

### **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.

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.

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М	mark is for method					
m or dM	mark is dependent on one or more M marks and is for method					
Α	mark is dependent on M or m marks and is for accuracy					
В	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	С	candidate			
PI	possibly implied	sf	significant figure(s)			
SCA	substantially correct approach	dp	decimal place(s)			

### Key to mark scheme and abbreviations used in marking

#### 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
<b>1.</b> (a)	$8 = \frac{1}{2}a \times 5^{2}$ $a = \frac{2 \times 8}{25} = 0.64 \text{ ms}^{-2}$ AG	M1		Use of constant acceleration equation with $u = 0$ to find <i>a</i> .
	$a = \frac{1}{25} = 0.64 \text{ ms}^2$	A1	2	Correct answer from correct working, showing evidence of solving for <i>a</i> . Allow verification / substitution.
(b)	$T - 70 \times 9.8 = 70 \times 0.64$	M1 A1		Three term equation of motion for crate.
		A1 A1	3	Correct equation Correct tension
	T = 730.8 = 731 N to 3 sf	AI	5	Correct tension
(c)	$v = \frac{8}{5} = 1.6 \text{ ms}^{-1}$	B1	1	Correct average speed.
	5			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. $\begin{bmatrix} & 8 & 6 \end{bmatrix}$
	$\theta = 037^{\circ}$			Allow $\begin{cases} \tan \theta = \frac{8}{6} \text{ or } \frac{6}{8} \\ \sin/\cos \theta = \frac{8}{10} \text{ or } \frac{6}{10} \end{cases}$
		A1	2	Correct angle.
				Accept 36.9° etc.
				Note 143° gives M1A0
	Total		4	

Q	Solution	Marks	Total	Comments
3.(a)	$T_1$ $T_2$ 4 g  or  mg	B1	1	Diagram with three forces, labels and arrow heads. Different variables must be used for each tension
(b)	$T_1 \sin 30^\circ = 4 \times 9.8$ $T_1 = \frac{4 \times 9.8}{\sin 30^\circ} = 78.4 \text{ N}$ AG	M1 A1 A1	3	Two term equation from resolving vertically. Must see a sin or cos term for M1 Correct equation
( <b>c</b> )	$T_2 = 78.4 \cos 30^\circ = 67.9 \text{ N}$	M1	3	Correct tension form correct working. Two term equation from resolving horizontally.
		A1	2	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		Equation for $U$ based on conservation of momentum.
		A1F	3	Correct value for <i>U</i> . Deduct one mark for using weight instea of mass.
(a)(ii)	30 + 15V = 20V 30 = 5V	M1		Equation for <i>V</i> based on conservation of momentum.
	$V = \frac{30}{5} = 6$	A1F	2	Correct value for V.
	5			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	

Q	Solution	Marks	Total	Comments
5(a)(i)	$0.2a = -0.2 \times 9.8 \sin 20^{\circ}$	M1		Two term equation of motion with weight
	AG			resolved
	$a = -9.8 \sin 20^\circ = -3.35 \text{ ms}^{-2}$	A1		Correct equation
	$a = -9.8 \sin 20^{\circ} = -3.35 \mathrm{ms}$	A1		Correct acceleration from correct working
			3	SC No negative sign but otherwise correct
				award M1A1A0
				Allow $a = -g \sin 20^{\circ}$
(a)(ii)	$0 - \frac{1^2}{2} + \frac{2}{2} \times (-2, \frac{2}{2}) =$	M1		Use of constant acceleration equation
(a)(II)	$0 = 4^2 + 2 \times (-3.35)s$	1911		with $v = 0$ and $u = 4$
		A1		Correct equation $v = 0$ and $u = 1$
	$s = \frac{16}{67} = 2.39 \text{ m}$			-
	$s = \frac{1}{6.7} = 2.39 \text{ m}$	A1	3	Correct distance
(a)(iii)	The puck slides back down the slope as	B1		Slides back down
( <b>u</b> )( <b>III</b> )	the puck is at rest and the resultant force	DI		Shides blek down
	is now acting down the slope / no friction			
	/ smooth slope.	E1	2	Acceptable explanation
(b)(i)	<b>D</b>	M1		Finding normal reaction by resolving.
(0)(1)	$R = 0.2 \times 9.8 \cos 20^{\circ} $ AG	1411		Must see a trig term.
	$F = 0.5 \times 0.2 \times 9.8 \cos 20^{\circ}$	M1		Use of $F = \mu R$
	= 0.921 N	A1	3	Correct friction from correct working.
(b)(ii)	$0.2a = -0.921 - 0.2 \times 9.8 \sin 20^{\circ}$	M1		Three term equation of motion with the
(0)(11)	0.24 0.921 0.279.051120	1011		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	B1		Stays at rest
(~)(***)	has a maximum of 0.921 and the	21		
	component of the weight down the slope			
	is less (0.670)	dE1	2	Acceptable explanation
	Total		16	

