

GCE 2005
January Series



Mark Scheme

Mathematics and Statistics B *(MBM2)*

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.

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Dr Michael Cresswell Director General

Key to Mark Scheme

M	mark is for	method
m	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	
AWFW	anything which falls within	
AWRT	anything which rounds to	
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)	

Abbreviations used in Marking

MC – x	deducted x marks for mis-copy
MR – x	deducted x marks for mis-read
ISW	ignored subsequent working
BOD	given benefit of doubt
WR	work replaced by candidate
FB	formulae booklet

Application of Mark Scheme

No method shown:

Correct answer without working	mark as in scheme
Incorrect answer without working.....	zero marks unless specified otherwise

More than one method/choice of solution:

2 or more complete attempts, neither/none crossed out	mark both/all fully and award the mean mark rounded down
1 complete and 1 partial attempt, neither crossed out	award credit for the complete solution only

Crossed out work

do not mark unless it has not been replaced

Alternative solution using a correct or partially
correct method

award method and accuracy marks as
appropriate

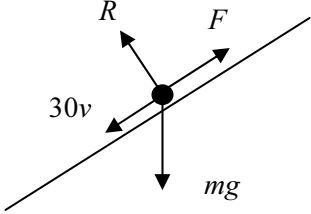
Mathematics and Statistics B Mechanics 2 MBM2 January 2005

Question Number and Part	Solution	Marks	Total	Comments
1(a)	$\mathbf{v} = -4e^{-t}\mathbf{i} + (6 - 3e^{-t})\mathbf{j}$ $t = 0$ $\mathbf{v} = -4\mathbf{i} + 3\mathbf{j}$	M1 A1 A1	3	Differentiating position vector Correct velocity ag Substituting $t = 0$ to obtain initial velocity
(b)	$\mathbf{a} = 4e^{-t}\mathbf{i} + 3e^{-t}\mathbf{j}$	M1 A1	2	Differentiating velocity Correct acceleration
(c)	$\mathbf{a} = 4\mathbf{i} + 3\mathbf{j}$ $a = \sqrt{4^2 + 3^2} = 5$	M1 A1	2	Finding acceleration when $t = 0$ Correct magnitude
(d)	$\mathbf{v} \rightarrow 0\mathbf{i} + 6\mathbf{j}$	B1 B1	2	For \mathbf{i} component For \mathbf{j} component
	Total		9	
2(a)	$EPE = \frac{1}{2} \times \frac{40}{2} \times 3^2 = 90 \text{ J}$	M1 A1	2	Finding EPE ag Correct EPE from correct working
(b)	$90 = \frac{1}{2} \times 5v^2$ $v^2 = 36$ $v = 6$	M1 A1 A1	3	Use of EPE = KE Correct equation ag Correct speed from correct working
(c)	$EPE = \frac{1}{2} \times \frac{40}{2} \times 1^2 = 10 \text{ J}$ $90 - 10 = \frac{1}{2} \times 5v^2$ $v^2 = 32$ $v = 5.66 \text{ ms}^{-1}$ (to 3 sf)	M1 A1 M1 A1 A1	5	Finding EPE 3 metres from O Correct EPE Using EPE lost = KE Correct equation Correct speed
	Total		10	

MBM2(cont)

Question Number and Part	Solution	Marks	Total	Comments
3(a)	$P = 2000$ $Q = 100$	B1 B1	2	Correct value for P Correct value for Q
(b)	$a = -\frac{F}{1000} = \frac{t}{10} - 2$	M1 A1	2	Use of $F = ma$ ag Correct expression from correct working
(c)	$v = \frac{t^2}{20} - 2t + c$ $0 = \frac{20^2}{20} - 2 \times 20 + c$ $c = 20$	M1 A1 M1		Integrating acceleration to give velocity Correct velocity with or without c Finding c
(d)	$v = \frac{t^2}{20} - 2t + 20$ $s = \int_0^{20} \frac{t^2}{20} - 2t + 20 \, dt$ $= \left[\frac{t^3}{60} - t^2 + 20t \right]_0^{20}$ $= 133 \text{ m}$	A1✓ M1 A1 A1 M1 A1	4 5	Correct expression for the velocity ft incorrect constants from (b) Integrating velocity Correct integral Correct limits/value of c Finding distance by substituting limits Correct distance
	Total		13	

