

Mark Scheme (Results)

Summer 2013

GCE Mechanics 2 (6678/01R)

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General Marking Guidance

- All candidates must receive the same treatment. Examiners must mark the first candidate in exactly the same way as they mark the last.
- Mark schemes should be applied positively. Candidates must be rewarded for what they have shown they can do rather than penalised for omissions.
- Examiners should mark according to the mark scheme not according to their perception of where the grade boundaries may lie.
- There is no ceiling on achievement. All marks on the mark scheme should be used appropriately.
- All the marks on the mark scheme are designed to be awarded. Examiners should always award full marks if deserved, i.e. if the answer matches the mark scheme. Examiners should also be prepared to award zero marks if the candidate's response is not worthy of credit according to the mark scheme.
- Where some judgement is required, mark schemes will provide the principles by which marks will be awarded and exemplification may be limited.
- Crossed out work should be marked UNLESS the candidate has replaced it with an alternative response.

EDEXCEL GCE MATHEMATICS

General Instructions for Marking

1. The total number of marks for the paper is 75.
2. The Edexcel Mathematics mark schemes use the following types of marks:
 - **M** marks: method marks are awarded for 'knowing a method and attempting to apply it', unless otherwise indicated.
 - **A** marks: accuracy marks can only be awarded if the relevant method (M) marks have been earned.
 - **B** marks are unconditional accuracy marks (independent of M marks)
 - Marks should not be subdivided.

3. Abbreviations

These are some of the traditional marking abbreviations that will appear in the mark schemes:

- bod – benefit of doubt
 - ft – follow through
 - the symbol \checkmark will be used for correct ft
 - cao – correct answer only
 - cso - correct solution only. There must be no errors in this part of the question to obtain this mark
 - isw – ignore subsequent working
 - awrt – answers which round to
 - SC: special case
 - oe – or equivalent (and appropriate)
 - dep – dependent
 - indep – independent
 - dp decimal places
 - sf significant figures
 - * The answer is printed on the paper
 - \square The second mark is dependent on gaining the first mark
4. All A marks are 'correct answer only' (cao.), unless shown, for example, as A1 ft to indicate that previous wrong working is to be followed through. After a misread however, the subsequent A marks affected are treated as A ft, but manifestly absurd answers should never be awarded A marks.
 5. For misreading which does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, in that part of the question affected.
 6. If a candidate makes more than one attempt at any question:
 - If all but one attempt is crossed out, mark the attempt which is NOT crossed out.
 - If either all attempts are crossed out or none are crossed out, mark all the attempts and score the highest single attempt.
 7. Ignore wrong working or incorrect statements following a correct answer.
 8. In some instances, the mark distributions (e.g. M1, B1 and A1) printed on the candidate's response may differ from the final mark scheme.

General Rules for Marking Mechanics

- Usual rules for M marks: correct no. of terms; dim correct; all terms that need resolving (i.e. multiplied by cos or sin) are resolved.
- Omission or extra g in a resolution is accuracy error not method error.
- Omission of mass from a resolution is method error.
- Omission of a length from a moments equation is a method error.
- Omission of units or incorrect units is not (usually) counted as an accuracy error.
- DM indicates a dependent method mark i.e. one that can only be awarded if a previous specified method mark has been awarded.
- Any numerical answer which comes from use of $g = 9.8$ should be given to 2 or 3 SF.
- Use of $g = 9.81$ should be penalised once per (complete) question.
- N.B. Over-accuracy or under-accuracy of correct answers should only be penalised *ONCE* per complete question.
- In all cases, if the candidate clearly labels their working under a particular part of a question i.e. (a) or (b) or (c),.....then that working can only score marks for that part of the question.
- Accept column vectors in all cases.
- Misreads – if a misread does not alter the character of a question or materially simplify it, deduct two from any A or B marks gained, bearing in mind that after a misread, the subsequent A marks affected are treated as A ft.

Question Number	Scheme	Marks	Notes
1.			
(a)	$F - 150 - 300 = 1500 \times 0.2$	M1	Needs total mass and both resistances. Condone sign errors
		A1	Correct unsimplified equation
	$F = 750$	A1	
	$P = 750 \times 20 = 15000 \text{ watts}$	M1	Independent M. 20 x their driving force
		A1	
		(5)	
(b)	Use their mass as a guide to which of these two alternatives is being used.		
	For caravan: $T - 150 = 600 \times 0.2$	M1	Requires all forces acting on caravan. Condone sign error(s)
	$T = 270 \text{ N}$	A1 (2)	
Or (b)	For car: $F - T - 300 = 900 \times 0.2$	M1	Requires all forces acting on car. Condone sign error(s)
	$T = 270 \text{ N}$	A1 (2)	
		[7]	

