
MATHEMATICS

9709/41

Paper 4

October/November 2019

MARK SCHEME

Maximum Mark: 50

Published

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Cambridge International is publishing the mark schemes for the October/November 2019 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

This document consists of **11** printed pages.



Cambridge Assessment
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PUBLISHED**Generic Marking Principles**

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5:

Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).

GENERIC MARKING PRINCIPLE 6:

Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

PUBLISHED**Mark Scheme Notes**

The following notes are intended to aid interpretation of mark schemes in general, but individual mark schemes may include marks awarded for specific reasons outside the scope of these notes.

Types of mark

- 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.
- DM or DB** 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 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.
- 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.

Abbreviations

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
ISW	Ignore Subsequent Working
SOI	Seen Or Implied
SC	Special Case (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)
WWW	Without Wrong Working
AWRT	Answer Which Rounds To

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Question	Answer	Marks	Guidance
1	$20\,000 = V \times 1250g$	M1	Use of $P = Fv$ with $F = mg$
	$V = 1.6$	A1	
		2	

Question	Answer	Marks	Guidance
2	Initial $KE = \frac{1}{2} \times 75 \times 10^2$ Final $KE = \frac{1}{2} \times 75 \times 5^2$	B1	Either correct
	PE gained $= 75g \times 700 \sin 1.5$ [=13 743]	B1	
	WD by $F = F \times 700$	B1	For WD by $F = F \times d$
	WD by $F + \text{Initial KE} = \text{Final KE} + \text{PE gain} + 2000$	M1	Use of work-energy equation. 5 dimensionally correct terms.
	$F = 18.5$	A1	
		5	

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Question	Answer	Marks	Guidance
3(i)	$R = 3g \cos 60$	B1	
	Use $F = \mu R$	M1	
	$[3g \sin 60 - \mu 3g \cos 60 - 15 = 0]$	M1	Resolve forces parallel to the plane, 3 terms
		A1	Correct equation
	$\mu = 0.732$	A1	Allow $\mu = \sqrt{3} - 1$
		5	
3(ii)	[Maximum force = $3g \sin 60 + F$ = $3 \sin 60 + \mu 3g \cos 60$]	M1	
	$X = 37(.0)$	A1	Allow $X = 15(2\sqrt{3} - 1)$
		2	

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Question	Answer	Marks	Guidance
4(i)	Apply Newton's second law to either or to the system	M1	
	Block A: $T - 4g \times \frac{7}{25} = 4a$ Block B: $36 - T - 5g \times \frac{7}{25} = 5a$ System: $36 - 5g \times \frac{7}{25} - 4g \times \frac{7}{25} = 9a$	A1	Any two correct. Allow $\alpha = 16.3$ used.
	Either solving the system for a or solving a pair of simultaneous equations for either a or T	M1	
	$a = 1.2 \text{ ms}^{-2}$	A1	
	$T = 16 \text{ N}$	A1	
		5	
4(ii)	$\left[0.65 = 1 \times t + \frac{1}{2} \times 1.2 t^2 \right]$	M1	Use constant acceleration equation(s) with $u = 1$ and solve a 3 term quadratic equation to find t
	$t = 0.5 \text{ s}$	A1	
	Alternative method for question 4(ii)		
	$v^2 = 1^2 + 2 \times 1.2 \times 0.65$ $[v = 1.6]$ and $0.65 = \frac{1}{2}(1 + v) \times t$	M1	Use relevant constant acceleration equations with $u = 1$ in a complete method to find t
	$t = 0.5 \text{ s}$	A1	
		2	

