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ASSESSMENT and QUALIFICATIONS ALLIANCE

General Certificate of Education

Mathematics 6360

MM1B Mechanics 1B

Mark Scheme

2008 examination - June 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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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.

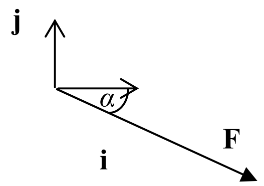
Where the answer can be reasonably obtained without showing working and it is very unlikely that the correct answer can be obtained by using an incorrect method, we must award **full marks**. However, the obvious penalty to candidates showing no working is that incorrect answers, however close, earn **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.

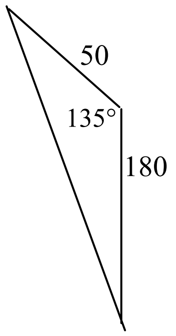
MM1B

Q	Solution	Marks	Total	Comments
1(a)	$s=\frac{1}{2}(3+10)\times 3$	M1		Finding distance by summing 3 areas or using formula for the area of a trapezium
		A1		Correct equation/3 correct expressions for the areas
	$=19.5$ m	A1	3	Correct total distance
(b)	$a=\frac{3}{4}=0.75\ \text{ms}^{-2}$	B1	1	Correct acceleration as a decimal or as a fraction
(c)	$T-400g=400\times 0.75$	M1		Three term equation of motion containing T, $400g$ and 400×0.75 or equivalent
		A1F		Correct equation
	$T=3920+300=4220$ N	A1F	3	Correct tension Only ft from $a=\frac{4}{3}$ (ft 4453 N or 4450 N from $a=\frac{4}{3}$ scores M1A1A1)
	Total		**7**	
2(a)	$\mathbf{F}=5\mathbf{j}+8\mathbf{i}-7\mathbf{j}=8\mathbf{i}-2\mathbf{j}$	M1		Adding the two forces. For incorrect answers, evidence of adding must be seen
		A1	2	Correct resultant
(b)	$F=\sqrt{8^2+2^2}=\sqrt{68}=8.25$ N	M1		Finding magnitude (must see addition and not subtraction)
		A1F	2	Correct magnitude Accept $2\sqrt{17}$, $\sqrt{68}$ or AWRT 8.25 (eg 8.246)
(c)		B1		Diagram with force in the correct quadrant and with correct direction shown by an arrow.
	$\tan\alpha=\frac{2}{8}$	M1		Using trig to find angle: if tan, 8 in denominator; if sin or cos, 8.25 or their answer to part (b) in denominator
	$\alpha=14.0°$	A1	3	Correct angle Accept 14.1 or 14 or AWRT 14.0 (eg 14.04) M1 and A1 not dependent on B1
	Total		**7**	

MM1B (cont)

Q	Solution	Marks	Total	Comments
3(a)(i)	$T = 6 \times 9.8 = 58.8$ N	B1	1	Use of tension being equal to the weight Accept $6g$
(a)(ii)	$58.8 = T + 4 \times 9.8$	M1		Three term equation for equilibrium containing 58.8, T and 4×9.8 or equivalent terms. For M1, 58.8 can be replaced by candidates answer to part (a)(i) provided it is not zero.
		A1		Correct equation
	$T = 58.8 - 39.2$ $= 19.6$ N	A1	3	Correct tension Accept $2g$
(b)	$6g - T = 6a$	M1		Three term equation of motion for 6 kg particle containing 58.8 or $6g$, T and $6a$.
		A1		Correct equation
	$T - 4g = 4a$	M1		Three term equation of motion for 4 kg particle containing 39.2 or $4g$, T and $4a$.
		A1		Correct equation
	$2g = 10a$ $a = 1.96$ ms^{-2}	A1	5	Correct acceleration Candidates who work consistently to obtain $a = -1.96$ gain full marks.
	Special Case for whole system $6g - 4g = 10a$	(M1)		Difference in weights equal to $10a$
		(A1)		A1: Correct equation
	$a = 1.96$	(A1)	(3)	A1: Correct acceleration
	Total		**9**	

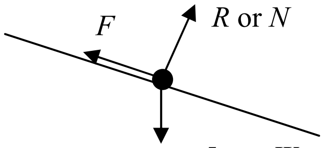
MM1B (cont)

