Version 1.0: 0106



General Certificate of Education

Mathematics 6360

MM1B Mechanics 1B

Mark Scheme

2006 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.

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			
В	mark is independent of M or m marks and is for method and accuracy			
Е	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)				
	\rightarrow 6ms ⁻¹			
	2 kg O O 3 kg			
	$\rightarrow v$			
	$2 \times 6 = 3 \times v$	M1		
	$v = 4 \mathrm{ms}^{-1}$	A 1		
	<u>v – †1115</u>	A1	3	
(b)	\rightarrow 6ms ⁻¹			
, ,	2 kg O O 3 kg			
	$\leftarrow v \longrightarrow 4v$			
	* **			
	$2 \times 6 \qquad = -2 \times v + 3 \times 4v$	M1		all terms
	12 = 10v	A1		
	$v = 1.2 \text{ms}^{-1}$	A1√	3	$\sqrt{\text{sign error }}(v=0.857)$
	m . 1			
2(a)	Total	M1	6	use of $\mathbf{v} = \mathbf{u} + \mathbf{a}t$
2(a)	$\mathbf{v} = 4\mathbf{i} + (-3\mathbf{i} + 12\mathbf{j})t$	M1 A1	2	$\mathbf{u} = \mathbf{v} - \mathbf{u} + \mathbf{a}t$
(b)	$t = 0.5, \ \mathbf{v} = 2.5\mathbf{i} + 6\mathbf{j}$	B1√		√ 2 terms and t subs
	Speed = $\sqrt{(2.5^2 + 6^2)}$	M1		2 terms
	$Speed = 6.5 \mathrm{m s^{-1}}$	A1√	3	√ 2 terms
	Total		5	
3(a)(i)	$s = ut + \frac{1}{2}at^2$			
	$s = ut + \frac{1}{2}at^2$ 25 = 0 + 4.9t ²	3.61		
	$25 = 0 + 4.9t^2$ $t = 2.26 \sec (2.236)(if g = 10)$	M1 A1	2	full method
	$t = 2.26 \sec (2.250)(\ln g - 10)$ (2.259)	Al	<u> </u>	
	(2.239)			
(ii)	$v^2 = u^2 + 2as$			
(/	$v^2 = 0 + 2 \times 9.8 \times 25$	M1		
	$v = 22.1 \mathrm{m s^{-1}}$ (21.913)	A1	2	
	(22.14)			
a >		1/1		(T: 1) 1 1
(b)	(Time longer) air resistance slows down motion, links with motion, no	M1 A1	2	(or Time less) package large so less distance to travel
	contradictions	4.1.1		so less distance to daver
	Total		6	

MM1B (cont)

