3
(b)	1st M1 for correct standardisation and $1-q$ (where $q=0.9\ldots$) for one of these probs
	1st A1 for 0.0026 or better (calc 0.0025551…) or $1-0.9974$ (or better)
	2nd A1 for 0.0446 or better (calc 0.0445654…) or $1-0.9554$ (or better)
	2nd M1 for a correct ratio of probability expressions or values (ft their 0.0026 and 0.0446 but if num. > denom. then M0)
	3rd A1 for answer in the range 0.057~0.0585. No fractions but $\frac{13}{223}$ can score M1A1A1M1A0
Ans. only	Can score full marks for either awrt 0.0583 (tables) or awrt 0.0573 (calc) only
(c)	1st M1 for attempt to standardise with μ, σ and 18 or 28 and set equal to a z value ($\pm$) The z values should be in the range (0.8, 0.9) for "18" and (0.95, 1.05) for "28"
	B1 for using $z=0.8416$ or better (allow $\pm$) Calculator gives 0.8416212…
	1st A1 for both equations with ± 1 and ± 0.84 or better
SC	for $\frac{28-\mu}{\sigma}=\pm 0.8416$ and $\frac{18-\mu}{\sigma}=\pm 1$ award M1B1A0 (0.84 instead of 0.8416 loses B1)
	2nd M1 for solving their linear equations in μ & σ. Reducing to an equation in one variable. Correct processes allow one sign slip
	2nd A1 for $\sigma=$ awrt 5.43
	3rd A1 for $\mu=$ awrt 22.57
Calc	No $z=0.8416$ or better seen: can award 6/6 for $\sigma=$ awrt 5.4300 or 5.4301 and $\mu=$ awrt 22.57
No working	For $\sigma=$ awrt 5.43 and $\mu=$ awrt 22.57 award M1B0A1M1A1A1 i.e. 5/6

Question Number	Scheme	Marks
6.(a)	$(\mu \text{ or } \bar{x} =)\dfrac{8360}{10} =$ **<u>836</u>**	B1
	$(\sigma =)\sqrt{\dfrac{\sum(x-\bar{x})^2}{10}} = \sqrt{6384}$ or $4\sqrt{399}, = 79.89993\ldots$ awrt **<u>79.9</u>**	M1, A1
		(3)
(b)	mean > median	B1
	So <u>positive</u> (skew)	dB1
		(2)
(c)	$\dfrac{776+896}{2} = 836$ which is the same as $\bar{x}$ <u>or</u> one is 60 above $\bar{x}$, one 60 below	B1
	So <u>no change</u> in the mean	dB1
		(2)
(d)	$(896-836)^2 = (776-836)^2 = 60^2 = 3600 < 6384$ the average of $\sum(x-\bar{x})^2$	B1
	<u>Or</u> $\sum(x-\bar{x})^2 \to 63840 + 2\times 60^2 = 71040$ and $\dfrac{71040}{12} = 5920 < \dfrac{63840}{10}$	
	So standard deviation will <u>reduce</u>	dB1
		(2)
		[9 marks]

	Notes
(a)	M1 for $\dfrac{63840}{10}$ with or without $\sqrt{}$ (ignore labels) <u>or</u> $s^2 = \dfrac{63840}{9}$
	NB $\sum x^2 = 7052800$ but must see at least $\sigma^2 = \frac{7052800}{10} - (\text{"836"})^2$ for M1
	A1 for awrt 79.9 Accept s = awrt 84.2 (84.2219..). Correct answer only M1A1
(b)	1st B1 for a correct comparison of mean and median (allow just 836 > 815)
	May see $\dfrac{k(\text{mean} - \text{median})}{\sigma \text{ or } \sigma^2}$ (o.e.) if so just check sign of answer (provided denom > 0)
	2nd dB1 dependent on 1st B1 for positive (skew) only. Positive correlation is B0
SC	If their mean is < 815 award B0B1 for the comparison <u>and</u> statement of negative skew
(c)	1st B1 for a suitable calculation to show(or statement) that mean of these two rabbits(or all 12) is the same e.g. new $\sum x = 8360 + 776 + 896 = 10032$, so mean $= \dfrac{10032}{12} = 836$
	2nd dB1 dependent on a suitable calculation or reason for stating "no change" o.e.
SC	If they only say differences are the same (but not 1 above and 1 below o.e.) <u>and</u> state no change then award B0B1
(d)	1st B1 for a suitable calculation showing 60 or 3600 and comparing with 79.9 or 6384 respectively (must see some calculation here)
	<u>or</u> calculation of new variance (5920 vs 6384) or st. dev (76.9 vs 79.9)
	2nd dB1 dependent on 1st B1 for stating s.d. "reduces" (o.e.)
Use of Σx^2	Send arguments based on Σx^2 to review

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