Q	Solution	Marks	Total	Comments
4(a)		B1		Diagram (may be implied) The shape is sufficient, but 50 and 180 must be seen. The 135° may be replaced by 45° or be absent.
	$v^2 = 50^2 + 180^2 - 2 \times 50 \times 180 \cos 135°$	M1		Use of cosine rule with 50, 180 and either 135° or 45°
		A1		Correct equation
	$v = 218 \text{ ms}^{-1}$	A1	4	Correct result for v
	ALTERNATIVE SOLUTION	**OR**		
	$180 + 50\cos 45° = 215.36$	(M1)		Calculation of northerly component with 180, 50 and 45°
		(A1)		Correct component
	$50\sin 45° = 35.36$	(B1)		Correct westerly component
	$v = \sqrt{215.36^2 + 35.36^2} = 218 \text{ ms}^{-1}$	(A1)		Correct result for v Accept AWRT 218
(b)	$\dfrac{\sin\alpha}{50} = \dfrac{\sin 135°}{218.24}$	M1		Use of the sine rule with 50, 135° or 45° and AWRT 218 or candidate's answer to part (a) to at least 3SF.
		A1F		Correct equation (must have 135° not 45°).
	$\alpha = 9.3°$	A1		Correct angle
	Bearing is 351°	A1	4	Three figure bearing
				Note the cosine rule could be used instead of the sine rule here. Apply mark scheme as for sine rule.
	ALTERNATIVE SOLUTION			
	$\tan\alpha = \dfrac{35.36}{215.36}$	(M1)		Use of trig to find angle
		(A1)		Correct equation
	$\alpha = 9.3°$	(A1)		Correct angle
	Bearing is 351°	(A1)		Three figure bearing
	Total		**8**	

MM1B (cont)

Q	Solution	Marks	Total	Comments
5				Use of column vectors is acceptable throughout this question.
(a)	$\mathbf{v} = 20\mathbf{i} + (-0.4\mathbf{i} + 0.5\mathbf{j})t$	M1		Use of constant acceleration equation to find expression for **v**
		A1	2	Any correct expression.
(b)	$\mathbf{v} = (20 - 0.4t)\mathbf{i} + 0.5t\mathbf{j}$	M1		Simplifying **v**. (May be implied.) (Missing brackets may be condoned if followed by correct working.)
	$20 - 0.4t = 0$	m1		Putting **i** component equal to zero
	$t = \frac{20}{0.4} = 50$ seconds	A1	3	Correct time Candidates who are able to see the correct time without supporting working gain full marks. Condone $\frac{20\mathbf{i}}{0.4\mathbf{i}} = 50$
(c)	$\mathbf{r} = 20\mathbf{i} \times t + \frac{1}{2}(-0.4\mathbf{i} + 0.5\mathbf{j}) \times t^2$	M1		Use of constant acceleration equation to find expression for **r**
		A1	2	Any correct expression
(d)(i)	$\mathbf{r} = 20\mathbf{i} \times 100 + \frac{1}{2}(-0.4\mathbf{i} + 0.5\mathbf{j}) \times 100^2$ $= 2000\mathbf{i} - 2000\mathbf{i} + 2500\mathbf{j}$	m1		Substituting $t = 100$ into their expression for **r** (dependent on M1 in part (c))
	$= 2500\mathbf{j}$	A1		Correct simplified position vector ie $2500\mathbf{j}$
	Therefore due north	A1	3	Conclusion that helicopter is due north provided their position vector is of the form $k\mathbf{j}$, where $k>0$ Note if integration is used there is no need to prove that the constant is zero. Note marks for (d) (i) can be awarded if part c scores zero.
(d)(ii)	$\mathbf{v} = (20 - 0.4 \times 100)\mathbf{i} + 0.5 \times 100\mathbf{j}$	m1		Substituting $t = 100$ into their expression for **v** (dependent on M1 in part (a)) or use of other constant acceleration equation and their position vector (dependent on M1 in part (c))
	$= -20\mathbf{i} + 50\mathbf{j}$	A1		Correct simplified velocity
	$v = \sqrt{20^2 + 50^2} = 53.9$	A1	3	Correct speed (accept $10\sqrt{29}$) Note marks for (d) (ii) can be awarded if part a scores zero.
	Total		**13**	

MM1B(cont)

