Cambridge International AS & A Level

Cambridge Assessment International Education
Cambridge International Advanced Subsidiary and Advanced Level

MATHEMATICS **9709/42**

Paper 4 **October/November 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 International 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.

Question	Answer	Marks	Guidance
1(i)	$F = 0.2g \sin 20 = 0.684$ N	**B1**	AG
		1	
1(ii)	$R = 0.2g \cos 20$	**B1**	
	$F = \mu R$ [$= 0.6 \times 0.2g \cos 20$]	**M1**	Using $F = \mu R$ $F = 1.1276\ldots$
	[$0.9 + 0.2g \sin 20 - F = 0.2a$]	**M1**	Use of Newton's 2nd law along the plane (4 relevant terms)
	$a = 2.28$ ms^{-2}	**A1**	
		4	

Question	Answer	Marks	Guidance
2	*EITHER:*	**(M1**	Attempt to resolve (either direction with correct number of terms and dimensionally correct)
	$T \sin\theta + 120 \sin 45 = 15g$	**A1**	Resolving vertically
	$T \cos\theta = 120 \cos 45$	**A1**	Resolving horizontally
	[$\tan\theta = \dfrac{(15g - 120\sin 45)}{(120\cos 45)}$ or $T = \sqrt{65.15^2 + 84.85^2}$]	**M1**	For using division to find θ or for using Pythagoras to find T
	$\theta = 37.5$	**A1**	
	$T = 107$	**A1)**	
	OR1: $\dfrac{120}{\sin(90+\theta)} = \dfrac{T}{\sin 135} = \dfrac{15g}{\sin(135-\theta)}$	**(A1**	One correct equation
		A1	A second correct equation
		M1	Attempt to solve for θ or T
	$\theta = 37.5$	**A1**	
	$T = 107$	**A1**	
		M1)	Attempt to use triangle of forces

Question	Answer	Marks	Guidance
	OR2: $\frac{T}{\sin 45} = \frac{15g}{\sin(45+\theta)} = \frac{120}{\sin(90-\theta)}$	**(A1**	One correct equation
		A1	A second correct equation
		M1	Attempt to solve for θ or T
	$\theta = 37.5$	**A1**	
	$T = 107$	**A1)**	
	OR3: $[T^2 = 150^2 + 120^2 - 2(150)(120)\cos 45]$	**(M1**	Use cosine rule in a triangle with sides 120, 150 and T and with corresponding angles $90 - \theta$, $45 + \theta$, 45
		A1	Correct equation
	$T = 107$	**A1**	
		M1	Use sin rule or cosine rule in an attempt to find θ
	$120/\sin(90 - \theta) = 106.97/\sin 45$	**A1**	A correct equation in θ such as this
	$\theta = 37.5$	**A1)**	
		6	

Question	Answer	Marks	Guidance
3(i)	$s_{AB} = 14 \times 5 + \frac{1}{2}a \times 5^2$	**B1**	or $s_{AB} = \frac{1}{2}(14 + 14 + 5a) \times 5$ OE
	$s_{AC} = 14 \times 8 + \frac{1}{2}a \times 8^2$	**B1**	or $s_{AC} = \frac{1}{2}(14 + 14 + 8a) \times 8$ OE
	$[112 + 32a = 2(70 + 12.5a)]$	**M1**	Using $AC = 2AB$ and solving for a or for substituting $a = 4$ and finding AB and AC
	$a = 4$ m s^{-2}	**A1**	AG, If substituting $a = 4$ must show $AB = 120$ and $AC = 240$ OE
		4	
3(ii)	$[v = 14 + 4 \times 8]$	**M1**	Use of $v = u + at$ or any complete method to find v
	Velocity = 46 m s^{-1}	**A1**	
		2	

Question	Answer	Marks	Guidance
4(i)	$[12t - \frac{1}{2}gt^2 = 0]$ or $[0 = 12 - gT]$ with $t = 2T$ used	**M1**	Using $s = ut + \frac{1}{2}at^2$ or equivalent such as finding time T to highest point and doubling.
	$t = 2.4$ s	**A1**	
		2	
4(ii)	Critical point at $t = 1.2$	**B1**	Seen in **4(ii)**
	Critical point at $t = 2$	**B1**	Seen in **4(ii)**
	Both moving in same direction $1 < t < 1.2$	**B1**	
	Both moving in same direction $2 < t < 2.4$	**B1**	
		4	

