Cambridge International AS & A Level

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MATHEMATICS **9709/43**

Paper 4 **May/June 2017**

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.

Cambridge will not enter into discussions about these mark schemes.

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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 FT 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/OE	Any Equivalent Form (of answer is equally acceptable) / Or Equivalent
AG	Answer Given on the question paper (so extra checking is needed to ensure that the detailed working leading to the result is valid)
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
SOI	Seen or implied
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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Question	Answer	Marks	Guidance
1(i)	WD = 35 cos 20 × 12	M1	Uses WD = $Fd \cos \theta$
	395 J	A1	
	Total:	**2**	
1(ii)	*EITHER:* WD against resistance = 15 × 12	(B1	
	35cos20 × 12 = 15 × 12 + ½ $(25v^2)$	M1	Uses $WD_{man} = WD_{resistance}$ + KE gain
	$v = 4.14$ ms^{-1}	A1)	
	OR: 35 cos 20 – 15 = 25 a [$a = 0.716$]	(B1	Applies Newton's Second Law
	$v^2 = 2 \times 0.7155. \times 12$	M1	Uses $v^2 = u^2 + 2as$
	$v = 4.14$ ms^{-1}	A1)	
	Total:	**3**	

Question	Answer	Marks	Guidance
2	*EITHER:* $3P \sin 55 + P \sin \theta = 20 + P \sin \theta$ or $3P \sin 55 = 20$	(M1	Resolves forces vertically
	$P = 8.14$	A1	
	$3P \cos 55 = 2P \cos \theta$	M1	Resolves forces horizontally
	$\cos \theta = 1.5 \cos 55 \rightarrow \theta = \ldots$	M1	Attempt to solve for θ
	$\theta = 30.6$	A1)	
	OR: $\frac{3P}{\sin 90} = \frac{20}{\sin 125}$	(M1	Uses Lami's Theorem (forces $3P$ and 20)
	$P = 8.14$	A1	
	$\frac{3P}{\sin 90} = \frac{2P\cos\theta}{\sin 145}$	M1	Uses Lami's Theorem (forces $3P$ and $2P \cos \theta$)
	$\cos \theta = 1.5 \sin 145 \rightarrow \theta = \ldots$	M1	Attempt to solve for θ
	$\theta = 30.6$	A1)	
	Total:	**5**	

Question	Answer	Marks	Guidance
3(i)	Trapezium, right-hand steeper than left-hand slope	**B1**	
	Total:	**1**	
3(ii)	Deceleration 0.5 T	**B1**	May be implied
	Constant speed 180 – 1.5 T	**B1**	
	Total:	**2**	
3(iii)	$0.5[180 + (180 - 1.5T)] \times 25 = 3300$	**M1**	Uses area property
	$T = 64$	**A1**	
	Distance decelerating = $[0.5 \times 32 \times 25 =]$ 400 m	**B1**	
	Total:	**3**	
4(i)	$a = 3 \times 2 \times (2t - 5)^2$ [= 54]	***M1**	Uses a = dv/dt
	$6(2t - 5)^2 = 54 \rightarrow t = ...$	**DM1**	Solves for t
	$t = 1, 4$	**A1**	
	Total:	**3**	

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Question	Answer	Marks	Guidance
4(ii)	$s = \frac{(2t-5)^4}{4\times 2}$ $(+\ C)$	*M1	Uses $s = \int v\ dt$
	$C = -\ \frac{625}{8}$	DM1	Uses $s = 0$ at $t = 0$
	$s = \frac{(2t-5)^4}{8} - \frac{625}{8}$	A1	
	Total:	3	
	Alternative method for Question 4		
4(i)	$v = 8t^3 - 60t^2 + 150t - 125$ $\rightarrow a = 24t^2 - 120t + 150$	*M1	Uses $a = dv/dt$
	$24t^2 - 120t + 150 = 54 \rightarrow t = \ldots$	DM1	Solves for t
	$t = 1, 4$	A1	
	Total:	3	
4(ii)	$s = \int 8t^3 - 60t^2 + 150t - 125\ dt$ $\rightarrow s = \frac{8}{4}t^4 - \frac{60}{3}t^3 + \frac{150}{2}t^2 - 125t\ (+\ C)$	*M1	Uses $s = \int v\ dt$
	$C = 0$	DM1	Uses $s = 0$ at $t = 0$ (may be implied)
	$s = 2t^4 - 20t^3 + 75t^2 - 125t$	A1	
	Total:	3	