Q	Solution	Marks	Total	Comments
6(a)		B1	1	Correct force diagram with labels and arrows Accept components of the weight if shown in a different notation with the weight also shown. B0 if components are shown instead of the weight.
(b)	$(R=)5\times 9.8\cos 40° = 37.5$ N **AG**	M1 A1	 2	Attempt at resolving perpendicular to the slope (eg 49sin40°) Correct value from correct working
(c)	$5\times 0.8 = 5\times 9.8\sin 40° - \mu\times 5\times 9.8\cos 40°$	B1 M1 A1 A1		Use of $F=\mu R$ at any stage and with any F but with $R = 37.5$ OE Three term equation of motion from resolving parallel to the slope with weight component, friction and *ma* term. Correct terms seen (may be as 31.5, 37.5μ (or F) and 4) Correct signs
	$\mu = \dfrac{5\times 9.8\sin 40° - 5\times 0.8}{5\times 9.8\cos 40°} = 0.733$	m1 A1	 6	Solving for μ A1: Correct value for μ Allow 0.732 but not $\frac{11}{15}$ unless converted to a decimal
(d)	There is less friction so the coefficient of friction must be less.	B1 B1	 2	Less friction Smaller coefficient of friction If the answer and explanation contradict each other, award no marks
	Total		**11**	

MM1B (cont)

Q	Solution	Marks	Total	Comments
7(a)(i)	$0 = 40\sin 35° t - 4.9t^2$	M1		Equation to find time of flight with 40, sin/cos35° and –4.9 or $-\frac{g}{2}$
		A1		Correct equation
	$t = \frac{40\sin 35°}{4.9} = 4.68$ s	m1		Solving for t
	AG	A1	4	Correct time from correct working Note: candidates must have a method for the complete time of flight before any marks can be awarded. Condone the use of a formula for the time of flight.
(a)(ii)	$AB = 40\cos 35° \times 4.682 = 153$ m	M1		Calculating the range using 40, cos/sin35° and 4.68 and acceleration zero.
		A1	2	Correct range Accept AWRT 153
(b)	$-1 = 40\sin 35° t - 4.9t^2$ $4.9t^2 - 40\sin 35° t - 1 = 0$	M1		Equation to find time of flight with a ±1, 40, sin/cos35° and –4.9 or $-\frac{g}{2}$
		A1		Correct terms
		A1		Correct signs
	$t = \frac{40\sin 35° \pm \sqrt{(40\sin 35°)^2 - 4 \times 4.9 \times (-1)}}{2 \times 4.9}$	m1		Solving quadratic equation
	$t = 4.73$ or $t = -0.0432$	A1		Accept AWRT 4.73 or 4.72
	$t = 4.73$	A1	6	Rejection of negative solution indicated (Only 4.73 or 4.72 given award 5/6 marks)
	Alternative methods based on finding two times. For example,	(M1)		Addition of two times
		(A1)		Use of AWRT 4.68 or AWRT 2.34
	$t = 4.682 + 0.044 = 4.73$	(m1)		Calculation of time for 'second' part
	$t = 2.341 + 2.384 = 4.73$	(A1)		Correct expression for time for 'second' part
		(A1)		Correct time (Allow AWRT 0.04 or AWRT 2.38)
		(A1)		Correct total time Accept 4.72
	Total		**12**	

MM1B (cont)

Q	Solution	Marks	Total	Comments
8(a)	$2m - 2\times3 = m\times(-0.5) + 3\times0.5$	M1		Equation for conservation of momentum with four terms: $2m$, 2×3, $0.5m$ and 3×0.5 regardless of signs.
		A1		Correct equation with correct signs
	$2.5m = 7.5$			
	$m = 3$ kg	A1	3	Correct mass Arguments based on the symmetry of the situation that lead to $m = 3$ can be awarded full marks. Note: Consistent use of mg instead of m: deduct one mark. Note: Use of all positive signs leads to $m = -3$, which might be changed to +3 by candidates (M1A0A0). Note: $m = 3$ can be obtained via $1.5m = 4.5$, which will usually score M1A0A0
(b)	$2m - 2\times3 = m\times0.5 + 3\times0.5$	M1		Four term equation for conservation of momentum with ±0.5 for both velocities (no marks for $3m\times0.5$)
		A1		Correct equation
	$1.5m = 7.5$			
	$m = 5$ kg	A1		Correct mass for velocity used
	or			
	$2m - 2\times3 = m\times(-0.5) + 3\times(-0.5)$	M1		Equation for conservation of momentum with opposite sign for the 0.5
	$2.5m = 4.5$			
	$m = 1.8$ kg	A1	5	Correct mass for the velocity used
	Total		**8**	
	TOTAL		**75**	