edexcel

Mark Scheme (Results)

Summer 2016

Pearson Edexcel GCE in Statistics S1 (6683/01)

ALWAYS LEARNING PEARSON

Edexcel and BTEC Qualifications

Edexcel and BTEC qualifications are awarded by Pearson, the UK's largest awarding body. We provide a wide range of qualifications including academic, vocational, occupational and specific programmes for employers. For further information visit our qualifications websites at www.edexcel.com or www.btec.co.uk. Alternatively, you can get in touch with us using the details on our contact us page at www.edexcel.com/contactus.

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

Summer 2016
Publications Code 6683_01_1606_MS
All the material in this publication is copyright
© Pearson Education Ltd 2016

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.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

PEARSON EDEXCEL GCE 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
   - $\sqsubset$ 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.

June 2016
6683 STATISTICS 1
Mark Scheme

Question Number	Scheme	Marks
1.(a)	$S_{dw} = 13833 - \frac{"1960" \times 33.6}{8}$ or $13833 - \frac{65856}{8}$ (But 13833 – 8232 is M0)	M1
	= **5601** (*)	A1 cso
		(2)
(b)	w, since the number of wiggles depends on the distance or w depends on d	B1
		(1)
(c)	$r = \frac{5601}{\sqrt{394600 \times 80.481}}$, $= 0.99389\ldots$ **awrt 0.994**	M1,A1
		(2)
(d)	$b = \frac{5601}{394600}$, = 0.014194…. (awrt 0.014)	M1, A1
	$a = \frac{33.6}{8} - "0.01419..." \times \frac{"1960"}{8} = 4.2 - "0.01419..." \times 245$ [= 0.72244..]	M1
	$w = 0.722 + 0.0142d$	A1
		(4)
(e)	(i) [0.722 + 0.0142×350 =] **awrt: 5.7** or **5.6**	B1
	(ii) Reliable since 350 m is in the range of the data	B1
		(2)
		[11 marks]

	Notes
(a)	M1 for clear attempt to find Σd and use in a correct formula. Accept $1300 < \Sigma d < 2500$ For the M1 we can condone a single slip e.g. using 1383 instead of 13833 etc A1cso for correct Σd and 5601 only. Must see the formula and so have scored M1
(b)	B1 Must select w (or wiggles) and reason based on the idea that w is dependent on d Allow w "changes according to"/ "is determined/affected by" Must mention w and d B0 for "w is measured" or "d is explanatory/indep't" or "w can't be controlled" or "w responds to d"
(c)	M1 for a correct expression (Allow ft of their incorrect S_{dw}) A1 for awrt 0.994 (Answer only 2/2) [Answer only of 0.99 scores M1A0]
(d)	1st M1 for a correct expression for b. (Allow ft of their incorrect S_{dw}) 1st A1 for awrt 0.014 No fractions. [Answer only 2/2] Can be given at final equation. [Must come from correct formula not gradient of line from e.g. (650, 9.555) to (30, 0.725)] 2nd M1 for a correct method for a. Follow through their value of b and their Σd 2nd A1 for a correct equation for w and d with a = awrt 0.722 and b = awrt0.0142 No fractions Equation in x and y is A0 Answer only 4/4
(e)	1st B1 for awrt 5.7 or awrt 5.6 2nd B1 for a reason citing 350 (m) or mentioning d is in the range of the data and stating reliable. Allow "Interpolation (or not extrapolation) therefore reliable". Saying "5.7 (or w or just "it") is in the range" is B0 "accurate" instead of "reliable" is B0 "strong correlation" (without mention of interpolation o.e.) is B0 Apply ISW if a correct comment is seen.