QSolutionMarksTotalComments6(a) $F = 0.4 \times 1000 \times 9.8$ AGMILis of $F = uR$ $= 3920$ AGAI2Us of $F = 0.4 \times 9800$ Allow $F = 0.4 \times 9800$ Allow verification(b) $P = 3920 = 5000 \times 0.8$ $P = 7920 N$ AGMIThree term equation of motion including an explicit 0.8 Correct quation(c) $T = 3920 = 1000 \times 0.8$ $T = 4720 N$ MIThree term equation of motion Correct force from correct working. Allow $P = 5000 \times 0.8 + 3920$ (c) $T = 3920 = 1000 \times 0.8$ $T = 4720 N$ MIThree term equation of motion Correct quation A1(d)Friction is reduced because the normal reaction is reduced.B1 E12(d)Friction is reduced.Total107(a)It is a particle /No air resistance / lift forces act on the ball.B1 A1 A12(b) $V \sin 40^{\circ}t - \frac{1}{2} \times 9.8t^2 = 0$ $t = \frac{V \sin 40^{\circ}}{4.9}$ MI A1 A1AC correct quation A1(c) $T = \frac{V \sin 40^{\circ}}{4.9}$ $s = V \cos 40^{\circ} \sin 40^{\circ}$ $4.9$ AG A1Finding range with their t Correct rungtion Correct working SC Quoing the formula for the range 2 marks.(c) $76 < \frac{V^2 \cos 40^{\circ} \sin 40^{\circ}}{4.9} \sqrt{\frac{76 \times 49}{1.9}} \sqrt{\frac{76 \times 49}{1.9}} \sqrt{\frac{76 \times 49}{1.49}} \sqrt{\frac{82 \times 4.9}{1.49}} \sqrt{\frac{76 \times 49}{1.49}} \sqrt{\frac{82 \times 4.9}{1.40^{\circ}}} A1AIAI(c)76 < \frac{V^2 \cos 40^{\circ} \sin 40^{\circ}}{4.9} \sqrt{\frac{100}{1.400}} \sqrt{\frac{82 \times 4.9}{1.40^{\circ}}} \sqrt{\frac{82 \times 4.9}{1.40^{\circ}}} \sqrt{\frac{82 \times 4.9}{1.40^{\circ}}} \sqrt{\frac{82 \times 4.9}{1.40^{\circ}}} \frac{82 \times 4$	MM1B (con	t)			
$ \begin{array}{ c c c c c c c c c c c c c c c c c c c$	Q	Solution	Marks	Total	
P = 7920 NAGP = 7920 NAGA1A2A1A1A1A2A1A2A2A1A1A1A1A2A2A3A1A3A1A4A1A3A2A4A1A3A1A4A1A4A1A4A1A4A1A4A1A4A1A4A1A4A1A4A1A4A1<	6(a)	AG		2	Correct friction from correct working. Allow $F = 0.4 \times 9800$
T = 4720 NAl A1Correct equation Correct tensionor 7920 - T = 4000 × 0.8 	(b)	AG	A1	3	an explicit 0.8 Correct equation Correct force from correct working.
7920 - T = 4000 × 0.8 T = 4720 NFinding range with their t Correct range from correct working SC Quoting the formula for the range 2 marks.Finding range with their t Correct 27.5 - 28.6 but not 28.6-27.5 For using values close to 76 and 82 	(c)	T = 4720  N	A1	3	Correct equation
Teaction is reduced.E12Acceptable explanationTotal107(a)It is a particle /No air resistance / lift forces act on the ball.B1 B12Particle Other acceptable assumption Deduct one mark for each additional incorrect assumption.(b) $V \sin 40^{\circ}t - \frac{1}{2} \times 9.8t^2 = 0$ $t = \frac{V \sin 40^{\circ}}{4.9}$ $= \frac{V^2 \cos 40^{\circ} \times \frac{V \sin 40^{\circ}}{4.9}$ $= \frac{V^2 \cos 40^{\circ} \sin 40^{\circ}}{4.9}$ AG A1Vertical equation to find t. Correct equation (Equals zero may be implied) Solving for t Correct t(c) $76 < \frac{V^2 \cos 40^{\circ} \sin 40^{\circ}}{4.9} < 82$ $\sqrt{\frac{76 \times 4.9}{\cos 40^{\circ} \sin 40^{\circ}}} < 82$ $\sqrt{\frac{76 \times 