

MARK SCHEME for the October/November 2013 series

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 should be read in conjunction with the question paper and the Principal Examiner Report for Teachers.

Cambridge will not enter into discussions about these mark schemes.

Cambridge is publishing the mark schemes for the October/November 2013 series for most IGCSE, GCE Advanced Level and Advanced Subsidiary Level components and some Ordinary Level components.

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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	Applying $T \cos \beta = W \sin \alpha$ Tension is 2.5 N	M1 A1 A1	3	For resolving forces parallel to the line of greatest slope $T (24/25) = 5.1 (8/17)$ or $T \cos 16.26 = 5.1 \sin 28.07$
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First Alternative Marking Scheme

	Applying $R \cos \alpha + T \sin (\alpha + \beta) = W$ and $R \sin \alpha = T \cos (\alpha + \beta)$ Tension is 2.5 N	M1 A1 A1	3	For resolving forces vertically or horizontally $R \cos 28.07 + T \sin 44.33 = 5.1$ and $R \sin 28.07 = T \cos 44.33$
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Second Alternative Marking Scheme

	Applying $T / \sin \alpha = 5.1 / \sin (90 + \beta)$ Tension is 2.5 N	M1 A1 A1	3	Using Triangle of forces $T / \sin 28.07 = 5.1 / \sin 106.26$
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2	Gain in KE = $\frac{1}{2} 25 \times 3^2$ or WD by pulling force = $220 \times 15 \cos \alpha$ WD by pulling force = $220 \times 15 \cos \alpha$ or Gain in KE = $\frac{1}{2} 25 \times 3^2$ [$3300 \cos \alpha = 112.5 + 3000$] $\alpha = 19.4$	M1 A1 B1 M1 A1	5	For using KE = $\frac{1}{2} m v^2$ or WD = $F d \cos \alpha$ For using WD by pulling force = KE gain + WD against resistance
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3	(i)	$100/4 - 4k = 0 \rightarrow k = 6.25$	M1 A1	2	For using $F = P/v$ and Newton's 2 nd law with $a = 0$ AG
	(ii)	$100/v - 70g \times 0.05 - 6.25v = 0$ $[6.25v^2 + 35v - 100 = 0]$ or $[v^2 + 5.6v - 16 = 0]$ Maximum speed is 2.08 ms^{-1}	M1 A1 M1 A1	4	For using Newton's 2 nd law with $a = 0$ uphill \rightarrow 3 term equation For solving a 3-term quadratic for v

4			M1		For resolving three forces parallel to the plane
		$0.6g \sin \alpha = F + P \cos \alpha$	A1		Value of α used or values of $\sin \alpha$ and $\cos \alpha$ used
			M1		For resolving three forces perpendicular to the plane
		$R = 0.6g \cos \alpha + P \sin \alpha$	A1		Value of α used or values of $\sin \alpha$ and $\cos \alpha$ used
			M1		For using $F = \mu R$
		$0.6g \sin \alpha - P \cos \alpha =$ $0.4 (0.6g \cos \alpha + P \sin \alpha)$ $6(12/13) - P(5/13) =$ $2.4(5/13) + 0.4P(12/13)$ $P = 6.12$	A1 M1 A1	8	Value of α used or values of $\sin \alpha$ and $\cos \alpha$ used For solving the resultant equation for P

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Alternative Marking Scheme

	$W = R \cos \alpha + F \sin \alpha$ $P = R \sin \alpha - F \cos \alpha$ $0.6g = R(5/13) + 0.4R(12/13)$ and $P = R(12/13) - 0.4R(5/13)$ $78 = R(5 + 4.8)$ and $13P = R(12 - 2)$ $\rightarrow 13P = (78 \div 9.8) \times 10$ $P = 6.12$	M1 A1 M1 A1 M1 A1 M1 A1	8	For resolving three forces vertically Value of α used or values of $\sin \alpha$ and $\cos \alpha$ used For resolving three forces horizontally Value of α used or values of $\sin \alpha$ and $\cos \alpha$ used For using $F = \mu R$ in both equations Value of α used or values of $\sin \alpha$ and $\cos \alpha$ used For finding R and substituting into an expression for P
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5	(i)	$[s = t^2/2 - 0.1t^3/3]$ $[s_1 = 25/2 - 0.1 \times 125/3]$ $s_1 = 8.33$	M1* DM1* A1	3	For integrating to find s for $0 \leq t \leq 5$ For obtaining s_1 by using limits 0 to 5 or having zero for constant of integration (can be implied) and substituting $t = 5$
	(ii)	$s_2 = 2.5 \times 40$ $[s = 9t^2/2 - 0.1t^3/3 - 200t$ for $45 \leq t \leq 50]$ $s_3 = [9(50)^2/2 - 0.1(50)^3/3 - 200(50)]$ $- [9(45)^2/2 - 0.1(45)^3/3 - 200(45)]$ $[= 8.33]$	A1 M1 A1	M1	For using $s = v(5) \times (45 - 5)$ for $5 \leq t \leq 45$ For integrating to find s for $45 \leq t \leq 50$ and implying the use of limits 45 and 50 or equivalent via constant of integration For applying the limits at 45 and 50 correctly or equivalent via constant of integration