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Question	Answer	Marks	Guidance
5(i)	Resolve forces either horizontally or vertically	M1	
	$7.5\cos 60 + 4.5\cos 20 = F\cos \theta$ [= 7.97861]	A1	
	$7.5\sin 60 - 4.5\sin 20 = F\sin \theta$ [= 4.95609]	A1	
	$F = \sqrt{(7.98^2 + 4.96^2)}$	M1	Use Pythagoras or use the value found for θ to find F
	$\theta = \tan^{-1}\left(\frac{4.96}{7.98}\right)$	M1	Use trigonometry or the value found for F to find θ
	$F = 9.39$ and $\theta = 31.8$	A1	
	Alternative method for question 5(i)		
	$\frac{F}{\sin 80} = \frac{4.5}{\sin(120 + \theta)} = \frac{7.5}{\sin(160 - \theta)}$	M1	Attempt to use Lami
		A1	One correct pair of terms
		A1	A second correct pair of terms
	$[4.5\sin(160 - \theta) = 7.5\sin(120 + \theta)]$	M1	Attempt to solve for θ
	Use the θ value found by valid trigonometry to find F	M1	
	$F = 9.39$ and $\theta = 31.8$	A1	

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Question	Answer	Marks	Guidance
5(i)	Alternative method for question 5(i)		
	Forces 4.5, 7.5, F opposite angles $60 - \theta$, $\theta + 20$, 100	M1	Illustrate a triangle of forces
	$[F^2 = 4.5^2 + 7.5^2 - 2 \times 4.5 \times 7.5 \times \cos 100]$	M1	For application of cosine rule to find F
		A1	Correct equation
	$\left[\frac{9.39}{\sin 100} = \frac{4.5}{\sin(60 - \theta)} = \frac{7.5}{\sin(\theta + 20)} \right]$	M1	One application of the sine rule to find θ
		A1	Correct equation
	$F = 9.39$ and $\theta = 31.8$	A1	
		6	
5(ii)	$9.5\cos 30 - 7.5\cos 60 - 4.5\cos 20 = m \times 1.5$	M1	Apply Newton's second law to the ring along AB (4 terms)
	$m = 0.166$ kg	A1	
		2	

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Question	Answer	Marks	Guidance
6(i)	$0.4g \times 1.8 = \frac{1}{2} \times 0.4 \times v^2$	M1	KE gain = PE lost
	$v = 6 \text{ ms}^{-1}$	A1	
	Alternative method for question 6(i)		
	$v^2 = 0^2 + 2 \times g \times 1.8$	M1	Use constant acceleration equation(s) with $a = g$ to find v
	$v = 6 \text{ ms}^{-1}$	A1	
		2	
6(ii)	$0.4g - 5.6 = 0.4a$	M1	Use Newton's second law for the particle in the vertical (3 terms)
	$a = -4 \text{ ms}^{-2}$	A1	
	$0 = 6 - 4t$	M1	Use of constant acceleration equation(s) such as $v = u + at$ to find t
	$t = 1.5 \text{ s}$	A1	
		4	
6(iii)	Straight line starting at (0,0) with positive gradient	B1	
	Second straight line starting at end of the first line with negative gradient and ending with $v = 0$	B1	
	All correct, start at (0, 0) with max velocity $v = 6$ at $t = 0.6$ i.e. (0.6, 6) and finishing at (2.1, 0)	B1FT	FT on <i>their</i> v from (i) and/or <i>their</i> t from (ii)
		3	

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Question	Answer	Marks	Guidance
7(i)	$0.6t^2 - 0.12t^3 = 0$	M1	For attempting to solve $v = 0$
	$(t = 0 \text{ or}) t = 5$	A1	
	$\int v \, dt = 0.2t^3 - 0.03t^4$	*M1	For integrating the velocity
	$OP = [0.2 \times 5^3 - 0.03 \times 5^4] - [0]$	DM1	Use limits to find OP
	Distance = 6.25 m	A1	AG
		5	
7(ii)	$k \times 5^3 + c \times 5^5 = 6.25$	B1	Using $s = 6.25$ at $t = 5$ to set up equation in k and c
	$v = 3kt^2 + 5ct^4$	*M1	For differentiating s to find v
	$1.25 = 3k \times 5^2 + 5c \times 5^4$	DM1	For using the given value of $v = 1.25$ in the expression for v
	$125k + 3125c = 6.25$ $75k + 3125c = 1.25$	M1	For attempting to solve a pair of simultaneous equations in k and c and finding a value of either k or c
	$k = 0.1, c = -0.002$	A1	
		5	
7(iii)	$a = 0.6t - 0.04t^3$	M1	For differentiating their expression for v
	At $t = 5, a = -2$ Acceleration = -2 ms^{-2}	A1	
		2	

