

GCE

Mathematics

Unit **4732**: Probability and Statistics 1

Advanced Subsidiary GCE

Mark Scheme for June 2018

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This mark scheme is published as an aid to teachers and students, to indicate the requirements of the examination. It shows the basis on which marks were awarded by examiners. It does not indicate the details of the discussions which took place at an examiners' meeting before marking commenced.

All examiners are instructed that alternative correct answers and unexpected approaches in candidates' scripts must be given marks that fairly reflect the relevant knowledge and skills demonstrated.

Mark schemes should be read in conjunction with the published question papers and the report on the examination.

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Annotations and abbreviations

| Annotation in scoris | Meaning |
|---|--|
| ✓ and ✕ | |
| BOD | Benefit of doubt |
| FT | Follow through |
| ISW | Ignore subsequent working |
| M0, M1 | Method mark awarded 0, 1 |
| A0, A1 | Accuracy mark awarded 0, 1 |
| B0, B1 | Independent mark awarded 0, 1 |
| SC | Special case |
| ^ | Omission sign |
| MR | Misread |
| Highlighting | |
| | |
| Other abbreviations in mark scheme | Meaning |
| E1 | Mark for explaining |
| U1 | Mark for correct units |
| G1 | Mark for a correct feature on a graph |
| M1 dep* | Method mark dependent on a previous mark, indicated by * |
| Cao | Correct answer only |
| Oe | Or equivalent |
| Rot | Rounded or truncated |
| Soi | Seen or implied |
| www | Without wrong working |
| | |
| | |

Subject-specific Marking Instructions for GCE Mathematics (OCR) Mechanics strand

A Annotations should be used whenever appropriate during your marking.

The A, M and B annotations must be used on your standardisation scripts for responses that are not awarded either 0 or full marks. It is vital that you annotate standardisation scripts fully to show how the marks have been awarded.

For subsequent marking you must make it clear how you have arrived at the mark you have awarded.

B An element of professional judgement is required in the marking of any written paper. Remember that the mark scheme is designed to assist in marking incorrect solutions. Correct *solutions* leading to correct answers are awarded full marks but work must not be judged on the answer alone, and answers that are given in the question, especially, must be validly obtained; key steps in the working must always be looked at and anything unfamiliar must be investigated thoroughly.

Correct but unfamiliar or unexpected methods are often signalled by a correct result following an *apparently* incorrect method. Such work must be carefully assessed. When a candidate adopts a method which does not correspond to the mark scheme, award marks according to the spirit of the basic scheme; if you are in any doubt whatsoever (especially if several marks or candidates are involved) you should contact your Team Leader.

C The following types of marks are available.

M

A suitable method has been selected and *applied* in a manner which shows that the method is essentially understood. Method marks are not usually lost for numerical errors, algebraic slips or errors in units. However, it is not usually sufficient for a candidate just to indicate an intention of using some method or just to quote a formula; the formula or idea must be applied to the specific problem in hand, eg by substituting the relevant quantities into the formula. In some cases the nature of the errors allowed for the award of an M mark may be specified.

A

Accuracy mark, awarded for a correct answer or intermediate step correctly obtained. Accuracy marks cannot be given unless the associated Method mark is earned (or implied). Therefore M0 A1 cannot ever be awarded.

B

Mark for a correct result or statement independent of Method marks.

E

A given result is to be established or a result has to be explained. This usually requires more working or explanation than the establishment of an unknown result.

Unless otherwise indicated, marks once gained cannot subsequently be lost, eg wrong working following a correct form of answer is ignored. Sometimes this is reinforced in the mark scheme by the abbreviation isw. However, this would not apply to a case where a candidate passes through the correct answer as part of a wrong argument.

- D When a part of a question has two or more ‘method’ steps, the M marks are in principle independent unless the scheme specifically says otherwise; and similarly where there are several B marks allocated. (The notation ‘dep *’ is used to indicate that a particular mark is dependent on an earlier, asterisked, mark in the scheme.) Of course, in practice it may happen that when a candidate has once gone wrong in a part of a question, the work from there on is worthless so that no more marks can sensibly be given. On the other hand, when two or more steps are successfully run together by the candidate, the earlier marks are implied and full credit must be given.
- E The abbreviation ft implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A and B marks are given for correct work only — differences in notation are of course permitted. A (accuracy) marks are not given for answers obtained from incorrect working. When A or B marks are awarded for work at an intermediate stage of a solution, there may be various alternatives that are equally acceptable. In such cases, exactly what is acceptable will be detailed in the mark scheme rationale. If this is not the case please consult your Team Leader.

