AQA

AS
MATHEMATICS
MECHANICS 1B

MM1B
Final Mark Scheme

6360
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Mark schemes are prepared by the Lead Assessment Writer and considered, together with the relevant questions, by a panel of subject teachers. This mark scheme includes any amendments made at the standardisation events which all associates participate in and is the scheme which was used by them in this examination. The standardisation process ensures that the mark scheme covers the students' responses to questions and that every associate understands and applies it in the same correct way. As preparation for standardisation each associate analyses a number of students' scripts. Alternative answers not already covered by the mark scheme are discussed and legislated for. If, after the standardisation process, associates encounter unusual answers which have not been raised they are required to refer these to the Lead Assessment Writer.

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Annotations

Annotation	Description
A1	Accuracy mark awarded one
^	Omission Mark
B1	Independent mark one
BOD	Benefit of the doubt
Cross	Incorrect point
FT	Follow through
H Line	Dynamic, Horizontal line that can be expanded
H Wavy	Dynamic, Horizontal Wavy line that can be expanded
ISW	Ignore subsequent work
M1	Method mark awarded one
MR	MR
Not Relevant	Not Relevant
Text box	On Page Comment
SEEN	Indicates that the point has been
Tick	Correct point
Tick Per	Different Perspectives
FIW	From incorrect work

Key to mark scheme abbreviations

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
CAO	correct answer only
CSO	correct solution only
AWFW	anything which falls within
AWRT	anything which rounds to
ACF	any correct form
AG	answer given
SC	special case
OE	or equivalent
A2,1	2 or 1 (or 0) accuracy marks
–*x* EE	deduct *x* marks for each error
NMS	no method shown
PI	possibly implied
SCA	substantially correct approach
c	candidate
sf	significant figure(s)
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.

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.

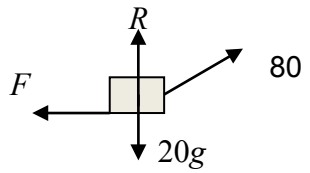
Do not accept mis-reads in this question.				
Q	**Solution**	**Mark**	**Total**	**Comment**
1 (a)	$P\cos 30° = 40$	M1		M1: Seeing $P\cos 30° = 40$ or $P\sin 30° = 40$ oe
		A1	3	A1: Correct equation.
	$P = \dfrac{40}{\cos 30°} = \dfrac{80}{\sqrt{3}} = \dfrac{80\sqrt{3}}{3} = 46.2\ (\text{to 3sf})$	A1		A1: Correct answer. Accept exact forms as shown. AWRT 46.2
(b)	$P\sin 30° = Q$	M1		M1: Seeing $P\cos 30° = Q$ or $P\sin 30° = Q$ oe where P is their answer to (a).
		A1F		A1F: Correct equation. Follow through their P from part (a).
	$Q = \dfrac{40}{\cos 30°} \times \sin 30°$		3	
	$= \dfrac{40}{\sqrt{3}} = \dfrac{40\sqrt{3}}{3} = 23.1\ (\text{to 3sf})$	A1		A1: Correct answer. Accept exact forms as shown. AWRT 23.1
	OR			
				M1: Resolving perpendicular to P.
	$40\cos 60° = Q\cos 30°$	(M1)		A1: Correct equation.
		(A1)		
	$Q = \dfrac{40\cos 60°}{\cos 30°}$			A1: Correct answer. Accept exact forms as shown. AWRT 23.1
	$= \dfrac{40}{\sqrt{3}} = \dfrac{40\sqrt{3}}{3} = 23.1\ (\text{to 3sf})$	(A1)	(3)	
	Total		**6**	

Do not accept mis-reads in this question.				
Q	**Solution**	**Mark**	**Total**	**Comment**
2 (a)	$20 \times 2 = 100v$	M1		M1: Seeing 20×2 or 40.
		M1		M1: Seeing 100v
	$v = 0.4\ \text{m s}^{-1}$	A1	3	A1: Correct speed. Final answer must be positive.
(b)	Allow either of these solutions depending on the candidate's interpretation.			
	Interpretation 1			
	$100 \times 0.4 = 80v - 1.6 \times 20$	M1 M1 M1		M1: Seeing momentum term of 40. M1: Seeing 80v. M1: Seeing ±2±v or 1.6
	$v = \dfrac{40+32}{80} = 0.9\ \text{m s}^{-1}$	A1	4	A1: Final speed as 0.9.
	OR			
	$80w - 20 \times 2 = 0$ $w = 0.5$	(M1) (M1) (M1)		M1: Seeing momentum term of 40. M1: Seeing 80 × Velocity of the trolley after the second bag has been thrown relative to its velocity before, for example 80w. M1: Adding or subtracting 0.4 to/from their w.
	$v = 0.4 + w = 0.9$	(A1)		A1: Final speed as 0.9.
	Interpretation 2			
	$40 = 80v - 20(2 - v)$ $80 = 100v$ $v = 0.8$	(M1) (M1) (M1) (A1)		M1: : Seeing momentum term of 40. M1: Seeing 80v. M1: Seeing ±2±v or 1.6 A1: Final speed as 0.8.
	OR			
	$80w + 20 \times (w - 2) = 0$ $w = 0.4$	(M1) (M1) (M1)		M1: Seeing 80w. M1: Seeing ±2±w M1: Adding or subtracting 0.4 to/from their w.
	$v = 0.4 + w = 0.8$	(A1)		A1: Final speed as 0.8.
NOTE: Deduct 1 mark from each part if g included consistently with the mass.				
	Total		**7**	

