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AQA

ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Mathematics 6360

MM1B Mechanics 1B

Mark Scheme

2007 examination - June series

Mark schemes are prepared by the Principal Examiner and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation meeting attended by all examiners and is the scheme which was used by them in this examination. The standardisation meeting ensures that the mark scheme covers the candidates' responses to questions and that every examiner understands and applies it in the same correct way. As preparation for the standardisation meeting each examiner analyses a number of candidates' scripts: alternative answers not already covered by the mark scheme are discussed at the meeting and legislated for. If, after this meeting, examiners encounter unusual answers which have not been discussed at the meeting they are required to refer these to the Principal Examiner.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of candidates' reactions to a particular paper. Assumptions about future mark schemes on the basis of one year's document should be avoided; whilst the guiding principles of assessment remain constant, details will change, depending on the content of a particular examination paper.

Set and published by the Assessment and Qualifications Alliance.

Key to mark scheme and abbreviations used in marking

M	mark is for method
m or dM	mark is dependent on one or more M marks and is for method
A	mark is dependent on M or m marks and is for accuracy
B	mark is independent of M or m marks and is for method and accuracy
E	mark is for explanation

√or ft or F	follow through from previous incorrect result	MC	mis-copy
CAO	correct answer only	MR	mis-read
CSO	correct solution only	RA	required accuracy
AWFW	anything which falls within	FW	further work
AWRT	anything which rounds to	ISW	ignore subsequent work
ACF	any correct form	FIW	from incorrect work
AG	answer given	BOD	given benefit of doubt
SC	special case	WR	work replaced by candidate
OE	or equivalent	FB	formulae book
A2,1	2 or 1 (or 0) accuracy marks	NOS	not on scheme
$-x$ EE	deduct x marks for each error	G	graph
NMS	no method shown	c	candidate
PI	possibly implied	sf	significant figure(s)
SCA	substantially correct approach	dp	decimal place(s)

No Method Shown

Where the question specifically requires a particular method to be used, we must usually see evidence of use of this method for any marks to be awarded. However, there are situations in some units where part marks would be appropriate, particularly when similar techniques are involved. Your Principal Examiner will alert you to these and details will be provided on the mark scheme.

Where the answer can be reasonably obtained without showing working and it is very unlikely that the correct answer can be obtained by using an incorrect method, we must award **full marks**. However, the obvious penalty to candidates showing no working is that incorrect answers, however close, earn **no marks**.

Where a question asks the candidate to state or write down a result, no method need be shown for full marks.

Where the permitted calculator has functions which reasonably allow the solution of the question directly, the correct answer without working earns **full marks**, unless it is given to less than the degree of accuracy accepted in the mark scheme, when it gains **no marks**.

Otherwise we require evidence of a correct method for any marks to be awarded.

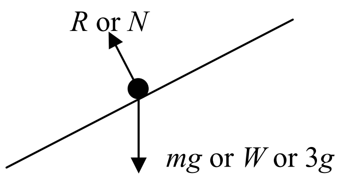
MM1B

Q	Solution	Marks	Total	Comments
1(a)	$v = 0 + 1.5 \times 9.8$	M1		Use of constant acceleration equation to find v
	$= 14.7 \text{ ms}^{-1}$	A1	2	AG Correct v from correct working $1.5 \times 9.8 = 14.7$ is not enough on its own
(b)	$h = \frac{1}{2} \times 9.8 \times 1.5^2$	M1		Use of constant acceleration equation with $a = 9.8$ to find h
	$= 11.0$ m (to 3 sf)	A1	2	Correct h Allow 11 m; ignore negative signs
(c)	$5^2 = 0^2 + 2 \times 9.8s$	M1		Use of constant acceleration equation with $u = 0$ to find s
		A1		Correct equation
	$s = \frac{25}{19.6} = 1.28$ m (to 3 sf) **OR** $t = \frac{5}{9.8} = 0.510$ $s = \frac{1}{2}(0+5)\frac{5}{9.8} = 1.28$ m **OR** $s = 0 + \frac{1}{2} \times 9.8 \times \left(\frac{5}{9.8}\right)^2 = 1.28$ m	A1	3	Correct s Accept 1.27
	Total		**7**	
2(a)	$2\begin{bmatrix} 3 \\ -2 \end{bmatrix} + 3\begin{bmatrix} -4 \\ 1 \end{bmatrix} = 5\mathbf{v}$	M1		Three term vector equation, with a '+' sign, for conservation of momentum
		A1		Correct equation Deduct this first A mark for use of mg
	$\mathbf{v} = \frac{1}{5}\begin{bmatrix} -6 \\ -1 \end{bmatrix} = \begin{bmatrix} -1.2 \\ -0.2 \end{bmatrix}$	A1	3	Correct velocity
(b)	$v = \sqrt{1.2^2 + 0.2^2} = 1.22 \text{ ms}^{-1}$	M1		Finding speed from their velocity in part (a) (Must include addition of two terms)
		A1F	2	Correct speed from their velocity Accept 1.21
	Total		**5**	

