

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.

- Cambridge will not enter into discussions or correspondence in connection with 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 \surd 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:

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| 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

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|-------|---|
| 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) $F = 720/12$ $[F - R = 75 \times 0.16]$ $R = 48$ | B1 M1 A1 | 3 | For use of Newton's second law |
| | (ii) $[720/v > 48]$ $v < 15$ i.e. speed is less than 15 ms^{-1} | M1 A1 | 2 | For using $P/v - R = ma$ and $a > 0 \rightarrow P/v > R$ |
| 2 | (i) $F = 0.2 \times 6g \cos 8$ $[6g \sin 8 - F = 6a]$ Deceleration is 0.589 ms^{-2} | B1 M1 A1 | 3 | For use of Newton's second law Accept $a = -0.589$ |
| | (ii) Distance is 7.64 m | M1 A1 | 2 | For use of $0 = u^2 + 2as$ |
| 3 | $v = (0.8/0.25)t^{0.25} + (C)$ $C = 1.8$ | M1 A1 B1 | | For using $v = \int a dt$ |
| | $s = (3.2/1.25)t^{1.25} + 1.8t + (K)$ | M1 A1ft | | For using $s = \int v dt$ ft only from an incorrect non-zero value of C |
| | Distance is 111 m | A1 | 6 | |
| | | | | |
| 4 | (i) For triangle of forces with 60° shown correctly, or $C \cos \phi = 4 \cos 30$ and $C \sin \phi = 10 - 4 \sin 30$, or $F = 4 \cos 30$ and $R = 10 - 4 \sin 30$ $[C^2 = 4^2 + 10^2 - 2 \times 4 \times 10 \cos 60$ or $C^2 = (4 \cos 30)^2 + (10 - 4 \sin 30)^2]$ $C = 8.72$ | B1 M1 A1 | 3 | For using cosine rule or for using $C^2 = (C \cos \phi)^2 + (C \sin \phi)^2$ or $C^2 = F^2 + R^2$ |
| | (ii) $[\mu = 4 \cos 30 / (10 - 4 \sin 30)]$ Coefficient is 0.433 (accept 0.43) | M1 A1 | 2 | For using $\mu = F/R = C \cos \phi / C \sin \phi$ |
| 4 | Alternative Method | | | |
| (i) | For obtaining $\phi = 66.6^\circ$ or $\tan \phi = 4 \div \sqrt{3}$ from $4 \div \sin(90^\circ + \phi) = 10 \div \sin(150^\circ - \phi)$ For using C N and (4 N or 10 N) in Lami's theorem to find C $[C \div \sin 120^\circ = (4 \div \sin 156.6^\circ \text{ or } 10 \div \sin 83.4^\circ)]$ $C = 8.72$ | B1 M1 A1 | 3 | |
| | (ii) $[\mu = \sqrt{3} \div 4 \text{ or } \mu = \cos 66.6^\circ \div \sin 66.6^\circ]$ Coefficient is 0.433 (accept 0.43) | M1 A1 | 2 | For using $\mu = F/R = C \cos \phi / C \sin \phi$ |

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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 | |
| | $[3^2 = 2 \times 2 \text{ h}]$ $[\frac{1}{2}(0.9 + 0.6)3^2 = (0.9 - 0.6)gh]$ | M1 | For using $v^2 = 0^2 + 2ah$ with $v_{\text{taut}} = u_{\text{slack}}$ or for using KE gain = PE loss while the string is in tension |
| | Height is 2.25 m | A1 | 4 |
| ----- | | | |
| 6 | (i) | KE loss = $\frac{1}{2} 16000(15^2 - 12^2)$ | B1 |
| | PE gain = $16000g(AB/20)$ | B1 | |
| | $1200 = 0.8g(AB) + 1.24(AB) - 648$ | M1 | For using WD by DF = PE gain + WD against resistance - KE loss |
| | Distance AB is 200 m | A1 | 5 |
| ----- | | | |
| | (ii) | Distance BD is 300 m | B1 1 |
| ----- | | | |
| | (iii) | WD against resistance = $1240(BC) + 1860(300 - BC)$ | B1ft ft distance BD |
| | $\frac{1}{2} 16000(12^2 - 7^2) = 2400000 + (558000 - 620BC) - 7200 \times 300$ | M1 | For using KE loss = PE gain + WD against res'ce - WD by DF |
| | Distance BC is 61.3 m | A1 | |
| | | 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 $BC = 61.3 \text{ m}$ | | 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 $v^2 = u^2 + 2as$ [$1200000 \div AB - 1240 - 160000/20 = 16000a$ and $a = (12^2 - 15^2)/2(AB)$] | | M1 |
| | For eliminating a and attempting to solve for AB | | M1 |
| | Distance AB is 200 m | | A1 |

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| 7 (i) (a) | $[2 \times \frac{1}{2}(1+9)400]$ | 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 | |
| | $v_1 - v = [0.00005t^2 - 0.02t + 2 - 1]$ | | |
| | $= 0.00005(t^2 - 400t + 40000) - 1$ $= 0.00005(t - 200)^2 - 1$ | 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 | |