Pearson Edexcel

Mark Scheme

Mock Set 4

Pearson Edexcel GCE In Mathematics (9MA0)
Paper 31 Statistics

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

Spring 2023
Publications Code 9MA0_31_MS4_MS

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.

EDEXCEL GCE MATHEMATICS
General Instructions for Marking

1. The total number of marks for the paper is 50.

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)
   - dep – dependent
   - indep – independent
   - dp decimal places
   - sf significant figures
   - * The answer is printed on the paper
   - ⎾ The second mark is dependent on gaining the first mark

4. 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.

5. Where a candidate has made multiple responses and indicates which response they wish to submit, examiners should mark this response.
   If there are several attempts at a question which have not been crossed out, examiners should mark the final answer which is the answer that is the most complete.
6. Ignore wrong working or incorrect statements following a correct answer.

7. Mark schemes will firstly show the solution judged to be the most common response expected from candidates. Where appropriate, alternatives answers are provided in the notes. If examiners are not sure if an answer is acceptable, they will check the mark scheme to see if an alternative answer is given for the method used.

Question	Scheme	Marks	AOs
1(a)	Greatest distance at which an object can be seen (and recognised in daylight)	B1	1.2
	11 000 m or 11 km (or 1100 dam – accept 1100 Dm)	B1	1.2
		(2)	
(b)	(–1.035 is not possible as) must have $-1 \leqslant r$ ($\leqslant 1$)	B1	2.4
		(1)	
(c)	–0.757	B1	1.1b
		(1)	
(d)	$H_0: \rho = 0$ $H_1: \rho \neq 0$	B1	2.5
	cv = (±) 0.7067	M1ft	1.1b
	(–0.757 < –0.7067 so in critical region, reject H_0 and accept H_1) Sufficient evidence of correlation between (Daily Maximum Relative) Humidity and (Daily Mean) Visibility (so supports Jen's belief).	A1	2.2b
		(3)	
(e)	May not be correct due to, any two from: • May differ at other times / sample only considered October/2015 • May differ in other locations • Sample was not representative • Even under H_0, there is a 5% chance the test result is not correct Condone may not be a causal relationship	B1 B1	3.5b 3.5b
		(2)	
			(9 marks)

Notes:

(a)	**B1:** correct interpretation of visibility **B1:** correct (interpretation of) units
(b)	**B1:** correct reasoning
(c)	**B1:** allow awrt –0.757 (calculator gives –0.757383…) Check for answer identified in the given list.
(d)	**B1:** must be in terms of ρ (Accept one-tail with $H_1: \rho < 0$) **M1:** ft on their H_1 (1 tail cv would be –0.6215) **A1:** correct conclusion in context
(e)	**B1:** any one equivalent reason from given options **B1:** a second equivalent reason from given options - allow each bullet once only

Question	Scheme	Marks	AOs
2(a)	[P($T = 0$) =] $(1 - p)^2$ oe	B1	1.1b
		(1)	
(b)	e.g. if $\mathrm{P}(T = 2) = \frac{1}{3} \Rightarrow p = \frac{1}{\sqrt{3}}$	M1	1.1b
	and $\mathrm{P}(T = 0) = \frac{1}{3} \Rightarrow p = 1 - \frac{1}{\sqrt{3}}$ or $\mathrm{P}(T = 1) = \frac{1}{3} \Rightarrow p = \frac{3 \pm \sqrt{3}}{6}$	M1	1.1b
	No consistent solution hence discrete uniform distribution not appropriate as model for T	A1	2.4
		(3)	
			(4 marks)

Notes:

(a)	**B1:** any correct form
(b)	**M1:** for use of probability of $\frac{1}{3}$ from discrete uniform distribution to deduce a value for p **M1:** for use of a second probability P($T = t$) to deduce a value for p e.g. $p^2 = (1 - p)^2 \Rightarrow p = \frac{1}{2}$ **A1:** for equivalent conclusion following correct working

