Comparison of key skills specifications 2000/2002 with 2004 standardsX015461July 2004Issue 1

Mark Scheme (Results)

Summer 2022

Pearson Edexcel GCE

In Mathematics (9MA0)

Paper 31 Statistics

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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.

**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.

1. 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 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

1. 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.
2. 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.

1. Ignore wrong working or incorrect statements following a correct answer.
2. 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)(i)** | | *X* ~B(15, 0.48) | | | M1 | 3.3 |
| awrt 0.0197 | | | A1 | 3.4 |
| **(ii)** | | awrt 0.920 | | | A1 | 1.1b |
|  | |  | | | **(3)** |  |
| **(b)** | | *Y* is the number of hits | *M* is the number of misses | |  |  |
|  |  | | B1 | 3.3 |
|  |  | | M1 | 3.4 |
| = 0.88544… | | | A1 | 1.1b |
|  | | | **(3)** |  |
| **(6 marks)** | | | | | | |
| **Notes:** | | | | | | |
| **(a)** | **M1** | Writing or using the binomial distribution in (i) or (ii) Allow for sight of B(15, 0.48)  or in words: binomial with *n* = 15 and *p* = 0.48 may be implied in (i) or (ii) by one  correct answer to 3sf or sight of = 0.07986… i.e. awrt 0.0799.  Allow for as this is "correct use" Condone B(0.48, 15) | | | | |
| **(i)** | **A1** | awrt 0.0197 | | | | |
| **(ii)** | **A1** | awrt 0.920 (Allow 0.92) | | | | |
| **(b)** | **B1** | Setting up a correct Normal model**.** Allow sight of  or oror  or may be awarded if used correctly in standardisation or in words: Normal with mean = 120/130 and  variance = 62.4 or sd =  condoneoror sd = 62.4  Look out for or awrt 7.90 (condone 7.9)  This may be implied by sight of 0.897 or 0.885**4**… | | | | |
|  | **M1** | Sight of the continuity correction with a normal distribution | | | | |
| **110.5** or 111.5 or 109.5 | | **139.5** or 140.5 or 138.5 | | |
| NB we will also allow **129.5** or 130.5 or 128.5 | | NB we will also allow **120.5** or 119.5 or 121.5 | | |
| Continuity correction may be seen in standardisation  NB No continuity correction(CC) gives awrt 0.897 which is M0 unless CC seen | | | | |
|  | **A1** | awrt 0.8854 or awrt 0.885 dependent on sight of >110.5 or <129.5 or < 139.5 or >120.5 Allowinstead of < or >  NB 0.885548… from B(250, 0.48) scores M0A0 | | | | |

