AQA

AS
Mathematics

MM1B Mechanics 1B
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.

It must be stressed that a mark scheme is a working document, in many cases further developed and expanded on the basis of students' 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.

Further copies of this mark scheme are available from aqa.org.uk

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.

Key to Annotations

Annotation	**Meaning/Use**
^	Missing work
A0	Zero accuracy marks
A1	One accuracy mark
B0	Zero independent marks
B1	One independent mark
BOD	Benefit of doubt
λ	Missing work
Cross	Incorrect work
FT	Follow through
H line	Highlight feature / error of solution
H wavy	Highlight feature / error of solution
ISW	Ignore subsequent work
M0	Zero method marks
M1	One method mark
MR	Mis-read
NMS	No method shown
V wavy	Highlight feature / error of solution
Tick	Correct work

Q	Solution	Mark	Total	Comment
1 (a)	$(3\mathbf{i}-7\mathbf{j})+(-6\mathbf{i}+14\mathbf{j})+(\mathbf{i}-\mathbf{j})$ $=-2\mathbf{i}+6\mathbf{j}$	M1 A1	2	M1: Finds the sum of the three forces. A1: Correct resultant. Accept $\begin{bmatrix}-2\\6\end{bmatrix}$
(b)	$\mathbf{a}=\dfrac{-2\mathbf{i}+6\mathbf{j}}{4}$ $=-0.5\mathbf{i}+1.5\mathbf{j}$ $a=\sqrt{0.5^2+1.5^2}$ $=1.58\text{ m s}^{-2}$	M1 M1 A1	3	M1: Dividing their resultant force or their magnitude by 4. M1: Finding the magnitude of the acceleration **OR** the resultant force (6.32). A1: Correct acceleration. CAO Units not needed.
	Total		5	

Q	Solution	Mark	Total	Comment
2 (a)	$s_1=\dfrac{1}{2}\times0.4\times16$ $=3.2\text{ metres}$	M1 A1	2	M1: Finding distance for first stage. A1: Correct distance.
(b)	$s_2=\dfrac{1}{2}\times0.6\times16$ $=4.8\text{ metres}$ $s_1+s_2=3.2+4.8$ $=8\text{ metres}$	B1 M1 A1	3	B1: Correct distance for second stage. Allow -4.8. M1: Adding both their distances. A1: Correct sum of their distances. CAO
(c)	$s_1-s_2=3.2-4.8$ $=-1.6$ $\text{Average Velocity}=\dfrac{-1.6}{40}$ $=-0.04\text{ m s}^{-1}$	M1 M1 A1	3	M1: Difference of their two distances. dM1: Their difference divided by 40. A1: Correct average velocity. CAO
	Total		8	

Q	Solution	Mark	Total	Comment
3 (a)	$2\begin{bmatrix}4\\2\end{bmatrix}+m\begin{bmatrix}3\\U\end{bmatrix}=(2+m)\begin{bmatrix}3.4\\2\end{bmatrix}$ $2\times 4+3m=(2+m)\times 3.4$ $8+3m=6.8+3.4m$ $1.2=0.4m$ $m=3$	**M1** **A1** **A1**	**3**	M1: Applies conservation of momentum for **i** component or as a vector equation. Must use (*m* + 2). A1: Correct equation for the **i** component. A1: Obtains correct mass
(b)	$2\times 2+3U=5\times 2$ $4+3U=10$ $U=2$	**M1** **A1** **A1**	**3**	M1: Applies conservation of momentum for **j** component, with at least 2 correct terms. A1: Correct equation. A1: Obtains correct *U*. Award full marks for *U* = 2 if they have used their mass consistently.
	Total		**6**	

