

UNIVERSITY OF CAMBRIDGE INTERNATIONAL EXAMINATIONS

GCE Advanced Subsidiary and Advanced Level

MARK SCHEME for the November 2004 question papers

9709 MATHEMATICS

9709/04

Paper 4 (Mechanics 1), 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 (Mathematics) in the November 2004 examination.

	maximum mark available	minimum mark required for grade:		
		A	B	E
Component 4	50	38	34	18

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. 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.

November 2004

GCE A AND AS LEVEL

MARK SCHEME
MAXIMUM MARK: 50
SYLLABUS/COMPONENT: 9709/04 MATHEMATICS (Mechanics 1)

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	A AND AS LEVEL – NOVEMBER 2004	9709

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1		$T = 1.7a$ $0.3g - T = 0.3a$	M1	For applying Newton's second law to one of the particles
			A1	
			A1	Alternative for either of the A marks; $0.3g = (1.7 + 0.3)a$ B1
		Acceleration is 1.5 ms^{-2} and tension is 2.55 N	M1	For finding a or T
			A1	5
2	(i)	$P = 18\cos 60^\circ$ or $\sin 30^\circ = P/18$ $P = 9$	M1	For resolving forces parallel to the plane or for trigonometry in the correct triangle of forces
			A1	2
	(ii)	<ul style="list-style-type: none"> $P\cos 30^\circ = 18\cos 60^\circ$ or $\tan 30^\circ = P/18$ or $18 = R\cos 30^\circ$ and $P = R\sin 30^\circ$ $P = 10.4$ (accept $6\sqrt{3}$)	M1	For resolving forces parallel to the plane or for trigonometry in the correct triangle of forces or for resolving forces both vertically and horizontally
			A1	3
				SR for candidates who mix sin/cos or have tan upside down: max 3/5 M marks as scheme M1 M1 Both $P = 15.6$ in (i) and $P = 31.2$ in (ii) A1 SR for candidates who use $W = 18g$: max 3/5 Allow M marks with g present M1 M1 Both $P = 90$ in (i) and $P = 104$ in (ii) A1

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3		Equation $F - 1130 + 1250g\sin 3^\circ$ $= 1250 \times 0.2$ contains not more than one error	M1		For using Newton's second law, equation must contain F (or P/v) and ma terms
		Equation is correct	A1		
		$22000 = 725.8v$	M1		For using $P = Fv$
		Speed is 30.3 ms^{-1}	A1	5	

4	(i)	Gain in GPE = $3.2 \times 10^6 \text{ J}$	B1	1	From $16000 \times 10 \times 20$
	(ii)	WD by driving force = $5 \times 10^6 \text{ J}$	B1	1	From 5000×1000
	(iii)	Work done is $1.8 \times 10^6 \text{ J}$	B1 ft	1	From ans (ii) – ans (i) or from $(5000 - 160\,000 \times 20/1000)1000$
	(iv)	Increase in KE $= \frac{1}{2} 16000 (25^2 - 10^2)$	M1		For using $KE = \frac{1}{2} mv^2$
		WD by resistance $= 1500 \times 2000$	A1		
	WD by driving force $= 4.2 \times 10^6 + 3 \times 10^6$	B1			
	WD by driving force $= 7.2 \times 10^6 \text{ J}$	M1		WD by driving force = increase in KE + WD by resistance	
		A1	5		
					SR for candidates who assume implicitly that the driving force is constant: max 2/5 $a = (625 - 100)/(2 \times 2000)$ $DF = 16000 \times 0.13125 = 2100$ $WD = (2100 + 1500) \times 2000 = 7.2 \times 10^6 \text{ J}$ B2 (candidates who use this approach and fail to reach the required answer should be marked according to the main scheme, and may score B mark – max 1/5)

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5	(i)	<ul style="list-style-type: none"> • $5 + 4t = 1.8(3 + 2t)$ or • $1.8v_Q = 5 + 4t$ and $v_Q = 3 + 2t$ or • $v_P = 5 + 4t$ and $(5/9)v_P = 3 + 2t$ <p>$t = 1$ or $v_Q = 5$ or correct equation in v_P only [eg $(10/9 - 1)v_P = 6 - 5$]</p> <p>Speed of $P = 9\text{ms}^{-1}$</p>	<p>M1</p> <p>A1</p> <p>A1</p> <p>A1ft 4</p>	<p>For using $v = u + at$ and $v_P = 1.8v_Q$</p>
	(ii)	<p>$5t + \frac{1}{2}4t^2 + 3t + \frac{1}{2}2t^2 = 51$</p> <p>$3t^2 + 8t - 51 = 0$ $\rightarrow (3t + 17)(t - 3)$</p> <p>Time is 3 s</p>	<p>M1</p> <p>A1</p> <p>M1</p> <p>A1 4</p>	<p>For using $s = ut + \frac{1}{2}at^2$ and $s_P + s_Q = 51$</p> <p>For attempting to solve the resulting quadratic equation</p>
6	(i)	<p>$R = 8000\text{ N}$</p> <p>For obtaining $P \leq 6000$</p>	<p>B1</p> <p>B1 2</p>	<p>From $P = F \leq \mu R = 0.75 \times 8000$</p>
	(ii)	<p>$F \leq 0.4 \times 4000$ or $F_{\max} = 0.4 \times 4000$</p> <p>$400a \leq 1600$ or $400a_{\max} = 1600$</p> <p>$a \leq 4$</p> <p>$P_{\max} - 6000 = 800 \times 4$ or $P - 6000 = 800a \leq 800 \times 4$</p> <p>Maximum possible value of P is 9200</p>	<p>B1</p> <p>M1</p> <p>A1</p> <p>A1</p> <p>M1</p> <p>A1</p> <p>A1 7</p>	<p>For applying Newton's 2nd law to the upper box and using $F \leq 1600$ or $F_{\max} = 1600$</p> <p>From $F = 400a$</p> <p>For applying Newton's 2nd law to the boxes</p>

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7	(i)	$t^2(0.009 - 0.0001t) = 0$ Time is 90 s	M1 A1 2	For attempting to solve $v(t) = 0$ for $t \neq 0$
	(ii)	$s = 0.003t^3 - 0.000025t^4 \quad (+ C)$ $(2187 - 1640.25) - (0 - 0)$ Distance is 547 m	M1 A1 M1 A1 4	For attempting to integrate $v(t)$ For attempting to find $s(\text{ans i}) - s(0)$ [the subtraction of $s(0)$ is implied if C is found to be zero or if C is absent]
	(iii)	$0.018t - 0.0003t^2 = 0 \rightarrow$ $t(0.018 - 0.0003t) = 0$ $t = 60 \quad (\text{may be implied})$ $32.4 - 21.6$ Maximum speed is 10.8 ms^{-1}	M1 A1 M1 A1 4	For obtaining \dot{v} and attempting to solve $\dot{v} = 0$ For attempting to find $v(60)$