MBM2(cont)

Question Number and Part	Solution	Marks	Total	Comments
4(a)		B1	1	Correct force diagram
(b)	$F = 1500g \cos 85^\circ + 300$ $P = (1500g \cos 85^\circ + 300) \times 10$ $= 15800 \text{ W (to 3 sf)}$	M1 A1 M1 A1	4	Finding F Correct F Use of $P = Fv$ ag Correct answer from correct working
(c)	$F = 1500g \cos 85^\circ + 30v$ $35000 = v(1500g \cos 85^\circ + 30v)$ $0 = 30v^2 + 1281v - 35000$ $v = \frac{-1281 \pm \sqrt{1281^2 + 4 \times 30 \times 35000}}{2 \times 30}$ $= 18.9 \text{ or } -61.6$ <p>Max Speed = 18.9 ms⁻¹</p>	M1 A1 m1 A1 m1 A1	6	F in terms of v Correct expression for F Using $P = Fv$ to obtain a quadratic Correct quadratic Solving quadratic equation Correct speed
Total			11	
5(a)	$a = 0.6 \times 10^2 = 60 \text{ ms}^{-2}$	M1 A1	2	Use of $a = r\omega^2$ Correct acceleration Allow ± 60
(b)	$R = 0.05 \times 60 = 3 \text{ N}$	M1 A1✓	2	Finding product of mass and acceleration Correct R Follow through incorrect a
(c)	$R - 0.05 \times 9.8 = 0.05 \times 60$ $R = 3.49 \text{ N}$	M1 A1 A1✓	3	Equation of motion at lowest point Correct equation Correct R Follow through incorrect a
Total			7	

MBM2(cont)

Question Number and Part	Solution	Marks	Total	Comments
6(a)	$2 \times 9.8 = \frac{\lambda}{0.5} \times 0.2$ $\lambda = \frac{9.8}{0.2} = 49 \text{ N}$	M1 A1 A1	3	Equilibrium considered to form equation in λ Correct equation Correct λ
(b)	$T = \frac{49x}{0.5} + 2g$ $2 \frac{d^2x}{dt^2} = 2g - (98x + 2g)$ $\frac{d^2x}{dt^2} = -\frac{98}{2}x = -49x$	M1 A1 M1 A1 A1	5	Equation for tension with two terms. Correct equation. Use of $F = m \frac{d^2x}{dt^2}$ Correct equation ag Correct result from correct working
(c)	$\text{Period} = \frac{2\pi}{\sqrt{49}}$ $t = \frac{1}{4} \times \frac{2\pi}{7} = \frac{\pi}{14} = 0.224 \text{ seconds}$	M1 A1 M1 A1	4	Finding period Correct period Dividing period by 4 Correct time
Total			12	
7(a)	$V = \pi \int_0^2 2 - x \, dx$ $= \pi \left[2x - \frac{x^2}{2} \right]$ $= \pi(4 - 2) = 2\pi$	M1 A1 A1	3	Use of $\int y^2 dx$ Correct expression for the volume ag Correct volume from correct working
(b)	$2\pi\bar{x} = \pi \int_0^2 2x - x^2 \, dx$ $= \pi \left[x^2 - \frac{x^3}{3} \right]_0^2$ $= \pi \left(4 - \frac{8}{3} \right)$ $\bar{x} = \frac{2}{3}$	M1 A1 M1 A1	4	Use of $\int xy^2 dx$ Correct expression containing \bar{x} Evaluating integral Correct final answer
(c)	$\tan \alpha = \frac{\frac{2}{3}}{\frac{3}{\sqrt{2}}}$ $\alpha = 25.2^\circ$	B1 M1 A1 A1 \checkmark	4	Use of $\sqrt{2}$ Use of tan to find angle Correct expression for tan Correct angle Follow through from part (b)
Total			11	