Q	Solution	Mark	Total	Comment
4 (a)	$V^2 = 120^2 + 20^2 - 2\times 20\times 120\cos 50°$ $V = \sqrt{11715} = 108\text{ m s}^{-1}$ OR $\begin{pmatrix}120\sin 40° - 20\\120\cos 40°\end{pmatrix}$ $V^2 = (120\sin 40° - 20)^2 + (120\cos 40°)^2$ $V = 108\text{ m s}^{-1}$	**M1A1** **A1** **(M1)** **(A1)** **(A1)**	**3**	M1: Use of cosine rule to find *V*. A1: Correct equation. A1: Correct *V*. M1: Velocity vector with sin40/50 or cos40/50 and ±20. A1: Correct expression for *V* or . V^2. A1: Correct *V*.
(b)	$\frac{\sin\beta}{20} = \frac{\sin 50°}{\sqrt{11715}}$ $\beta = 8.1$ $\alpha = 40 - 8.1 = 032°$ OR $\tan\theta = \frac{120\cos 40°}{120\sin 40° - 20}$ $\theta = 58.1377..$ $\alpha = 90 - 58.1 = 032°$	**M1** **A1** **M1A1** **(M1)** **(A1)** **(M1A1)**	**4**	M1: Use of sine rule to find angle in the velocity triangle. A1: Correct angle. M1: Finding *α* having used the sine rule. Only award if their *α* is less than 40° A1: Correct value for α. M1: Use of appropriate trig to find angle in the velocity triangle. A1: Correct angle. M1: Finding *α* having used appropriate trig. Only award if their *α* is less than 40° A1: Correct value for α. Condone 32°
	Total		**7**	

Q	Solution	Mark	Total	Comment
5 (a)	$P-T=0$ $T-6g=0$ $P=6g=58.8$	**M1** **A1** **A1**	**3**	M1: Equations of equilibrium for both objects. Need correct terms but with any signs. A1: Both equations correct. A1: Correct value for *P*.
(b)	$P-T=4\times 0.6$ $T-6g=6\times 0.6$ $P-6g=6$ $P=6g+6=64.8$	**M1** **M1A1** **A1**	**4**	M1: Three term equation of motion for the block. . Need correct terms but with any signs. M1: Three term equation of motion for the particle. Need correct terms but with any signs. A1: Both equations correct. A1: Correct value of *P*. CAO
(c)	$-T=4a$ $T-6g=6a$ $-6g=10a$ $a=-\frac{3g}{5}=-5.88\text{ m s}^{-2}$ $0^2=2^2+2\times(-5.88)s$ $s=\frac{4}{11.76}=0.340\text{ m}$	**M1** **A1** **A1** **M1A1** **A1**	**6**	M1: Equations of motion for block and particle. Need correct terms but with any signs. A1: Both equations correct. A1: Correct acceleration. Allow +5.88 if consistent with signs. M1: Equation to find distance using their acceleration provided their acceleration is negative. A1: Correct equation. A1: Correct distance. Condone 0.34.
(d)	Distance is less. Air resistance produces a deceleration of greater magnitude.	**B1** **B1**	**2**	B1: Less distance stated. B1: Reason attributed to air resistance. Only award the second mark if the distance has been stated as less.
	Total		**15**	

Q	Solution	Mark	Total	Comment
6 (a)	$\cos\alpha = \frac{5}{\sqrt{89}}$ or $\alpha = 57.99°$ $5 = 20 \times \frac{5}{\sqrt{89}} t$ $t = \frac{\sqrt{89}}{20} = 0.472\text{ s}$	B1 M1 A1 A1	4	B1: Angle or cosine (0.530) of angle found. Award even if seen later in (b) or (c). M1: Equation to find time. Allow their value for cos θ. A1: Correct equation. A1: Correct time.
(b)	$y = 20 \times \frac{8}{\sqrt{89}} \times \frac{\sqrt{89}}{20} - \frac{1}{2} \times 9.8\left(\frac{\sqrt{89}}{20}\right)^2$ $= 6.91\text{ m}$ Height = 6.91 + 1 = 7.91 m	M1A1F A1	3	M1: Equation to find height. Allow their time and their value for sin θ. A1F: Correct equation for their time. A1: Correct height. Use of 0.47 will score 2 out of 3.
(c)	$v_y = 20 \times \frac{8}{\sqrt{89}} - 9.8 \times \frac{\sqrt{89}}{20}$ $= 12.337$ $v_x = 20 \times \frac{5}{\sqrt{89}} = 10.600$ $v = \sqrt{10.600^2 + 12.337^2}$ $= 16.3\text{ m s}^{-1}$	M1 A1 B1 M1 A1	5	M1: Finding vertical component of velocity using their time. Allow their value for sin θ. A1: Correct component. B1: Correct horizontal component of velocity. M1: Finding speed from their velocity components. A1: Correct speed. Use of 0.47 can gain full marks.
	Total		**12**	

