

**MARK SCHEME for the May/June 2012 question paper  
for the guidance of teachers**

**9709 MATHEMATICS**

**9709/42**

Paper 4, maximum raw mark 50

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 must be read in conjunction with the question papers and the report on the examination.

- Cambridge will not enter into discussions or correspondence in connection with 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  $\surd$  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.

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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 $\sqrt{}$ ” 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		M1	For using $WD = Fd \cos \alpha$
	$F \times 5 \cos 60^\circ = 75$	A1	
	Magnitude of the force is 30 N	A1	[3]
2	[ $12 = 15 \sin \alpha$ ]	M1	For resolving forces in the direction of the force of magnitude 12 N
	$\alpha = 53.1$	A1	
	[ $F = 15 \cos \alpha$ ]	M1	For resolving forces in the direction of the force of magnitude F N
	$F = 9 \text{ N}$	A1	[4]
2	ALTERNATIVE 1		
	[ $F \sin \alpha = 12 \cos \alpha$ and $F \cos \alpha + 12 \sin \alpha = 15 \rightarrow \sin \alpha \div \cos \alpha = 12 \cos \alpha \div 15 - 12 \sin \alpha$ ]	M1	For resolving forces in the $x$ and $y$ directions and eliminating F from the resultant equations
	$15 \sin \alpha - 12 \sin^2 \alpha = 12 \cos^2 \alpha \rightarrow 15 \sin \alpha = 12 \rightarrow \alpha = 53.1$	A1	
		M1	For substituting into $F \sin \alpha = 12 \cos \alpha$ or $F \cos \alpha + 12 \sin \alpha = 15$
	$F = 9 \text{ N}$	A1	[4]
2	ALTERNATIVE 2		
	[ $\sin \alpha = 12/15$ ]	M1	For using correct triangle of forces to find $\alpha$
	$\alpha = 53.1$	A1	
	[ $F^2 = 15^2 - 12^2$ ]	M1	For using correct triangle of forces to find F
	$F = 9 \text{ N}$	A1	[4]
2	ALTERNATIVE 3		
	[ $12 \div \sin(180 - \alpha) = 15 \div \sin 90 \rightarrow 12 = 15 \sin \alpha$ ]	M1	For using Lami's rule and $\sin(180^\circ - \alpha) = \sin \alpha$
	$\alpha = 53.1$	A1	
	[ $F \div \sin 143.1 = 15 \div \sin 90$ ]	M1	For using Lami's rule and value of $\alpha$ to find F
	$F = 9 \text{ N}$	A1	[4]
<b>SR (max 2/4) For candidates who have sin and cos interchanged.</b>			
Allow B1 for $\alpha = 36.9$ and allow B1 for $F = 9$ following correct work relative to the cos/sin interchange error.			

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<b>3</b>	<b>(i)</b>	M1	For an attempt to find $v(t)$ using integration of $a(t)$
	$v = 1.2t^{5/3} + 2$	A1	
		DM1	For attempting to solve $v(t) = 3$ for $t^{5/3}$ or For confirming $v = 3$ by substituting $t^{5/3} = 5/6$ into the expression found for $v(t)$
	$t^{5/3} = 5/6$	A1	[4] AG
<hr/>			
	<b>(ii)</b>	M1	For integrating and using $s(0) = 0$ (may be implied by absence of +C) to find $s(t)$
	$s = 0.45t^{8/3} + 2t$	A1	
	Distance is 2.13 m	A1	[3]
<hr/>			
<b>4</b>	<b>(i)</b>	M1	For resolving forces horizontally
	Horizontal component is $T\cos 25^\circ$ (0.906T)	A1	
		M1	For resolving forces vertically
	Vertical component is $4g + T\sin 25^\circ$ ( $40 + 0.423T$ )	A1	[4]
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	<b>(ii)</b>	M1	For using $F = 0.4R$
	$0.906T = 16 + 0.169T$	A1ft	May be implied by correct answer for T
	$T = 21.7\text{ N}$	A1	[3]
<hr/>			
<b>5</b>	<b>(i)</b>	B1	
	Tension in $S_1$ is 30 N Tension in $S_2$ is 50 N	B1	[2]
<hr/>			
	<b>(ii)</b>	M1	For applying Newton's second law to A or to B
	$3g - T - 1.6 = 3a$ (or $2g + T - 4 = 2a$ )	A1	
	$2g + T - 4 = 2a$ (or $3g - T - 1.6 = 3a$ ) or $(3g + 2g) - (1.6 + 4) = (3 + 2)a$	B1	
	Acceleration is $8.88\text{ ms}^{-2}$	B1	
	Tension is 1.76 N	A1	[5]
<b>SR (max. 1 / 2) for candidates who do not give numerical answers in (i).</b>			
Allow B1 for Tension in $S_1$ is $3g$ and Tension in $S_2$ is $5g$			

