ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Mathematics 6360

MM1B Mechanics 1B

Mark Scheme

2008 examination - January 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.

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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.

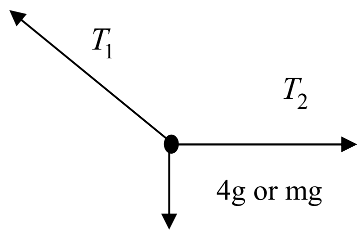
Where the permitted calculator has functions which reasonably allow the solution of the question directly, the correct answer without working earns **full marks**, unless it is given to less than the degree of accuracy accepted in the mark scheme, when it gains **no marks**.

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

MM1B

Q	Solution	Marks	Total	Comments
1. (a)	$8 = \frac{1}{2} a \times 5^2$ **AG**	M1		Use of constant acceleration equation with $u = 0$ to find *a*.
	$a = \frac{2 \times 8}{25} = 0.64 \text{ ms}^{-2}$	A1	2	Correct answer from correct working, showing evidence of solving for *a*. Allow verification / substitution.
(b)	$T - 70 \times 9.8 = 70 \times 0.64$	M1		Three term equation of motion for crate.
		A1		Correct equation
	$T = 730.8 = 731 \text{ N to 3 sf}$	A1	3	Correct tension
(c)	$v = \frac{8}{5} = 1.6 \text{ ms}^{-1}$	B1	1	Correct average speed. Accept $\frac{8}{5}$ Allow $\frac{3.2+0}{2} = 1.6 \text{ ms}^{-1}$
	Total		**6**	
2.(a)	$U = \sqrt{10^2 - 8^2} = 6$	M1		Expression/equation for U based on a right angled triangle.
		A1	2	Correct U. Note $10^2 + 8^2$ gives M1A0
(b)	$\cos\theta = \frac{8}{10}$	M1		Use of trigonometry to find angle. Allow $\begin{cases} \tan\theta = \frac{8}{6} \text{ or } \frac{6}{8} \\ \sin/\cos\theta = \frac{8}{10} \text{ or } \frac{6}{10} \end{cases}$
	$\theta = 037°$	A1	2	Correct angle. Accept 36.9° etc. Note 143° gives M1A0
	Total		**4**	

MM1B (cont)

Q	Solution	Marks	Total	Comments
3.(a)	 	B1	1	Diagram with three forces, labels and arrow heads. Different variables must be used for each tension
(b)	$T_1 \sin 30° = 4 \times 9.8$ $T_1 = \dfrac{4 \times 9.8}{\sin 30°} = 78.4$ N **AG**	M1 A1 A1	 3	Two term equation from resolving vertically. Must see a sin or cos term for M1 Correct equation Correct tension form correct working.
(c)	$T_2 = 78.4 \cos 30° = 67.9$ N	M1 A1	 2	Two term equation from resolving horizontally. Correct tension.
	Total		**6**	
4. (a)(i)	$5\begin{bmatrix} 2U \\ U \end{bmatrix} + 15\begin{bmatrix} V \\ -1 \end{bmatrix} = 20\begin{bmatrix} V \\ 0 \end{bmatrix}$	M1		Three term equation for conservation of momentum.
	$5U - 15 = 0$ $U = 3$	dM1 A1F	 3	Equation for U based on conservation of momentum. Correct value for U. Deduct one mark for using weight instead of mass.
(a)(ii)	$30 + 15V = 20V$ $30 = 5V$ $V = \dfrac{30}{5} = 6$	M1 A1F	 2	Equation for V based on conservation of momentum. Correct value for V. Deduct one mark for using weight instead of mass.
(b)	$v = \sqrt{3^2 + 6^2} = 3\sqrt{5} = 6.71 \text{ ms}^{-1}$	M1 A1F	 2	Calculation of speed. Correct speed. Allow $\sqrt{45}$
	Total		**7**	

MM1B (cont)

Q	Solution	Marks	Total	Comments
5(a)(i)	$0.2a = -0.2\times 9.8\sin 20°$ **AG**	M1		Two term equation of motion with weight resolved
		A1		Correct equation
	$a = -9.8\sin 20° = -3.35\ \text{ms}^{-2}$	A1	3	Correct acceleration from correct working SC No negative sign but otherwise correct award M1A1A0 Allow $a = -g\sin 20°$
(a)(ii)	$0 = 4^2 + 2\times(-3.35)s$	M1		Use of constant acceleration equation with $v = 0$ and $u = 4$
		A1		Correct equation
	$s = \dfrac{16}{6.7} = 2.39\ \text{m}$	A1	3	Correct distance
(a)(iii)	The puck slides back down the slope as the puck is at rest and the resultant force is now acting down the slope / no friction / smooth slope.	B1		Slides back down
		E1	2	Acceptable explanation
(b)(i)	$R = 0.2\times 9.8\cos 20°$ **AG**	M1		Finding normal reaction by resolving. Must see a trig term.
	$F = 0.5\times 0.2\times 9.8\cos 20°$	M1		Use of $F = \mu R$
	$= 0.921\ \text{N}$	A1	3	Correct friction from correct working.
(b)(ii)	$0.2a = -0.921 - 0.2\times 9.8\sin 20°$	M1		Three term equation of motion with the weight resolved
		A1		Correct equation
	$a = -7.96\ \text{ms}^{-2}$	A1	3	Correct acceleration (with or without the minus sign, applied to both A1 marks)
(b)(iii)	The puck stays at rest because the friction has a maximum of 0.921 and the component of the weight down the slope is less (0.670)	B1		Stays at rest
		dE1	2	Acceptable explanation
	Total		**16**	

