**UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS**

**GCE Advanced Subsidiary Level and GCE Advanced Level**

# MARK SCHEME for the October/November 2011 question paper for the guidance of teachers

## 9709 MATHEMATICS

**9709/42** Paper 4, 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 must be read in conjunction with the question papers and the report on the examination.

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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.

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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.

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| | | | | | |
|---|---|---|---|---|---|
| **1** | **(i)** | F = 720/12 | B1 | | |
| | | [F – R = 75 × 0.16] | M1 | | For use of Newton's second law |
| | | R = 48 | A1 | 3 | |
| | **(ii)** | [720/v > 48] | M1 | | For using P/v – R = ma and $a > 0 \rightarrow P/v > R$ |
| | | v < 15 i.e. speed is less than 15 $ms^{-1}$ | A1 | 2 | |
| **2** | **(i)** | F = 0.2 × 6g cos8 | B1 | | |
| | | [6g sin8 – F = 6a] | M1 | | For use of Newton's second law |
| | | Deceleration is 0.589 $ms^{-2}$ | A1 | 3 | Accept a = –0.589 |
| | **(ii)** | | M1 | | For use of $0 = u^2 + 2as$ |
| | | Distance is 7.64 m | A1 | 2 | |
| **3** | | | M1 | | For using v = $\int a dt$ |
| | | $v = (0.8/0.25)\, t^{0.25} + (C)$ | A1 | | |
| | | C = 1.8 | B1 | | |
| | | | M1 | | For using s = $\int v dt$ |
| | | $s = (3.2/1.25)t^{1.25} + 1.8t + (K)$ | A1ft | | ft only from an incorrect non-zero value of C |
| | | Distance is 111 m | A1 | 6 | |
| **4** | **(i)** | For triangle of forces with 60º shown correctly, or<br>$C\cos\phi = 4\cos30$ and $C\sin\phi = 10 - 4\sin30$, or<br>F = 4cos30 and R = 10 – 4sin30 | B1 | | |
| | | $[C^2 = 4^2 + 10^2 - 2 \times 4 \times 10\cos60$ or<br>$C^2 = (4\cos30)^2 + (10 - 4\sin30)^2]$ | M1 | | For using cosine rule or for using $C^2 = (C\cos\phi)^2 + (C\sin\phi)^2$ or $C^2 = F^2 + R^2$ |
| | | C = 8.72 | A1 | 3 | |
| | **(ii)** | $[\mu = 4\cos30/(10 - 4\sin30)]$ | M1 | | For using $\mu = F/R = C\cos\phi/C\sin\phi$ |
| | | Coefficient is 0.433 (accept 0.43) | A1 | 2 | |
| **4** | Alternative Method | | | | |
| | **(i)** | For obtaining $\phi = 66.6º$ or<br>$\tan\phi = 4 \div \sqrt{3}$ from<br>$4 \div \sin(90º + \phi) = 10 \div \sin(150º - \phi)$ | B1 | | |
| | | For using C N and (4 N or 10 N) in Lami's theorem to find C<br>$[C \div \sin120º = (4 \div \sin156.6º$ or $10 \div \sin83.4º)]$ | M1 | | |
| | | C = 8.72 | A1 | 3 | |
| | **(ii)** | $[\mu = \sqrt{3} \div 4$ or $\mu = \cos66.6º \div \sin66.6º]$ | M1 | | For using $\mu = F/R = C\cos\phi / C\sin\phi$ |
| | | Coefficient is 0.433 (accept 0.43) | A1 | 2 | |