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1	$(v \Rightarrow) 3t^2 - 12t + 4$	*M1	Attempt at differentiation of s to find v
	$(a \Rightarrow) 6t - 12$	*M1	Attempt at differentiation of v to find a
	[When $a = 0$, $t = 2$]	DM1	Solve to find t when $a = 0$ and find v at this time
	$v = -8 \text{ ms}^{-1}$	A1	
	Alternative method for question 1		
	$(v \Rightarrow) 3t^2 - 12t + 4$	M1	Attempt at differentiation of s to find v
	$(v \Rightarrow) 3(t - 2)^2 - 8$ or $t = \frac{-b}{2a} = \frac{12}{6} = 2$	M1	For using the method of completing the square or using the value of $\frac{-b}{2a}$ to find the t value of the minimum velocity
		M1	Use of the t value at minimum velocity to find v
	$v = -8 \text{ ms}^{-1}$	A1	
		4	

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Question	Answer	Mark	Guidance
2(i)	$\frac{(12-V)}{(35-30)} = 0.8$ or $12 = V + 0.8 \times 5$	M1	Use gradient of graph or constant acceleration formulae to set up an equation in V
	$V = 8$	A1	
		2	
2(ii)	$\left[25 \times 8 + 5 \times 10 + 15 \times 6 + \frac{1}{2} \times (U + 8) \times 5 = 375 \right]$	M1	Attempt to find total distance travelled by the tractor in 50s to set up an equation for U using EITHER areas OR suvat equations OR a combination of areas and suvat In either case total distance must be attempted
		A1FT	Correct equation FT on <i>their</i> V from (i)
	$U = 6$	A1	
		3	

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Question	Answer	Mark	Guidance
3	$T_A \times \frac{4}{5} + T_B \times \frac{3}{5} + 0.3g = 5$	M1	Resolving vertically
	$T_A \times \frac{3}{5} = T_B \times \frac{4}{5}$	M1	Resolving horizontally
		A1	Both correct
		M1	Solve for T_A or T_B
	$T_A = 1.6 \text{ N}$ and $T_B = 1.2 \text{ N}$	A1	
	Alternative method for question 3		
	$\left[\frac{5-3}{\sin 90} = \frac{T_A}{\sin 126.9} = \frac{T_B}{\sin 143.1} \right]$	M1	Attempt one pair of Lami's equations
		M1	Attempt a second pair of Lami equations
		A1	Equations all correct
		M1	Evaluate T_A or T_B
	$T_A = 1.6 \text{ N}$ and $T_B = 1.2 \text{ N}$	A1	

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Question	Answer	Mark	Guidance
3	Alternative method for question 3		
	$T_A = 5 \cos 36.9 - 3 \cos 36.9 = 5 \times \frac{4}{5} - 3 \times \frac{4}{5}$	M1	Resolve along PA
	$T_B = 5 \cos 53.1 - 3 \cos 53.1 = 5 \times \frac{3}{5} - 3 \times \frac{3}{5}$	M1	Resolve along PB
		A1	Both correct
		M1	Evaluate T_A or T_B
	$T_A = 1.6 \text{ N}$ and $T_B = 1.2 \text{ N}$	A1	
	Alternative method for question 3		
	Forces 2N , T_A and T_B with angles 36.9 and 53.1	M1	Attempt to illustrate a triangle of forces
	$[T_A = 2 \cos 36.9, T_B = 2 \cos 53.1]$	M1	Use trigonometry in the triangle to find T_A and T_B
		A1	Both correct
		M1	Solve for T_A or T_B
	$T_A = 1.6 \text{ N}$ and $T_B = 1.2 \text{ N}$	A1	
		5	

