GCE 2005
January Series

ASSESSMENT and QUALIFICATIONS ALLIANCE

Mark Scheme

Mathematics and Statistics B
(MBM1)

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.

Further copies of this Mark Scheme are available to download from the AQA Website: www.aqa.org.uk

Set and published by the Assessment and Qualifications Alliance.

The Assessment and Qualifications Alliance (AQA) is a company limited by guarantee registered in England and Wales 3644723 and a registered charity number 1073334. Registered address AQA, Devas Street, Manchester. M15 6EX. *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

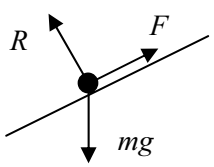
Crossed out work — do not mark unless it has not been replaced

Alternative solution using a correct or partially correct method — award method and accuracy marks as appropriate

Mathematics and Statistics B Mechanics 1 MBM1 January 2005

Question Number and Part	Solution	Marks	Total	Comments
1(a)(i)	$80 = \frac{1}{2}(0+20)t$	M1		Use of constant acceleration equation to form an equation for t.
	$t = 8$ seconds	A1	2	Correct time.
(ii)	$20^2 = 0^2 + 2 \times a \times 80$	M1		Use of constant acceleration equation to form an equation for a.
	$a = \frac{20^2}{160} = 2.5\ \text{ms}^{-2}$	A1	2	**ag** Correct acceleration from correct working.
(b)(i)	$F = 1200 \times 2.5 = 3000$ N	M1 A1	2	Use of $F = ma$ Correct force.
(ii)	$F - 400 = 3000$	M1		Three term equation of motion.
	$F = 3400$ N	A1	2	Correct F.
	Total		**8**	
2(a)(i)	$9 = 18 + 6a$	M1		Use of constant acceleration equation to form an equation for a.
		A1		Correct equation.
	$a = -\frac{9}{6} = -1.5\ \text{ms}^{-2}$	A1	3	**ag** Correct acceleration from correct working.
(ii)	$s = 18 \times 6 + \frac{1}{2} \times (-1.5) \times 6^2$	M1		Use of constant acceleration equation to find s.
	$= 81$ m	A1	2	Correct distance.
(b)(i)	$15 = 9 + 1.2t$	M1		Use of constant acceleration equation to form an equation for t.
	$t = \frac{15-9}{1.2} = 5$ s	A1	2	Correct time.
(ii)	$s = \frac{1}{2}(9+15) \times 5$	M1		Use of constant acceleration equation to find s.
		A1		Correct expression.
	$= 60$ m	A1	3	Correct distance.
(c)	$81 + 60 = 141$ m	B1	1	Correct sum of distances from (a)(ii) and (b)(ii)
	Total		**11**	

MBM1 (cont)

Question Number and Part	Solution	Marks	Total	Comments
3(a)	$8\times5+4\times(-5)=4v$	M1		Three term momentum equation.
		A1		Correct LHS.
		A1		Correct RHS.
	$v=\frac{20}{4}=5$ ms^{-1}	A1	4	Correct speed (accept ± 5)
(b)	$20=4\times2v+8v$	M1		Three term momentum equation with $v_B=2v_A$
		A1		Correct equation.
	$v=\frac{20}{16}=1.25$	A1		Correct v_A
	$v_B=2.5$ ms^{-1}	A1	4	Correct v_B
	Total		**8**	
4(a)(i)		B1	1	Correct force diagram.
(ii)	$R=20\times9.8\cos40°=150$ N	M1		Resolving perpendicular to the slope
		A1	2	**ag** Correct answer from correct working.
(iii)	$F=20\times9.8\sin40°=126$ N	M1		Resolving parallel to the slope.
		A1		Correct friction
	$126=\mu\times150$	M1		Use of $F=\mu R$
	$\mu=\frac{126}{150}=0.84$	A1	4	**ag** Correct μ from correct working
(b)	It would be reduced	B1	1	Correct explanation
	Total		**8**	
5(a)	$\bar{x}=\frac{3\times1+12\times2.5+15\times3+10\times2}{3+12+15+10}$	M1		Five term moment equation
		A1		Correct numerator
		A1		Correct denominator
	$=\frac{98}{40}=2.45$ m	A1	4	**ag** Correct answer from correct working
(b)	$4T_B=2.45\times40\times9.8$	M1		Two term moment equation
		A1		Correct moment equation
	$T_B=240$ N (to 3 sf)	A1		Correct tension.
	$T_A+240=40\times9.8$	m1		Vertical equilibrium or second moment equation
	$T_A=152$ N (to 3 sf)	A1	5	Correct second tension
	Total		**9**	