Question	Scheme	Marks	AOs
3(a)(i) (ii)	$\left[\mathrm{P}\left(Y \cap X'\right) =\right]$ 0.2	B1	1.1b
	$\left[\mathrm{P}\left(Y \middle\| X'\right) =\right]$ $\dfrac{\mathrm{P}\left(Y \cap X'\right)}{\mathrm{P}\left(X'\right)}$	M1	3.1a
	$= \dfrac{0.2}{b+0.2}$	A1	1.1b
		(3)	
(b)	$\dfrac{a}{a+0.2} = \dfrac{0.2}{b+0.2}$	M1	3.1a
	$ab + 0.2a = 0.2a + 0.2 \times 0.2$	dM1	1.1b
	$ab = 0.04$ *	A1*cso	1.1b
		(3)	
(c)	$a + b = 1 - 0.3 - 0.2 \quad (= 0.5)$	B1	1.1b
	e.g. $a\left(0.5 - a\right) = 0.04$	M1	3.1a
	$a^2 - 0.5a + 0.04 = 0$	dM1	1.1b
	$a = 0.4$ [or 0.1]	dM1	1.1b
	$a = 0.4$ and $b = 0.1$	A1	1.1b
		(5)	
(d)	e.g. $\mathrm{P}\left(X\right) = 0.3 + "0.4" \quad (= 0.7)$ and $\mathrm{P}\left(X \middle\| Y\right) = \dfrac{"0.4"}{"0.4" + 0.2} \quad (= 0.666...)$ or $\mathrm{P}\left(X\right) \times \mathrm{P}\left(Y\right) = \left(0.3 + "0.4"\right)\left("0.4" + 0.2\right) \quad (= 0.42)$ and $\mathrm{P}\left(X \cap Y\right) = "0.4"$	M1	2.1
	$\mathrm{P}\left(X\right) \neq \mathrm{P}\left(X \middle\| Y\right)$ or $\mathrm{P}\left(X\right) \times \mathrm{P}\left(Y\right) \neq \mathrm{P}\left(X \cap Y\right)$ […hence not independent]	A1cso	1.1b
		(2)	
			(13 marks)

Notes:	
(a)(i) **(ii)**	**B1:** cao **M1:** correct ratio of probabilities **A1:** correct expression
(b)	**M1:** attempts quotient equation in a and b, with one side correct (allow RHS = their (a)(ii)) **dM1:** eliminate fractions from their equation **A1*:** cso
(c)	**B1:** makes use of $\Sigma p = 1$ **M1:** solve $ab = 0.04$ with their $a + b = 0.5$ to obtain equation in one variable **dM1:** simplify their quadratic **dM1:** solve their quadratic equation to reach at least 0.4 or 0.1 **A1:** both a and b correct, any extra values dismissed
(d)	**M1:** attempt all necessary probabilities for an appropriate test (allow in terms of a or b) **A1:** all correctly evaluated probabilities used in an appropriate test to show not independent

Question	Scheme	Marks	AOs
4(a) **(i)** **(ii)**	$X \sim \mathrm{B}\left(6, \frac{1}{6}\right)$	M1	3.3
	$\left[\mathrm{P}(X = 3) =\right]$ 0.053583... awrt 0.0536	A1	1.1b
	$\left[\mathrm{P}(X \geqslant 3) = 1 - 0.93771... =\right]$ 0.062285... awrt 0.0623	A1	1.1b
		(3)	
(b)	$\mathrm{H}_0 : p = 0.0623$ $\mathrm{H}_1 : p > 0.0623$ (allow $\mathrm{H}_0 : p = \frac{1}{6}$ $\mathrm{H}_1 : p > \frac{1}{6}$)	B1ft	2.5
	[If Y = number who score] $Y \sim \mathrm{B}(5, 0.0623)$	M1	3.3
	$\mathrm{P}(Y \geqslant 2) = 1 - \mathrm{P}(Y \leqslant 1)$ $1 - 0.96581\ldots = 0.03418\ldots$ awrt 0.0342	A1	3.4
	[$0.0342 < 0.05$, reject H_0] There is evidence to support Ali's claim	A1	2.2b
		(4)	
			(7 marks)

