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MATHEMATICS **9709/41**

Paper 4 **May/June 2016**

MARK SCHEME

Maximum Mark: 50

Published

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.

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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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Qu	Answer	Part Mark	Marks	Guidance
1 (i)	Trapezium seen	B1		*v*–*t* graph with three straight lines, with positive, zero and negative gradients, continuous
	0, 3, 9, 13 shown on the *t* axis	B1		
	$v = 2.7$ soi in either part	B1	[3]	
(ii)	$[0.5 \times (6 + 13) \times 2.7]$	M1		Using area of trapezium
	Total distance = 25.65 m	A1	[2]	Allow Distance = 513/20 m
Alternative method for 1(ii)				
(ii)	Stage 1 $s_1 = 0.5 \times 0.9 \times 3^2 = 4.05$ Stage 2 $s_2 = 2.7 \times 6 = 16.2$ Stage 3 $s_3 = 0.5 \times (2.7 + 0) \times 4 = 5.4$	M1		Complete method to find the total distance travelled by the lift using constant acceleration equations for all three stages
	Total distance = 25.65 m	A1	[2]	
2 (i)	WD = 40 × 36 = 1440 J	B1	[1]	
(ii)		M1		Using PE = *mgh*
	PE = 25 × *g* × 36 sin 20 = 3080 J	A1	[2]	[PE = 3078.18]
(iii)	WD by pulling force = **(i)** + **(ii)**	M1		For using WD by pulling force = Gain in PE + WD against *F*
	WD = 4520 J	A1	[2]	[WD = 4518.18]
Alternative for (iii)				
(iii)	$[(25g \sin 20 + 40) \times 36]$	M1		For attempting to find the pulling force and multiply it by 36 to find the work done
	WD = 4520 J	A1	[2]	[WD = 4518.18]

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Qu	Answer	Part Mark	Marks	Guidance
3 (i)	Driving Force = 300	B1		Using DF = Resistance
	$P = 300 \times 40$	M1		Using $P = Fv$
	$P = 12000$ W = 12 kW	A1	[3]	Must give answer in kW
(ii)	$P = 0.9 \times 12000 = 10800$	B1√		ft on 12000
	$\frac{10\,800}{25} - 300 = 1000a$	M1		Applying Newton's second law with 3 terms to the car
	$a = 132/1000 = 0.132$ ms^{-2}	A1	[3]	
4	$P\cos\theta = 48\cos\alpha - 14\sin\alpha$ and/or $P\sin\theta = 50 - 48\sin\alpha - 14\cos\alpha$	M1		For resolving forces horizontally and/or vertically
	$P\cos\theta = 48(24/25) - 14(7/25)$ $= 42.16$	A1		Allow α = 16.3 used throughout
	$P\sin\theta = 50 - 48(7/25) - 14(24/25)$ $= 23.12$	A1		
		M1		For attempting to find P or θ
	$P = \sqrt{42.16^2 + 23.12^2} = 48.1$	A1		Allow $P = 34\sqrt{2}$
	$\tan\theta = \frac{23.12}{42.16}$ $\theta = 28.7$	B1	[6]	

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Qu	Answer	Part Mark	Marks	Guidance
5	$R = 5g \cos \alpha = 4g$ $F = 0.5 \times 4g = 2g$	**B1**		For finding the normal reaction R acting on the 5 kg particle and using $F = \mu R$
		M1		For applying Newton's second law to one or both particles or to the system
	$T - 2g - 5g\sin \alpha = 5a \rightarrow$ $T - 5g = 5a$	**A1**		System equation is $10g - 5g \sin \alpha - 2g = 5g = 15a$
	$10g - T = 10a$	**A1**		
	$[5g = 15a]$	**M1**		For eliminating T and solve for a
	$a = g/3 = 3.33 \text{ ms}^{-2}$	**A1**		
	$T = 10g - 10(g/3)$ $= 20g/3 = 66.7$ N	**B1**	[7]	
6 (i)	$a = 12t - 30$	**M1**		For differentiating v to find a
	$t < 2.5$	**A1**	[2]	
(ii)	$v = 0$ at $t = 1$ and $t = 4$	**B1**		Using $v = 6(t - 4)(t - 1)$
	$s = \int \left(6t^2 - 30t + 24\right) dt$ $= \frac{6}{3}t^3 - \frac{30}{2}t^2 + 24t$	**M1**		For using integration to find s
	$s = \left[2t^3 - 15t^2 + 24t\right]_1^4$	**M1**		For using limits
	Distance = 27 m	**A1**	[4]	
(iii)	$2t^3 - 15t^2 + 24t = 0$	**M1**		State $s = 0$
	$2t^2 - 15t + 24 = 0$	**M1**		Reduce to a quadratic and attempt to solve
	$t = 2.31$ and $t = 5.19$	**A1**	[3]	

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Qu			Answer	Part Mark	Marks	Guidance
7	(i)	(a)	$200 - 30g \sin 20 = 30a$	M1		For applying Newton's second law with 3 terms parallel to the plane
			$a = 3.25$ ms^{-2}	A1	[2]	[$a = 3.2465$]
		(b)	[$v^2 = 2 \times 3.2465 \times 12 = 77.9$]	M1		For using $v^2 = u^2 + 2as$ and attempting to find KE change
			KE change $= 0.5 \times 30 \times 77.9 = 1170$ J	A1	[2]	[KE = 1168.7 J]
Alternative method for 7(i)(b)						
		(b)	KE change = $200 \times 12 - 30g \times 12 \sin 20$	M1		Using KE gain = WD by DF – PE gain
			KE change = 1170 J	A1	[2]	
	(ii)	(a)	$N = 30g \cos 20$	B1		[$N = 281.9$]
			$F = 0.12 \times 30g \cos 20$ [= 33.8]	M1		Using $F = \mu Na$
			$200 - 30g \sin 20 - 33.8 = 30a$	M1		For using Newton's second law with 4 terms applied to the particle
			$a = 2.12$ ms^{-2}	A1	[4]	
		(b)	$N + 200 \sin 10 = 30g \cos 20$ [$N = 247.2$]	M1		For resolving forces perpendicular to the plane. Three term equation.
			$F = 0.12\,N$ [$= 0.12 \times 247.2 = 29.66$]	M1		N must be from a 3 term equation
			$200 \cos 10 - 29.66 - 30g \sin 20 = 30a$	M1		For using Newton's second law with 4 terms applied to the particle
			$a = 2.16$ ms^{-2}	A1	[4]	

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