Question	Answer	Marks	Guidance
5(i)	$s_2 = 20t - 0.5gt^2$	B1	Second particle
		M1	Uses $s = ut + ½ at^2$ for first particle
	$s_1 = 12(t + 2) - 0.5g(t + 2)^2$	*A1	
	$12(t + 2) - 0.5g(t + 2)^2 = 20t - 0.5gt^2$ $\rightarrow$ t=…	DM1	Solves $s_1 = s_2$
	$t = \frac{1}{7} = 0.143$	A1	
	Total:	**5**	
5(ii)	$[s = 20 \times \frac{1}{7} - 5 \times (\frac{1}{7})^2 = 2.755\ldots]$ Height is 2.76 m	B1	
	Total:	**1**	

Question	Answer	Marks	Guidance
6(i)(a)	$16\,000 = F \times 40$	M1	Using $P = Fv$
	Resistance is 400 N	A1	
	Total:	2	
6(i)(b)	$22\,500 = F \times 45$ $F = 500$	B1	
	$500 - 400 = 1200a$	M1	Applying Newton's Second Law
	$a = \frac{1}{12} = 0.0833$ (ms^{-2})	A1	
	Total:	3	
6(ii)	$16\,000 = (590 + 2v)v$	M1	Using $P = Fv$
	$[2v^2 + 590v - 16\,000 = 0] \rightarrow v = \ldots$	M1	Solving for v
	$v = 25$ (ms^{-1})	A1	
	Total:	3	

Question	Answer	Marks	Guidance
7(i)	$R = mg\cos 30$	B1	Resolves normally
	$F = 2m\cos 30\ [= m\sqrt{3}]$	M1	Uses $F = \mu R$
	$T = 4g\ [= 40]$	B1	Particle B
	$T = mg\sin 30 + F$	M1	Resolves parallel to plane for particle A
	$40 = 5m + m\sqrt{3}$	A1	Equation in m
	$m = \dfrac{40}{5+\sqrt{3}} = 5.94$	A1	**AG** All correct and no errors seen
	Total:	**6**	

Question	Answer	Marks	Guidance
7(ii)	*EITHER:* [$R = 3g\cos30$] $F = 0.2 \times 3g\cos30$ ($3\sqrt{3} = 5.196$)	(B1	
	$4g - T = 4a$ or $T - 3g\sin30 - F = 3a$ or $4g - 3g\sin30 - F = 7a$	M1	Applies Newton's Second Law to one of the particles or forms system equation in a ($m_Bg - m_Ag\sin30 - F = (m_A + m_B)a$)
	$T - 3g\sin30 - 3\sqrt{3} = 3a$ or $40 - T = 4a$ or $4g - 3g\sin30 - 3\sqrt{3} = 7a \rightarrow a = \ldots$	M1	Applies Newton's Second Law to form second equation in T and a and solves for a or solves system equation for a
	$a = \dfrac{25 - 3\sqrt{3}}{7}$ $= 2.83$.	A1	
	$v^2 = 2 \times 2.83 \times 0.5$ $v = 1.68\ldots$	B1 FT	v as T becomes zero FT on a
	$-3g\sin30 - 0.2(3g\cos30) = 3a$ $-15 - 3\sqrt{3} = 3a$ $\rightarrow a = \ldots(-5-\sqrt{3} = -6.73)$	M1	Applies Newton's Second Law and solves for a
	$0 = 1.68^2 - 2 \times 6.73s$ $s = \ldots(0.210)$	M1	Uses $v^2 = u^2 + 2as$ and solves for s
	Total distance = 0.710 m	A1)	
	OR: [$R = 3g\cos30$] $F = 0.2 \times 3g\cos30$ ($3\sqrt{3} = 5.196$)	(B1	

Question	Answer	Marks	Guidance
		M1	For 4kg mass, uses PE loss – WD_T = KE gain
		M1	For 3kg mass, uses WD_T = KE gain + PE gain + WD_{Fr}
	$4g(0.5) – 0.5T = ½ (4v^2)$ and $0.5T = ½ (3v^2) + 3g(0.5\sin30) + 3\sqrt{3}(0.5)$	A1	
	$v^2 = (25 – 3\sqrt{3})/7$ or $v = 1.68$	B1	
	$½ (3)(1.68)^2 = 3g(s \sin30) + 3\sqrt{3}s$	M1	For 3kg mass, uses KE loss = PE gain + WD_{Fr}
	$s = …(0.210)$	M1	Solves for s
	Total distance = 0.710 m	A1)	
	Total:	8	