



ASSESSMENT and  
QUALIFICATIONS  
ALLIANCE

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# Mark scheme January 2004

## GCE

### Mathematics & Statistics B

### Unit MBM2

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## Key to mark scheme

<b>M</b>	mark is for	method
<b>m</b>	mark is dependent on one or more M marks and is for	method
<b>A</b>	mark is dependent on M or m mark and is for	accuracy
<b>B</b>	mark is independent of M or m marks and is for	method and accuracy
<b>E</b>	mark is for	explanation
<b>✓ or ft or F</b>		follow through from previous incorrect result
<b>CAO</b>		correct answer only
<b>AWFW</b>		anything which falls within
<b>AWRT</b>		anything which rounds to
<b>AG</b>		answer given
<b>SC</b>		special case
<b>OE</b>		or equivalent
<b>A2,1</b>		2 or 1 (or 0) accuracy marks
<b>- x EE</b>		Deduct $x$ marks for each error
<b>NMS</b>		No method shown
<b>PI</b>		Perhaps implied
<b>c</b>		Candidate

## Abbreviations used in marking

<b>MC - <math>x</math></b>	deducted $x$ marks for miscopy
<b>MR - <math>x</math></b>	deducted $x$ marks for misread
<b>ISW</b>	ignored subsequent working
<b>BOD</b>	gave benefit of doubt
<b>WR</b>	work replaced by candidate

## Application of mark scheme

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

Award method and accuracy marks as appropriate to an alternative solution using a correct method or partially correct method.

Question Number and Part	Solution	Marks	Total	Comments
1(a)(i)	Initial KE = $\frac{1}{2} \times 65 \times 2^2$ = 130 J	M1 A1	2	Use of KE formula Correct energy
(ii)	$65 \times 9.8h = 130$ $h = \frac{130}{637} = 0.204$ m (to 3 sf)	M1 A1	2	Using $mgh = 130$ Correct $h$
(b)(i)	KE = $130 + 65 \times 9.8 \times 6 = 3950$ J (3 sf)	M1 A1 A1	3	Sum of KE+PE or PE at $h = 6.204$ Correct equation Correct energy
(ii)	$\frac{1}{2} \times 65v^2 = 3952$ $v = \sqrt{121.6} = 11.0$ ms <sup>-1</sup>	M1 A1✓	2	Use of KE formula to find $v$ Correct $v$ from their energy in part 1(b)(ii)
<b>Total</b>			<b>9</b>	
2(a)	$v = \int 20 \sin 4t \, dt$ = $-5 \cos 4t + c$ $t = 0, v = 0 \Rightarrow c = 5$ $v = 5 - 5 \cos 4t$	M1 A1 M1 A1	4	Attempt to integrate $a$ Correct integral with or without $c$ Finding $c$ Correct $c$
(b)	$s = \int 5 - 5 \cos 4t \, dt$ = $5t - \frac{5}{4} \sin 4t + c$ $t = 0, s = 0.8 \Rightarrow c = 0.8$ $s = 5t - \frac{5}{4} \sin 4t + 0.8$	M1 A1 M1 A1	4	Attempt to integrate $v$ Correct integral with or without $c$ Finding $c$ Correct $c$
<b>Total</b>			<b>8</b>	
3(a)(i)	$R \cos 60^\circ = 3 \times 9.8$ $R = 58.8$ N	M1 A1 A1	3	Resolving vertically Correct equation Correct $R$
(ii)	$58.8 \cos 30^\circ = 3 \times \frac{v^2}{0.5}$ $v = \sqrt{\frac{58.8 \cos 30^\circ}{6}} = 2.91$ ms <sup>-1</sup>	M1 A1 M1 A1	4	Resolving vertically Correct equation Solving for $v$ Correct $v$
(b)(i)	No change	B1	1	No change
(ii)	Increased because $v^2$ is proportional to the radius	B1 B1	2	Increases Reason
<b>Total</b>			<b>10</b>	

