



Mark Scheme (Results)

Summer 2019

Pearson Edexcel GCE In Mechanics 3
Paper 6679/01

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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.
- When examiners are in doubt regarding the application of the mark scheme to a candidate's response, the team leader must be consulted.
- 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 \surd 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

General Principles for Mechanics Marking

(But note that specific mark schemes may sometimes override these general principles)

- Rules for M marks: correct no. of terms; dimensionally correct; all terms that need resolving (i.e. multiplied by cos or sin) are resolved.
- Omission or extra g in a resolution is an accuracy error not method error.
- Omission of mass from a resolution is a 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. However, premature approximation should be penalised every time it occurs.

Marks must be entered in the same order as they appear on the mark scheme.

- 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
- Mechanics Abbreviations

M(A)	Taking moments about A
N2L	Newton's Second Law (Equation of Motion)
NEL	Newton's Experimental Law (Newton's Law of Impact)
HL	Hooke's Law
SHM	Simple harmonic motion
PCLM	Principle of conservation of linear momentum
RHS, LHS	Right hand side, left hand side.

Question Number	Scheme	Marks
1.	<p>Mass ratio 1 $\frac{2}{5}$ $\frac{7}{5}$ (5 2 7)</p> <p>Dist from O $\frac{h}{2}$ $h + \frac{x}{3}$ $\frac{3h}{4}$</p> $5 \times \frac{h}{2} + 2 \times \left(h + \frac{x}{3} \right) = 7 \times \frac{3h}{4}$ $x = \frac{9h}{8}$	<p>B1</p> <p>M1A1ft</p> <p>A1</p> <p style="text-align: right;">[4]</p>
Notes		
<p>B1</p> <p>M1</p> <p>A1ft</p> <p>A1</p>	<p>Correct distances – using $h + \frac{x}{3}$ or d (distance from ground). May use distances from the vertex or centre of the common face</p> <p>Dimensionally correct moments equation</p> <p>Correct equation, follow through their distances</p> <p>Correct height of cone</p>	

Question Number	Scheme	Marks
2		
(a)	At surface $\frac{k}{R^2} = mg \Rightarrow k = mgR^2$ *	M1A1cso (2)
(b)	$m\ddot{x} = -\frac{mgR^2}{x^2}$ $v \frac{dv}{dx} = -\frac{gR^2}{x^2}$ $\int v \frac{dv}{dx} dx = -gR^2 \int \frac{1}{x^2} dx \quad \text{or} \quad \int \frac{d(\frac{1}{2}v^2)}{dx} dx = -gR^2 \int \frac{1}{x^2} dx$ $\frac{1}{2}v^2 = \frac{gR^2}{x} (+c)$ $x = \frac{4R}{3}, v = \sqrt{\frac{2gR}{5}} \Rightarrow c = -\frac{11gR}{20}$ $v = 0 \quad 0 = \frac{gR^2}{x} - \frac{11gR}{20} \Rightarrow x = \dots \left(\frac{20R}{11} \right)$ <p>Height above surface = $\frac{9R}{11}$</p>	M1 DM1A1ft DM1A1 M1 A1 (7)
[9]		

Notes

(a)	Attempt NL2
M1	Complete to the given result – no errors in work
A1cso	
(b)	
M1	Attempt NL2 minus may be missing. Accel to be form $v \frac{dv}{dx}$
DM1	Attempt integration.
A1ft	Correct integration – follow through their equation
DM1	Use given initial conditions to obtain a value for the constant (Definite integration must have correct limits)
A1	Correct constant (not ft) (or correct equation following substitution of limits)
M1	Use $v = 0$ and obtain a value for x (or solve the equation for x)
A1	Complete to correct height above the surface