Question Number	Scheme	Marks	Notes
2.	NB This question tells candidates to use work-energy - suvat approach scores 0/6		
	$1.24 \times 8; 0.2g \times 8; \frac{1}{2}0.2.20^2$ or $\frac{1}{2}0.2.v^2$	B1;B1;B1	B1 for each term seen or implied 9.92, 15.68, 40 or $0.1v^2$
	$1.24 \times 8 = \frac{1}{2}0.2.20^2 - \frac{1}{2}0.2.v^2 - 0.2g \times 8$	M1	Condone sign errors but all terms should be present
		A1	Correct equation
	$v = 12$	A1	
		(6)	
		[6]	

Question Number	Scheme	Marks	Notes
3.			
(a)	$\frac{1}{2}t^2 - 3t + 4 = 0$	M1	Set $v = 0$
	$t^2 - 6t + 8 = 0$		
	$(t - 2)(t - 4) = 0$	DM1	Solve for v
	$t = 2 \text{ s } \text{ or } 4 \text{ s}$	A1 A1	
		(4)	
(b)	$\int \frac{1}{2}t^2 - 3t + 4 dt$	M1	Integration – majority of powers increasing
	$= \frac{1}{6}t^3 - \frac{3}{2}t^2 + 4t (+C)$	A1	Correct (+C not required)
	$s = \int_0^2 \frac{1}{2}t^2 - 3t + 4 dt - \int_2^4 \frac{1}{2}t^2 - 3t + 4 dt$	DM1	Correct strategy for finding the required distance. Follow their “2”. Subtraction/swap limits/modulus signs
	$= \left[\frac{1}{6}t^3 - \frac{3}{2}t^2 + 4t \right]_0^2 - \left[\frac{1}{6}t^3 - \frac{3}{2}t^2 + 4t \right]_2^4$		
	$= \frac{8}{6} - 6 + 8 - (\frac{64}{6} - 24 + 16 - (\frac{8}{6} - 6 + 8))$	A1	Correct unsimplified
	$= \frac{10}{3} - \frac{8}{3} + \frac{10}{3}$		
	$= 4$	A1	
		(5)	
		[9]	

Question Number	Scheme	Marks	Notes
4.			
(a)	$AC = 4a \tan 60^\circ = 4a\sqrt{3}.$	M1 A1	Or $\frac{4a}{\tan 30}$ or $\sqrt{(8a)^2 - (4a)^2}$
		(2)	
(b)	use of $F = \mu R$ at either A or C	M1	
	3 independent equations required. Award M1A1 for each in the order seen. If more than 3 relevant equations seen, award the marks for the best 3.		
	$M(A), \quad R_C \cdot 4a\sqrt{3} = W \cdot 3a\sqrt{3} \cos 60^\circ$	M1 A1	$R_C = \frac{3W}{8}$
	$(\uparrow), \quad R_A + R_C \cos 60^\circ + F_C \cos 30^\circ = W$	M1 A1	$R_A = \frac{5W}{8}$
	$(\rightarrow), \quad F_A - R_C \cos 30^\circ + F_C \cos 60^\circ = 0$	M1 A1	$F_A = R_C \frac{\sqrt{3}}{3}$
	$M(C) \quad a\sqrt{3} \cos 60^\circ W + F_A \cdot 4a\sqrt{3} \sin 60^\circ = R_A \cdot 4a\sqrt{3} \cos 60^\circ$		
	Parallel: $F_A \cos 60^\circ + R_A \cos 30^\circ + F_C = W \cos 30^\circ$		
	Perpendicular: $R_C + R_A \cos 60^\circ = F_A \cos 30^\circ + W \cos 60^\circ$		
	solving to give $\mu = \frac{\sqrt{3}}{5}$; 0.346 or 0.35.	DM1 A1	Equation in μ only. Dependent on 4 M marks for their equations.
	Reactions in the wrong direction(s) – check carefully		
		(9)	
		[11]	

Question Number	Scheme	Marks	Notes
5. (a)	$2mu = 2mv_P + mv_Q$	M1	CLM. Needs all 3 terms of correct form but condone sign slips
		A1	Correct equation
	$\frac{3}{4}mu^2 = \frac{1}{2}2mv_P^2 + \frac{1}{2}mv_Q^2$	M1	KE after impact. 3 terms of correct form
		A1	Correct equation
	$3v_Q^2 - 4uv_Q + u^2 = 0$ or $12v_P^2 - 16uv_P + 5u^2 = 0$	M1	Use CLM equation to form quadratic in v_P or v_Q
		A1	Correct equation
	$v_Q = \frac{u}{3}, v_P = \frac{5u}{6}$ or $v_Q = u, v_P = \frac{u}{2}$	DM1	Solve for a value of v_Q . Dependent on the previous M1.
		A1	A v_Q, v_P pair correct or two correct values for v_Q
	$v_Q = u$	DM1	Select solution from a choice of two. Dependent on all 4 M marks.
 since $v_Q > v_P$	A1	Correct justification
		(10)	
(b)	$e = \frac{u - \frac{u}{2}}{u} \left(\frac{v_Q - v_P}{u} \right)$	M1	Impact law. Must be used correctly. Condone $\pm e$ Follow their speeds from (a).
		A1 ft	Correct for their speeds
	$= \frac{1}{2}$	A1	
		(3)	
		[13]	