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Question	Answer	Mark	Guidance
4(i)	$P = 3000 \times 30$	M1	Use of $P = Fv$ with $F = \text{resistance}$
	$P = 90000 \text{ W} = 90\text{kW}$	A1	
		2	
4(ii)	PE gained = $25000gh$	B1	Correct expression for PE Allow PE = $25\,000\,g\,d\,\sin 2$
	Initial KE = $\frac{1}{2} \times 25000 \times 30^2$ [= 11 250 000] Final KE = $\frac{1}{2} \times 25000 \times 25^2$ [= 7 812 500]	B1	For either correct [KE loss = 3 437 500]
	Initial KE = Final KE + $25000gh + \frac{3000h}{\sin 2}$ OR Initial KE = Final KE + $25000g d \sin 2 + 3000d$	M1	For a 4 term work-energy equation, correct dimensions
		A1	Correct work-energy equation involving h or d
	$h = 10.2 \text{ m (10.2318...)}$	A1	
		5	

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Question	Answer	Mark	Guidance
5(i)	$h_A = 20t - \frac{1}{2} \times 10t^2$ or $h_B = \pm \frac{1}{2} \times 10(t-1)^2$	B1	OE $h_A = 20(T+1) - \frac{1}{2} \times 10(T+1)^2$ or $h_B = \pm \frac{1}{2} \times 10T^2$
	[Meet when $20t - \frac{1}{2} \times 10t^2 + \frac{1}{2} \times 10(t-1)^2 = 40$]	*M1	Set up an equation using <i>their</i> h_A , <i>their</i> h_B and 40
	$10t - 35 = 0$	DM1	Solve for t and attempt to find the height at collision.
	$t = 3.5$ so height at collision = 8.75 m	A1	$T = 2.5$ and height at collision = 8.75 m
	Alternative method for question 5(i)		
	$h_A = 20 \times 1 - \frac{1}{2} \times 10 \times 1^2 = 15$, $v = 20 - 10 \times 1 = 10$	B1	Finding distance travelled by A and its speed after 1 second
	$H_A + H_B = 25$ $\left(10T - \frac{1}{2} \times 10 \times T^2\right) + \frac{1}{2} \times 10 \times T^2 = 25$	*M1	T is the time beyond 1s until the particles reach same level H_A and H_B are distances travelled by A and B in T seconds.
	$[10T = 25 \rightarrow T = 2.5]$	DM1	Solve for T and attempt to find the height at collision
	$t = 3.5$ so height = 8.75 m	A1	
		4	

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Question	Answer	Mark	Guidance
5(ii)	$v_A = 20 - gt = -15$ or $v_A^2 = 20^2 + 2(-g)(8.75)$	M1	Use of <i>their</i> t or <i>their</i> $h \leq 20$ from 5(i) in a constant acceleration formula which would lead to finding v_A
	$v_B = -g(t - 1) = -25$ or $v_B^2 = 2(g)(40 - 8.75)$	M1	Use of <i>their</i> $t \pm 1$ or <i>their</i> $40 - h$ from 5(i) in a constant acceleration formula which would lead to finding v_B
	Difference = 10 ms^{-1}	A1	CWO
		3	

Question	Answer	Mark	Guidance
6(i)	$4.5 = 0 + \frac{1}{2} \times a \times 5^2$	M1	For use of $s = ut + \frac{1}{2}at^2$ to find a
	$a = 0.36$	A1	
	$6 \times \frac{24}{25} - F = 3 \times 0.36$	M1	Resolving horizontally. Allow use of $\theta = 16.3$
	$F = 4.68 \text{ N}$	A1	
		4	
6(ii)	$R = 3g - 6\sin 16.3 = 3g - 6 \times \frac{7}{25} \quad [= 28.32]$	B1	
	$4.68 = \mu \times 28.32$	M1	Use of $F = \mu R$
	$\mu = 0.165 \text{ (0.165254...)}$	A1	AG. Allow $\mu = \frac{39}{236}$
		3	