Question Number	Scheme	Marks
<p>3(a)</p>	$T = \frac{\lambda x}{1}$ $25 = \frac{\lambda \times 0.5}{1.5}$ $\lambda = 75 \text{ N}$ $\text{Initial EPE} = \frac{\lambda x^2}{2l} = \frac{75 \times 0.5^2}{3} \quad (\text{J})$ $\frac{75 \times 0.5^2}{3} - \frac{3}{4} \times \frac{1}{2} g \times 0.5 = \frac{1}{2} \times 0.5 v^2$ $v^2 = 17.65$ $v = 4.201... \quad v = 4.2 \text{ or } 4.20 \text{ m s}^{-1}$	<p>M1 A1 B1 M1A1ft A1 (6)</p>
<p>(b)</p>	<p>Comes to rest $0.75 \times 0.5 g \times y = \frac{75 \times 0.5^2}{3}$</p> $y = \frac{75 \times 0.5^2}{0.75 \times 0.5 \times 9.8 \times 3} = 1.7 \text{ or } 1.70 \text{ m}$	<p>M1A1 A1 (3) [9]</p>
Notes		
<p>(a) M1 A1 B1 M1 A1ft A1 (b) M1 A1 A1</p>	<p>Attempt HL Obtain $\lambda = 75$ Correct initial EPE 3 term energy equation Correct equation, follow through their EPE Correct speed, 2 or 3 s f</p> <p>Attempt energy equation to rest Correct energy equation to rest, no ft Correct distance BC</p>	
<p>ALT 1</p>	<p>ALTs for (b): Equate KE at nat length to work done by friction Solve for distance (1.2) Add 0.5 to answer.</p>	
<p>ALT 2</p>	<p>Find deceleration (3/4 g) Use SUVAT equation to find distance Add 0.5 to answer</p> <p>M1 complete method for the distance, A1 correct distance, A1 correct answer.</p>	

Question Number	Scheme	Marks
<p>4</p> <p>(a)</p> <p>(b)</p>	$R(\uparrow) T \cos 30^\circ + R \cos 60^\circ = mg$ <p>NL2 along radius: $T \sin 30^\circ + R \sin 60^\circ = m(a \cos 30^\circ) \omega^2$</p> $T = mg\sqrt{3} - \frac{\sqrt{3}}{2} ma\omega^2 \quad \text{oe}$ $R = \frac{3}{2} ma\omega^2 - mg$ <p>For contact: $\frac{3}{2} ma\omega^2 - mg > 0$</p> $\omega^2 > \frac{2g}{3a}$ $\text{time for 1 rev} = \frac{2\pi}{\omega} < 2\pi \sqrt{\frac{3a}{2g}} \quad *$	<p>M1A1</p> <p>M1A1A1</p> <p>DM1A1 (7)</p> <p>B1</p> <p>M1</p> <p>A1</p> <p>DM1A1cso (5) [12]</p>
Notes		
<p>(a)</p> <p>M1</p> <p>A1</p> <p>M1</p> <p>A1</p> <p>A1</p> <p>DM1</p> <p>A1</p> <p>(b)</p> <p>B1</p> <p>M1</p> <p>A1</p> <p>DM1</p> <p>A1cso</p>	<p>Resolve vertically, 3 term equation</p> <p>Correct equation</p> <p>Attempt NL2 along the radius, radius may be r, both forces included and resolved</p> <p>Correct LHS</p> <p>Correct RHS</p> <p>Solve the equations to obtain an expression for the tension. Depends on previous 2 M marks</p> <p>Correct expression – any equivalent allowed</p> <p>Correct expression for R - any equivalent allowed</p> <p>Use $R > 0$</p> <p>Correct expression for ω or ω^2</p> <p>Use $T = \frac{2\pi}{\omega}$ and correct inequality to obtain the time for 1 rev</p> <p>Correct given answer from correct working.</p>	

Question Number	Scheme	Marks
5(a)	$\text{Vol} = \pi \int_0^3 y^2 dx = \pi \int_0^3 3x dx$ $= \pi \left[\frac{3x^2}{2} \right]_0^3 = \frac{27\pi}{2}$ $\pi \int_0^3 xy^2 dx = \pi \int_0^3 3x^2 dx$ $\pi \left[x^3 \right]_0^3 = 27\pi$ $\frac{\bar{x}}{x} = \frac{\int xy^2 dx}{\int y^2 dx} = 27 \div \frac{27}{2} = 2$	<p>M1</p> <p>A1</p> <p>M1</p> <p>A1</p> <p>DM1A1 (6)</p>
(b)	$\tan \alpha = \frac{3}{3 - \bar{x}} = \frac{3}{1}$ <p>$\alpha = 71.5\dots$ Accept 71° or 72° for max</p> <p>Moments about B:</p>	<p>M1A1</p> <p>A1 (3)</p>
(c)	<p>eg $k(Mg) \times 6 \sin 10^\circ = (Mg) \cos 10 (1 - 3 \tan 10)$</p> <p>or $k(Mg) \times 6 \sin 10^\circ = (Mg) \sin \left(\tan^{-1} \left(\frac{1}{3} \right) - 10^\circ \right) \times \sqrt{10}$</p> <p>$k = 0.445$</p>	<p>M1A1A1</p> <p>A1 (4)</p> <p>[13]</p>