Question Number	Scheme	Marks	Notes
6. (a)	$ABC \quad ADE \quad BCED$		
	$M \quad \frac{4M}{9} \quad \frac{5M}{9}$	B1	Correct mass ratios
	$\frac{h}{3} \quad (\frac{h}{3} + \frac{1}{3} \frac{2h}{3}) \quad \bar{y}$	B1	Correct distance ratios
		M1	Moments equation. Condone sign slip
	$M \frac{h}{3} - \frac{4M}{9} \frac{5h}{9} = \frac{5M}{9} \bar{y}$	A1	
	$\bar{y} = \frac{7h}{45}$ * Answer Given*	A1 (5)	
(b)		M1	Moments equation for the folded shape. Requires correct mass ratios, and terms of correct structure.
	$\frac{5M}{9} \frac{7h}{45} + \frac{4M}{9} \left(\frac{h}{3} - \frac{1}{3} \times \frac{2h}{3} \right) = M \bar{x}$	A1 A1	-1 each error $\frac{h}{9}$
	$\bar{x} = \frac{11h}{81}$	A1 (4)	
(c)	$\tan \alpha = \frac{\frac{h}{3} - \bar{x}}{\frac{2a}{3}}$	M1 A1 ft	Use of tan in correct triangle. Allow reciprocal. Correct unsimplified for their \bar{x}
	$= \frac{8h}{27a}$	DM1 A1	Substitute and simplify
		(4)	
		[13]	

Question Number	Scheme	Marks	Notes
7. (a)	$(\rightarrow)\sqrt{27ag} \cos \theta. t = 9a$	M1	Horizontal motion. Condone trig confusion.
		A1	
	$(\uparrow)\sqrt{27ag} \sin \theta. t - \frac{1}{2}gt^2 = 6a$	M1	Vertical motion. Condone sign errors and trig confusion.
		A1	
	$(\uparrow)\sqrt{27ag} \sin \theta. \frac{9a}{\sqrt{27ag} \cos \theta} - \frac{1}{2}g \left(\frac{9a}{\sqrt{27ag} \cos \theta} \right)^2 = 6a$	DM1	Substitute for t (unsimplified). Dependent on both previous M marks
	$9a \tan \theta - \frac{1}{2}g \cdot 81a^2 \frac{(1 + \tan^2 \theta)}{27ag} = 6a$	DM1	Express all trig terms in terms of \tan . Dependent on preceding M.
	$\tan^2 \theta - 6 \tan \theta + 5 = 0$	A1 (7)	
(b)	$\tan^2 \theta - 6 \tan \theta + 5 = 0$		
	$(\tan \theta - 1)(\tan \theta - 5) = 0$	M1	Method to find one root of the quadratic
	$\tan \theta_2 = 1 \quad \text{or} \quad \tan \theta_1 = 5$	A1 A1 (3)	
(c)	$t = \frac{9a}{\sqrt{27ag} \cos \theta} = \frac{9a}{\sqrt{27ag}} \times \frac{\sqrt{26}}{1}$	M1 A1ft	Use $\tan \theta =$ their 5 to find t . Correct unsimplified. Correct $\cos \theta$ for their $\tan \theta$
	$= \sqrt{\frac{81a^2 \cdot 26}{27a}} = \sqrt{\frac{78a}{g}} * \text{Answer given} *$	A1 (3)	Given answer \rightarrow evidence of working is required

Question Number	Scheme	Marks	Notes
Question 7 continued...			
(d)	$\frac{1}{2} m(27ag - v^2) = mg 6a$	M1 A1	Conservation of energy. Requires all 3 terms. Condone sign error Correct equation
	$v = \sqrt{15ag}$	A1 (3)	
Or (d)	$v^2 = \left(\sqrt{27ag} \cos \theta \right)^2 + \left(\sqrt{27ag} \sin \theta - g \cdot \sqrt{\frac{78a}{g}} \right)^2$	M1	Horizontal and vertical components and Pythagoras. Condone trig confusion.
	$= \left(\frac{27ag}{26} \right) + \left(5\sqrt{\frac{27ag}{26}} - \sqrt{78ag} \right)^2 \left(= ag \left(\frac{27}{26} + \frac{363}{26} \right) \right)$	A1	Correctly substituted
	$v = \sqrt{15ag}$	A1 (3)	
		[16]	

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