(ii) (iii) (iii) (iii) (iii) (iii) (iiii) (iiii) (iiiiiiii	Q	Solution	Marks	Total	Comments
(ii) $tan 74 = \frac{12}{u}$ $u = 3.44$ (b) $\frac{344}{45}$ $\frac{\theta}{\theta} = 135^{\circ}$ $v = 14.6$ $tan 74 = \frac{1}{u}$ $0 = 2\frac{1}{2}ut - \frac{1}{2}gt$ $0 = 2(2\frac{1}{2}u - \frac{1}{2}gt)$ $0 = 16(2\frac{1}{2}u - \frac{1}{2}gt)$ $0 = 30u^{2}$ $0 = 30u^{2}$ $0 = 30u^{2}$ $0 = 30u^{2}$ $0 = 6u + \frac{5u}{g}$ $0 = \frac{30u^{2}}{g}$ $0 = \frac{30u^{2}$	4(a)(i)	v = 12.5 (12.48)	M1		
(ii)					
tan $74^{\circ} = \frac{12}{u}$ $u = 3.44$ (b) $ \frac{3}{45} \frac{3}{\theta} $ Alt: $12 \cos \sin 45^{\circ} B1$ Full method $v^{2} = (12 \sin 45)^{2} + (3.44 + 12 \sin 45)^{2} M1$ (8.485) (11.925) Al 14.6 (8.485) (11.925) Al 14.6 Subs all correct $v = (1.6 + 1.6)$ $v = 14.6$ Total $ 0 = 1\sqrt{2} \frac{1}{2}ut - \frac{1}{2}gt^{2} $ $ 0 = 2\frac{1}{2}ut - \frac{1}{2}gt$ MI $ t = \frac{5u}{g} $ Al Al (if $g = 9.8$ used, lose last A1) (b) $OA = 6ux > \frac{5u}{g}$ Al $ e = \frac{30u^{2}}{g} $ Al Al (c) speed $ext{2} = (6u)^{2} + \left(2\frac{1}{2}u\right)^{2}$ Speed $ext{3} = 6\frac{1}{2}u$ Al Al Al Al (a) Alt: $12 \cos \cos \sin 45^{\circ} B1$ Full method $v^{2} = (12 \sin 45)^{2} + (3.44 + 12 \sin 45)^{2} M1$ Subs all correct $v = (1.6 + 1.6)$ Al (b) subs all correct subtraction $v = (1.6 + 1.6)$ (c) speed $v = (1.6 + 1.6)$ Al (d) Least speed, at top, $v = 6u$ B1 MI Alt: $v = (1.6 + 1.6)$ Alt: v	(;;)	TW .	A1	2	or Pythagoras with 3.44
tan $74^{\circ} = \frac{12}{u}$ $u = 3.44$ (b) Alt: 12 cos or sin 45° B1 Full method $v^{2} = (12\sin 45)^{2} + (3.44 + 12\sin 45)^{2}$ M1 (8.485) (11.925) A1 14.6 A1 Subs all correct $v = 14.6$ Total 5(a) $s = ut + \frac{1}{2}at^{2}$ $0 = 2\frac{1}{2}ut - \frac{1}{2}gt^{2}$ $0 = t(2\frac{1}{2}u - \frac{1}{2}gt)$ $t = \frac{5u}{g}$ A1 (b) $OA = 6u \times \frac{5u}{g}$ $= \frac{30u^{2}}{g}$ A1 (c) speed $= 6\frac{1}{2}u$ A1	(11)	74.7			M1 (1 st use) A1 A1 each answer (3 max)
$tan 74^{\circ} = \frac{12}{u}$ $u = 3.44$ (b) $\frac{3}{45} \frac{3}{6}$ $\theta = 135^{\circ}$ $v = 14.6$ 81 $0 = 2\frac{1}{2}ut - \frac{1}{2}gt^{2}$ $0 = 2\frac{1}{2}ut - \frac{1}{2}gt^{2}$ $0 = 46u \times \frac{5u}{g}$ $to b$ $0 = 30u^{2}$ $to b$ $0 = 40u \times \frac{5u}{g}$ $to c$ $0 = 6u \times \frac{5u}{g}$ $to c$ $0 = 4u + (2\frac{1}{2}u)^{2}$ $to c$					
(b) $u = 3.44$ $u = 3.44$ Alt: 12 cos or sin 45° B1 Full method $v^2 = (12\sin 45)^2 + (3.44 + 12\sin 45)^2$ M1 (8.485) (11.925) A1 14.6 A1 $v = 14.6$ B1 $v = 14.6$ Total $v = 14.6$ $v = 14.6$ Solution and the substant of the equation of motion, or standard result) $v = 14.6$ $v = 14.6$ $v = 14.6$ M1 $v = 14.6$ $v = 14.6$ $v = 14.6$ Total $v = 14.6$ $v = 1$		121 1			
