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MATHEMATICS **9709/42**

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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/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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1	**(i)**	$3.5 = 10a \quad \rightarrow \quad a = 0.35\,\text{ms}^{-2}$	**B1**		Allow $a = 3.5/10$
		$[10\cos 15 - F = 2 \times 0.35]$	**M1**		For applying Newton's 2nd law to the particle
		$F = 8.96\,\text{N}$ AG	**A1**	[3]	
		Alternative to 1(i)			
		$s = \frac{1}{2}(0 + 3.5) \times 10 = 17.5\,\text{m}$	**B1**		Distanced moved in 10 secs
		$[10\cos 15 \times 17.5 = F \times 17.5 + \frac{1}{2}\,2\,(3.5)^2]$	**M1**		Work done by 10 N force = WD against F + KE gain
		$F = 8.96\,\text{N}$ AG	**A1**	[3]	
	(ii)	$[R = 2g - 10\sin 15]$	**M1**		Resolving forces vertically
		$[\mu = 8.96/(2g - 10\sin 15)]$	**M1**		Using $F = \mu R$
		$\mu = 0.515$	**A1**	[3]	
2	**(i)**	$[v = 4t - 40t^{0.5}]$	**M1***		For differentiating s to find v
		$[a = 4 - 20t^{-0.5}]$	**M1***		For differentiating v to find a
		$[4 - 20t^{-0.5} = 0]$	**DM1**		For setting $a = 0$ and attempt to solve to find t
		$t = 25\,\text{s}$	**A1**	[4]	
	(ii)	Substitute their t into s **or** v	**M1**		
		Displacement = –2083.3 m (= –2080 3sf) **and** Velocity = $-100\,\text{ms}^{-1}$	**A1**	[2]	or Displacement = – 6250/3

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3 (i)	$[X = 60\cos25 + 50\cos15]$	**M1**		For resolving both forces in the direction of river
	$= 103\,\text{N}$	**A1**	[2]	Value of X is 102.7 N
(ii)	$Y = 60\sin25 - 50\sin15$ [= 12.4]	**B1**		Component perpendicular to the direction of the river
	$[R^2 = X^2 + Y^2]$ or $[\alpha = \arctan(Y/X)]$	**M1**		For using Pythagoras or for using arctan to find the resultant force or its direction
	Magnitude is 103 N (or $\alpha = 6.9^\circ$ with direction specified unambiguously)	**A1**		Magnitude is 103.4 N
	$\alpha = 6.9^\circ$ with direction specified unambiguously (or Magnitude = 103 N)	**B1**	[4]	
4 (i)	PE loss = $mg \times 100\sin20$	**B1**		
	$[\frac{1}{2}mv^2 - \frac{1}{2}m \times 5^2 = mg \times 100\sin20]$	**M1**		Using KE gain = PE loss
	$v = 26.6\,\text{ms}^{-1}$	**A1**	[3]	
Alternative method for 4(i)				
	$a = g \sin 20$ [= 3.42]	**B1**		
	$[v^2 = 5^2 + 2 \times a \times 100]$	**M1**		Using $v^2 = u^2 + 2as$
	$v = 26.6\,\text{ms}^{-1}$	**A1**	[3]	
(ii)	KE = $\pm(0.5m \times 441 - 0.5m \times 25)$ [$= \pm208m$]	**B1**		
	$[mg \times 100\sin20 = 8500 + 208m]$	**M1**		For using PE loss = WD against Friction + KE gain
	Mass $m = 63.4\,\text{kg}$	**A1**	[3]	

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5	$F = \mu mg\cos 30$	**B1**		
	$[10 + F - mg\sin 30 = 0]$	**M1**		Resolving up, first case
	$[75 - F - mg\sin 30 = 0]$	**M1**		Resolving up, second case
	$[85 = 2mg\sin 30]$ or $[10 + \mu mg\cos 30 - mg\sin 30 = 0$ $75 - \mu mg\cos 30 - mg\sin 30 = 0]$	**M1**		Either attempt to solve for m or Solve a pair of two 3 term simultaneous equations for either m or μ
	$m = 8.5\,\text{kg}$ or $\mu = 0.442$	**A1**		
	$\mu = 0.442$ or $m = 8.5\,\text{kg}$	**B1**	[6]	
6 (i)	[Power = 400 × 25]	**M1**		For using $P = Fv$ where $F =$ resistance = 400 N
	Power = 10000 W	**A1**	[2]	Allow 10 kW
(ii)	Tension = 100 N	**B1**	[1]	Considering the trailer
(iii)	New driving force $= 25000/20 = 1250\,\text{N}$	**B1**		Driving force = P/v at the instant when $v = 20$
	$[\text{DF} - 300 - T - 3000\,g\sin 4 = 3000a]$ or $[T - 100 - 500\,g\sin 4 = 500a]$ or $[\text{DF} - 400 - 3500\,g\sin 4 = 3500a]$	**M1**		For using Newton's second law applied **either** to the van **or** to the trailer **or** to the system of van and trailer.
		M1		For using N2 applied to one of the other cases
	$[a = -0.4547$ may be seen$]$	**M1**		Solving or using substitution to find T
	$T = 221\,\text{N}$	**A1**	[5]	Allow $T = 1550/7\,\text{N}$

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7 (i)	$v = 3 \times 10 = 30\,\text{ms}^{-1}$	**B1**		Velocity after 10 seconds
	[$s = ½ (30 + 40) \times 30$] or equivalent complete method	**M1**		For determining distance travelled in first 40 seconds
	Total distance = 1050 m	**A1**	[3]	
(ii)	[Distance = 450 m Time taken = 450 / 15 = 30 s]	**M1**		For finding distance covered in deceleration stage and time taken for this stage
	Total time of motion for car = 70 s	**A1**		May be implied by time for motorcycle = 50 s
	[Motorcycle takes 50 s to travel 1500 m $1500 = ½ (30 + 50) \times V$ or $1500 = 30V + 0.5 \times 20V$]	**M1**		For setting up an equation for distance travelled by M / C (v–t graph or other) involving V or a and up to one other variable.
	$V = 37.5\,\text{ms}^{-1}$	**A1**		
	[20 s is split between 5 s accelerating and 15 s decelerating]	**M1**		For finding time taken to accelerate to speed V
	$a = 37.5 / 5 = 7.5\,\text{ms}^{-2}$	**A1**	[6]	
(iii)	Displacement-time graph	**B1**		Two of the three graph stages correct with correct curvature
		B1		All three stages of the graph correct with correct curvature
		B1	[3]	Correct graph, fully labelled t=10,40,70s = 150,1050, 1500

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