

# UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary and Advanced Level

## MARK SCHEME for the November 2004 question papers

### 9709 MATHEMATICS 8719 HIGHER MATHEMATICS

9709/05, 8719/05

Paper 5 (Mechanics 2), maximum raw mark 50

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 Examiners were initially instructed to award marks. It does not indicate the details of the discussions that took place at an Examiners' meeting before marking began. Any substantial changes to the mark scheme that arose from these discussions will be recorded in the published *Report on the Examination*.

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 must be read in conjunction with the question papers and the *Report on the Examination*.

- CIE will not enter into discussion or correspondence in connection with these mark schemes.

CIE is publishing the mark schemes for the November 2004 question papers for most IGCSE and GCE Advanced Level syllabuses.



**Grade thresholds** taken for Syllabus 9709/8719 (Mathematics and Higher Mathematics) in the November 2004 examination.

|             | maximum mark available | minimum mark required for grade: |    |    |
|-------------|------------------------|----------------------------------|----|----|
|             |                        | A                                | B  | E  |
| Component 5 | 50                     | 41                               | 37 | 22 |

The thresholds (minimum marks) for Grades C and D are normally set by dividing the mark range between the B and the E thresholds into three. For example, if the difference between the B and the E threshold is 24 marks, the C threshold is set 8 marks below the B threshold and the D threshold is set another 8 marks down. If dividing the interval by three results in a fraction of a mark, then the threshold is normally rounded down.

## 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.



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 $\sqrt{}$ " marks. MR is not applied when the candidate misreads his own figures – this is regarded as an error in accuracy. |
| PA -1 | This is deducted from A or B marks in the case of premature approximation.  |



November 2004

GCE A AND AS LEVEL

MARK SCHEME

MAXIMUM MARK: 50

**SYLLABUS/COMPONENT: 9709/05, 8719/05**

**MATHEMATICS AND HIGHER MATHEMATICS  
Paper 5 (Mechanics 2)**



| Page 1 | Mark Scheme                    | Syllabus  | Paper |
|--------|--------------------------------|-----------|-------|
|        | A AND AS LEVEL – NOVEMBER 2004 | 9709/8719 | 5     |

- 1 (i) For using  $T = \frac{\lambda x}{L}$   $(T = 60(0.5)/1.5)$  **M1**
- Tension is 20 N **A1 2**
- (ii) For using extension 0.5 m (or 1 m) in Hooke's Law **M1**
- $T = 60(0.5)/0.75$  or  $T = 60(1)/1.5$   $(T = 40)$  **A1**
- For resolving forces vertically  $(W = 2T \times (\frac{3}{5}))$  **M1**
- (2 components of  $T$  necessary)
- $W = 48$  N **A1 4**
- 2 (i) For taking moments about A (N.B. A moment = a force is  $M_0$ ) **M1**
- $30 \times 0.6 = T \times 1.2 \times \frac{0.5}{1.3}$  or  $30 \times 0.6 = T \times 1.2 \sin 22.62^\circ$  **A1**
- Tension is 39 N **A1 3**
- (ii) Horizontal component is 36 N **B1 ft**
- For taking moments about B ( $1.2Y = 30 \times 0.6$ ) or for resolving forces vertically ( $30 - T \sin 22.62^\circ$ ) **M1**
- Vertical component is 15 N **A1 ft 3**
- 3 (i) For using Newton's second law and  $a = \frac{dv}{dt}$  **M1**
- Correct working to obtain the given answer **A1 2**
- (ii) For separating the variables and attempting to integrate **M1**
- $t = -125 \ln(7000 - v^2)$  (+C) (aef) **A1**
- For attempting to find  $t(40) - t(10)$  (or equivalent) **M1**
- Time taken is 30.6 s **A1 4**
- 4 (i) For 'speed at greatest height =  $x$ ' used  $(40 = 50 \cos \theta)$  **M1**
- $\cos \theta = 0.8$  **A1 2**
- (ii) For using  $\dot{y} = 0$  at maximum height or  $y = 0$  at impact **M1**
- [At max height  $t = 50 \times 0.6/10$  or at impact  $t = 50 \times 0.6$  ( $\frac{1}{2} 10$ )]
- [if (b) is answered before (a) using the range formula, this mark may be scored using  $R/2 = (50t \cos \theta)$  for  $t$  at max ht or  $R = (50t \cos \theta)$  for  $t$  at impact]

| Page 2 | Mark Scheme                    | Syllabus  | Paper |
|--------|--------------------------------|-----------|-------|
|        | A AND AS LEVEL – NOVEMBER 2004 | 9709/8719 | 5     |

(a) For substituting for  $t$  at max height (= 3) into **M1**

$$H = 50t \sin \theta - \frac{1}{2} g t^2 \text{ or } H = \frac{50 \sin \theta + 0}{2} t$$

Greatest height is 45m **A1**

(b) For substituting  $t$  at max ht (= 3) into  $R = 2(50t \cos \theta)$  **M1**  
or  $t$  at impact (= 6) into  $R = (50t \cos \theta)$  or for using  
 $R = V^2 \sin 2\theta / g$  (directly or by substituting  $y = 0$  in the  
trajectory equation)