4.9}{\sqrt{\cos 40^{\circ} \sin 40^{\circ}}}} < V < \sqrt{\frac{82 \times 4.9}{\sqrt{\cos 40^{\circ} \sin 40^{\circ}}}}$ M1 A1(c) $76 < \frac{V^2 \cos 40^{\circ} \sin 40^{\circ}}{4.9} < 82$ $\sqrt{\frac{75 \times 4.9}{\cos 40^{\circ} \sin 40^{\circ}}} < V < \sqrt{\frac{82 \times 4.9}{\sqrt{\cos 40^{\circ} \sin 40^{\circ}}}}$ M1 A1(c) $76 < \frac{V^2 \cos 40^{\circ} \sin 40^{\circ}}{4.9} < 82$ $\sqrt{\frac{27.5 < V < 28.6}$ M1 A1An equation to find one value of V. Correct $27.5 < V < 28.6$ A14Correct 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.		$7920 - T = 4000 \times 0.8$			
7(a)It is a particle /No air resistance / lift forces act on the ball.B1 B12Particle Other acceptable assumption Deduct one mark for each additional incorrect assumption.(b) $V \sin 40^{\circ}t - \frac{1}{2} \times 9.8t^2 = 0$ $t = \frac{V \sin 40^{\circ}}{4.9}$ $= \frac{V^2 \cos 40^{\circ} \sin 40^{\circ}}{4.9}$ M1 AG A12Particle Other acceptable assumption Deduct one mark for each additional incorrect assumption.(b) $V \sin 40^{\circ}t - \frac{1}{2} \times 9.8t^2 = 0$ $t = \frac{V \sin 40^{\circ}}{4.9}$ $= \frac{V^2 \cos 40^{\circ} \sin 40^{\circ}}{4.9}$ AG AGM1 A1Vertical equation to find t. Correct requation (Equals zero may be implied) Solving for t Correct t(c) $76 < \frac{V^2 \cos 40^{\circ} \sin 40^{\circ}}{4.9} < 82$ $\sqrt{\frac{76 \times 4.9}{\cos 40^{\circ} \sin 40^{\circ}}} < V < \sqrt{\frac{82 \times 4.9}{\cos 40^{\circ} \sin 40^{\circ}}}$ M1 A1A1 A1An equation to find one value of V. Correct value for V Other value of V correct(c) $76 < \frac{V^2 \cos 40^{\circ} \sin 40^{\circ}}{4.9} < 82$ $\sqrt{\frac{76 \times 4.9}{\cos 40^{\circ} \sin 40^{\circ}}} < V < \sqrt{\frac{82 \times 4.9}{\cos 40^{\circ} \sin 40^{\circ}}}$ M1 A1A1 A1(c) $76 < \frac{V^2 \cos 40^{\circ} \sin 40^{\circ}}{4.9} < 82$ $\sqrt{\frac{27.5 < V < 28.6}$ M1 A1A1 A1A1 A1	(d)	reaction is reduced.		2	
forces act on the ball.B12Other acceptable assumption Deduct one mark for each additional incorrect assumption.(b) $V \sin 40^{\circ}t - \frac{1}{2} \times 9.8t^2 = 0$ $t = \frac{V \sin 40^{\circ}}{4.9}$ $= \frac{V \cos 40^{\circ} \times \frac{V \sin 40^{\circ}}{4.9}}{4.9}$ M1 AG AIM1 AIVertical equation to find t. Correct equation (Equals zero may be implied) Solving for t Correct t(c) $76 < \frac{V^2 \cos 40^{\circ} \sin 40^{\circ}}{4.9} < 82$ $\sqrt{\frac{76 \times 4.9}{\cos 40^{\circ} \sin 40^{\circ}}} < 82$ $\sqrt{\frac{76 \times 4.9}{\cos 40^{\circ} \sin 40^{\circ}}} < V < \sqrt{\frac{82 \times 4.9}{\cos 40^{\circ} \sin 40^{\circ}}}$ M1 A1An equation to find one value of V. Correct value for V Other value of V correct(c) $76 < \frac{V^2 \cos 40^{\circ} \sin 40^{\circ}}{4.9} < 82$ $\sqrt{\frac{76 \times 4.9}{\cos 40^{\circ} \sin 40^{\circ}}} < V < \sqrt{\frac{82 \times 4.9}{\cos 40^{\circ} \sin 40^{\circ}}}$ M1 A1An equation to find one value of V. Correct range for V Other value of V correct(c) $76 < \frac{V^2 \cos 40^{\circ} \sin 40^{\circ}}{4.9} < 82$ $\frac{100000000000000000000000000000000000$				10	