Do not accept mis-reads in this question.				
Q	**Solution**	**Mark**	**Total**	**Comment**
3				
(a)	$\text{Time} = \frac{30}{2} = 15\,\text{s}$	B1		B1: Correct time. PI.
	$BC = 1.2 \times 15 = 18\,\text{m}$	M1		M1: Their time multiplied by 1.2.
		A1	3	A1: Correct distance.
	OR			
	$\tan\alpha = \frac{1.2}{2}$ $(\alpha = 30.96°)$	(B1)		B1: Correct expression for tanα or correct angle α. Allow $\tan\beta = \frac{2}{1.2}$, $(\beta = 59.04°)$
	$BC = 30\tan\alpha = 30 \times \frac{1.2}{2} = 18\,\text{m}$	(M1)		M1:Using 30tanα with their angle.
		(A1)	(3)	A1: Obtaining 18 m. AWRT 18.0
(b)	$\sin\theta = \frac{1.2}{2} = 0.6$	M1		M1: Equation to find an angle. Accept $\sin\theta = 0.6$ oe or $\cos\theta = 0.6$ oe.
	$\theta = 36.87°$	A1		A1: Angle as 36.87° allow 53.13° AWRT 37 or 53
	$\text{Time} = \frac{30}{2\cos 36.87°}$	A1		A1: Correct expression for time $\text{Time} = \frac{30}{2\cos 36.87}$ or $\text{Time} = \frac{30}{2\sin 53.13}$ Allow angles as AWRT 37 or 53.
	$= 18.8\,\text{s}$	A1	4	A1: Correct time. AWRT 18.8. Accept 18.75
	OR			
	$V = \sqrt{2^2 - 1.2^2}$	(M1)		M1: Use of Pythagoras with 2, 1.2 and a minus sign.
	$= 1.6$	(A1)		A1: Correct resultant velocity.
	$\text{Time} = \frac{30}{1.6}$	(A1)		A1: Correct expression for time.
	$= 18.8\,\text{s}$	(A1)	(4)	A1: Correct time. AWRT 18.8. Accept 18.75
	Total		**7**	

Do not accept mis-reads in this question.				
Q	**Solution**	**Mark**	**Total**	**Comment**
4 (a)	$0^2 = 4^2 + 2 \times a \times 3.2$	M1 A1		M1: Use of $v^2 = u^2 + 2as$ with $v = 0$. A1: Correct equation.
	$a = -\frac{16}{6.4} = -2.5 \text{ m s}^{-2}$	A1	3	A1: Correct acceleration. Must be negative.
	OR			
	$3.2 = \frac{1}{2}(4+0)t$ $t = 1.6$ $0 = 4 + 1.6a$	(M1) (A1)		M1: Use of a constant acceleration equation with their t and $v = 0$ to find a. A1: Correct equation.
	$a = -\frac{4}{1.6} = -2.5 \text{ m s}^{-2}$	(A1)	(3)	A1: Correct acceleration. Must be negative.
(b)	$R = 2 \times 9.8 = 19.6 \text{ N}$	B1	1	B1: Correct final answer. Allow 19.62 from g =9.81. Accept $2g$.
(c)	$2 \times 2.5 = 19.6\mu$	M1M1		M1: Use of $F = \mu R$ with their R. M1: Use of $\mu R = ma$ with ±their answer to (a).
	$\mu = \frac{5}{19.6} = 0.255$	A1	3	A1: Correct final answer AWRT 0.255.
(d)	Less because the friction force would be less (due to the presence of air resistance).	B1 B1	2	B1: Less. B1: Must say that the friction force would be less. Do not award second B1 mark if they say that coefficient of friction is greater or unchanged.
	Total		**9**	

