

GCE 2005
January Series



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.

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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

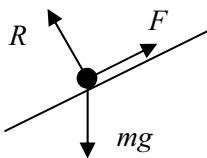
Alternative solution using a correct or partially
correct method

award method and accuracy marks as
appropriate

Mathematics and Statistics B Mechanics 1 MBM1 January 2005

Question Number and Part	Solution	Marks	Total	Comments
1(a)(i)	$80 = \frac{1}{2}(0 + 20)t$ $t = 8 \text{ seconds}$	M1 A1	2	Use of constant acceleration equation to form an equation for t . Correct time.
(ii)	$20^2 = 0^2 + 2 \times a \times 80$ $a = \frac{20^2}{160} = 2.5 \text{ ms}^{-2}$	M1 A1	2	Use of constant acceleration equation to form an equation for a . ag Correct acceleration from correct working.
(b)(i)	$F = 1200 \times 2.5 = 3000 \text{ N}$	M1 A1	2	Use of $F = ma$ Correct force.
(ii)	$F - 400 = 3000$ $F = 3400 \text{ N}$	M1 A1	2	Three term equation of motion. Correct F .
Total			8	
2(a)(i)	$9 = 18 + 6a$ $a = -\frac{9}{6} = -1.5 \text{ ms}^{-2}$	M1 A1 A1	3	Use of constant acceleration equation to form an equation for a . Correct equation. ag Correct acceleration from correct working.
(ii)	$s = 18 \times 6 + \frac{1}{2} \times (-1.5) \times 6^2$ $= 81 \text{ m}$	M1 A1	2	Use of constant acceleration equation to find s . Correct distance.
(b)(i)	$15 = 9 + 1.2t$ $t = \frac{15 - 9}{1.2} = 5 \text{ s}$	M1 A1	2	Use of constant acceleration equation to form an equation for t . Correct time.
(ii)	$s = \frac{1}{2}(9 + 15) \times 5$ $= 60 \text{ m}$	M1 A1 A1	3	Use of constant acceleration equation to find s . Correct expression. Correct distance.
(c)	$81 + 60 = 141 \text{ m}$	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)	$8 \times 5 + 4 \times (-5) = 4v$ $v = \frac{20}{4} = 5 \text{ ms}^{-1}$	M1 A1 A1 A1	4	Three term momentum equation. Correct LHS. Correct RHS. Correct speed (accept ± 5)
(b)	$20 = 4 \times 2v + 8v$ $v = \frac{20}{16} = 1.25$ $v_B = 2.5 \text{ ms}^{-1}$	M1 A1 A1 A1	4	Three term momentum equation with $v_B = 2v_A$ Correct equation. Correct v_A Correct v_B
Total			8	
4(a)(i)		B1	1	Correct force diagram.
(ii)	$R = 20 \times 9.8 \cos 40^\circ = 150 \text{ N}$	M1 A1	2	Resolving perpendicular to the slope ag Correct answer from correct working.
(iii)	$F = 20 \times 9.8 \sin 40^\circ = 126 \text{ N}$ $126 = \mu \times 150$ $\mu = \frac{126}{150} = 0.84$	M1 A1 M1 A1	4	Resolving parallel to the slope. Correct friction Use of $F = \mu R$ ag Correct μ from correct working
(b)	It would be reduced	B1	1	Correct explanation
Total			8	
5(a)	$\bar{x} = \frac{3 \times 1 + 12 \times 2.5 + 15 \times 3 + 10 \times 2}{3 + 12 + 15 + 10}$ $= \frac{98}{40} = 2.45 \text{ m}$	M1 A1 A1 A1	4	Five term moment equation Correct numerator Correct denominator ag Correct answer from correct working
(b)	$4T_B = 2.45 \times 40 \times 9.8$ $T_B = 240 \text{ N (to 3 sf)}$ $T_A + 240 = 40 \times 9.8$ $T_A = 152 \text{ N (to 3 sf)}$	M1 A1 A1 m1 A1	5	Two term moment equation Correct moment equation Correct tension. Vertical equilibrium or second moment equation Correct second tension
Total			9	

MBM1 (cont)

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

MBM1 (cont)

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