# MARK SCHEME for the October/November 2014 series

## 9709 MATHEMATICS

9709/63        Paper 6, maximum raw mark 50

This mark scheme is published as an aid to teachers and candidates, to indicate the requirements of the examination. It shows the basis on which Examiners were instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began, which would have considered the acceptability of alternative answers.

Mark schemes should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge will not enter into discussions about these mark schemes.

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## Mark Scheme Notes

Marks are of the following three types:

M Method mark, awarded for a valid method applied to the problem. Method marks are not 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, e.g. by substituting the relevant quantities into the formula. Correct application of a formula without the formula being quoted obviously earns the M mark and in some cases an M mark can be implied from a correct answer.

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).

B Mark for a correct result or statement independent of method marks.

- When a part of a question has two or more 'method' steps, the M marks are generally independent unless the scheme specifically says otherwise; and similarly when there are several B marks allocated. The notation DM or DB (or dep*) is used to indicate that a particular M or B mark is dependent on an earlier M or B (asterisked) mark in the scheme. When two or more steps are run together by the candidate, the earlier marks are implied and full credit is given.

- The symbol √ implies that the A or B mark indicated is allowed for work correctly following on from previously incorrect results. Otherwise, A or B marks are given for correct work only. A and B marks are not given for fortuitously 'correct' answers or results obtained from incorrect working.

- Note: B2 or A2 means that the candidate can earn 2 or 0.
      B2/1/0 means that the candidate can earn anything from 0 to 2.

  The marks indicated in the scheme may not be subdivided. If there is genuine doubt whether a candidate has earned a mark, allow the candidate the benefit of the doubt. Unless otherwise indicated, marks once gained cannot subsequently be lost, e.g. wrong working following a correct form of answer is ignored.

- Wrong or missing units in an answer should not lead to the loss of a mark unless the scheme specifically indicates otherwise.

- For a numerical answer, allow the A or B mark if a value is obtained which is correct to 3 s.f., or which would be correct to 3 s.f. if rounded (1 d.p. in the case of an angle). As stated above, an A or B mark is not given if a correct numerical answer arises fortuitously from incorrect working. For Mechanics questions, allow A or B marks for correct answers which arise from taking $g$ equal to 9.8 or 9.81 instead of 10.

The following abbreviations may be used in a mark scheme or used on the scripts:

AEF     Any Equivalent Form (of answer is equally acceptable)

AG      Answer Given on the question paper (so extra checking is needed to ensure that the detailed working leading to the result is valid)

BOD     Benefit of Doubt (allowed when the validity of a solution may not be absolutely clear)

CAO     Correct Answer Only (emphasising that no 'follow through' from a previous error is allowed)

CWO     Correct Working Only – often written by a 'fortuitous' answer

ISW     Ignore Subsequent Working

MR      Misread

PA      Premature Approximation (resulting in basically correct work that is insufficiently accurate)

SOS     See Other Solution (the candidate makes a better attempt at the same question)

SR      Special Ruling (detailing the mark to be given for a specific wrong solution, or a case where some standard marking practice is to be varied in the light of a particular circumstance)

## Penalties

MR –1   A penalty of MR –1 is deducted from A or B marks when the data of a question or part question are genuinely misread and the object and difficulty of the question remain unaltered. In this case all A and B marks then become 'follow through √' marks. MR is not applied when the candidate misreads his own figures – this is regarded as an error in accuracy. An MR –2 penalty may be applied in particular cases if agreed at the coordination meeting.

PA –1   This is deducted from A or B marks in the case of premature approximation. The PA –1 penalty is usually discussed at the meeting.

| 1 | $z = -2.326$ | B1 | $\pm 2.325$ to $\pm 2.33$ seen |
|---|---|---|---|
| | $\dfrac{250 - 260}{\sigma} = -2.326$ | M1 | Standardising and = or < their $z$, no cc, sq, sq rt |
| | $\sigma = 4.30$ | A1 **3** | Correct ans |

| 2 | (i) | $0.7 - 2.4 + 2.2 - 0.5 + 6.3 + 4.9 + 0 + 0.3$ $= 11.5$ | B1 **1** | |
|---|---|---|---|---|
| | (ii) | $(0.7^2 + 2.4^2 + 2.2^2 + 0.5^2 + 6.3^2 + 4.9^2 + 0.3^2)$ $= 75.13 \ (75.1)$ | B1 **1** | |
| | (iii) | mean = 63.4375 | B1✓ | ft $62 +$ their (i)/8 |
| | | Variance = $75.13/8 - (11.5/8)^2$ | M1 | their(ii)/8 $- ($(i)/8$)^2$ |
| | | $= 7.32$ | A1 **3** | correct answer |
| | | OR mean = $507.5/8 = 63.4375$ | B1 | |
| | | Var $= 32253/8 - 63.4375^2 = 7.32$ | M1 | subst in correct variance or standard deviation formula |
| | | | A1 | correct answer – allow 6.62, 6.93–7.04, 7.260–7.325 |
| | | | | Marks can be awarded in (i) or (ii) if not 'contradicted' by further working |