Notes:

(a)(i)	**M1:** correct model selected, seen or implied **A1:** awrt 0.0536
(ii)	**A1**: awrt 0.0623
(b)	**B1ft:** hypotheses must be in terms of p (or π). Allow $\frac{1}{6}$ or ft their (a)(ii) **M1:** correct distribution seen or implied **A1:** awrt 0.0342 **A1:** correct conclusion in context, must mention **Ali's claim** or **dice**

Question	Scheme	Marks	AOs
5(a)	e.g. Polygon for *B* shows less dispersion (oe)	B1	2.4
		(1)	
(b)	$780\times0.05-640\times0.05$ (oe)	M1	3.4
	$=7$	A1	1.1b
		(2)	
(c)	$\sqrt{\frac{3371.1975}{100}-\bar{x}^2}=0.0483632$ (o.e.)	M1	3.1a
	$\bar{x}=5.806$ awrt 5.81	A1	1.1b
		(2)	
(d)	$\left[\mathrm{P}(D<5.75)=\right]$ 0.105649... awrt 0.106	B1	1.1b
		(1)	
(e)	$\left[\mathrm{P}(D>5.85\middle\vert D>5.75)=\right]$ $\frac{\mathrm{P}(D>5.85)}{\mathrm{P}(D>5.75)}$	M1	3.1b
	$\frac{0.20232...}{1-"0.106"}$ (= 0.22622…)	M1	1.1b
	Number machined down = $40\times"0.226..."$ $[=9.049...]$	dM1	1.1b
	so expect 9 machined down	A1	2.2a
		(4)	
			(10 marks)

Notes:

(a)	**B1:** equivalent conclusion related to dispersion. Accept polygon for *B* is higher for the range of suitable diameters.
(b)	**M1:** using frequency density, correctly for either polygon, **and** attempt difference **A1:** cao
(c)	**M1:** correct use of standard deviation or variance **A1:** cao
(d)	**B1:** correct probability using calculator
(e)	**M1:** attempt correct ratio of probabilities **M1:** correct expression with numerator awrt 0.202 < denominator (1 – their (d)), implied by answer 9.05 or better (calculator gives 9.04917…) **dM1:** dep on 2nd M1 for 40 × their 0.226 (implied by answer 9.05 or better) **A1:** cao

Question	Scheme	Marks	AOs
6(a) (i)	Points close to a straight line supports Roberta's belief	B1	2.4
(ii)	$\log c = \log a + x\log b$ or $\log c = 1.10 + 0.204x$	M1	1.1b
	$\log a = 1.10$ and $\log b = 0.204$ or $c = 10^{1.10}(10^{0.204x})$	M1	2.1
	$a = 12.589\ldots$ $b = 1.5995\ldots$	A1	1.1b
	$c = 12.6\times 1.60^{x}$	A1	1.1b
		(5)	
(b)	$\left[12.6\times 1.60^{6} = \right] 211 > 200$, so claim is supported	B1ft	1.1b
		(1)	
(c)	e.g. Prediction may be unreliable due to extrapolation / 6 years is beyond the range of data (oe) **or** 6 years is only just outside the range so may be reliable (oe)	B1	3.5b
		(1)	
			(7 marks)

Notes:

(a)(i) (ii)	**B1:** reference to graph being (nearly) linear **M1:** correct use of laws of logarithms with the given model **M1:** correctly matching model to given regression line **A1:** either value a = awrt 12.6 or b = awrt 1.60 **A1:** correct final model with a = awrt 12.6 and b = awrt 1.60 (accept 1.6 with working)
(b)	**B1ft:** correct conclusion with correct evaluation (awrt 211), ft their answer to (a) if correct form.
(c)	**B1:** any suitable justified conclusion e.g. unreliable and idea of extrapolation e.g. growth in number of customers may not continue

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