MM1B (cont)

Q	Solution	Marks	Total	Comments
3(a)	$T_1 \sin 35° = T_2 \sin 35°$	M1		Resolving two forces and forming an equation, with different tensions for each string
	$T_1 = T_2$	A1	2	Correct result from correct working
	OR $T_1 \cos 55° = T_2 \cos 55°$ $T_1 = T_2$			
(b)	$T_1 \cos 35° + T_2 \cos 35° = 2 \times 9.8$	M1		Resolving forces to form a three term vertical equation
	$T_1 \cos 35° + T_1 \cos 35° = 2 \times 9.8$	A1		Correct equation
		A1		T_1 or T_2 eliminated correctly
	$T_1 = \dfrac{2 \times 9.8}{2 \cos 35°} = 12.0$ N (to 3sf)	dM1		Solving for T_1 or T_2
		A1	5	Correct tension Accept 12 N or 11.9 N
(c)	$2 \times 40 \cos 35° = 9.8m$	M1		Forming an equation with two tensions to find m
		A1		Correct equation
	$m = \dfrac{80 \cos 35°}{9.8} = 6.69$ kg	A1	3	Correct mass Accept 6.68
	OR $m = \dfrac{40}{11.96} \times 2$	(M1) (A1)		
	$= 6.69$ kg	(A1)		
	Total		**10**	
4(a)	$T - 800 = 1200 \times 0.4$	M1 A1		Three term equation of motion for the car Correct equation
	$T = 800 + 480$ $= 1280$ N	A1	3	Correct tension Treat calculation of two tensions as two methods unless one selected Treat sum or difference of two tensions as an incorrect method
(b)	$3000 - 800 - F = 4000 \times 0.4$	M1		Four term equation of motion (truck or both)
		A1 A1		Correct terms Correct signs
	$F = 3000 - 800 - 1600$ $F = 600$ N	A1	4	AG Correct resistance force from correct working
	OR $3000 - 1280 - F = 2800 \times 0.4$ $F = 3000 - 1280 - 1120$ $F = 600$ N			
(c)	Increase, because a greater tension would be needed so that the horizontal component would be the same as the tension above.	B1 B1	2	Greater Reason Second B1 dependent on the first B1 mark
	Total		**9**	

MM1B (cont)

Q	Solution	Marks	Total	Comments
5(a)	$V = 150\tan 30°$	M1		Using trigonometry (usually tan or sine rule) to find V
	$= 86.6\ \text{ms}^{-1}$	A1	2	AG Correct answer from correct working (Division by 2 only acceptable if sin30° or cos60° seen)
	OR $\dfrac{V}{\sin 30°} = \dfrac{150}{\sin 60°}$ AG $V = 86.6\ \text{ms}^{-1}$			
(b)	$\dfrac{150}{v} = \cos 30°$	M1		Using trigonometry or Pythagoras to find v
		A1		Correct expression
	$v = \dfrac{150}{\cos 30°} = 173\ \text{ms}^{-1}$ (to 3sf)	A1	3	Correct answer
	Total		**5**	
6(a)(i)	 	B1	1	Correct diagram with arrows and labels
(ii)	$3a = 3g\sin 30°$	M1		Two term equation of motion
	$a = g\sin 30° = 4.9\ \text{ms}^{-2}$	A1	2	AG Correct acceleration from correct working (Allow $a = g\sin 30°$)
(b)(i)	$5 = \dfrac{1}{2}a \times 2^2$	M1		Constant acceleration equation with $u = 0$
	$a = 2.5\ \text{ms}^{-2}$	A1	2	AG Correct answer from correct working. (Use of $v = 5$ must be justified)
(ii)	$3 \times 2.5 = 3g\sin 30° - F$	M1 A1		Three term equation of motion Correct equation
	$F = 3g\sin 30° - 7.5$ $= 7.20$ N (to 3 sf)	A1	3	Correct F Accept 7.2 N
(iii)	$R = 3g\cos 30°$ $(= 25.46)$	M1		Resolving perpendicular to the slope to find R
		A1		Correct R
	$7.2 = \mu \times 3g\cos 30°$	M1		Use of $F = \mu R$
		A1F		Correct expression
	$\mu = \dfrac{7.2}{3g\cos 30°} = 0.283$	A1F	5	Correct μ Accept 0.282 (Follow through from incorrect F from above, but not an incorrect R)
(iv)	Reduce a, as the air resistance would reduce the magnitude of the resultant force or because the air resistance increases as the velocity increases towards its terminal value	B1 B1	2	Reduces Explanation Second B1 dependent on the first B1 mark
	Total		**15**	