Distance is 240m **A1 5**

Alternative for methods not involving  $t$  at max ht. or  $t$  at impact:

For using  $\dot{y} = 0$  in  $\dot{y}^2 = \dot{y}_0^2 - 2gH$  or using the principle of **M1**  
conservation of energy (2 non-zero KE terms and a GPE term  
needed) or using the trajectory equation with  $x = R/2$  if (b) is  
answered before (a).

$$0 = (50 \times 0.6)^2 - 2 \times 10H \text{ or } \frac{1}{2}m50^2 = \frac{1}{2}m40^2 + mgH \text{ or } \mathbf{A1}$$

$$H = 120(0.75) - 10(120)^2/[2(50)^2(0.8)^2]$$

Greatest height is 45m **A1**

For using  $R = V^2 \sin 2\theta / g$  (directly or by substituting  $y = 0$  in the  
trajectory equation) **M1**

Distance is 240m **A1**

**5** Loss in EPE =  $\frac{16(0.1)^2}{2 \times 0.4}$  (= 0.2) **B1**

For using  $F = \mu R$  and  $R = mg$  **M1**

$$F = 0.2 \times 0.8 \times 10 \quad (=1.6) \quad \mathbf{A1}$$

$$\text{WD against friction} = 1.6 \times 0.1 \quad (= 0.16) \quad \mathbf{B1 ft}$$

For using KE gained = EPE lost – WD against friction **M1**

$$\frac{1}{2} 0.8v^2 = 0.2 - 0.16 \quad \mathbf{A1 ft}$$

Speed is  $0.316 \text{ ms}^{-1}$  **A1 7**

**6 (i)** For using  $F = m\omega^2 r$  (0.36 N) **M1**

$$\text{For using } F = \mu R \quad (0.36 = 0.8 \mu) \quad \mathbf{M1}$$

$$\mu = 0.45 \quad \mathbf{A1 3}$$

| Page 3 | Mark Scheme                    | Syllabus  | Paper |
|--------|--------------------------------|-----------|-------|
|        | A AND AS LEVEL – NOVEMBER 2004 | 9709/8719 | 5     |

|   |      |  |            |  |              |
|---|------|--|------------|--|--------------|
|   | (ii) | $(\mu, R \text{ fixed } \rightarrow)$  | $F = 0.36$ |  | <b>B1 ft</b> |
|   |      | For using $F = mv^2/r$ or $F = mr(1.2/r)^2$ ( $r \neq 0.5$ )   |            |  | <b>M1</b>    |
|   |      | $(0.36 = 0.08 \times 1.2^2/r$ or $0.36 = 0.08 r(1.2/r)^2$ )  |            |  |              |
|   |      | [for $F = m(v/\omega) \times \omega^2$ treat as for alternative case below.]   |            |  |              |
|   |      | For using $v = \omega r$ ( $r \neq 0.5$ )  |            |  | <b>M1</b>    |
|   |      | $r = 0.32$ or unsimplified equation in $\omega$ only   |            |  | <b>A1 ft</b> |
|   |      | Alternative for the above last three marks:  |            |  |              |
|   |      | For using $F = mv\omega$   |            |  | <b>M2</b>    |
|   |      | $0.08 \times 1.2\omega = 0.36$   |            |  | <b>A1</b>    |
|   |      | $\omega = 3.75$  |            |  | <b>A1 5</b>  |
| 7 | (i)  | Centre of mass of triangle is at height 0.2m   |            |  | <b>B1</b>    |
|   |      | For taking moments about the base  |            |  | <b>M1</b>    |
|   |      | $(0.4 \times 0.3 + \frac{1}{2} 0.6 \times 0.3)\bar{y}$   |            |  |              |
|   |      | $= 0.4 \times 0.3 \times 0.15 + \frac{1}{2} 0.6 \times 0.3 \times 0.2$   |            |  |              |
|   |      | For correct total area and correct (unsimplified) moment of the rectangle  |            |  | <b>A1</b>    |
|   |      | For the correct (unsimplified) moment of triangle  |            |  | <b>A1 ft</b> |
|   |      | Distance of centre of mass is 0.171 or $6/35$ m  |            |  | <b>A1 5</b>  |
|   | (ii) | Centre of mass of triangle is $\frac{2y}{3}$ from interface  |            |  | <b>B1</b>    |
|   |      | For using 'moment about the interface = 0' or equivalent or 'moment about AD = 0.4A' <u>AND</u> with areas in terms of y |            |  | <b>M1</b>    |
|   |      | $[0.4y \times 0.2 = \frac{1}{2} 2y \times y \times \frac{2y}{3}$   |            |  |              |
|   |      | or $0.4(0.4y + \frac{1}{2} 2y \times y) = 0.4y \times 0.2 + \frac{1}{2} 2y \times y (0.4 + \frac{2y}{3})$ ]              |            |  |              |
|   |      | For LHS of the above   |            |  | <b>A1</b>    |
|   |      | For RHS of the above   |            |  | <b>A1 ft</b> |
|   |      | Value of y is or $\frac{\sqrt{3}}{5} 0.346$  |            |  | <b>A1 5</b>  |