

CAMBRIDGE INTERNATIONAL EXAMINATIONS
Cambridge International Advanced Level

MARK SCHEME for the May/June 2015 series

9280 MATHEMATICS (US)

9280/51

Paper 5 (Paper 5), maximum raw mark 50

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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	$EE(B) = \frac{\lambda \times 0.5^2}{2 \times 0.7} \left[= \frac{5\lambda}{28} \right]$ $\text{OR } EE = \frac{\lambda \times 0.2^2}{2 \times 0.7} \left[= \frac{\lambda}{35} \right]$ $\frac{\Lambda \times 0.5^2}{2 \times 0.7} - \frac{\lambda \times 0.2^2}{2 \times 0.7} = \frac{0.3 \times 4^2}{2}$ $\lambda = 16 \text{ N}$	B1 M1 A1	[3]	<p>Correct EE when AP = 1.2 m Correct EE when AP = 0.9 m</p> <p>Using EE loss = KE gain</p>
2 (i)	$\frac{dy}{dx} = 1.2 - 2(0.15x) = 0$ $y = 2.4$ <p>OR</p> <p>Greatest height at half range (ii)</p> $y = 2.4$	M1 A1 M1 A1	[2]	<p>Solving trajectory derivative = 0</p> <p>From $x = 4$</p> <p>Uses $y = 1.2x - 0.15x^2$ with $x =$ distance in (ii) $\div 2$</p>
3 (ii)	<p>Twice 'x' for greatest height</p> <p>Distance = 8 m</p> <p>OR</p> $1.2x - 0.15x^2 = 0$ <p>Distance = 8 m</p>	M1 A1 M1 A1	[2]	<p>Using 'x' from (i)</p> <p>No ft</p> <p>Solves quadratic with $y = 0$</p>
3 (i)	$T \sin \theta = m \omega^2 r$ $3 \omega \sin \theta = \left(\frac{\omega}{g} \right) 5^2 (L \sin \theta)$ $L = 1.2 \text{ m} \quad \text{AG}$	M1 A1 A1	[3]	<p>Newton's 2nd law, acceleration = $5^2 r$ and component of T</p> $3mg \sin \theta = m 5^2 (L \sin \theta)$
	$3 \omega \cos \theta = \omega$ $\theta = 70.53^\circ$ $v = 5 \times 1.2 \sin \theta$ $v = 5.66 \text{ ms}^{-1}$	M1 A1	[4]	<p>Resolves vertically for P</p> <p>OR $\theta = \cos^{-1} \left(\frac{1}{3} \right)$,</p> $\theta = \sin^{-1} \sqrt{\frac{8}{9}}$ <p>etc.</p> $v = \omega r$

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4	(i)	$x' = 15\cos 30$ (= 12.990..)	B1	[5]	Or with signs reversed Or 30° to the vertical	
		$y' = 15\sin 30 - 3g$ (= - 22.5)	B1			
		$v^2 = (15\cos 30)^2 + (15\sin 30 - 3g)^2$ or	M1			
		$\tan\theta = \frac{3g - 15\sin 30}{15\cos 30}$				
		$v = 26(.0) \text{ ms}^{-1}$	A1			
			$\theta = 60^\circ$ to the horizontal	A1		
	(ii)	$y = 3(15\sin 30) - \frac{3^2 g}{2}$	M1		Uses $s = ut + \frac{1}{2}at^2$	
		Height = 22.5 m	A1	[2]	N.B. this is also y'	
		OR				
		$(-22.5)^2 = (15\sin 30)^2 - 2 \times 10y$	M1		Uses $v^2 = u^2 + 2as$	
Height = 22.5 m		A1				
5	(i)	$0.3g = \frac{18e}{0.9}$	M1	[2]	Uses $T = \frac{\lambda x}{l}$	
		$e = 0.15 \text{ m}$	A1			
	(ii) (a)	$12 = \frac{18\text{ext}}{0.9}$ and $ht = 3 - 0.9 - \text{ext}$	M1		[2]	Both ideas needed, ext = 0.6
		$ht = 1.5 \text{ m}$	A1			
	(ii) (b)	$\frac{0.3 \times 6^2}{2} - \frac{0.3u^2}{2} + 0.3g(0.6 - 0.15)$	M1	[2]	KE/PE/EE balance up to string breaking $u^2 = 22.5$	
		$= \frac{18 \times 0.6^2}{2 \times 0.9} - \frac{18 \times 0.15^2}{2 \times 0.9}$	A1			
$\left(\frac{0.3u^2}{2} = 3.375 \right)$						
		$0.3v^2 = 0.3u^2 + 0.3g(3 - 0.6 - 0.9)$ OR $v^2 = u^2 + 2g(3 - 0.6 - 0.9)$	M1		KE/PE balance after string breaks or $v^2 = u^2 + 2g(ht)$ using ht from (ii)(a)	
		$v = 7.25 \text{ ms}^{-1}$	A1	4	7.2456	
6	(i)	$0.1v \frac{dv}{dx} = -0.2 e^{-x}$	M1	[2]	Newton's 2nd law, 1 force Must have negative coefficient	
		$v \frac{dv}{dx} = -2e^{-x}$				
		$k = -2$	A1*			

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7	(ii)	$\int v dv = \int -2e^{-x} dx$	M1		Integrates
		$\frac{v^2}{2} = 2e^{-x} (+ c)$	D*A1		Needs first A1 in (i)
		$c = \left(\frac{2.2^2}{2} - 2e^0 \right) = 0.42$	M1		Or uses limits of 2 and 2.2 for v and x and 0 for x
		$\frac{2^2}{2} = 2e^{-x} + 0.42$	A1	[4]	
		$x = 0.236$			
	(iii)	$\frac{v^2}{2} = 2e^{-\infty} + 0.42$	M1		OR finds x when $v = 0.9165$
		$v = 0.917 \text{ ms}^{-1}$ AG	A1	[2]	No solution when $v = 0.917$
	(i)	$d(0.6 \times 0.8 + 0.6^2) =$ $0.4(0.6 \times 0.8) - (0.6/3) \times 0.6^2$	M1 A1		Moments about BAD
		$d = 0.143 \text{ m}$	A1	[3]	Exact 1/7
	(ii) (a)	$21 \times 0.143 = 1.2P$	M1		Moments about B
	$P = 2.5(0)$	A1	[2]		
(ii) (b)	$F_r = 21\sin 45 - 2.5\cos 45$ and $R = 21\cos 45 + 2.5\sin 45$	B1			
		M1		For using $F_r = \mu R$	
	$\mu = 0.787$	A1	[3]		
(iii)	$P \times 0.6 = 21 \times (0.143 + 0.6)$	M1		Moments about C	
	$P = 26(.0)$	A1			
	Required $F_r = 26\sin 45 - 21\sin 45$	M1		3.5355..	
	Max $F_r = 26(.155)$	A1		$0.787 \times (26\cos 45 + 21\cos 45)$	
	As actual $F_r < \max F_r$, no sliding	A1	[5]		