Sometimes the answer to one part of a question is used in a later part of the same question. In this case, A marks will often be ‘follow through’. In such cases you must ensure that you refer back to the answer of the previous part question even if this is not shown within the image zone. You may find it easier to mark follow through questions candidate-by-candidate rather than question-by-question.

- F Unless units are specifically requested, there is no penalty for wrong or missing units as long as the answer is numerically correct and expressed either in SI or in the units of the question. (e.g. lengths will be assumed to be in metres unless in a particular question all the lengths are in km, when this would be assumed to be the unspecified unit.)

We are usually quite flexible about the accuracy to which the final answer is expressed and we do not penalise over-specification.

When a value is given in the paper

Only accept an answer correct to at least as many significant figures as the given value. This rule should be applied to each case.

When a value is not given in the paper

Accept any answer that agrees with the correct value to 2 s.f.

ft should be used so that only one mark is lost for each distinct accuracy error, except for errors due to premature approximation which should be penalised only once in the examination.

There is no penalty for using a wrong value for g . E marks will be lost except when results agree to the accuracy required in the question.

- G Rules for replaced work

If a candidate attempts a question more than once, and indicates which attempt he/she wishes to be marked, then examiners should do as the candidate requests.

If there are two or more attempts at a question which have not been crossed out, examiners should mark what appears to be the last (complete) attempt and ignore the others.

NB Follow these maths-specific instructions rather than those in the assessor handbook.

- H For a *genuine* misreading (of numbers or symbols) which is such that the object and the difficulty of the question remain unaltered, mark according to the scheme but following through from the candidate's data. A penalty is then applied; 1 mark is generally appropriate, though this may differ for some units. This is achieved by withholding one A mark in the question.

Marks designated as cao may be awarded as long as there are no other errors. E marks are lost unless, by chance, the given results are established by equivalent working.

'Fresh starts' will not affect an earlier decision about a misread.

Note that a miscopy of the candidate's own working is not a misread but an accuracy error.

- I If a graphical calculator is used, some answers may be obtained with little or no working visible. Allow full marks for correct answers (provided, of course, that there is nothing in the wording of the question specifying that analytical methods are required). Where an answer is wrong but there is some evidence of method, allow appropriate method marks. Wrong answers with no supporting method score zero. If in doubt, consult your Team Leader.
- J If in any case the scheme operates with considerable unfairness consult your Team Leader.

Note: "(2 sfs)" means "answer which rounds to ... to 2 sfs". If correct ans seen to ≥ 2 sfs, ISW for later rounding
 Penalise over-rounding only once in paper.

| Question | | Answer | Mk | Guidance |
|----------|----|---|--|--|
| 1 | i | $\frac{3}{6} \times \frac{1}{5} + \frac{1}{6} \times \frac{3}{5}$ or $\frac{2}{6} \times \frac{1}{5}$ (not $\times 2$) or $\frac{1}{2} \times \frac{1}{5} \times 2$ $\frac{3}{6} \times \frac{1}{5} + \frac{1}{6} \times \frac{3}{5} + \frac{2}{6} \times \frac{1}{5}$ oe or $\frac{1}{2} \times \frac{1}{5} \times 2 + \frac{1}{3} \times \frac{1}{5}$ (= $\frac{4}{15}$ AG) | B1 [2] | Method using table: Correct table with $\frac{8}{30}$ B1B1 Correct table, diag crossed out B1 Must see $\frac{8}{30}$ for 2nd B1 Must see sufficient working all correct method |
| | ii | $P(X=5) = \frac{2}{15}$ Σxp $= \frac{10}{3}$ oe or 3.33 or 3.3 (2 sf) $\Sigma x^2 p$ (= 12) $- (\frac{10}{3})^2$ $= \frac{8}{9}$ oe or 0.889 or 0.89 (2 sf) | B1 M1 A1 M1 M1 A1 [6] | soi $\div 4$ M0A0 ≥ 3 terms correct $\div 4$ M0A0 dep +ve result $x - \frac{10}{3}$ attempted, ≥ 3 terms M1 $\Sigma(x - \frac{10}{3})^2 p$ (≥ 3 terms correct) M1 $= \frac{8}{9}$ oe or 0.89 (2 sf) A1 |
| 2 | i | $\frac{3}{4}$ or 0.75 | B1 [1] | |
| | ii | $\frac{\text{no. of pairs} > 10}{\text{no. of pairs} > 8}$ or $\frac{P(X > 10)}{P(X > 8)}$ $= \frac{3}{10}$ or 0.3 | M1 A1 [2] | attempted, with num ≥ 2 & denom ≥ 6 in fraction or division. May be implied in fractions method Must be clearly attempting both num & denom & dividing $P(X > 10 X > 8)$ stated is insufficient |