Do not accept mis-reads in this question.				
Q	**Solution**	**Mark**	**Total**	**Comment**
5 (a)	$45 = 0 + \frac{1}{2} \times a \times 12^2$	M1		M1: Use of a constant acceleration equation, with $u = 0$, to find a.
		A1		A1: Correct equation.
	$a = \frac{45}{72} = 0.625 \text{ m s}^{-2}$	A1	3	A1: Correct acceleration. Accept $\frac{5}{8} \text{ m s}^{-2}$.
(b) (i)				
	$T - 80 = 400 \times 0.625$	M1 A1F		M1: Equation of motion for trailer with T and 80. Must have mass 400 × their acceleration. Allow sign errors. A1F: Correct equation with their acceleration from (a).
	$T = 330$	A1	3	A1: Correct T.
	OR If P is found first, then the equation below applies:			
	$P - T - 500 = 1600 \times 0.625$	(M1) (A1F)		M1: Equation of motion for car with T, 500 and their P. Must have mass 1600 × their acceleration. A1F: Correct equation with their acceleration from (a).
	$T = 330$	(A1)		A1: Correct T.
(b) (ii)				
	$P - 500 - 80 = 2000 \times 0.625$	M1 A1F		M1: Equation of motion for car and trailer combined with P, 500 and 80. Must have mass 2000 × their acceleration. Allow sign errors. A1F: Correct equation with their acceleration from (a).
	$P = 1830$	A1	3	A1: Correct P.
	OR			
	$P - T - 500 = 1600 \times 0.625$	(M1) (A1F)		M1: Equation of motion for car with their T, 500 and P. Must have mass 1600 × their acceleration. A1F: Correct equation with their acceleration from (a).
	$P = 1830$	(A1)		A1: Correct P.
	Total		**9**	

Do not accept mis-reads in this question.				
Q	**Solution**	**Mark**	**Total**	**Comment**
6 (a)		B1	1	B1: All forces shown with arrows and labels. Accept: 80 or T for the tension. R or N for reaction force. $20g$, mg, W or 196 for weight. F or μR for friction.
(b)	$R + T\sin 30° = mg$ $R + 80\sin 30° = 196$ $R = 156$ N	M1 A1 A1	3	M1: Correct terms used to form an equation. Allow sign errors Allow cos30°. A1: Correct fully substituted equation. A1: Correct reaction force. AWRT 156.
(c)	$T\cos 30° - \mu R = ma$ $80\cos 30° - 0.4\times 156 = 20a$	M1 A1		M1: Correct terms used to form an equation of motion. Allow sign errors. Allow sin30°. A1: Correct, fully substituted, equation.
	$a = 0.344$ m s^{-2}	A1	3	A1: Correct acceleration. AWRT 0.344. Allow 0.34 or 0.340 from use of $g = 9.81$.
(d) (i)	$80\cos 30° - 0.4\times 156 - 5 = 20a$	M1		M1: Seeing -5 inserted into their equation of motion from part (c) or subtracting 0.25 from their answer to part (c).
	$a = 0.0941$ m s^{-2}	A1	2	A1: Correct acceleration. Allow 0.0901 or 0.090 from use of $g = 9.81$. Accept AWRT 0.094.
(d) (ii)	The air resistance force will (not be constant but) vary with speed or velocity.	B1	1	B1: Statement about air resistance varying with the speed. Stating that the box is accelerating implies that the speed is changing. However, stating that the resistance varies with/as the acceleration is not acceptable.
	Total		**10**	

