GradeMax

Cambridge International AS & A Level

**Cambridge Assessment International Education**
Cambridge International Advanced Subsidiary and Advanced Level

**MATHEMATICS** **9709/42**

Paper 4 **May/June 2018**

MARK SCHEME

Maximum Mark: 50

**Published**

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.

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## Generic Marking Principles

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

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GENERIC MARKING PRINCIPLE 5:

Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).

GENERIC MARKING PRINCIPLE 6:

Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

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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 FT 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.

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

AEF/OE Any Equivalent Form (of answer is equally acceptable) / Or Equivalent

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

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

SOI Seen or implied

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.

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| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 1 | KE gain = $\frac{1}{2} \times 80 \times (5.5^2 - 4^2)$ [= 570] | **B1** | Either initial or final KE correct |
| | WD against Res = $60P$ | **B1** | |
| | $[\frac{1}{2} \times 80 \times (5.5^2 - 4^2) + 60P = 1200]$ | **M1** | Four term work-energy equation |
| | $P = 10.5$ | **A1** | |
| | | **4** | |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 2 | Driving force DF = $\frac{P}{15}$ | **B1** | Correct use of $P = Fv$ |
| | $\left[\text{DF} - 240\ 000g\sin 4 - 18\ 000 = 240\ 000 \times (-0.2)\right]$ | **M1** | A four-term Newton 2nd law equation |
| | | **A1** | Correct equation |
| | Power is 2 060 000 (W) | **A1** | Allow 2060 kW or 2.06 MW |
| | | **4** | |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 3 | [3 cos 60 = 2 cos θ] | **M1** | Attempt to resolve forces horizontally (2 terms) |
| | θ = 41.4 | **A1** | |
| | [$P$ = 3 sin 60 + 2 sin θ] | **M1** | Attempt to resolve forces vertically (3 terms) |
| | $P$ = 3.92 | **A1** | |
| | | **4** | |
| | **First alternative method for Q3** | | |
| | $\frac{P}{\sin(120-\theta)} = \frac{2}{\sin 150} = \frac{3}{\sin(90+\theta)}$ | **M1** | Attempt two terms of Lami's equation which can be used to find θ |
| | θ = 41.4 | **A1** | |
| | | **M1** | Attempt an equation which can be used to find $P$ |
| | $P$ = 3.92 | **A1** | |
| | **Second alternative method for Q3** | | |
| | [Triangle with sides 2, 3, $P$ and angles opposite of 30, 90 – θ, 60 + θ]<br>$\frac{P}{\sin(60+\theta)} = \frac{2}{\sin 30} = \frac{3}{\sin(90-\theta)}$ | **M1** | Attempt two terms from the triangle of forces which can be used to find θ |
| | θ = 41.4 | **A1** | |
| | | **M1** | Attempt an equation which can be used to find $P$ |
| | $P$ = 3.92 | **A1** | |

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| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 4(i) | For example $100 = 4u + 8a$<br>or $100 = \frac{1}{2}(u + v) \times 4$<br>or $148 = 4v + 8a$<br>or any equation in two of the variables $u$, $v$, $w$, $a$ | **M1** | Any relevant use of constant acceleration equations in any two of the variables below<br>$a$ is acceleration<br>$u$ is speed at $A$<br>$v$ is speed at $B$<br>$w$ is speed at $C$ |
| | | **A1** | One correct equation |
| | For example $248 = 8u + 32a$<br>or<br>two further correct equations in 3 unknowns such as<br>$148 = 4v + 8a$ **and** $v = u + 4a$<br>or<br>$148 = \frac{1}{2}(v + w) \times 4$ and $248 = \frac{1}{2}(u + w) \times 8$ | **A1** | A second correct equation in the same two variables<br>or<br>two further correct equations leading to three equations in three of the unknowns $u$, $v$, $w$, $a$ |
| | | **M1** | Attempt to solve for $a$ or $u$<br>This must reach $a = ...$ or $u = ...$ |
| | $a = 3$ | **A1** | **AG** |
| | $u = 19$ | **B1** | |
| | | **6** | |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 4(ii) | $61^2 = 19^2 + 2\times 3\times s$ | **M1** | Attempt equation for $s = AD$ |
| | $[s = 560 \rightarrow CD = 560 - 248]$ | **M1** | Attempt to find $CD$ |
| | Distance $CD$ is 312 | **A1** | |
| | | **3** | |
| | **Alternative method for 4(ii)** | | |
| | Speed at $C$ is $19 + 8 \times 3$ [= 43] | **M1** | Attempt to find speed at $C$ |
| | $\left[61^2 = 43^2 + 2\times 3\times CD\right]$ | **M1** | Attempt to find $CD$ |
| | Distance $CD$ is 312 | **A1** | |

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| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 5 | $R = 20g \cos 60$ [= 100] | **B1** | |
| | $F = \mu \times 20g \cos 60$ [= 100μ] | **M1** | Use $F = \mu R$ |
| | | **M1** | Resolve along plane in either case |
| | $(P_{max} =) 20g \sin 60 + F$ | **A1** | One correct equation |
| | $(P_{min} =) 20g \sin 60 - F$ | **A1** | Second correct equation |
| | $20g \sin 60 + F = 2(20g \sin 60 - F)$ | **M1** | Use of $P_{max} = 2P_{min}$ to give four term equation in $F$ or μ or $P$ |
| | $\mu = \frac{}{3} = 0.577$ | **A1** | |
| | | **7** | |
| | **lternative solution for final 3 marks if $P_{min}$ is taken as acting down the plane** | | |
| | $P_{min} = F - 20g \sin 60$ | **A1** | |
| | $20g \sin 60 + F = 2(F - 20g \sin 60)$ | **M1** | |
| | $\mu = 3 \quad = 5.196$ | **A1** | |

| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 6(i) | | **M1** | Attempt to integrate $a$ |
| | $v = 6t - 0.12t^2$ $(+ c)$ | **A1** | |
| | $0 = 6 \times 20 - 0.12 \times 20^2 + c$ | **DM1** | Substitute $v = 0$, $t = 20$ in an equation with arbitrary constant |
| | $0.12t^2 - 6t + 72 = 0$ | **DM1** | Substitute $v = 0$ and attempt to solve a 3-term quadratic |
| | $t = 30$ | **A1** | |
| | | **5** | |
| 6(ii) | $s = 3t^2 - 0.04t^3 - 72t$ $(+ k)$ | **M1** | Attempt to integrate $v$ |
| | $s(30) - s(20) = -540 - (-560)$ | **DM1** | Use of limits 20 and their 30 |
| | Distance travelled = 20 | **A1** | |
| | | **3** | |

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| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 7(i) | [$T = 1.6a$, $2.4g \sin 30 - T = 2.4a$]<br>System is $2.4g \sin 30 = 4a$ | **M1** | Attempt Newton's 2nd law for $A$ or $B$ or for the system |
| | | **A1** | Two correct equations |
| | | **M1** | Solve for $a$ or $T$ |
| | $a = 3$ | **A1** | |
| | $T = 4.8$ | **A1** | |
| | | **5** | |
| 7(ii) | Friction force on $A$ is<br>$F = 0.2 \times 1.6g$ [= 3.2] | **B1** | From $F = \mu R$ |
| | $T - F = 1.6a$<br>$2.4g \sin 30 - T = 2.4a$<br>System is $2.4g \sin 30 - F = 4a$ | **M1** | Attempt Newton's 2nd law for both particles or for the system |
| | | **A1** | Correct equations for $A$ and $B$ or correct system equation |
| | | **M1** | Attempt to solve for $a$ |
| | $a = 2.2$ | **A1** | |
| | $v^2 = 2 \times 2.2 \times 1$ | **M1** | Attempt to find $v$ or $v^2$ when $B$ reaches the barrier |
| | Subsequent acceleration of $A$ is $-2$ | **B1** | |
| | $4.4 = 2 \times 2 \times s$ | **M1** | Attempt to find distance $A$ travels while decelerating to $v = 0$ |
| | Total distance travelled is 2.1 m | **A1** | |
| | | **9** | |

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| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 7(ii) | **Alternative method for Q7 [Work-Energy applied to *A* and *B*]** | | |
| | $F = 0.2 \times 1.6g$ [= 3.2] | **B1** | From $F = \mu R = 0.2 \times 1.6g = 3.2$ |
| | | **M1** | Attempt PE loss as *B* reaches the barrier |
| | PE loss = $2.4g \sin 30$ [= 12] | **A1** | |
| | | **M1** | Attempt KE gain for both *A* and *B* |
| | KE gain = $\frac{1}{2}(1.6 + 2.4)v^2$ [= $2v^2$] | **A1** | |
| | **[**$2.4g \sin 30 = \frac{1}{2} \times 4 \times v^2 + 3.2 \times 1$**]**<br>[$v^2 = 4.4$] | **M1** | Apply work-energy equation for the motion until *B* reaches the barrier (Three relevant terms) |
| | KE loss = $\frac{1}{2} \times 1.6 \times 4.4$ | **B1** | Find KE loss as *A* comes to rest after *B* has stopped |
| | [$\frac{1}{2} \times 1.6 \times 4.4 = 3.2d$**]**<br>**[**$d = 1.1$**]** | **M1** | Apply work-energy equation where *d* is the extra distance travelled by *A* leading to a positive value for *d* |
| | Total distance = 2.1 m | **A1** | Distance = $d + 1$ |

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| Question | Answer | Marks | Guidance |
|---|---|---|---|
| 7(ii) | **Alternative scheme for first 6 marks of 7(ii) [Work-energy applied to *A*]** | | |
| | Friction = $0.2 \times 1.6g$ [= 3.2] | **B1** | |
| | [$2.4g \sin 30 - T = 2.4a$<br>$T - F = 1.6a$] | **M1** | Apply Newton's 2nd law to *A* and *B* and solve for *T* |
| | $T = 6.72$ | **A1** | |
| | $[\frac{1}{2} \times 1.6 \times v^2]$ | **M1** | Attempt KE for *A* only |
| | | **A1** | Correct KE for *A* |
| | $[6.72 \times 1 = \frac{1}{2} \times 1.6 \times v^2 + 3.2 \times 1]$ | **M1** | Use work/energy equation for *A* |
| | **Alternative scheme for first 6 marks of 7(ii) [Work-energy applied to *B*]** | | |
| | Friction = $0.2 \times 1.6g$ [= 3.2] | **B1** | |
| | [$2.4g \sin 30 - T = 2.4a$<br>$T - F = 1.6a$] | **M1** | Apply Newton's 2nd law to *A* and *B* and solve for *T* |
| | $T = 6.72$ | **A1** | |
| | | **M1** | Find energy loss/gain for *B*<br>Allow either term |
| | $\pm(\frac{1}{2} \times 2.4 \times v^2 - 2.4g \sin 30)$ | **A1** | |
| | $2.4g \sin 30 = \frac{1}{2} \times 2.4 \times v^2 + 6.72 \times 1$ | **M1** | Use work/energy equation for *B* |

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