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| **Qu** | | **Scheme** | | | | **Marks** | **AOs** |
| **2(a)** | | oe | | | | M1 | 3.4 |
| \* | | | | A1cso\* | 1.1b |
|  | | **SC** B1( mark as M0A1) for | | | |  |  |
|  | |  | | | | **(2)** |  |
| **(b)** | | = 0.8490… **awrt 0.849** | | | | B1 | 1.1b |
|  | |  | | | | **(1)** |  |
| **(c)** | | (awrt 0.115) **or** (awrt 0.036) | | | | B1 | 1.1b |
| (awrt 0.115) **& (**awrt 0.036) | | | | B1 | 1.1b |
| Expected income per 500 rods =  **or** Expected profit per rod **=**  **[**= 0.2446..] | | | | M1 | 3.4 |
| Expected profit per 500 rods  **or**  =  **or** = | | | | M1d | 3.1b |
| = [£]122.3… **awrt [£]122** | | | | A1 | 1.1b |
|  | | | | **(5)** |  |
| **(d)** | | Let | | | | M1 | 3.3 |
|  | | = | | M1 | 1.1b |
|  | | 0.9176… | | 0.0824 | | A1 | 1.1b |
|  | | Manufacturer is unlikely to achieve their aim since 0.9176 < 0.95 | | Manufacturer is unlikely to achieve their aim since 0.0824 > 0.05 | | A1ft | 2.4 |
|  | |  | | | | **(4)** |  |
| **Notes: (12 marks)** | | | | | | | |
| **(a)** | **M1** | | Using the normal distribution to set up equation. Allow *σ* for *x* and awrt | | | | |
|  | **A1\*** | | cso For a correct expression for *x* followed by 0.05 or 0.05000… No incorrect working seen | | | | |
| **(b)** | **B1** | | awrt 0.849 | | | | |
| **(c)** | **B1** | | awrt 0.115 (Implied byawrt57.5 for number of rods) **or** awrt 0.036 (Implied by awrt 18 for number of rods) | | | | |
|  | **B1** | | awrt 0.115 (Implied byawrt57.5 for number of rods) **and** awrt 0.036 (Implied by awrt 18 for number of rods) | | | | |
|  | **M1** | | Correct method to find the total income of 500 rods. Attempt at all 3 with at least two correct and no extras  **or** Correct method to find sum of all three profits with at least two of 30, −15 or 20 correct. May work in pence but need to be consistent. Allow awrt 24.5or 0.245 | | | | |
|  | **M1d** | | Dep on previous method for finding profit for 500 rods. May work in pence but need to be consistent. Allow or(accept 499 or 501) | | | | |
|  | **A1** | | All previous marks must be awarded for awrt 122 awrt 12200p  **NB** if uses any integer values for numbers of rods then it is A0 other than for 18 for *L* > 8.09 | | | | |
| **(d)** | **M1** | | Selecting the appropriate model. May be seen or used. Allow B(200,0.985) or Po(3)  Condone B(0.015, 200) or B( 0.985, 200). | | | | |
|  | **M1** | | Writing or using Do not accept  unless found | | Writing or using  Do not accept  unless found | | |
|  | **A1** | | 0.92 (Poisson 0.916…) | | 0.08 or better | | |
|  | **A1ft** | | Need at least one of the method marks to be awarded. Correct conclusion with the comparison (may be in words). Ft "their *p* = 0.9176…" as long as *p* > 0.9 If "their 0.9176…"< 0.95 must … be unlikely… If "their 0.9176…"> 0.95 they must say … be likely... To ft the alternative then *p* < 0.1 | | | | |

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| **Question** | | **Scheme** | | **Marks** | **AOs** |
| **3(a)** | | tr | | B1 | 1.2 |
|  | | **(1)** |  |
| **(b)(i)** | | = 5.6419… | awrt 5.64 | B1 | 1.1b |
| **(ii)** | |  | | M1 | 1.1b |
|  | | = 9.04559… awrt 9.05 | | A1 | 1.1b |
|  | |  | | **(3)** |  |
| **(c)** | | Leuchars is in the North and Camborne is in the South | | M1 | 2.4 |
| The mean is smaller for Leuchars than Camborne therefore there is no evidence that Dian's belief is true | | A1ft | 2.2b |
|  | |  | | **(2)** |  |
| **(d)** | | eg *p* = 0.27 is unlikely to be constant. | | B1 | 2.4 |
|  | |  | | **(1)** |  |
| **(7 marks)** | | | | | |
| **Notes:** | | | | | |
| **(a)** | **B1** | Allow Tr or trace or Trace | | | |
| **(b)**  **(i)** | **B1** | For a correct mean awrt 5.64 | | | |
| **(ii)** | **M1** | For a correct expression for sd including the  Ft their mean | | | |
|  | **A1** | awrt 9.05 (Allow *s* = 9.1932… awrt 9.19)  NB awrt to 9.05 or 9.19 with no working is M1 A1 | | | |
| **(c)** | **M1** | For stating Leuchars is North of Camborne oe eg Camborne is further south | | | |
|  | **A1ft** | M1 must be awarded. A correct conclusion **and** correct comment about the means ft their mean in (b) Allow No | | | |
|  | **SC** | for No **and** there are only 2 places used so there is insufficient data. Mark as M0A1 on epen | | | |
| **(d)** | **B1** | A correct reason referring to   * independence (needs context as to what is independent) eg consecutive 14 days unlikely to be independent. * probability [of rain] not being constant. * Allow a comment that conveys the idea that the proportion of days with no rain will be different over the year. | | | |

