ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark scheme
January 2004

GCE

Mathematics & Statistics B

Unit MBM2

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 mark 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		Perhaps implied
c		Candidate

Abbreviations used in marking

MC – *x*	deducted *x* marks for miscopy
MR – *x*	deducted *x* marks for misread
ISW	ignored subsequent working
BOD	gave benefit of doubt
WR	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 $= \frac{1}{2} \times 65 \times 2^2$	M1		Use of KE formula
	$= 130$ J	A1	2	Correct energy
(ii)	$65 \times 9.8h = 130$	M1		Using $mgh = 130$
	$h = \frac{130}{637} = 0.204$ m (to 3 sf)	A1	2	Correct h
(b)(i)	KE $= 130 + 65 \times 9.8 \times 6 = 3950$ J (3 sf)	M1		Sum of KE+PE or PE at $h = 6.204$
		A1		Correct equation
		A1	3	Correct energy
(ii)	$\frac{1}{2} \times 65v^2 = 3952$	M1		Use of KE formula to find v
	$v = \sqrt{121.6} = 11.0\ \text{ms}^{-1}$	A1√	2	Correct v from their energy in part 1(b)(ii)
	Total		**9**	
2(a)	$v = \int 20 \sin 4t\, dt$	M1		Attempt to integrate a
	$= -5 \cos 4t + c$	A1		Correct integral with or without c
	$t = 0, v = 0 \Rightarrow c = 5$	M1		Finding c
	$v = 5 - 5 \cos 4t$	A1	4	Correct c
(b)	$s = \int 5 - 5 \cos 4t dt$	M1		Attempt to integrate v
	$= 5t - \frac{5}{4} \sin 4t + c$	A1		Correct integral with or without c
	$t = 0, s = 0.8 \Rightarrow c = 0.8$	M1		Finding c
	$s = 5t - \frac{5}{4} \sin 4t + 0.8$	A1	4	Correct c
	Total		**8**	
3(a)(i)	$R \cos 60° = 3 \times 9.8$	M1		Resolving vertically
		A1		Correct equation
	$R = 58.8$ N	A1	3	Correct R
(ii)	$58.8 \cos 30° = 3 \times \frac{v^2}{0.5}$	M1		Resolving vertically
		A1		Correct equation
	$v = \sqrt{\frac{58.8 \cos 30°}{6}} = 2.91\ \text{ms}^{-1}$	M1		Solving for v
		A1	4	Correct v
(b)(i)	No change	B1	1	No change
(ii)	Increased because v^2 is proportional to the radius	B1		Increases
		B1	2	Reason
	Total		**10**	

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

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

Question Number and Part	Solution	Marks	Total	Comments
8(a)	$0.1v\frac{\mathrm{d}v}{\mathrm{d}x} = -0.1\times 9.8 - \frac{v^2}{200}$	M1		Use of $F = ma$ with the resultant force
	$v\frac{\mathrm{d}v}{\mathrm{d}x} = -(9.8 + \frac{v^2}{20})$	A1	2	Correct result from correct working
(b)	$\int \frac{v}{9.8 + \frac{v^2}{20}}\mathrm{d}v = \int -1\mathrm{d}x$	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 $v = 0$
		A1		Correct equation
	$x = 10(\ln 17 - \ln 9.8) = 5.51\,\mathrm{m}$	A1	3	Correct x
	Total		**11**	
	TOTAL		**80**	