$V \sin 40^{\circ}t - \frac{1}{2} \times 9.8t^{2} = 0$ $t = \frac{V \sin 40^{\circ}}{4.9}$ $s = V \cos 40^{\circ} \times \frac{V \sin 40^{\circ}}{4.9}$ $= \frac{V^{2} \cos 40^{\circ} \sin 40^{\circ}}{4.9}$ $(c)  76 < \frac{V^{2} \cos 40^{\circ} \sin 40^{\circ}}{4.9} < 82$ $\sqrt{\frac{76 \times 4.9}{\sqrt{\frac{76 \times 4.9}{\cos 40^{\circ} \sin 40^{\circ}}}} < V < \sqrt{\frac{82 \times 4.9}{\cos 40^{\circ} \sin 40^{\circ}}}$ $AI$ $AI$ $AI$ $AI$ $AI$ $AI$ $AI$ $AI$	7(a)	*		2	Other acceptable assumption Deduct one mark for each additional
(c) $76 < \frac{V^2 \cos 40^\circ \sin 40^\circ}{4.9} < 82$ M1An equation to find one value of V. $\sqrt{\frac{76 \times 4.9}{\sqrt{\cos 40^\circ \sin 40^\circ}}} < V < \sqrt{\frac{82 \times 4.9}{\cos 40^\circ \sin 40^\circ}}$ A1A1Correct value for V $27.5 < V < 28.6$ A14Correct 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.	(b)	$t = \frac{V\sin 40^{\circ}}{4.9}$	A1 dM1		Correct equation (Equals zero may be implied) Solving for <i>t</i>
$\frac{76 < \frac{1}{4.9}}{\sqrt{\frac{76 \times 4.9}{\cos 40^{\circ} \sin 40^{\circ}}} < V < \sqrt{\frac{82 \times 4.9}{\cos 40^{\circ} \sin 40^{\circ}}}$ A1 27.5 < V < 28.6 A1 A1 A1 A1 A1 A1 A1 A1 A1 A1 A1 A1 A1		$=\frac{V^2\cos 40^\circ\sin 40^\circ}{4.9}$		6	Correct range from correct working SC Quoting the formula for the range 2
$\sqrt{\frac{76 \times 4.9}{\cos 40^{\circ} \sin 40^{\circ}}} < V < \sqrt{\frac{82 \times 4.9}{\cos 40^{\circ} \sin 40^{\circ}}}$ A1 27.5 < V < 28.6 A1 Correct value for V A1 A1 A1 A1 A1 A1 A1 A1 A1 A1 A1 A1 A1	(c)	$76 < \frac{V^2 \cos 40^\circ \sin 40^\circ}{40^\circ} < 82$	M1		An equation to find one value of V.
27.5 < V < 28.6A14Correct 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.			A1		Correct value for V
Accept 27.5 – 28.6 but not 28.6-27.5 For using values close to 76 and 82 deduct one mark.		$V \cos 40^\circ \sin 40^\circ$ $V \cos 40^\circ \sin 40^\circ$	A1		Other value of V correct
Total 12		27.5 < <i>V</i> < 28.6	A1	4	Accept 27.5 – 28.6 but not 28.6-27.5 For using values close to 76 and 82
		Total		12	

Q	Solution	Marks	Total	Comments
<b>8</b> (a)	$4\mathbf{i} = 5\mathbf{j} + 40\mathbf{a}$	M1		Forming a vector equation based on constant acceleration
	$a = \frac{4i - 5j}{40} = 0.1i - 0.125j$ AG	A1		Correct equation
	40	dM1		Solving for <b>a</b>
		A1	4	Correct <b>a</b> from correct working
				For $\frac{4\mathbf{i} - 5\mathbf{j}}{40}$ on its own give M0
				Allow verification
<b>(b)</b>	$\mathbf{r} = 5\mathbf{j} \times 40 + \frac{1}{2}(0.1\mathbf{i} - 0.125\mathbf{j}) \times 40^2$	M1		Finding position vector
	$\mathbf{r} = 5\mathbf{j} \times 40 + \frac{-(0.11 - 0.125\mathbf{j}) \times 40^{-10}}{2}$	A1		Correct expression
	= 80i + 100j	A1	3	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 $t = \frac{5}{0.025} = 200$	M1 A1 dM1 A1 A1 A1	5	Expression for <b>v</b> Correct expression for <b>v</b> 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 u = 4i or 5i or a = 0.1i + 0.125j award method marks only.