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| **Question** | | **Scheme** | **Marks** | **AOs** |
| **4(a)** | | H0: *p* = 0.1 H1: *p*  0.1 | B1 | 2.5 |
|  | **(1)** |  |
| **(b)** | | Use of *X* ~ B (50, 0.1)  implied by sight of one of  or or | M1 | 3.4 |
|  | | Critical regions *X* = 0 or | A1 | 1.1b |
|  | | *X* = 0 and  plus  and | A1 | 1.1b |
|  | | **SC**: Both CR correct with no probabilities and no distribution seen scores M0A1A0 |  |  |
|  | |  | **(3)** |  |
| **(c)** | | 0.0297 | B1ft | 1.1b |
|  | **(1)** |  |
| **(d)** | | 15 is in the critical region therefore there is evidence to support the **manager**'s belief | B1ft | 2.2b |
|  | |  | **(1)** |  |
| **(6 marks)** | | | | |
| **Notes** | | | | |
| **(a)** | **B1** | For both hypotheses in terms of *p* or π. Connected to H0 and H1 correctly  Condone 10% but not 10 | | |
| **(b)** | **M1** | Using correct distribution to find the probability associated with one tail of the CR  If the correct distribution is stated (may be seen in part(a)) allowfor one tail of the correct CR **or** one of (awrt 0.025 or awrt 0.005 or awrt 0.975) seen connected to a correct probability statement | | |
|  | **A1** | Lower CR *X* = 0 / *X* < 1 / / [condone eg P(*X* = 0) labelled as CR]  Or Upper CR  or [condone oe labelled as CR] | | |
|  | **A1** | Both CR's correct with the relevant probabilities Allow for "and" and *X* < 1,  [**do not allow** P(*X* = 0) or oe]  Allow CR in different form eg (9, ), [10,) | | |
| **(c)** | **B1ft** | awrt 0.0297 or 2.97% or ft for the sum of the probabilities in (b) for "their 2 critical regions" if seen. If none seen it must be awrt 0.0297  **SC** **M0 in (b) for a one tail test** Allow B1ft for their one tail CR in (b) eg 0.0338 or 0.0245 or 0.0579 | | |
| **(d)** | **B1ft** | A correct statement about 15 and "their CR" or sight and comparison with "their 0.0245"  **and** a compatible correct statement in context. eg There is evidence that there has been a change in the **proportion/probability** arriving **late**  Condone increase rather than change  Do not allow contradicting statements.  NB No CR given in (b) then B0 | | |

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| **Question** | | **Scheme** | **Marks** | **AOs** |
| **5(a)** | | oe | B1 | 1.1b |
|  | **(1)** |  |
| **(b)** | |  | B1 | 1.1b |
|  | |  | **(1)** |  |
| **(c)** | | or  or  or | M1 | 3.1b |
|  | | *H*  *R*  *F*  481  123  247  412  259  133  40  130 | B1  B1  A1 | 1.1b 1.1b  1.1b |
|  | |  | **(4)** |  |
| **(d)** | | oe awrt 0.208 | B1 | 1.1b |
|  | **(1)** |  |
| **(e)** | | awrt 0.144 | B1ft | 1.1b |
|  | |  | **(1)** |  |
| **(f)** | |  | M1 | 3.4 |
|  | | =  awrt 0.817 | A1 | 1.1b |
|  | |  | **(2)** |  |
| **Notes: (10 marks)** | | | | |
|  |  | **Look out for answers given in the question. If you see answers in the question and in the answer space those in the answer space take precedence.** | | |
| **(a)** | **B1** | Allow equivalent | | |
| **(b)** | **B1** | Allow equivalent | | |
| **(c)** | **M1** | Correct method to find one of the values 40 or 130 or 481or 259  Implied by 40, 481, 259 or130 seen in correct place on diagram | | |
|  | **B1** | One of the highlighted correct | | |
|  | **B1** | A second value highlighted correct or or  or | | |
|  | **A1** | Fully correct | | |
| **(d)** | **B1** | 380/1825oe or awrt 0.208 | | |
| **(e)** | **B1ft** | Correct answer or  Ft their 130 ( > 0) do not allow if blank  Allow ft correct to 3 sf. | | |
| **(f)** | **M1** | For a single fraction with the numerator < denominator and *n* is an integer we will award for *n*/ 891 **or** *n*/(sum of their 4 values in *H*, each > 0) or awrt 0.817 | | |
|  | **A1** | 728/891 oe or awrt 0.817 | | |