Question Number	Scheme	Marks
2.(a)	$p + q + 0.2 + 0.3 + p = 1$ or $2p + q = 0.5$ (o.e.)	B1 (1)
(b)	[E(X) =] $-2p - q + \frac{1}{2}\times 0.2 + \frac{3}{2}\times 0.3 + 2p$ [= 0.4] or $-q + 0.1 + 0.45$ [= 0.4]	M1A1
	$\underline{\boldsymbol{q = 0.15}}$	A1 (3)
(c)	$2p$ + "0.15" = 0.5 (o.e)	M1
	$\underline{\boldsymbol{p = 0.175}}$	A1 (2)
(d)	[Var(X) =] $2.275 - (0.4)^2$	M1
	= $\underline{\mathbf{2.115}}$ (Accept 2.12)	A1 (2)
(e)	r | $-\frac{1}{2}$ | -1 | 2 | $\frac{2}{3}$ | $\frac{1}{2}$ P($R = r$) | p | q | 0.2 | 0.3 | p	M1
	E(R) = $-\frac{1}{2}p - q + 0.4 + 0.2 + \frac{1}{2}p$	dM1
	$= 0.6 - q =$ $\underline{\mathbf{0.45}}$ (or $\frac{9}{20}$)	A1ft (3)
(f)(i)	$S > R$ when x = 1.5 and 2	M1
	P(Sarah wins) = $0.3 + p$ = $\underline{\mathbf{0.475}}$ (or $\frac{19}{40}$)	A1ft
(ii)	$R > S$ when x = -2 and $\frac{1}{2}$ or $r = -\frac{1}{2}$ and 2	M1
	P(Rebecca wins) = $0.2 + p$ = $\underline{\mathbf{0.375}}$ (or $\frac{15}{40}$)	A1ft (4)
		[15 marks]

	Notes
(a)	B1 for any correct equation based on sum of probs. = 1
	Correct answer only in (b), (c), (d), (e) or (f) scores full marks for that part.
(b)	M1 for an attempt at an expression based on E(X). At most 2 errors or omissions.
	1st A1 for a correct equation [May be implied by a correct answer]
	2nd A1 for q = 0.15 or exact equivalent e.g. $\frac{6}{40}$
(c)	M1 for correct equation or using their equation from (a) with their q, provided $q \in$ [0,1]
	A1 for p = 0.175 or exact equivalent e.g. $\frac{7}{40}$
(d)	M1 for a correct numerical expression but M0 if followed by division by k (e.g. k = 5)
	A1 for 2.115 or accept awrt 2.12 (also accept exact equivalent e.g. $\frac{423}{200}$)
(e)	1st M1 for correct values for R, allow 1 error, and allow unsimplified. Condone no label if not used as probabilities. If seen in table on QP allow, but must be labelled. Just writing the sum Σr is M0 but adding later can score 1st M1
	2nd dM1 dependent on 1st M1 for an attempt at an expression based on E(R), ft p and q, (if probabilities) ft their r values. At least 3 correct (or correct ft) products seen.
	A1ft for 0.45 or (0.6 – their q) provided q is a probability
	Answers for (f) must be clearly labelled or take 1st as (i) and 2nd as (ii)
(f)(i)	M1 for identifying the correct values of X
	A1ft for 0.475 or 0.3 + their p , provided answer is a probability
(ii)	M1 for identifying the correct values of X or R
	A1ft for 0.375 or 0.2 + their p or 1 – their 0.475 – their q, provided ans. is a probability
SC1 X_1,X_2	They use two values of X: (i) for P($S > R$) = 0.445 (B1) (ii) for P($R > S$) = 0.4625 (B1). No ft
SC2 swap	Answers wrong way round: (i) P($S > R$) = 0.375 and (ii) P($R > S$) = 0.475 (B1) No ft
Epen	**On epen record SC1 as: (i) M0A1 (ii) M0A1 and SC2 as M0A0M0A1**

Question Number	Scheme	Marks
3 .(a)	$[\sigma_x^2 =]\ \frac{985.88}{8} - \left(\frac{86.8}{8}\right)^2 = \frac{985.88}{8} - 10.85^2$	M1
	$\sigma_x = \sqrt{\frac{985.88}{8} - \left(\frac{86.8}{8}\right)^2} = \sqrt{123.235 - 117.7225} = \sqrt{5.5125}$ or $\sqrt{\frac{44.1}{8}}$	A1
	$= 2.3478\ldots$ = awrt **2.35**	A1
		(3)
(b)	$S_{yy} = 8 \times \sigma_y^2 = 716$ (3 sf) but may see	
	$1136.584 - \frac{58^2}{8}$ or $27628(.084168) - \frac{464^2}{8}$ or 716.08... (= 716 to 3 sf) **(*)**	B1cso
		(1)
(c)	$S_{xy} = 4900.5 - 58 \times 86.8$ or $4900.5 - \frac{86.8 \times 464}{8}$	M1
	$= -$**133.9** (Allow -134)	A1
		(2)
(d)	$r = \frac{-133.9/8}{\sigma_x \times \sigma_y}$ or $\frac{-133.9}{\sqrt{44.1 \times 716}}$	M1
	= awrt $-$**0.753** or $-$**0.754**	A1
		(2)
(e)	$r < 0$ means high sunshine and low rain; this is high sunshine high rain	B1
	[this is not in keeping with the trend so] r is closer to 0 or $\lvert r \rvert$ decreases	B1
		(2)
		[10 marks]