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| | | | | | |
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| **5** | **(i)** | | M1 | | For applying Newton's second law to A or to B |
| | | $0.9g - T = 0.9a$ or $T - 0.6g = 0.6a$ | A1 | | |
| | | $T - 0.6g = 0.6a$ or $0.9g - T = 0.9a$ or $(0.9 - 0.6)g = (0.9 + 0.6)a$ | B1 | | |
| | | Acceleration is 2 $ms^{-2}$ and tension is 7.2 N | A1 | 4 | |
| | **(ii)** | | M1 | | For using $0 = u - gt$ |
| | | $u = 3$ | A1 | | |
| | | $[3^2 = 2 \times 2\ h]$<br>$[½\ (0.9 + 0.6)3^2 = (0.9 - 0.6)gh]$ | M1 | | For using $v^2 = 0^2 + 2ah$ with $v_{taut} = u_{slack}$ or for using KE gain = PE loss while the string is in tension |
| | | Height is 2.25 m | A1 | 4 | |
| **6** | **(i)** | KE loss = $½\ 16000(15^2 - 12^2)$ | B1 | | |
| | | PE gain = $16000g(AB/20)$ | B1 | | |
| | | | M1 | | For using WD by DF = PE gain + WD against resistance – KE loss |
| | | $1200 = 0.8g(AB) + 1.24(AB) - 648$ | A1 | | |
| | | Distance AB is 200m | A1 | 5 | |
| | **(ii)** | Distance BD is 300m | B1 | 1 | |
| | **(iii)** | WD against resistance = | | | |
| | | $1240(BC) + 1860(300 - BC)$ | B1ft | | ft distance BD |
| | | | M1 | | For using KE loss = PE gain + WD against res'ce – WD by DF |
| | | $½\ 16000(12^2 - 7^2) =$<br>$2400000 + (558000 - 620BC) - 7200 \times 300$ | A1 | | |
| | | Distance BC is 61.3 m | A1 | 4 | |

Alternative for Q6 part **(iii)**.

| | |
|---|---|
| For BC $16000a = 7200 - 1240 - 8000$ and for CD $16000a = 7200 - 1860 - 8000$ | B1 |
| For using $v^2 = u^2 + 2as$ for both BC and CD | M1 |
| $v_C^2 = 144 - 2 \times 0.1275(BC)$ and $49 = v_c^2 - 2 \times 0.16625(300 - BC)$ | A1 |
| For eliminating $v_c^2$ and obtaining BC = 61.3 m | A1 |

SR for candidates who assume that the acceleration is constant in part **(i)**, although there is no justification for the assumption (max. 3/5)

| | |
|---|---|
| For appropriate use of Newton's second law and $v^2 = u^2 + 2as$<br>$[1200000 \div AB - 1240 - 160000/20 = 16000a$ and $a = (12^2 - 15^2)/2(AB)]$ | M1 |
| For eliminating a and attempting to solve for AB | M1 |
| Distance AB is 200m | A1 |

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| | | | | | | |
|---|---|---|---|---|---|---|
| 7 | (i) | (a) | [ 2 × ½ (1 + 9)400] | M1 | | For using area property for distance |
| | | | Approximation is 4000 m | A1 | 2 | |
| | | (b) | | M1 | | For using the gradient property for acceleration |
| | | | Accelerations are 0.02 $ms^{-2}$ and – 0.02 $ms^{-2}$ | A1 | 2 | Accept deceleration is 0.02 $ms^{-2}$ |
| | (ii) | (a) | | M1 | | For using a = dv/dt and attempting to solve a= 0.02 or a = –0.02. |
| | | | $0.04 – 0.0001t = \pm 0.02$ | A1ft | | |
| | | | Values of t are 200 and 600 | A1 | 3 | |
| | | (b) | $v_1 – v = 0.02t + 1 – 0.04t + 0.00005t^2$ | B1 | | |
| | | | $v_1 – v = [0.00005t^2 – 0.02t + 2 – 1]$<br>$= 0.00005(t^2 – 400t + 40000) – 1$<br>$= 0.00005(t – 200)^2 – 1$ | B1 | 2 | AG |
| | | (c) | For using $(v_1 – v)_{min}$ occurs when | | | |
| | | | $t = 200 \rightarrow –1 \leq v_1 – v$ | B1 | | |
| | | | For using $(v_1 – v)_{max}$ occurs when t = 0 and when $t = 400 \rightarrow v_1 – v \leq 1$ | B1 | 2 | |

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