| Question | | Answer | Mk | Guidance | |
|----------|-----|---|---|--|--|
| | iii | (1,1,4) (1,1,5) (1,1,6) (1,2,6) (2,1,6) $(\frac{1}{6})^3 \times 5$ oe $= \frac{5}{216}$ oe or 0.0231 or 0.023 (2 sf) | M1 A1 A1 [3] | At least four correct triples soi. Allow extras or eg $\frac{1}{6} \times \frac{1}{6} \times \frac{3}{6} + \frac{1}{6} \times \frac{1}{6} \times \frac{1}{6} \times 2$ | May be implied by next line or eg $\frac{1}{36} \times \frac{3}{6} + \frac{2}{36} \times \frac{1}{6}$ MR clearly omit "twice" in qu: ≥ 10 "correct" triples soi M1A0A0 (ans poss $\frac{13}{216}$ or $\frac{35}{216}$) MR clearly omit "at least" in qu: ≥ 3 "correct" triples soi M1A0A0 |
| 3 | i | $\frac{174858 - \frac{202 \times 4906}{7}}{\sqrt{(7306 - \frac{202^2}{7})(4204260 - \frac{4906^2}{7})}}$ = 0.9897 or 0.9896 (4 sf) or 0.989 or 0.990 (3sf) | M1 A1 [2] | $\frac{33285}{\sqrt{1476.9 \times 765855}} \quad \frac{232994/7}{\sqrt{10338/7 \times 5360984/7}}$ must see at least 3 sf, not just 0.99 | Correct sub in any correct formula for r Correct ans no working: M1A1 |
| | ii | 0.99 | B1f [1] | Allow "Same", "No change" oe | ft their (i) NB Not 99 or 9.9 etc |
| | iii | $\frac{174858 - \frac{202 \times 4906}{7}}{7306 - \frac{202^2}{7}}$ = 22.54 $y - \frac{4906}{7} = '22.54'(x - \frac{202}{7})$ $y = 22.5x + 50.5$ | M1 M1 A1 [3] | or $\frac{33285}{1476.9}$ or $\frac{232994/7}{10338/7}$ or $a = \frac{4906}{7} - '22.54'x \frac{202}{7}$ or $y = (22\text{to}23)x + (50\text{to}52)$ incl Must incl "y =" | correct sub in any correct formula for b Correct sub Correct ans, no working: M1M1A1 |
| | iv | $(y = 22.5 \times 25 + 50.5) = 608$ to 618 | B1f [1] | | |
| | v | Reliable because: r near 1, or high 25 within range of data | B1 B1 | oe, eg Strong (+ve) correlation Allow "Good PMCC" Allow "Close to st line" oe eg No extrapolation or eg within 20-29 | Allow "Fairly reliable" or "Accurate" or similar with correct expl'n Must be x-value |