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| **Question** | | | **Scheme** | | **Marks** | **AOs** |
| **6(a)** | | | eg As the number of minutes exercise (*m*) increases the resting heart rate (*h*) decreases **or**  the gradient of the curve is becoming flatter with increasing *m*: diminishing effect of each additional minute of exercise | | B1 | 2.4 |
|  | | **(1)** |  |
| **(b)** | | |  | | B1 | 2.5 |
|  | | | Critical value – 0.3887 (Allow ) | | M1 | 1.1b |
|  | | | There is evidence that the product moment **correlation** is **less than 0/ there is a negative correlation** | | A1 | 2.2b |
|  | | |  | | **(3)** |  |
| **(c)** | | |  |  | M1 | 1.1b |
| or  or oe | or | M1 | 2.1 |
| or  or oe |  | M1 | 1.1b |
| or or | and *k* = –0.05 | M1 | 1.1b |
|  | | | or  or *a* = awrt 83.17 **and** *k* = –0.05 | | A1 | 1.1b |
|  | | |  | | **(5)** |  |
| **Notes: (9 marks)** | | | | | | |
| **(a)** | **B1** | eg Idea as one increases the other decreases (in context). Allow use of *m* and *h* eg As *m* increases *h* decreases. Do not allow negative correlation with no context or  Allow there is a negative correlation/association/relationship/exponential between minutes exercise(*m*) and resting heart rate (*h*) oe | | | | |
| **(b)** | **B1** | Both hypotheses correct in terms of(allow p) | | | | |
|  | **M1** | For the cv of −0.3887 or any cv such that 0.3 < |cv| < 0.5 | | | | |
|  | **A1** | Independent of hypotheses. Correct conclusion that implies reject H0 on basis of seeing – 0.3887 or if they give 0.3887 we must see the comparison 0.3887 < 0.897 **and**  which mentions “pmcc/correlation/relationship” and less than 0/ negative or **< 0**  A contradictory statement scores A0 eg Accept H0 therefore negative correlation | | | | |
| **(c)** |  | **In this part once M0 is scored no more marks can be scored. Condone no base** | | | | |
|  | **M1** | **May be implied by 2nd M1 mark**  Method 1: Correct substitution for both *x* and *y*  Method 2 : Taking the log of both sides | | | | |
|  | **M1** | **May be implied by 3rd M1 mark**  Method 1: Correct use of the power log rule **or** making *h* the subject  Method 2 : Correct use of the addition/subtraction log rule | | | | |
|  | **M1** | **This line implies M1M1M1**  Method 1: Correct use of the addition/subtraction log rule or eqn in the form  Method 2: A second correct step for correct use of the power log rule | | | | |
|  | **M1** | **This line implies M1M1M1M1**  Method 1: Correct removal of logs or  Method 2: Log *a* (or *a*) and *k* correct | | | | |
|  | **A1** | Allow  NB award 5/5 for *a* = awrt 83.2 and *k* = –0.05 or or | | | | |

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