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**MATHEMATICS**

**9709/04**

Paper 4

**For examination from 2017**

MARK SCHEME

Maximum Mark: 50

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**Specimen**

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This document consists of **8** printed pages.

**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  $\surd$  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 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)
- SOSSee 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  $\sqrt{\wedge}$ ” 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	Partial Marks	Guidance
1(i)	$200g \times 0.7$	1	M1	For using $WD = mg \times h$
	Work done = 1400 J	1	A1	
		2		
1(ii)	$1400 / 1.2$	1	M1	For using Power = WD / Time
	Average Power = 1170 W	1	A1 <sup>✓</sup>	
		2		
2(i)	$a = g \sin 30 = 5$	1	B1	
	$2.5 = 0 + 5t$	1	M1	Using $v = u + at$
	$t = 0.5$ Time = 0.5 s	1	A1	
		3		
2(ii)	$v^2 = 0 + 2 \times 5 \times 3 = 30$	1	B1	
	$-1 = 0.5a \rightarrow a = -2$ $0 = 30 + 2 \times (-2) \times s$	1	M1	For applying Newton's second law to the particle and using $v^2 = u^2 + 2as$
	Distance = 7.5 m	1	A1	
	<b>First alternative method for 2(ii)</b>			
	$v^2 = 0 + 2 \times 5 \times 3 = 30$	1	(B1)	
	$0.5 \times 0.5 \times 30 = 1 \times \text{distance}$	1	(M1)	KE lost = WD against Friction
	Distance = 7.5 m	1	(A1)	
	<b>Second alternative method for 2(ii)</b>			
	PE lost = $0.5 \times 10 \times 3 \sin 30 = 7.5$	1	(B1)	Using PE lost = $mgh$
	$7.5 = 1 \times \text{distance}$	1	(M1)	PE lost = WD against Friction
	Distance = 7.5 m	1	(A1)	
		3		

Question	Answer	Marks	Partial Marks	Guidance
<b>3(i)</b>		1	<b>M1</b>	For applying Newton's second law to the lorry up the hill
	$F - 24000g \sin 3 - 3200 = 24000 \times (0.2)$	1	<b>A1</b>	[ $F = 20561$ ]
	Power = $Fv = 20561 \times 25$	1	<b>M1</b>	Using $P = Fv$
	Power = 514 kW	1	<b>A1</b>	
		<b>4</b>		
<b>3(ii)</b>	DF = $3200 + 24000g \sin 3$ [=15761]	1	<b>M1</b>	Using Newton's second law up the hill in the steady case
	$v = 500000 / 15761 = 31.7 \text{ ms}^{-1}$	1	<b>A1</b>	$P = Fv$ so $v = P / F$
		<b>2</b>		
<b>4</b>	$F = 0.2 \times mg \cos 35$	1	<b>B1</b>	Maximum value of $F$
		1	<b>M1</b>	For resolving forces along the plane in either case
	$5g - mg \sin 35 - 0.2 mg \cos 35 = 0$	1	<b>A1</b>	Equilibrium, on the point of moving up the plane
	$5g - Mg \sin 35 + 0.2 Mg \cos 35 = 0$	1	<b>A1</b>	Equilibrium, on the point of moving down the plane
	$m = 6.78$ or $M = 12.2$	1	<b>M1</b>	For solving either
	$6.78 \leq \text{mass} \leq 12.2$	1	<b>A1</b>	
		<b>6</b>		

Question	Answer	Marks	Partial Marks	Guidance
<b>5(i)</b>	For resolving forces either horizontally or vertically	1	<b>M1</b>	
	$F\cos 70 + 20 - 10 \cos 30 = R\cos 15$	1	<b>A1</b>	
	$10\sin 30 - F \sin 70 = R \sin 15$	1	<b>A1</b>	
		1	<b>M1</b>	For solving simultaneously
	$F = 1.90 \text{ N and } R = 12.4 \text{ N}$	1	<b>A1</b>	
	<b>Alternative method for 5(i)</b>			
	$[X = 0.342 F + 11.34$ $Y = 0.94 F - 5]$	1	<b>(M1)</b>	For finding components of the forces in the $x$ and $y$ directions
	$(0.342 F + 11.34)^2 + (0.94 F - 5)^2 = R^2$	1	<b>(A1)</b>	
	$\tan 15 = (5 - 0.94F) / (0.342F + 11.34)$	1	<b>(A1)</b>	
		1	<b>(M1)</b>	Solve the $\tan 15$ equation for $F$ and substitute to find $R$
		1	<b>(A1)</b>	
		<b>5</b>		
<b>5(ii)</b>	$11.7^2 = 0 + 2a \times 3$ $a = 22.815$	1	<b>B1</b>	
	$R \cos 15 = m \times 22.815$	1	<b>M1</b>	Applying Newton's second law to the particle in direction $AB$
	Mass of bead = 0.526 kg	1	<b>A1</b>	
			<b>3</b>	

Question	Answer	Marks	Partial Marks	Guidance
<b>6(i)</b>	$s = 0.3t^2 - 0.01t^3$	1	<b>M1</b>	For integration
	$s(5) = 0.3 \times 5^2 - 0.01 \times 5^3 = 6.25$	1	<b>A1</b>	
	$a = 0.6 - 0.06t$	1	<b>M1</b>	For differentiation
	$a(5) = 0.6 - 0.0 \times 5 = 0.3 \text{ ms}^{-2}$	1	<b>A1</b>	
		<b>4</b>		
<b>6(ii)</b>	Maximum velocity is when $0.6 - 0.06t = 0$	1	<b>M1</b>	For setting $a = 0$
	$[t = 10]$	1	<b>M1</b>	For solving $a = 0$
	Max velocity = $3 \text{ ms}^{-1}$	1	<b>A1</b>	
	$0.6t - 0.03t^2 = 1.5$ $[t^2 - 20t + 50 = 0]$	1	<b>M1</b>	Setting velocity = half its maximum and attempting to solve a three term quadratic
	Times are 2.93 s	1	<b>A1</b>	
	and 17.07 s	1	<b>A1</b>	
		<b>6</b>		
<b>7(i)</b>	$36 = 0 + 0.5 \times 0.5t^2$ $t = 12$	1	<b>B1</b>	
	$v^2 = 0 + 2 \times 0.5 \times 36$ $v = 6$	1	<b>B1</b>	
	$s = 6 \times 25$ remaining distance $= 210 - 36 - 150 = 24$	1	<b>B1</b>	
	$24 = (6 + 0) / 2 \times t$	1	<b>M1</b>	Using $s = (u + v)t / 2$
	$t = 8$ Total Time = $12 + 25 + 8 = 45 \text{ s}$	1	<b>A1</b>	
		<b>5</b>		

Question	Answer	Marks	Partial Marks	Guidance
7(ii)	Distance travelled by cyclist $= 36 + 6(t - 12)$	1	M1	For attempting distance travelled by cyclist for $t > 12$
	Distance travelled by car $= 0.5 \times 4 \times (t - 24)^2$	1	M1	For attempting distance travelled by car
	$2t^2 - 96t + 1152$ $= 36 + 6t - 72$ $[t^2 - 51t + 594 = 0]$	1	M1	Equating expressions and attempting to solve a three term quadratic equation
	$t = 33$ or $t = 18$	1	A1	
	Time = 33 s	1	B1	Choosing the correct solution
			5	