Question Number and Part	Solution	Marks	Total	Comments
4(a)	$20 \times 9.8 = \frac{0.7\lambda}{2}$	M1		Use of $T = mg$
	$\lambda = \frac{2 \times 20 \times 9.8}{0.7} = 560$	A1	3	Correct equation Correct result from correct working
(b)(i)	$20 \times 9.8L = \frac{560(L-2)^2}{2 \times 2}$	M1		Two term energy equation
	$196L = 140L^2 - 560L + 560$	A1		Correct terms
		A1		Correct signs
		m1		Expanding and simplifying
(ii)	$5L^2 - 27L + 20 = 0$	A1	5	Correct result from correct working
	$L = \frac{27 \pm \sqrt{27^2 - 4 \times 5 \times 20}}{2 \times 5}$	M1		Solving a quadratic
	$= 4.51 \text{ or } 0.886$	A1		Correct solutions
	$L = 4.51$	A1	3	Selecting the appropriate solution
	<b>Total</b>		<b>11</b>	
5(a)(i)	$s(10) = 25 - 100 + 150 = 75$	B1	1	Correct distance
(ii)	$v = \frac{t^3}{100} - \frac{3t^2}{10} + 3t$	M1		Differentiating $s$
	$v(10) = 10 - 30 + 30 = 10$	A1	3	Correct derivative
		A1		Correct $v$
(iii)	$a = \frac{3t^2}{100} - \frac{3t}{5} + 3$	M1		Differentiating $v$
	$a(10) = 3 - 6 + 3 = 0$	A1	3	Correct derivative
		A1		Correct $a$
(b)	$h = 10$	B1		Value of $h$
	$75 = 100 - k$	M1		Substituting $s = 75$ and $t = 10$
	$k = 25$	A1	3	Correct $k$
	<b>Total</b>		<b>10</b>	

Question Number and Part	Solution	Marks	Total	Comments
6(a)	$\int_0^a kx dx = \left[ \frac{kx^2}{2} \right]_0^a = \frac{ka^2}{2}$	M1 A1	2	Forming integral to find area Correct area
(b)	$\frac{ka^2}{2} \bar{x} = \int_0^a kx^2 dx$ $\frac{ka^2}{2} \bar{x} = \frac{ka^3}{3}$ $\bar{x} = \frac{2a}{3}$	M1 A1  m1 A1	4	Forming integral to find $\bar{x}$ Correct expression  Evaluating integral and finding $\bar{x}$ Correct $\bar{x}$ from correct working
(c)	$\frac{ka^2}{2} \bar{y} = \int_0^a \frac{k^2 x^2}{2} dx$ $\frac{ka^2}{2} \bar{y} = \frac{k^2 a^3}{6}$ $\bar{y} = \frac{ka}{3}$	M1 A1  M1  A1	4	Forming integral to find $\bar{y}$ Correct expression  Evaluating integral and finding $\bar{y}$ Correct $\bar{y}$
<b>Total</b>			<b>10</b>	
7(a)	$a = 0.2$ $0.2\omega = 10$ $\omega = 50$ $P = \frac{2\pi}{50} = \frac{\pi}{25}$	B1 M1 A1  A1	4	Stating amplitude Using $v = a\omega$ Correct value of $\omega$  Correct period from correct working
(b)	$v = 50\sqrt{0.2^2 - 0.16^2}$ $= 6 \text{ ms}^{-1}$	M1 A1 A1	3	Using $x = 0.16$ in SHM formula Correct substitution of all values Correct speed
(c)(i)	$\omega = 50, q = 0.2$	B1 B1	2	Correct $\omega$ Correct $q$
(ii)	$0 = p - 0.2 \cos 0$ $p = 0.2$	M1 A1	2	Using $s = 0$ Correct $p$
<b>Total</b>			<b>11</b>	

Question Number and Part	Solution	Marks	Total	Comments
8(a)	$0.1v \frac{dv}{dx} = -0.1 \times 9.8 - \frac{v^2}{200}$	M1		Use of $F = ma$ with the resultant force
	$v \frac{dv}{dx} = -(9.8 + \frac{v^2}{20})$	A1	2	Correct result from correct working
(b)	$\int \frac{v}{9.8 + \frac{v^2}{20}} dv = \int -1 dx$	M1		Forming two integrals
	$10 \ln(9.8 + \frac{v^2}{20}) = -x + c$	M1 A1		Integrating Correct integrals
	$v = 12, x = 0 \Rightarrow c = 10 \ln 17$	M1 A1		Finding $c$ Correct $c$
	$10 \ln(9.8 + \frac{v^2}{20}) + x = 10 \ln 17$	A1	6	Correct result from correct working
(c)	$10 \ln 9.8 + x = 10 \ln 17$	M1		Substituting $v = 0$
	$x = 10(\ln 17 - \ln 9.8) = 5.51 \text{ m}$	A1 A1	3	Correct equation Correct $x$
	<b>Total</b>		<b>11</b>	
	<b>TOTAL</b>		<b>80</b>	