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Alternative mark scheme for previous 2 marks

	<p>Recognising the symmetry of the velocity distribution due to the correspondence of the points $(0,0) \rightarrow (50,0)$ and $(5,2.5) \rightarrow (45,2.5)$</p> <p>Complete the idea of symmetry with one further property and hence State $s_3 = s_1 = 8.33$</p> <p>Distance from O to A is 117m</p> <p>Average speed is 2.33 ms^{-1}</p>	<p>(M1)</p> <p>(A1)</p> <p>A1</p> <p>B1ft</p>	6	<p>Property is any one of $a(0) = -a(50)$ $a(5) = a(45)$ $v(2.5) = v(47.5)$ oe</p> <p>ft answer for total distance</p>
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6	(i)	<p>$T - 0.4g = 0.4a$ or $1.6g - T = 1.6a$</p> <p>$1.6g - T = 1.6a$ or $T - 0.4g = 0.4a$ or $1.6g - 0.4g = (1.6 + 0.4)a$</p> <p>$T = 6.4$</p> <p>Work done by tension is 7.68 J</p>	<p>M1</p> <p>A1</p> <p>B1</p> <p>A1</p> <p>B1ft</p>	5	<p>For applying Newton's 2nd law to A or B</p>
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Alternative mark scheme for 6 (i)

	<p>$T - 0.4g = 0.4a$ or $1.6g - T = 1.6a$</p> <p>$1.6g - T = 1.6a$ or $T - 0.4g = 0.4a$ or $1.6g - 0.4g = (1.6 + 0.4)a$</p> <p>WD by T = initial PE – final KE $= 1.6 \times g \times 1.2 - \frac{1}{2} \times 1.6 \times 14.4$</p> <p>WD by T = $19.2 - 11.52 = 7.68$</p>	<p>M1</p> <p>A1</p> <p>B1</p> <p>M1</p> <p>A1</p>	5	<p>For applying Newton's 2nd law to A or B</p> <p>For finding v^2 and applying Work/Energy equation to B</p>
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6	(ii)	$[1.6 \times 10 \times 1.2 = \frac{1}{2} 1.6 v^2 + 7.68]$	M1	4	For using PE loss = KE gain + WD by T to find v^2 For using PCE for A's motion after B reaches the ground or $0 = u^2 - 2gh$ and $H = 2 \times 1.2 + h$
		$v^2 = 14.4$	A1		
		$14.4 = 2 \times 10 \times h$ $h = 0.72$ $H = 2 \times 1.2 + h$	M1		
		Greatest height is 3.12 m	A1		

First Alternative Marking Scheme for 6 (ii)

		$[v^2 = 2 \times 6 \times 1.2]$	M1	4	For using $v^2 = 2as$ to find v^2 For using PCE for A's motion after B reaches the ground or $0 = u^2 - 2gh$ and $H = 2 \times 1.2 + h$
		$v^2 = 14.4$	A1		
		$14.4 = 2 \times 10 \times h$ $h = 0.72$ $H = 2 \times 1.2 + h$	M1		
		Greatest height is 3.12 m	A1		

Second Alternative Marking Scheme for 6 (ii)

		WD by T = Increase in PE $7.68 = 0.4 \times g \times s$	M1	4	For applying WD by T to particle A's complete motion
		$s = 1.92$	A1		
		$H = 1.2 + s$	M1		For adding 1.2 to s
		$H = 1.2 + 1.92 = 3.12$ Height = 3.12 m	A1		

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7	(i)	$[s = \frac{1}{2} 5 \times 0.4 + 19 \times 0.4 + \frac{1}{2} 4 \times 0.4]$ Distance = 9.4	M1 A1	2	For using the area property for distance
	(ii)	Acceleration is 0.08 ms^{-2} Deceleration is 0.1 ms^{-2}	B1 B1	2	
	(iii)	$[T - (800 + 100)g = (800 + 100)a]$ $T - 900g = 900a$ $T = 9072 \text{ N}$ in 1 st stage $T = 9000 \text{ N}$ in 2 nd stage $T = 8910 \text{ N}$ in 3 rd stage	M1 A1 A1	3	For applying Newton's 2 nd law to the <u>elevator and box</u>
	(iv)	$[R - 100g = 100a]$ $R = 1008 \text{ N}$ $R = 990 \text{ N}$	M1 A1 A1	3	For applying Newton's 2 nd law to the <u>box</u> For obtaining the greatest value of the force on the box For obtaining the least value of the force on the box