(b) $u = 3.44$ $u = 3.44$ Alt: 12 cos or sin 45° B1 Full method $v^2 = (12\sin 45)^2 + (3.44 + 12\sin 45)^2$ M1 (8.485) (11.925) A1 14.6 A1 $v = 14.6$ B1 $v = 14.6$ Total $v = 14.6$ $v = 14.6$ Solution and the substant of the equation of motion, or standard result) $v = 14.6$ $v = 14.6$ $v = 14.6$ M1 $v = 14.6$ $v = 14.6$ $v = 14.6$ Total $v = 14.6$ $v = 1$		ton 74° – 12	M1A1F		$ \int \text{incorrect } v \text{ if used} $
(b) $\frac{344}{43.99}$ $\frac{341}{43.99}$ $\frac{341}{4$		u	A 1	3	cao
Full method $v^2 = (12\sin 45)^2 + (3.44 + 12\sin 45)^2 \text{ M1}$ (8.485) (11.925) A1 (8.485) A1 (9.485) A1 (9.485) A1 (9.485) A1 (9.485) A1 (9.485) A		u = 3.44			
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$	(b)	3.44			Alt: 12 cos or sin 45° B1
$\begin{array}{c ccccccccccccccccccccccccccccccccccc$		45' 0			
$\theta = 135^{\circ} \\ v^{2} = 3.44^{2} + 12^{2} - 2 \times 12 \times 3.44 \cos 135^{\circ} \\ v = 14.6$ B1 M1 A1 \checkmark A1 \checkmark A1 \checkmark A1 \checkmark A1 \checkmark B1 M1 A1 \checkmark A1 \checkmark A1 \checkmark A1 \checkmark B1 M1 A1 \checkmark A1 \checkmark A1 \checkmark B1 M1 A1 \checkmark A1 \checkmark A1 \checkmark A1 \checkmark A1 \checkmark B1 M1 A1 \checkmark A1 B1 B1 M1 A1 \checkmark A1 B1 B1 A1 B1 B1 B1 A1 B1		12			, , , , , , , , , , , , , , , , , , , ,
$\theta = 135^{\circ}$ $v^{2} = 3.44^{2} + 12^{2} - 2 \times 12 \times 3.44 \cos 135^{\circ}$ $v = 14.6$ $S_{0} = \frac{1}{2}u^{2}$ $0 = 2\frac{1}{2}ut - \frac{1}{2}gt^{2}$ $0 = t\left(2\frac{1}{2}u - \frac{1}{2}gt\right)$ $t = \frac{5u}{g}$ $0 = \frac{30u^{2}}{g}$ $0 = \frac{3u^{2}}{g}$ $0 = $		1/			` '
$v^{2} = 3.44^{2} + 12^{2} - 2 \times 12 \times 3.44 \cos 135^{\circ} \qquad M1 \\ A1 \checkmark \\ v = 14.6 \qquad A1 \checkmark \qquad 4 \qquad \text{subs all correct} \\ \searrow \text{ incorrect subtraction } \rightarrow 135^{\circ} \qquad 9$ $5(a) \qquad s = ut + \frac{1}{2}at^{2} \\ 0 = 2\frac{1}{2}ut - \frac{1}{2}gt^{2} \qquad M1 \\ 0 = t\left(2\frac{1}{2}u - \frac{1}{2}gt\right) \qquad m1 \qquad (if g = 9.8 \text{ used, lose last A1})$ $(b) \qquad OA = 6u \times \frac{5u}{g} \qquad M1 \\ = \frac{30u^{2}}{g} \qquad A1 \qquad 2 \qquad \text{cao}$ $(c) \qquad \text{speed}^{2} = (6u)^{2} + \left(2\frac{1}{2}u\right)^{2} \qquad M1 \\ \text{speed} = 6\frac{1}{2}u \qquad A1 \qquad 2 \qquad \text{cao}$ $(d) \qquad \text{Least speed, at top, = } 6u \qquad B1 \qquad 1$					14.6 A1