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Question	Answer	Mark	Guidance
6(iii)	$v = 5 \times 0.36 [= 1.8]$ or $v = \sqrt{(2 \times 0.36 \times 4.5)} [= 1.8]$	B1FT	For velocity at $t = 5$ ft on <i>their</i> a from 6(i)
	$3a = -0.165 \times 3g$	M1	Using Newton's second law with new frictional force
	$0 = 1.8 - 0.165gt \quad (t = 1.09)$	M1	Using constant acceleration equations which would lead to a positive value of t
	Total time = $5 + 1.09 = 6.09$ s	A1	
		4	

Question	Answer	Mark	Guidance
7(i)		M1	Use of Newton's second law for P or Q or the system
	For P : $T - 0.3g \times \frac{3}{5} = T - 0.3g \sin 36.9 = 0.3a$ For Q : $0.2g - T = 0.2a$ System: $0.2g - 0.3g \times \frac{3}{5} = (0.2 + 0.3)a$ or $0.2g - 0.3g \sin 36.9 = (0.2 + 0.3)a$	A1	Two correct equations Allow use of $\theta = 36.9$
	$[0.2g - 0.18g = 0.5a]$	M1	For solving either the system for a or for solving a pair of simultaneous equations for a or T
	$a = 0.4 \text{ ms}^{-2}$	A1	
	$T = 1.92 \text{ N}$	A1	
		5	

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Question	Answer	Mark	Guidance
7(ii)	$0.8 = 0 + \frac{1}{2} \times 0.4 \times t^2$ a	M1	For use of the constant acceleration equations with <i>their</i> a from 7(i) and $a \neq \pm g$ for a complete method to find t
	$t = 2$ s	A1	
		2	
7(iii)	Speed when Q hits the floor $= 2 \times 0.4 (= 0.8)$ or $v = \sqrt{(2 \times 0.4 \times 0.8)} [= 0.8]$	B1FT	Using $v = u + at$ with $u = 0$ Allow FT for <i>their</i> unsimplified $v = at$ or $v^2 = 2as$ with a from (i), t from (ii) and $s = 0.8$
	$-0.3g \times \frac{3}{5} = -0.3g \sin 36.9 = 0.3a$ [$a = -6$]	M1	Using Newton's second law for P to find $a \neq \pm g$
	$0 = 0.8t + \frac{1}{2} \times (-6)t^2$ ($t = 0.2666\dots$) or $0 = 0.8 - 6T$ ($T = 0.13333 = \frac{2}{15}$ and $t = 2T = 0.26666 = \frac{4}{15}$)	M1	Use of the constant acceleration equation(s) to find the time taken for P to return to the position where the string first became slack.
	Total time $= 2 + 0.266\dots = 2 + \frac{4}{15} = 2.27 = \frac{34}{15}$ s	A1	
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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.

Cambridge International is publishing the mark schemes for the October/November 2019 series for most Cambridge IGCSE™, Cambridge International A and AS Level components and some Cambridge O Level components.

This document consists of **11** printed pages.

PUBLISHED**Generic Marking Principles**

These general marking principles must be applied by all examiners when marking candidate answers. They should be applied alongside the specific content of the mark scheme or generic level descriptors for a question. Each question paper and mark scheme will also comply with these marking principles.

GENERIC MARKING PRINCIPLE 1:

Marks must be awarded in line with:

- the specific content of the mark scheme or the generic level descriptors for the question
- the specific skills defined in the mark scheme or in the generic level descriptors for the question
- the standard of response required by a candidate as exemplified by the standardisation scripts.