Q	Solution	Mark	Total	Comment
7 (a)	$R = mg\cos 30°$ $F = 0.2mg\cos 30°$ $ma = -mg\sin 30° - 0.2mg\cos 30°$ $a = -g\sin 30° - 0.2g\cos 30°$ $= -6.60\text{ m s}^{-2}$ $\lvert a\rvert = 6.60\text{ m s}^{-2}$	**M1** **A1** **M1A1** **A1**	**5**	M1: Resolving to find normal reaction. Allow sin30 ° A1: Correct expression for friction. M1: Three term equation of motion for coin (ignore signs). Allow $ma = mg\cos30° + 0.2mg\sin30°$ or equivalent. A1: Correct equation of motion. Allow $ma = mg\sin30° + 0.2mg\cos30°$ A1: Correct magnitude (must be positive). Allow 6.61 from 9.81 Condone 6.6
(b)	$0^2 = 4^2 + 2(-6.60)s$ $s = \frac{16}{13.2} = 1.21\text{ m}$	**M1** **A1**	**2**	M1:Using their acceleration to find distance. Allow positive or negative values for the acceleration. A1: Correct distance. Must be positive.
(c)	$0 = 4 + (-6.60)t_1$ $t_1 = 0.606$ $ma = mg\sin 30° - 0.2mg\cos 30°$ $a = g\sin 30° - 0.2g\cos 30°$ $= 3.20\text{ m s}^{-1}$ $\frac{16}{13.2} = \frac{1}{2}\times 3.2{t_2}^2$ $t_2 = 0.870$ $t_1 + t_2 = 1.48\text{ s}$	**M1** **A1** **M1** **A1** **M1** **A1** **A1**	**7**	M1: Finding time up the slope with their acceleration. A1: Correct time. AWRT 0.606 M1: Three term equation of motion for coin with at least two correct terms (with different signs for each force) A1: Correct acceleration. Allow ±3.20 M1: Finding time down the slope with their acceleration for the motion down the slope. Must not be 6.60. A1: Correct time. AWRT 0.87 A1: Correct total time.
	Total		**14**	

Q	Solution	Mark	Total	Comment
8 (a)	$\mathbf{r}_A = (7\mathbf{i}+8\mathbf{j})+(4\mathbf{i}+3\mathbf{j})t+\frac{1}{2}(8\mathbf{i}+4\mathbf{j})t^2$ $\mathbf{r}_B = (70\mathbf{i}+k\mathbf{j})+(2\mathbf{i}-\mathbf{j})t+\frac{1}{2}(6\mathbf{i}+10\mathbf{j})t^2$ $7+4t+4t^2 = 70+2t+3t^2$ $t^2+2t-63=0$ $t=7$ or -9 $\mathrm{t}=7$	**B1** **B1** **M1A1** **A1**	**5**	B1: Correct position vector for *A*. B1: Correct position vector for *B*. Both B1 marks can be awarded if the correct quadratic is obtained. M1: Equates **i** components. A1: Forms correct simplified quadratic. A1: Final answer as 7.
(b)	$8+3\times7+2\times49=127$ $k-7+5\times49=127$ $k=-111$	**M1A1** **A1**	**3**	Forms equation from **j** components to find *k*. A1: Correct equation. A1: Correct value for *k*.
	Total		**8**	