Do not accept mis-reads in this question.				
Q	**Solution**	**Mark**	**Total**	**Comment**
7 (a)	$\mathbf{v} = (4 + 0.25 \times 2)\mathbf{i} + (1.2 \times 2 - 1.6)\mathbf{j}$	M1		M1: Correct expression for the velocity when $t = 2$.
	$= 4.5\mathbf{i} + 0.8\mathbf{j}$	A1		A1: Correct simplified velocity.
	$v = \sqrt{4.5^2 + 0.8^2}$	dM1		dM1: Finding magnitude of the velocity.
	$= 4.57 \text{ m s}^{-1}$	A1	4	A1: Correct magnitude. AWRT 4.57.
(b)	$\mathbf{v} = (4 + 0.25t)\mathbf{i} + (1.2t - 1.6)\mathbf{j}$	M1		M1: Correct expression for velocity in any form, eg $(4\mathbf{i} - 1.6\mathbf{j}) + (0.25\mathbf{i} + 1.2\mathbf{j})t$
		A1		A1: Correct velocity as the sum of two components. PI.
	$10^2 = (4 + 0.25t)^2 + (1.2t - 1.6)^2$	M1		M1: Quadratic equation to find time when speed is 10, including both their velocity components.
	$0 = 1.5025t^2 - 1.84t - 81.44$	A1		A1: Correct expanded quadratic, that is equal to zero. (Allow any multiple of the equation.)
	$t = 8$ or $t = -6.77....$	dM1		dM1: One or two times obtained from their quadratic.
	$t = 8$	A1		A1: Concludes that $t = 8$.
	$\mathbf{r} = \left(4 \times 8 + \frac{1}{2} \times 0.25 \times 8^2\right)\mathbf{i}$			
	$+ \left(-1.6 \times 8 + \frac{1}{2} \times 1.2 \times 8^2\right)\mathbf{j}$	dM1		dM1: Finding the position vector at their time.
	$= 40\mathbf{i} + 25.6\mathbf{j}$	A1		A1: Correct position vector. AWRT $40.0\mathbf{i} + 25.6\mathbf{j}$
	$\text{Average Velocity} = \frac{40\mathbf{i} + 25.6\mathbf{j}}{8}$			
	$= 5\mathbf{i} + 3.2\mathbf{j}$	A1		A1: Correct average velocity.
	OR			
	$\mathbf{v} = (4 + 0.25 \times 8)\mathbf{i} + (1.2 \times 8 - 1.6)\mathbf{j}$	(dM1)		dM1: Finding the velocity at their time.
	$= 6\mathbf{i} + 8\mathbf{j}$	(A1)		A1: Correct velocity vector.
	$\text{Average Velocity} = \frac{(4\mathbf{i} - 1.6\mathbf{j}) + (6\mathbf{i} + 8\mathbf{j})}{2}$			
	$= 5\mathbf{i} + 3.2\mathbf{j}$	(A1)	9	A1: Correct average velocity. AWRT $5.0\mathbf{i} + 3.2\mathbf{j}$
	Total		**13**	

Do not accept mis-reads in this question.				
Q	**Solution**	**Mark**	**Total**	**Comment**
8 (a)	$\sin\alpha = \frac{3}{5}, \cos\alpha = \frac{4}{5}$	B1		B1: Correct values for sinα and/or cosα. PI. Or finding α = AWRT 37°.
	$8 = 4\times\frac{3}{5}t + 4.9t^2$	M1 A1 A1		M1: Seeing three term equation with: 4sinαt or 4cosαt, 8 and $\pm 4.9t^2$. A1: Correct terms with possible sign errors. A1: Correct equation.
	$4.9t^2 + 2.4t - 8 = 0$ $t = 1.056$ or $t = -1.545$	A1		A1: Correct time obtained.
	$x = 4\times\frac{4}{5}\times 1.056$	dM1		dM1: 4cosα × their time.
	$x = 3.38\,\text{m}$	A1	7	A1: Correct distance. Accept final answers between 3.37 and 3.39.
(b)	$v_x = 4\times\frac{4}{5} = 3.2$	B1		B1: Correct horizontal component seen.
	$v_y^2 = \left(4\times\frac{3}{5}\right)^2 + 2\times 9.8\times 8$	M1		M1: Equation to find vertical component, with correct terms but possible sign errors.
	$= 162.56$	A1		A1: Correct component or the square of the correct component.
	$v = \sqrt{3.2^2 + 162.56} = 13.1\,\text{m s}^{-1}$	dM1 A1	5	dM1: Finding the magnitude of the velocity. A1: Correct speed. Accept final answers between 13.1 and 13.2 from correct method.
	OR			
	$v_x = 4\times\frac{4}{5} = 3.2$	(B1)		B1: Correct horizontal component seen.
	$v_y = 4\times\frac{3}{5} + 9.8\times 1.056$	(M1)		M1: Equation to find vertical component, with their time and 4sinα but possible sign errors.
	$= 12.75$	(A1)		A1: Correct component or the square of the correct component.
	$v = \sqrt{3.2^2 + 12.75^2} = 13.1\,\text{m s}^{-1}$	(dM1) (A1)	(5)	dM1: Finding the magnitude of the velocity. A1: Correct speed. Accept final answers between 13.1 and 13.2 from correct method.
				Allow 13.2 from the use of $g = 9.81$.
(c)	As the particle starts at rest it will not move if $\mu \geq \tan\alpha$ therefore for movement $\mu < \frac{3}{4}$.	B1B1	2	B1: Conclusion that $\mu < \frac{3}{4}$. B1: Correct justification.
	Total		**14**	