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<b>6 (i)</b>	PE gain = $1250 \times 10 \times 400 \times 0.125$	B1	
	WD against resistance is $800 \times 400$ J	B1	
		M1	For using WD by car's engine = Gain in PE + WD against resistance
	WD by car's engine is 945 000 J (945 kJ)	A1	[4]
<b>(ii)</b>			For using $P = Fv \rightarrow$
	$[v_2/6 = 5 \times (1/3)]$	M1	$\frac{v_2}{v_1} = \frac{P_2}{P_1} \times \frac{F_1}{F_2}$
	$v_2 = 10$	A1	
	KE gain = $\frac{1}{2} 1250(10^2 - 6^2)$	B1ft	
	[WD by car's engine = 945 000 + 40 000]	M1	For using WD by car's engine = (Gain in PE + WD against resistance) + KE gain
	WD by car's engine is 985 000 J (985 kJ)	A1ft	[5] ft incorrect ans(i)
<b>Alternative scheme for part (i)</b>			
<b>(i)</b>		M1	For using Newton's second law with $a = 0$
	DF = $1250g \times 0.125 + 800$	A1	
		M1	For using WD = DF $\times$ 400
	WD by car's engine is 945 00 J (945 kJ)	A1	[4]

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7	(i)	$[-0.12 = 0.15a]$	M1	For using Newton's 2 <sup>nd</sup> law
		$a = -0.8 \text{ ms}^{-2}$	A1	
		$[v = 3 - 0.8 \times 2]$	M1	For using $v = u + at$ to find speed of approach
		$v_{\text{approach}} = 1.4$	A1	
		$[\frac{1}{2} 0.15(1.4^2 - v_r^2)]$	M1	For using KE loss = $\frac{1}{2} m(v_a^2 - v_r^2)$
		$v_{\text{return}} = -1$	A1	
			M1	For using $0 = v_{\text{return}} + a(t - 2)$
		$t = 3.25 \text{ s}$ when block comes to rest	A1	
				Alternative for the M1 A1 immediately above. $t_{YZ} = 1.25$ B1 $t = 3.25 \text{ s}$ when block is at rest B1ft
		For correct sketch	B1ft	[9] ft incorrect values of v and t (although $v_{\text{return}}$ must be negative)
	(ii)	$[XY = \frac{1}{2} (3 + 1.4) \times 2, YZ = \frac{1}{2} 1.25 \times 1]$	M1	For using area property (or equivalent) to find distances XY and YZ
		$s = 4.4$ at Y and $3.775$ at Z, stated or on graph	A1	(accept 3.77 or 3.78)
		Curve starts at origin, s increases, slope decreases (convex upwards) for $0 < t < 2$ , value of s(2) shown	B1ft	ft incorrect value for s(2)
		Curve starts at (2, 4.4), s decreases, magnitude of slope decreases to zero at (3.25, 3.775)	B1ft	[4] ft incorrect values of s and t