MBM1 (cont)

Question Number and Part	Solution	Marks	Total	Comments
6(a)	$-16\mathbf{i}+16\mathbf{j}=\frac{1}{2}\mathbf{a}\times 4^2$	M1		Use of vector constant acceleration equation
		A1		Correct equation
	$\mathbf{a}=\frac{-16\mathbf{i}+16\mathbf{j}}{8}=-2\mathbf{i}+2\mathbf{j}$	M1		Solving for **a**
		A1	4	**ag** Correct **a**
(b)	$\mathbf{v}=5(-2\mathbf{i}+2\mathbf{j})=-10\mathbf{i}+10\mathbf{j}$	M1		Expression for **v** at $t = 5$
		A1		Correct expression
	$v=\sqrt{10^2+10^2}=14.1\ \text{ms}^{-1}$ (to 3 sf)	M1		Finding magnitude
		A1	4	Correct speed
(c)	$20\mathbf{i}-10\mathbf{j}+\mathbf{Q}=3(-2\mathbf{i}+2\mathbf{j})$	M1		Application of Newton's second law to form equation.
		A1		Correct equation
	$\mathbf{Q}=(-20-6)\mathbf{i}+(10+6)\mathbf{j}=-26\mathbf{i}+16\mathbf{j}$	M1		Solving for **Q**
		A1	4	Correct **Q**
	Total		**12**	
7(a)	$25\cos 17°t=12$	M1		Equation to find time of flight
		A1		Correct equation
	$t=\frac{12}{25\cos 17°}=0.502$ s	A1	3	**ag** Correct time from correct working
(b)	$h=25\sin 17°\times 0.502-4.9\times 0.502^2$	M1		Substituting $t = 0.502$ into an expression for the height of the ball
		A1		Correct expression
	$=2.43$ m	A1	3	Correct height
(c)	$v_x=25\cos 17°$	M1		Finding horizontal and vertical components of velocity
	$v_y=25\sin 17°-9.8\times 0.502=2.390$	A1		Horizontal component correct
		A1		Vertical component correct
	$\tan\alpha=\frac{25\cos 17°}{2.390}$	M1		Use of tan to find angle
	$\alpha=84.3°$	A1	5	Correct angle
(d)	Ball is a particle	B1		First assumption
	No air resistance	B1	2	Second assumption
	Total		**13**	

MBM1 (cont)

Question Number and Part	Solution	Marks	Total	Comments
8(a)	$150\text{g} - T = 150a$ $T - 200g\sin 30° = 200a$	M1 A1		Three term equation of motion for tank. Correct equation
	$150g - 200a - 200g\sin 30° = 150a$	M1 A1		Three term equation of motion for trolley. Correct equation
	$a = \dfrac{150g - 200g\sin 30°}{350} = 1.4\ \text{ms}^{-2}$	m1 A1 A1	7	Solving for a Correct equation for a **ag** Correct a from correct working.
(b)	$T = mg$ $T = 200g\sin 30°$ $m = 200\sin 30° = 100\ \text{kg}$	M1 A1 A1 A1	4	Equations of motion for both bodies. Correct equation for tank. Correct equation for trolley Correct mass.
	Total		**11**	
	TOTAL		**80**	