| 3 | (i) | max = 12 | B1 | (Implied by P(12) with power 12) |
|---|---|---|---|---|
| | | $P(12) = (0.7)^{12} = 0.0138$ | B1 **2** | Accept 0.014 |
| | (ii) | P(fewer than 10) = 1– P (10, 11, 12) | M1 | Binomial term $^{12}C_r(0.7)^r(0.3)^{12-r}$ or $^{12}C_r(p)^r(q)^{12-r}$, $0.99 \leqslant p + q \leqslant 1.00$ |
| | | $= 1 - \ ^{12}C_{10} \times (0.7)^{10}(0.3)^2 - 12 \times (0.7)^{11}(0.3) - (0.7)^{12}$ | | |
| | | $= 1 - 0.2528$ | A1 | Correct unsimplified expression oe |
| | | $= 0.747$ | A1 **3** | Correct answer |

**4 (i)**

| Stem | leaf |
| --- | --- |
| 1 | 4 5 7 8 9 9 |
| 2 | 1 2 2 3 4 5 6 6 8 8 |
| 3 | 0 2 6 8 |
| 4 | 1 2 5 6 7 |

Key 1|4 represents 14 glasses (of water)

| | |
| --- | --- |
| B1 | Correct stem (or reversed order) |
| B1 | Correct leaves, ordered in numerical sequence, with ½ 'column' tolerance |
| B1  **3** | Key must include 'glasses' or similar drinking item |

**(ii)** LQ = 20  Med = 26  UQ = 37



10   20   30   40   50

Glasses  of water

SC No values stated
3 quartiles on diagram in correct relative positions
End points of attached whiskers not through box
correct relative to quartiles

| | |
| --- | --- |
| B1 | Correct median |
| B1 | Correct quartiles |
| B1√ | Correct on diagram ft any wrong med or quartiles. Linear scale based upon 3 quartiles plotted |
| B1 | Correct end points of attached whiskers not through box |
| B1  **5** | Linear axis, label, both must be seen |
| B2 | |
| B1 | |

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**5 (i)** $P(<1.2)=P\left(z < \dfrac{1.2-1.9}{0.55}\right)=P(z < -1.2727)$

$= 1 - \Phi(1.273) = 1 - 0.8986$

$= 0.1014$

$P(>2.5)=P\left(z < \dfrac{2.5-1.9}{0.55}\right)=P(z > 1.0909)$

$= 1 - \Phi(1.0909) = 1 - 0.8623$

$= 0.138$

$P (1.2 < wt < 2.5) = 1 - 0.101 - 0.138$

$= 0.761$

| | |
| --- | --- |
| M1 | Standardising for wt 1.2 or 2.5, no cc, sq, sq rt. May be awarded in (ii) if not attempted in (i). Accept 0.102 |
| A1 | First correct proportion seen |
| A1 | Second correct proportion seen |
| M1 | Third proportion 1 – their previous 2 proportions or correct attempt for remaining proportion |
| A1√  **5** | Correct answer or 1 – *their* 2 previous correct proportions |

**(ii)** $P(x > k) = 0.8 + 0.1377 = 0.9377$

$z = -1.536$

$-1.536 = \dfrac{k-1.9}{0.55}$

$k = 1.06$

| | |
| --- | --- |
| M1 | Valid method to obtain $P(x > k)$ or $P(x < k)$ |
| A1 | $\pm 1.536$ seen accept 3sf rounding to 1.53 or 1.54 |
| M1 | Attempt to solve equation with their 'correct' area z value, $k$, 1.9 and 0.55 |
| A1  **4** | Correct answer or rounding to 1.05 |

| | | | | | |
|---|---|---|---|---|---|
| **6** | **(a)** | 1*****3 or 3*****1 or 2*****2 | M1 | | Mult by $6^5$ (for middle 5 dice outcomes) |
| | | $= 6^5 \times 3$ | M1 | | Mult by 3 or summing 3 different combinations (for end dice outcomes) |
| | | $= 23328$ | A1 | **3** | Correct answer accept 23 300 |
| | **(b)** | W   J   H | | | |
| | | 1   1   7 $= {}^9C_1 \times {}^8C_1 \times 1 = 72$ | M1 | | Multiplying 3 combinations (may be implied) |
| | | 1   7   1 $= {}^9C_1 \times {}^8C_7 \times 1 = 72$ | A1 | | 1 unsimplified correct answer (72, 504, 1680, 216 or 3024) |
| | | 7   1   1 $= {}^9C_7 \times {}^2C_1 \times 1 = 72$ | A1 | | A 2$^{nd}$ unsimplified different correct answer |
| | | 1   3   5 $= {}^9C_1 \times {}^8C_3 \times 1 = 504$ mult by 3! | M1 | | Summing options for 1,1.7 or 1,3,5 oe (mult by 3 or 3!) |
| | | 3   3   3 $= {}^9C_3 \times {}^6C_3 \times 1 = 1680$ | M1 | | Summing at least 2 different options of the 3 |
| | | Total 4920 | A1 | **6** | Correct ans |
| | | If no marks gained | | | If games replaced M1M1M1 max available |
| | | Listing all 10 different outcomes | SCM1 | | If factorials used M0M1M1 max available |
| **7** | **(a) (i)** | P($X = 3$) = P(GRR) + P(RGR) | M1 | | Mult 3 probs |
| | | $\dfrac{2}{4} \times \dfrac{2}{3} \times \dfrac{1}{2} + \dfrac{2}{4} \times \dfrac{2}{3} \times \dfrac{1}{2}$ | M1 | | Summing 2 options |
| | | $\dfrac{1}{3}$ **AG** | A1 | **3** | Correct working with appropriate justification and fraction sequencing |