	Notes
(a)	M1 for a correct expr' for st. dev or variance (ignore label)[may be implied by 2.35 or 5.5125] 1st A1 for a correct expression for st. dev (must have square root) can ignore label 2nd A1 for awrt 2.35 (allow $s = 2.5099\ldots$ or awrt 2.51). If they have $\sigma^2 = 2.35$ score A0 but condone no label
(b)	B1cso for a correct expression or sight of at least 716.08… (NB limits: 716.00~716.16) Do not allow verification. Beware circular arguments: $716 \rightarrow \Sigma y^2 \rightarrow$ expr' $\rightarrow 716$
(c)	M1 for a correct expression for S_{xy} (NB $\Sigma y = 464$) A1 for -133.9 or awrt -134 [No fractions] (Answer only 2/2)
(d)	M1 for a correct expression for r (ft their values for S_{xy} and σ_x or S_{xx})[Allow ft of S_{yy}] A1 for awrt -0.753 or -0.754 (Answer only 2/2)
(e)	**If they do not have an answer to (d) or their value of r is > 0 or $\lvert r \rvert$ > 1 score B0B0 here** 1st B1 for a suitable reason contradicting $r < 0$ e.g. new value is not in keeping with trend or both $14 > \bar{x}$ and $70 > \bar{y}$ or saying both above average. Allow for $-0.48 <$ new $r < -0.47$ 2nd B1 for a correct statement about r getting closer to zero e.g. $\lvert r \rvert$ decreases A comment that r decreases or r is smaller or r is "less negative" is B0 "r increases" is B0 unless they also say that it gets closer to 0

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

	Notes
(b)	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 or in a correct equation. May see e.g. $\mathrm{P}(B \mid D) = \dfrac{0.27}{0.42+t}$ 2nd M1 for using the independence to form a linear equation in t. ft their probs if stated. 1st A1 for solving leading to a correct equation as far as $p + t = q$ or $pt = q$ 2nd A1 for 0.03 or exact equivalent
(c)	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) or ft their t. i.e. $u = 0.25 - t$ provided u & t are probs Can score M1A1ft provided their u + their t = 0.25 where u and t are both in [0, 1]
(d)(i)	M1 for a correct numerical ratio of probabilities A1 for 0.45 or exact equivalent (Answer only 2/2)
(ii)	M1 for a correct numerical ratio of probabilities, ft their u, provided u is a probability A1 for $\frac{15}{37}$ or $0.\dot{4}0\dot{5}$ or allow awrt 0.41 following a correct expression (Ans only 2/2)
(e)	M1 for a correct method for both 18 and 15 ft their 0.45 and their $\frac{15}{37}$ provided both in [0,1] NB $\mathrm{P}(D) \times 77$ is M0 A1 for 33 only NB $\frac{27}{33} \times 40 = 32.7\ldots$ which rounds to 33 but scores M0A0. (**Ans only send to review**)