| Question | | Answer | Mk | Guidance |
|----------|-----|---|---|--|
| | | | | Ignore all else. |
| | | | [2] | |
| 4 | i | 1 2 3 4 5 6 6 5 3 4 1 2 -5 -3 0 0 4 4 $\Sigma d^2 = 66$ $1 - \frac{6 \times 66}{6 \times 35}$ $= -\frac{31}{35}$ or -0.886 or -0.89 (2 sf) | M1 A1 M1 M1 A1 [5] | Attempt ranks or both sets reversed Σd^2 attempted, not $(\Sigma d)^2$ not $(\Sigma d)^2$ dep M1 dep M1M1 S_{xx} or $S_{yy} = 91 - 21^2/6 (= 17.5)$ or $S_{xy} = 58 - 21^2/6 (= -15.5)$ $\frac{-15.5}{\sqrt{17.5 \times 17.5}}$ correct ans seen 5 marks One set reversed: max M1A0M1M1A0 |
| | ii | Judges have (roughly) opposite opinions oe | B1f | Allow Judges disagree oe Allow (Judges') ranks are (nearly) opp or inverse ft their (i) (if within -1 to 1) Ignore all else NOT As one judge's rank increases, the other decreases NOT -ve corr'n between ranks oe NOT Opinions very different NOT No (or little) rel'nship between judges' ranks or views |
| | iii | Remain same oe Ranks unchanged oe | B1 B1 [2] | C's rank (or position) unchanged oe |
| 5 | i | med = 5.0 or 5 6.1 and 3.9 2.2 | B1 M1 A1 [3] | Allow (6.0 to 6.3) and (3.8 to 4.2) cao Allow without subtraction Correct IQR, no working, M1A1 If all values $\times 10$, MR: Max B0M1A1 |
| | ii | Not (or less) affected by the outlier of 79 Or mean <u>more</u> affected or takes account etc | B1 [1] | Not (or less) affected by (or ignores) outliers Not (or less) skewed by outliers oe Does not take account of outliers oe Does not take include outliers oe Ignore all else Outliers affect the value less oe Allow extremes or anomalies oe NOT Median is one of the orig values |
| | iii | ((2.95, 0)) (3.95, 7) (4.95,13) (5.95, 19) (6.95, 26) (7.95, 27) | B1 B1 [2] | B1 correct x-coords B1 correct y-coords Ignore point where $y = 0$ Allow y's as list of nos. Allow (y, x) |
| | iv | $\sqrt{\frac{36.96}{27}}$ $= 1.17$ or 1.2 (2 sf) | M1 A1 | Allow $\sqrt{\frac{36.96}{26}}$ or 1.19 or $\frac{36.96}{27}$ or 1.37 for M1A0 Answer 1.2: check wking M1A1 or M1A0 $\sqrt{(\frac{\Sigma x^2}{27} - 5^2)} = (\sqrt{(\frac{711.96}{27} - 5^2)})$ If no wking 1.2 M1A1 |

| Question | | | Answer | Mk | Guidance | |
|----------|-----|---|--|--|--|--|
| | | | | | | ans 11.7 or 12 from original data M1A0 |
| 6 | i | | Binomial, $n = 15, p = 0.04$ Radios, or faults, independent OR Prob of faulty is same (or is 0.04) for each radio | [2] B1 B1 [2] | Allow 4% OR Radios packed randomly in boxes OR No. of faulty ones in a box random | Allow Prob of radio faulty is indep Allow No. of faulty radios is indep In context. Ignore all else NOT Boxes are independent |
| | ii | | 0.96^{45} alone oe eg ${}^{45}C_0 \times 0.04^0 \times 0.96^{45}$ = 0.159 (3 sf) | M1 A1 [2] | or $((0.96)^{15})^3$ or 0.542^3 | $1 - 0.96^{45}$ (= 0.841) M0A0 |
| | iii | | Bin stated or implied $1 - (0.96^{15} + 15 \times 0.96^{14} \times 0.04)$ = 0.119 or 0.12 (2 sf) | B1 M2 A1 [4] | eg by $0.04^a \times 0.96^b$ ($a + b = 15$ or 45) P($X=2$)+... +P($X=15$) all terms correct M2 one term wrong or omitted or extra <u>or</u> omit coeffs: M1 ft their 0.96^{15} or 0.542 from (ii) for M2 or M1 | or ${}^{15}C_n$ or ${}^{45}C_n$ (or 0.0202) 1-(with one extra term) (=0.0203) M1 or $(0.96^{15} + 15 \times 0.96^{14} \times 0.04)$ M1 or $1 - (0.96^{15} + 0.96^{14} \times 0.04)$ M1 Correct ans (2 sf) 4 marks |
| | iv | | Use of their (iii) in attempted bin calc'n $0.881^{10} + 10 \times 0.881^9 \times 0.119 +$ ${}^{10}C_2 \times 0.881^8 \times 0.119^2 + {}^{10}C_3 \times 0.881^7 \times 0.119^3$ = 0.977 or 0.98 (2 sf) | B1 M2 A1 [4] | M1 for any three terms correct <u>or</u> omit coeff(s) | ft 0.1 if clear using (iii) (ans 0.9872) ft their (iii) for M2 or M1 Check ans eg 0.996 prob B1M1M0A0 |
| 7 | i | a | Geo($\frac{1}{4}$) stated $P(X = 4) = (\frac{3}{4})^3 \times \frac{1}{4}$ $= \frac{27}{256}$ or 0.105 or 0.11 (2 sf) | M1 M1 A1 [3] | or implied by $(\frac{3}{4})^n \times \frac{1}{4}$ or $(\frac{1}{4})^n \times \frac{3}{4}$ alone or 0.1055 | ($n > 0$) |
| | i | b | $P(X \leq 6) = 1 - (\frac{3}{4})^6$ | M2 | or $\frac{1}{4} + \frac{3}{4} \times \frac{1}{4} + \dots + (\frac{3}{4})^5 \times \frac{1}{4}$ oe decimals | one term incorrect or omitted or extra: M1 |