MM1B (cont)

Q	Solution	Marks	Total	Comments
6(a)	$F = 0.4 \times 1000 \times 9.8$ $= 3920$ **AG**	M1 A1	2	Use of $F = \mu R$ Correct friction from correct working. Allow $F = 0.4 \times 9800$ Allow verification
(b)	$P - 3920 = 5000 \times 0.8$ $P = 7920$ N **AG**	M1 A1 A1	3	Three term equation of motion including an explicit 0.8 Correct equation Correct force from correct working. Allow $P = 5000 \times 0.8 + 3920$
(c)	$T - 3920 = 1000 \times 0.8$ $T = 4720$ N or $7920 - T = 4000 \times 0.8$ $T = 4720$ N	M1 A1 A1	3	Three term equation of motion Correct equation Correct tension
(d)	Friction is reduced because the normal reaction is reduced.	B1 E1	2	Friction reduced Acceptable explanation
	Total		**10**	
7(a)	It is a particle /No air resistance / lift forces act on the ball.	B1 B1	2	Particle Other acceptable assumption Deduct one mark for each additional incorrect assumption.
(b)	$V \sin 40° t - \frac{1}{2} \times 9.8 t^2 = 0$ $t = \frac{V \sin 40°}{4.9}$ $s = V \cos 40° \times \frac{V \sin 40°}{4.9}$ **AG** $= \frac{V^2 \cos 40° \sin 40°}{4.9}$	M1 A1 dM1 A1 M1 A1	6	Vertical equation to find t. Correct equation (Equals zero may be implied) Solving for t Correct t Finding range with their t Correct range from correct working SC Quoting the formula for the range 2 marks.
(c)	$76 < \frac{V^2 \cos 40° \sin 40°}{4.9} < 82$ $\sqrt{\frac{76 \times 4.9}{\cos 40° \sin 40°}} < V < \sqrt{\frac{82 \times 4.9}{\cos 40° \sin 40°}}$ $27.5 < V < 28.6$	M1 A1 A1 A1	4	An equation to find one value of V. Correct value for V Other value of V correct Correct range of values Accept 27.5 – 28.6 but not 28.6-27.5 For using values close to 76 and 82 deduct one mark.
	Total		**12**	

MM1B (cont)

Q	Solution	Marks	Total	Comments
8(a)	$4\mathbf{i} = 5\mathbf{j} + 40\mathbf{a}$ $\mathbf{a} = \dfrac{4\mathbf{i} - 5\mathbf{j}}{40} = 0.1\mathbf{i} - 0.125\mathbf{j}$ **AG**	M1 A1 dM1 A1	4	Forming a vector equation based on constant acceleration Correct equation Solving for **a** Correct **a** from correct working For $\dfrac{4\mathbf{i} - 5\mathbf{j}}{40}$ on its own give M0 Allow verification
(b)	$\mathbf{r} = 5\mathbf{j} \times 40 + \dfrac{1}{2}(0.1\mathbf{i} - 0.125\mathbf{j}) \times 40^2$ $= 80\mathbf{i} + 100\mathbf{j}$	M1 A1 A1	3	Finding position vector Correct expression Correct simplified result
(c)(i)	$\mathbf{v} = 5\mathbf{j} + (0.1\mathbf{i} - 0.125\mathbf{j})t$ $= 0.1t\mathbf{i} + (5 - 0.125t)\mathbf{j}$ $5 - 0.125t = -0.1t$ $5 = 0.025t$ $t = \dfrac{5}{0.025} = 200$	M1 A1 dM1 A1 A1	5	Expression for **v** Correct expression for **v** seen or implied Equating components, with or without a minus sign Correct equation Correct time.
(c)(ii)	$\mathbf{v} = 0.1 \times 200\mathbf{i} + (5 - 0.125 \times 200)\mathbf{j}$ $= 20\mathbf{i} - 20\mathbf{j}$	M1 A1F	2	Finding velocity using their time Correct velocity for their time
	Total		**14**	
	TOTAL		**75**	

Note for question 8. Consistent use of $\mathbf{u} = 4\mathbf{i}$ or $5\mathbf{i}$ or $\mathbf{a} = 0.1\mathbf{i} + 0.125\mathbf{j}$ award method marks only.