Question Number	Scheme	Marks
5.(a)	Width = **0.5** (cm) e.g 4 [cm^2] represents 8 babies or frequency densities are 8 and 34 Height = **17** (cm)	B1 M1 A1 (3)
(b)	$[Q_2 =]$ $\{3\}+\frac{(25-9)}{(26-9)}\times 0.5$, or $\{3.5\}-\frac{(25-24)}{(41-24)}\times 0.5$ = awrt **3.47** (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 **0.680** (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 **0.254~0.255**	M1 M1 A1 (3)
(e)	(b) and (c)(i) mean ≠ med or skew or mean~ median or no skew **and** 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 or 0.18 similar to 0.25 so normal is OK	B1 B1 dB1 (3)
(f)(i) **(ii)**	No change in mean (since weight is the same) s.d. will decrease (Extra value is at "centre" so data more concentrated) Both statements correct and correct reasons for each	B1 B1 dB1 (3) **[17 marks]**
	Notes	
(a)	M1 for clear representation of area with frequency or height × 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 $\frac{16}{17}\times 0.5$ or 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] or (if using (n + 1) for 3.485 or awrt 3.49)	
(c)(i)	B1cso for Σfx (at least 3 correct & no incorrect products seen) and correct $\frac{\sum fx}{50}$ 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)	1st M1 for an attempt to standardise with 3, 3.43 and 0.65. Allow ± and also use of their sd 2nd M1 for 1 – p where 0.74 < p < 0.75 NB calculator gives 0.7458665… A1 for awrt 0.254 or 0.255	
(e)	1st B1 for a statement about mean/median **and** compatible comment about normal 2nd B1 for statement comparing their (d) with data (sight of 0.18 or 12.7 and 9 required) 3rd dB1 dep on 2nd B1 for conclusion about normal compatible with 2nd statement	
(f)(i) **(ii)**	1st B1 for no change in mean {send a correct argument for decrease to review} 2nd B1 for s.d. decreases 3rd dB1 dep on 1st and 2nd Bs for a correct reason for both mean and sd e.g. "new mean the same so within 1 s.d. of old mean"	

Question Number	Scheme	Marks
6.(a)	[$T \sim N(240, 40^2)$…require $P(T > 300)$]	
	$P\left(Z > \frac{300-240}{40}\right)$	M1
	$= 1 - P(Z < 1.5)$ or $1 - 0.9332$	M1
	= awrt **<u>0.0668</u>** or 6.68%	A1
		(3)
(b)	$\left[P(T < n) = 0.20 \Rightarrow\right]$ $\frac{n-240}{40} = -0.8416$	M1 B1
	n = awrt **<u>206</u>** minutes	A1
		(3)
(c)	$[P(W < \mu - 30 \mid W < \mu) =]$ $\frac{P(W < \mu - 30)}{P(W < \mu)}$	M1
	$= \frac{1-0.82}{0.50}$	A1
	= **<u>0.36</u>**	A1cao
		(3)
		[9 marks]

	Notes
(a)	1st M1 for standardising with 300, 240 and 40. May be implied by use of 1.5 Allow <u>±</u> 2nd M1 for $1 - P(Z <$ "1.5") i.e. a correct method for finding $P(Z >$ "1.5") e.g. $1 - p$ where $0.5 < p < 0.99$ A1 for awrt 0.0668 (Answer only 3/3)
(b)	M1 for an attempt to standardise with 240, 40 and n and set = <u>±</u> z $(0.8 < \lvert z \rvert < 0.9)$ B1 for $z = \pm 0.8416$ (or better) <u>used</u> as a z value. Do not allow for $1 - 0.8416$ Calc gives 0.8416212…[**May be implied by awrt 206.34**, give B1 as well as A1 if seen] A1 for awrt 206 (can be scored for using a z value of 0.84 or even 0.85) Must follow from correct working but a range of possible z values are OK
Ans only	If answer is awrt 206 score M1B0A1 (unless of course z = 0.8416 seen) but awrt 206.34 scores 3/3
(c)	M1 for the correct ratio expression (<u>Not</u> $P(\left[W < 30 - \mu\right] \cap \left[W < \mu\right])$ on numerator) Condone use of Z instead of W <u>only if</u> they later get a correct numerical ratio otherwise M0 However they may write $P\left(Z < \frac{-30}{\sigma}\right)$ etc which is of course fine 1st A1 for a correct numerical ratio
Use tables	May see use of $z = 0.92$ or better (calc: 0.9153650…) or $\sigma = 32.6$~32.8 allow:
ALT	1st M1 for $\frac{P(Z < -0.92)}{P(Z < 0)}$ and 1st A1 for $\frac{1-0.8212}{0.5}$ or $\frac{0.1788}{0.5}$
	2nd A1 for 0.36 or an exact equivalent e.g. $\frac{9}{25}$ (Answer only M1A1A0) The final answer of 0.36 <u>must</u> come from exact values; 0.36 rounded from 0.3576 etc is A0

Pearson Education Limited. Registered company number 872828
with its registered office at 80 Strand, London, WC2R 0RL, United Kingdom