| Question | | | Answer | Mk | Guidance | |
|----------|-----|---|---|--|---|--|
| | | | $= \frac{3367}{4096}$ or 0.822 or 0.82 (2 sf) | A1 [3] | or $\frac{1}{4} \times \frac{1 - (\frac{3}{4})^6}{1 - \frac{3}{4}}$ M2 | or $1 - (\frac{3}{4})^7$ oe M1 or $(\frac{3}{4})^6$ <u>alone</u> or 0.178 M1 or $1 - P(X \leq 6)$ all correct M1 |
| | ii | | 4 | B1 [1] | | |
| | iii | | $1 - (\frac{3}{4})^7$ oe (= 0.866(51....)) $(\frac{3}{4})^7$ oe seen (or x 0.133.....) $2 \times (1 - (\frac{3}{4})^7) \times (\frac{3}{4})^7$ = 0.231 or 0.23 (2 sf) | M1 M1 M1 A1 [4] | or $P(X \geq 1)$ all terms correct or ${}^7C_0 \times (\frac{1}{4})^0 \times (\frac{3}{4})^7$ $2 \times (\frac{3}{4})^7 \times P(\text{sees on } \geq 1 \text{ day in } 7)$ | or their (i)(b) + $(\frac{3}{4})^6 \times \frac{1}{4}$ indep all correct method SC: 0.116 or 0.117 M2M0A0 |
| 8 | i | | ${}^4C_2 \times {}^3C_2$ = 18 | M1 A1 [2] | not nec'y alone | eg $\frac{{}^4C_2 \times {}^3C_2}{{}^7C_4}$ M1A0 |
| | ii | a | $\frac{3!4!}{7!}$ or $\frac{{}^4P_4 \times {}^3P_3}{7P_7}$ oe or $\frac{4 \times 3 \times 3 \times 2 \times 2 (\times 1 \times 1)}{7!}$ = $\frac{1}{35}$ oe or 0.0286 or 0.029 (2sf) | M1 A1 | or $\frac{4}{7} \times \frac{3}{6} \times \frac{3}{5} \times \frac{2}{4} \times \frac{2}{3} \times \frac{1}{2} (\times 1)$ or $\frac{144}{5040}$ | or $\frac{1}{7} \times \frac{1}{6} \times \frac{1}{5} \times \frac{1}{4} \times \frac{1}{3} \times \frac{1}{2} \times 4! \times 3!$ oe NB not 0.286 |
| | | | | [2] | | |
| | ii | b | $\frac{5! \times 3!}{7!}$ or $\frac{{}^5P_5 \times {}^3P_3}{7!}$ oe or $\frac{5 \times 4! \times 3!}{7!}$ oe | | or M1 for 5! seen or 5P_5 or 120 but not in denom | or $\frac{3}{7} \times \frac{2}{6} \times \frac{1}{5} \times 5$ M2 |
| | | | | M2 | | or $\frac{3}{7} \times \frac{2}{6} \times \frac{1}{5}$ alone M1 or product of ≥ 3 fractions x 5 M1 |

| Question | | | Answer | Mk | Guidance | | |
|--------------|-----|--|---|-------------------------|--|---|-------------------|
| | | | $= \frac{1}{7}$ or $\frac{720}{5040}$ or 0.143 or 0.14 (2 sf) | A1 [3] | | | |
| | iii | | $3! \times 2!$ or $3! \times 2$ or $3 \times 2 \times 2$ or ${}^3P_2 \times 2! P_1$ | M1 | or ${}^3P_3 \times 2! P_2$ or 12 not nec'y alone May be implied | eg $\frac{3! \times 2! \times 2}{\dots\dots}$ or $\frac{7!}{3! \times 2! \dots}$ | M1M0A0 |
| | | | 12×3 | M1 | All correct method, or in num of fraction | eg $\frac{3! \times 2! \times 3}{\dots\dots}$ | M1M1A0 |
| | | | $= 36$ | A1 [3] | Must check method | SC $\frac{1}{4} \times \frac{1}{3} \times 3$ $\frac{1}{4} \times \frac{1}{3} \times 2$ | M1M1A0 M1M0 A0 |
| Total | | | | 72 | | | |

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