**(ii)**

| $X$ | 2 | 3 | 4 |
|---|---|---|---|
| Prob | $\dfrac{1}{6}$ | $\dfrac{1}{3}$ | $\dfrac{1}{2}$ |

| | | | | | |
|---|---|---|---|---|---|
| | | | B1 | | Values 2, 3, 4 only in table Condone $X$=0,1 if P($X$)=0 stated |
| | | P($X = 2$) = P(RR) = $\dfrac{2}{4} \times \dfrac{1}{3} = \dfrac{1}{6}$ | B1 | | One correct prob other than (i) |
| | | P($X = 4$) = $1 - \left( \dfrac{1}{6} + \dfrac{1}{3} \right) = \dfrac{1}{2}$ | | | |
| | | Or P(GGRR) + P(RGGR) + P(GRGR) | | | |
| | | $= \left( \dfrac{2}{4} \times \dfrac{1}{3} \times \dfrac{2}{2} \times \dfrac{1}{1} \right) \times 3 = \dfrac{1}{2}$ | B1√ | **3** | Second correct prob ft 1 – their previous 2 probs |

**(iii)** P(3 orange | at least 2 O) =

$$\frac{P(3O)}{P(at\ least\ 2O)}$$

P(3 orange) = P(OOO)

$$= \frac{5}{7} \times \frac{4}{6} \times \frac{3}{5} = \frac{2}{7}$$

| | M1 | Attempt at P(OOO) one three-factor option, not added |
|---|---|---|
| | A1 | Correct unsimplified num of a fraction |

P(at least 2O) = P(YOO) + P(OYO) +

P(OOY) + $\frac{2}{7}$

$$= \frac{2}{7} \times \frac{5}{6} \times \frac{4}{5} + \frac{5}{7} \times \frac{2}{6} \times \frac{4}{5} + \frac{5}{7} \times \frac{4}{6} \times \frac{2}{5} + \frac{2}{7}$$

$$= \frac{6}{7}$$

| | M1 | Attempt at P(at least 2O) sum 3 or 4 three-factor options |
|---|---|---|
| | A1 | Correct unsimplified answer seen anywhere |

$$P(3O\ |\ at\ least\ 2O) = \frac{2}{7} \div \frac{6}{7} = \frac{1}{3}\ (0.333)$$

| A1 | **5** | Correct answer evaluated |

__Alternative 1__

3 Orange = $^5C_3$

| | M1 | Attempt at combinations for 3 orange oe, not added |
|---|---|---|
| | A1 | Correct unsimplified num of a fraction |

At least 2 Orange = $^5C_2 \times {}^2C_1 + {}^5C_3$

| | M1 | Attempt at combinations for at least 2 orange condone omission of $+^5C_3$ |
|---|---|---|
| | A1 | Correct unsimplified answer seen anywhere |

$$P(3O\ |\ at\ least\ 2O) = \frac{^5C_3}{^5C_2 \times {}^2C_1 + {}^5C_3} = \frac{1}{3}$$

| A1 | **5** | Correct answer evaluated |

__Alternative 2__

No Yellow = $^2C_0$

| | M1 | Attempt at combinations for 0 yellow oe, not added |
|---|---|---|
| | A1 | Correct unsimplified num of a fraction |

No more than 1 Yellow = $^2C_1 + {}^2C_0$

| | M1 | Attempt at combinations for no more than 1 yellow. Condone omission of +2C0 |
|---|---|---|
| | A1 | Correct unsimplified answer seen anywhere |

$$P(3O\ |\ at\ least\ 2O) = \frac{^2C_0}{^2C_1 + {}^2C_0} = \frac{1}{3}$$

| A1 | **5** | Correct answer evaluated |

__Misread – with replacement__

MR–1 applied to first Accuracy Mark earned

$$P(3O) = \frac{5}{7} \times \frac{5}{7} \times \frac{5}{7} = \frac{125}{343}$$

| | M1 | Attempt at P(OOO) one three factor option oe not added |
|---|---|---|
| | A1 | Correct unsimplified num of a fraction |

$$P(at\ least\ 2O) = \frac{5}{7} \times \frac{5}{7} \times \frac{2}{7} \times {}^3C_2 + \left(\frac{5}{7}\right)^3$$

| | M1 | Attempt at P(at least 2O) sum of 3 or 4 three factor options |
|---|---|---|
| | A1 | Correct unsimplified seen anywhere |

$$P(3O\ |\ at\ least\ 2O) = \frac{5}{11}$$

| A1 | **4** | Answer evaluated |
| | **max** | |