$v = 14.6$ $A1\sqrt{A1}\sqrt{4}$ $A1\sqrt{4}\sqrt{4}$ $A1\sqrt{4}\sqrt{4}\sqrt{1}$ $A1\sqrt{4}\sqrt{1}\sqrt{4}\sqrt{1}$ $A1\sqrt{4}\sqrt{1}\sqrt{1}\sqrt{4}\sqrt{1}$ $A1\sqrt{4}\sqrt{1}\sqrt{1}\sqrt{1}\sqrt{1}$ $S = ut + \frac{1}{2}ut^2$ $0 = 2\frac{1}{2}ut - \frac{1}{2}gt^2$ $0 = t\left(2\frac{1}{2}u - \frac{1}{2}gt\right)$ $t = \frac{5u}{g}$ $A1$ $A1$ $A1$ $0 = t\left(\frac{5u}{g}\right)$ $A1$ $1 = \frac{30u^2}{g}$ $2 = \frac{30u^2}{g}$ $3 = \frac{30u^2}{g}$ $4 = \frac{3u^2}{g}$ 4					,
		$v = 3.44 + 12 - 2 \times 12 \times 3.44 \cos 133$			
5(a) $s = ut + \frac{1}{2}at^2$ $0 = 2\frac{1}{2}ut - \frac{1}{2}gt^2$ M1 $0 = t\left(2\frac{1}{2}u - \frac{1}{2}gt\right)$ m1 $t = \frac{5u}{g}$ A1 4 (if $g = 9.8$ used, lose last A1) (b) $OA = 6u \times \frac{5u}{g}$ M1 $= \frac{30u^2}{g}$ A1 2 cao (c) $speed^2 = (6u)^2 + \left(2\frac{1}{2}u\right)^2$ M1 $speed = 6\frac{1}{2}u$ A1 2 cao (d) Least speed, at top, = $6u$ B1 1		v = 14.6		4	
$0 = t \left(2\frac{1}{2}u - \frac{1}{2}gt \right)$ $t = \frac{5u}{g}$ A1 A1 A1 A1 Gif $g = 9.8$ used, lose last A1) $OA = 6u \times \frac{5u}{g}$ $= \frac{30u^2}{g}$ A1				9	
$0 = t \left(2\frac{1}{2}u - \frac{1}{2}gt \right)$ $t = \frac{5u}{g}$ A1 A1 A1 A1 Gif $g = 9.8$ used, lose last A1) $0A = 6u \times \frac{5u}{g}$ $= \frac{30u^2}{g}$ A1	5(a)	$s = ut + \frac{1}{2}at^2$			
$0 = t \left(2\frac{1}{2}u - \frac{1}{2}gt \right)$ $t = \frac{5u}{g}$ A1 A1 A1 A1 Gif $g = 9.8$ used, lose last A1) $0A = 6u \times \frac{5u}{g}$ $= \frac{30u^2}{g}$ A1		$0 = 2 \frac{1}{2} ut - \frac{1}{2} gt^2$	M1		full method required for time
$t = \frac{5u}{g}$ (b) $OA = 6u \times \frac{5u}{g}$ $= \frac{30u^2}{g}$ (c) $speed^2 = (6u)^2 + \left(2\frac{1}{2}u\right)^2$ $speed = 6\frac{1}{2}u$ A1		2 2 8	A 1		
(b) $OA = 6u \times \frac{5u}{g}$		$0 = t \left(2\frac{1}{2}u - \frac{1}{2}gt \right)$	m1		
(b) $OA = 6u \times \frac{5u}{g}$		$t = \frac{5u}{}$	A1	4	(if $g = 9.8$ used, lose last A1)
(c) $speed^{2} = (6u)^{2} + \left(2\frac{1}{2}u\right)^{2}$ M1 $speed = 6\frac{1}{2}u$ A1 2 cao (d) Least speed, at top, = 6u B1 1		g			
(c) $speed^{2} = (6u)^{2} + \left(2\frac{1}{2}u\right)^{2}$ M1 $speed = 6\frac{1}{2}u$ A1 2 cao (d) Least speed, at top, = 6u B1 1	(h)	5u	N /1		
(c) $speed^{2} = (6u)^{2} + \left(2\frac{1}{2}u\right)^{2}$ M1 $speed = 6\frac{1}{2}u$ A1 2 cao (d) Least speed, at top, = 6u B1 1	(0)	$OA = 6u \times {g}$	IVII		
(c) $speed^{2} = (6u)^{2} + \left(2\frac{1}{2}u\right)^{2}$ M1 $speed = 6\frac{1}{2}u$ A1 2 cao (d) Least speed, at top, = 6u B1 1		$=\frac{30u^2}{}$	A1	2	cao
(d) Least speed, at top, = $6u$ B1 1		g			
(d) Least speed, at top, = $6u$ B1 1	(a)	$(1)^2$			
(d) Least speed, at top, = $6u$ B1 1	(c)	$speed^2 = \left(6u\right)^2 + \left(2\frac{1}{2}u\right)$	M1		
(d) Least speed, at top, = $6u$ B1 1		speed = $6\frac{1}{2}u$	A1	2	cao
		2			
	(d)	Least speed, at top, $= 6u$	B1	1	
10tai 9		Total		9	