GENERIC MARKING PRINCIPLE 2:

Marks awarded are always **whole marks** (not half marks, or other fractions).

GENERIC MARKING PRINCIPLE 3:

Marks must be awarded **positively**:

- marks are awarded for correct/valid answers, as defined in the mark scheme. However, credit is given for valid answers which go beyond the scope of the syllabus and mark scheme, referring to your Team Leader as appropriate
- marks are awarded when candidates clearly demonstrate what they know and can do
- marks are not deducted for errors
- marks are not deducted for omissions
- answers should only be judged on the quality of spelling, punctuation and grammar when these features are specifically assessed by the question as indicated by the mark scheme. The meaning, however, should be unambiguous.

GENERIC MARKING PRINCIPLE 4:

Rules must be applied consistently e.g. in situations where candidates have not followed instructions or in the application of generic level descriptors.

GENERIC MARKING PRINCIPLE 5:

Marks should be awarded using the full range of marks defined in the mark scheme for the question (however; the use of the full mark range may be limited according to the quality of the candidate responses seen).

GENERIC MARKING PRINCIPLE 6:

Marks awarded are based solely on the requirements as defined in the mark scheme. Marks should not be awarded with grade thresholds or grade descriptors in mind.

PUBLISHED**Mark Scheme Notes**

The following notes are intended to aid interpretation of mark schemes in general, but individual mark schemes may include marks awarded for specific reasons outside the scope of these notes.

Types of mark

- 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.
- DM or DB** 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 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.
- 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.

Abbreviations

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

ISW Ignore Subsequent Working

SOI Seen Or Implied

SC Special Case (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)

WWW Without Wrong Working

AWRT Answer Which Rounds To

Question	Answer	Marks	Guidance
1	$F = \mu \times 500g$	B1	Use of $F = \mu R$
	$[2500 = \mu \times 500g]$	M1	Resolving horizontally
	$\mu = 0.5$	A1	
		3	

Question	Answer	Marks	Guidance
2	PE gain $= 150000g \times 500 \sin \alpha$ $(= 75000000g \sin \alpha)$	B1	Correct expression for PE gain
	$\frac{1}{2} \times 150000 \times 45^2 - \frac{1}{2} \times 150000 \times 42^2$ $(= 19575000)$	B1	Correct expression for KE loss
		M1	For 5 term work energy equation (or 4 terms if using loss in KE as 1 term)
	$150000g \times 500 \sin \alpha = 19575000 + 16000 \times 500 - 4 \times 10^6$	A1	
	$\alpha = 1.8$	A1	
		5	

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Question	Answer	Marks	Guidance
3	Resolving horizontally or vertically	M1	
	$50\cos 20 + 60 - 100\sin 30$ (=56.984...)	A1	
	$100\cos 30 - 50\sin 20$ (= 69.501...)	A1	
	$R = \sqrt{(56.984...)^2 + 69.501...^2}$ or $\alpha = \tan^{-1}\left(\frac{56.984...}{69.501...}\right)$	M1	Method to find either R or α
	$R=89.9$ (89.876...)	A1	
	$\alpha=39.3$ (39.348...)	A1	
		6	

Question	Answer	Marks	Guidance
4(i)	$s_{PQ} = 20 \times 10 - 0.5a \times 10^2$ or $s_{QR} = 20 \times 10 + 0.5a \times 10^2$	M1	For use of $s = vt - \frac{1}{2}at^2$ or $s = ut + \frac{1}{2}at^2$ OE suvat to find PQ or QR
	$s = 200 - 50a$ and $1.5s = 200 + 50a$	A1	OE
	$1.5(200 - 50a) = 200 + 50a \rightarrow 100 = 125a \rightarrow a = 0.8 \text{ ms}^{-2}$	B1	AG
		3	
4(ii)	Distance $QS = 20 \times 20 + \frac{1}{2} \times 0.8 \times 20^2$	M1	Using $s = ut + \frac{1}{2}at^2$
	Distance=560 m	A1	
	Average speed between Q and $S = \frac{560}{20} = 28 \text{ ms}^{-1}$	B1	
		3	