MM1B (cont)

Q	Solution	Marks	Total	Comments
7(a)	A particle or no spin	B1		First assumption
	No air resistance or no wind or only gravity acting	B1	2	Second assumption
				If more than 2 assumptions given, subtract one mark for each incorrect additional assumption
(b)	$0 = 25\sin 40° t - 4.9t^2$	M1		Equation for time of flight
		A1		Correct equation
	$0 = t(25\sin 40° - 4.9t)$	dM1		Solving for t
	$t = 0$ or $t = \dfrac{25\sin 40°}{4.9}$			
	Time of flight $=$ 3.28 s	A1	4	AG Correct final answer from correct working (Verification method M1A1M1A0)
(c)	$s = 3.28 \times 25\cos 40° = 62.8$ m	M1		Finding range
		A1	2	Correct range
(d)	25 ms^{-1} at 40° **below** the horizontal	B1		Speed
		B1	2	Direction
(e)	$v_{\text{min}} = 25\cos 40° = 19.2\ \text{ms}^{-1}$	M1		Horizontal component of velocity
		A1	2	Correct speed
	OR			Accept 19.1 ms^{-1}
	$v_{\text{min}} = \dfrac{62.807}{3.2795} = 19.2\ \text{ms}^{-1}$			
	Total		**12**	

MM1B (cont)

Q	Solution	Marks	Total	Comments
8(a)	$\mathbf{u} = 5\mathbf{i}$ or $\begin{bmatrix} 5 \\ 0 \end{bmatrix}$	B1	1	Correct velocity
(b)	$\mathbf{v} = 5\mathbf{i} + (-0.2\mathbf{i} + 0.25\mathbf{j})t$	M1		Use of constant acceleration equation, with **u** and **a** not zero
		A1	2	Correct velocity M1A0 for using 5**j** or just 5
	OR $\mathbf{v} = \begin{bmatrix} 5 - 0.2t \\ 0.25t \end{bmatrix}$			
(c)	$5 - 0.2t = 0$	M1 A1		Easterly component zero Correct equation
	$t = \frac{5}{0.2} = 25$ seconds	A1	3	Correct t
(d)	$\mathbf{r} = 5\mathbf{i} \times 25 + \frac{1}{2}(-0.2\mathbf{i} + 0.25\mathbf{j}) \times 25^2$	M1		Use of constant acceleration equation with t from part (c)
		A1F		Correct expression based on t from part (c)
	$= 62.5\mathbf{i} + 78.125\mathbf{j}$	A1		Correct simplification CAO
	$\theta = \tan^{-1}\left(\frac{62.5}{78.125}\right)$	dM1 A1F		Using tan to find the angle Correct expression based on t from part (c), with correct two values(either way)
	$= 038.7°$	A1	6	Correct angle Accept 38.6° or 039°
	OR $\mathbf{r} = \frac{1}{2}(5\mathbf{i} + 6.25\mathbf{j}) \times 25$ $\theta = \tan^{-1}\left(\frac{5}{6.25}\right) = 038.7°$	(M1) (A1F) (A1) (dM1) (A1F) (A1)		
	Total		**12**	
	TOTAL		**75**	