Question	Answer	Marks	Guidance
5(i)	*EITHER:* Resistance force = $\frac{600}{25}$ = 24 N	**(B1**	
	Weight component = 80 g (0.04) = 32 N	**B1**	For correct unsimplified numerical form of the weight component
	[Power = 56 × 4]	**M1**	For use of $P = Fv$ where F is from two relevant force terms
	Power = 224 W	**A1)**	
		4	
	OR: PE gain = 80g × 25 (0.04) = 800	**(B1**	For a correct unsimplified numerical expression for PE
	Time taken = $\frac{25}{4}$ = 6.25	**B1**	
	[WD by cyclist = P × 6.25 = 800 + 600]	**M1**	For using WD = $P \times t$ where WD is from two relevant terms
	Power = 224 W	**A1)**	
		4	

Question	Answer	Marks	Guidance
5(ii)	Work done by cyclist = 224 × 10 (= 2240J)	**B1 FT**	For stating WD = power × time FT on P value found in **5(i)**
	Initial KE = ½ × 80 × 4^2 [= 640 J]	**B1**	
	[½ × 80v^2 = 640 + P×10 –1200]	**M1**	For using Work/Energy equation
	Speed = 6.48 m s^{-1}	**A1**	Allow speed = √42
		4	

Question	Answer	Marks	Guidance
6(i)	$R = mg \cos \alpha$ ($R = 9.6m$)	**B1**	Allow use of α = 16.3º throughout
	[$T = mg$ $F = mg \sin \alpha + T$]	**M1**	For resolving forces on P and Q and eliminating T **or** for considering the equilibrium of the system
	$F = mg \sin \alpha + mg$	**A1**	($F = 12.8m$)
		M1	For use of $F = \mu R$
	Coefficient of friction = 1⅓ = $\frac{4}{3}$	**A1**	**AG** so must be from exact working
		5	

Question	Answer	Marks	Guidance
6(ii)	*EITHER:* *P* equation is $10 - mg \sin \alpha - F - T = 2.5m$ *Q* equation is $T - mg = 2.5m$	**(*M1**	For applying Newton's 2nd law to *P* (5 terms) **or** *Q* (3 terms)
		***M1**	For applying Newton's 2nd law to the other particle and eliminate *T*
	$10 - mg \sin \alpha - \mu mg \cos \alpha - mg = 2m\ (2.5)$	**A1**	If evaluated then this is $10 - 2.8m - 12.8m - 10m = 5m$
		DM1	For solving this equation for *m* as far as *m* = Dependent on one or other of the previous M marks having been scored
	$m = 0.327$	**A1)**	Allow $m = \frac{50}{153}$
	OR: $[10 - mg \sin \alpha - F - mg = m(2.5 + 2.5)]$	**(*M1**	For applying Newton's 2nd law to the system. Allow with 5 terms
		***M1**	System equation with all 6 terms
	$10 - mg \sin \alpha - \mu mg \cos \alpha - mg = 2m\ (2.5)$	**A1**	
		DM1	For solving this equation for *m* as far as *m* = Dependent on one or other of the previous M marks having been scored
	$m = 0.327$	**A1)**	Allow $m = \frac{50}{153}$
		5	

Question	Answer	Marks	Guidance
7(i)	$-0.01t(t^2 - 22t + 40) = 0$ $-0.01t(t - 20)(t - 2) = 0$	**M1**	Attempting to solve $v = 0$ for t for a solvable quadratic using factors or quadratic formula and obtaining two non-zero solutions
	$t = 2$ or $t = 20$	**A1**	
		2	
7(ii)	$a = -0.03t^2 + 0.44t - 0.4$	**M1**	For differentiation
	a is greatest (maximum) when $0.44 - 0.06t = 0$	**M1**	For differentiation **or** finding values of $t = t_1$ and $t = t_2$ where $a = 0$ and using $t = \frac{1}{2}(t_1 + t_2)$ **or** completing the square **or** other method to find maximum value
	Max acceleration when $t = 7.33$	**A1**	Allow $t = \frac{22}{3}$
		3	
7(iii)	$\int\left(-0.01t^3 + 0.22t^2 - 0.4t\right)\mathrm{d}t$	***M1**	For using integration.
	$s(t) = -\frac{0.01}{4}t^4 + \frac{0.22}{3}t^3 - 0.2t^2$	**A1**	Correct Integration Allow + C included
	$s(20) - s(2)$	**DM1**	Limits 2 and 20 used correctly Dependent on previous M1 having been scored
	Distance = 107 m	**A1**	Distance = $\frac{2673}{25} = 106.92$
		4	