Question	Answer	Marks	Guidance
5(i)	Driving force = $\frac{240}{6}$ (= 40 N)	B1	Use of power = force × velocity
	$[40 - R = 80 \times 0.3]$	M1	Use of Newton's Second Law (3 terms)
	Resistance is 16 N	A1	AG
		3	
5(ii)	$\left[\frac{240}{v} = 16 \right]$	M1	Use of $P=Fv$ with DF=resistance
	Steady speed is 15 ms^{-1}	A1	
		2	
5(iii)	Use of Newton's Second Law	M1	(4 terms)
	$\frac{240}{4} - 16 - 80g \sin 3 = 80a$	A1	
	Acceleration is 0.0266 ms^{-2}	A1	
		3	

Question	Answer	Marks	Guidance
Q6(i)	$10 = 0.04 \times 5^3 + 5^2 c + 5k$ $(5c + k = 1)$	B1	Use of $t=5$, $v=10$
	$s = \frac{0.04}{4}t^4 + \frac{ct^3}{3} + \frac{kt^2}{2} + (C)$	*M1	For use of $s = \int v dt$
	$25 = 0.01 \times 5^4 + \frac{5^3}{3}c + \frac{5^2}{2}k$	DM1	Use of $t = 0$, $s = 0$ and $t = 5$, $s = 25$
	$6.25 + \frac{125}{3}c + \frac{25}{2}k = 25$ $\left(\frac{125}{3}c + \frac{25}{2}k = 18.75\right)$	A1	
	Solving for c or for k	M1	
	$c = -0.3$ and $k = 2.5$	A1	
		6	
Q6(ii)	$a = 0.12t^2 - 0.6t + 2.5$	M1	For use of $a = \frac{dv}{dt}$
	$a' = 0.24t - 0.6 = 0 \rightarrow t = \dots$ or $a = 0.12(t^2 - 5t + \dots) = 0.12[(t - 2.5)^2 + \dots]$	M1	Uses $\frac{da}{dt} = 0$ or completes the square for a
	Minimum when $t = 2.5$	A1	AG
		3	

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Question	Answer	Marks	Guidance
7(i)	$\left[0.81 = 0 + \frac{1}{2} \times a \times 0.9^2 \right]$	M1	For use of $s = ut + \frac{1}{2}at^2$
	$a = 2$	A1	
	$T - mg = ma$ or $kmg - T = kma$	M1	Use of Newton's Second Law for A or B or use of $a = \frac{(m_B - m_A)g}{(m_B + m_A)}$
	$T - mg = ma$ and $kmg - T = kma$ or $\left[a = \frac{(km - m)g}{(km + m)} \right]$	A1	
	$a = \frac{(kg - g)}{(k + 1)} = 2 \rightarrow k = \dots$	M1	Solves to find k
	$k = 1.5$	A1	
	$T = 10m + 2m = 12m \text{ N}$	B1	AG
		7	
7(ii)	Velocity of A when string breaks = 2×0.9 (=1.8 ms ⁻¹ upwards)	B1FT	For use of $v = u + at$ ft a from (i)
	$v^2 = 1.8^2 + 2g \times 1.62 \rightarrow v = \dots$	M1	For use of <i>suvat</i> to find v_A at ground
	Speed is 5.97 ms ⁻¹	A1	AG
	Time taken = $\frac{(1.8 + 5.97)}{g} = 0.777s$ (0.7769...)	B1	
		4	

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Question	Answer	Marks	Guidance
7(iii)	Straight line from (0, 0) to (0.9, 1.8)	B1	
	Straight line from (0.9, 1.8) to approx. (1.7, –6)	B1FT	FT $0.9 + t$ from (ii) for 1.7
		2	