MM1B (cont)

Q	Solution	Marks	Total	Co	omments
6(a)(i)	4 0 10 20 30	B1 B1 B1	3	3 straight lines correct end points sensible scales + 1	
(ii)	$s = \frac{1}{2} \times 10 \times 4 + \frac{1}{2} \times (4 + 12) \times 10 + \frac{1}{2} (12 + 16) \times 10$	M1 m1 A1		area attempt full method equation correct	Or equation attempted full method all correct
	s = 240 metres	A1√	4	√ one slip	$\sqrt{}$ one slip
(iii)	Average speed = $\frac{240}{30}$	M1	·		
	$=8\mathrm{ms^{-1}}$	A1√	2	√distance	
(iv)	Greatest acceleration = 2^{nd} stage = $\frac{12-4}{10}$	M1			
	$=0.8\mathrm{ms}^2$	A1	2	cao	
(b)(i)	Less	B1			
	area below curve < area below line/velocity lower	B1	2	no additional inco	rrect statements
(ii)	Change in velocity more gradual oe	B1	1		
	Total		14		

MM1B (cont)

Q	Solution	Marks	Total	Comments
7(a)(i)	$T = 0.6 \times 9.8 = 5.88N$ Or $0.6g$	B1	1	
(ii)	Force = $2T = 11.76N$ Or 11.8 N	B1		Magnitude
	Or 1.2 <i>g</i>	B1	2	Direction
(b)(i)	Q:0.8g-T=0.8a	M1		Either equation
(0)(1)	Q.0.08 - 1 = 0.00	A1		Ethici equation
	T - 0.6g = 0.6a	A1		
	0.2g = 1.4a	m1		Alternative for m1 A1 if solving for T
	a = 1.4	A1		m1 method for solving, A1 accurate
	T 6.72N	A 1	(attempt
	$T = 6.72 \mathrm{N}$	A1	6	cao SC whole string to find $a:0.2g = 1.4a$ M1
				a = 1.4 A1
(ii)	Force = $2T = 13.44$ N	B1	1	cao to find T:M1 A1
	Total		10	
8(a)(i)	$R = 80\cos 25^{\circ}$	M1		component attempted
	R = 72.5N	A1	2	correct component
	R = 72.5N	A1	3	cao
(ii)	$F = 0.32 \times 72.5$	M1		condone inequality
	F = 23.2N	A1	2	cao
(iii)	$T + F = 80\cos 65^{\circ}$	M2		3 forces direction correct, component
				attempted
		A1		component
	T = 10.6 N	A1√	4	√ friction
			•	
(iv)	$T = F + 80\cos 65^{\circ}$	M1		3 forces, direction correct, component
		A 1		attempted
		A1		component
	T = 57.0 N (57 N)	A1√	3	√ friction
(iv)	Mass = $\frac{80}{g}$ = (8.16kg)	B1	1	
	g (orrors)			
(b)	$80\cos 65^{\circ} - F = \text{mass} \times \text{acceleration}$	M1		3 terms, component attempted
	00			
	$10.6 = \frac{80}{g} \times acc$	A1		all correct
	g 1 2 2 2			
	$acc = 1.30 \mathrm{ms}^{-2}$	A1	3	cao
	$\left(1.3\mathrm{ms}^{-2}\right)$			
	Total		16	
	Total		75	