Notes

(a)	Correct volume integral – ignore any limits shown - π may be omitted
M1	Correct result for the volume π may be omitted
A1	
M1	Attempt $\pi \int_0^3 xy^2 dx = \pi \int_0^3 3x^2 dx$ ignore limits π may be omitted
A1	Correct result for this integral - π may be omitted
DM1	Attempt $\frac{\bar{x}}{x} = \frac{\int xy^2 dx}{\int y^2 dx}$ using their results. π in both or neither integral. Depends on both previous M marks
A1	Correct answer
(b)	
M1	For $\tan \alpha$ either way up with their \bar{x}
A1	Correct value for $\tan \alpha$
A1	Correct value for α_{\max}
(c)	
M1	Attempt a moments about B
A1	Either term correct
A1	Second term correct
A1	Correct value for k – must be 3 sf

Question Number	Scheme	Marks
6(a)	Energy A to B: $\frac{1}{2}mU^2 - \frac{1}{2}mv^2 = mgr(1 + \cos \alpha)$	M1A1
	NL2 at B (R) + $mg \cos \alpha = m \frac{v^2}{r}$	M1A1A1
	$\cos \alpha = \frac{1}{3gr}(U^2 - 2gr) \quad *$	DM1A1 (7)
(b)	$\frac{1}{4} = \frac{1}{3gr}(U^2 - 2gr)$	M1
	$U^2 = \frac{11gr}{4}$	A1
	Energy A to C $\frac{1}{2}mU^2 - \frac{1}{2}mV^2 = mgr$	M1
	$V^2 = \frac{11gr}{4} - 2gr, \quad V = \sqrt{\frac{3gr}{4}} \quad \text{oe}$	DM1A1 (5)
[12]		

Notes

(a)	
M1	Attempt an energy equation from A to B. Must have 2 KE terms and 1 or 2 PE terms
A1	Fully correct equation
M1	Attempt an eqn of motion along the radius at B. Weight must be resolved, R may be included or assumed to be zero here. Acceleration in either form.
A1	Correct LHS, with or without R
A1	Correct acceleration as shown
DM1	Make R = 0 (if included) and solve for $\cos \alpha$ Depends on both previous M marks
A1cso	Correct given expression for $\cos \alpha$ obtained from fully correct working.
(b)	
M1	Use $\cos \alpha = \frac{1}{3}$ to obtain an expression for U^2 or v_B^2
A1	Correct expression for U^2 or v_B^2
M1	Attempt an energy equation from A to C or B to C. Must have the correct no of terms and KE and GPE terms must be consistent.
DM1	Solve the equations to obtain an expression for V^2 – need not be simplified. Depends on both M marks above.
A1	Correct, simplified, expression for V

Question Number	Scheme	Marks
7 (a)	$T_{AC} = \frac{12x}{1.6}$	M1
	$T_{BC} = \frac{15(1.2-x)}{1.2}$	A1
	$\frac{12x}{1.6} = \frac{15(1.2-x)}{1.2} \Rightarrow x = \dots$	M1
	$x = 0.75$	A1
	(i) AC = 2.35 m (ii) BC = 1.65 m	A1 (5)
(b)	$\frac{15(0.45-y)}{1.2} - \frac{12(0.75+y)}{1.6} = 0.4\ddot{y}$	M1A1
	$-20y = 0.4\ddot{y}$	DM1
	$\ddot{y} = -50y \therefore$ SHM (about C)	A1 (4)
(c)	Max speed = $\frac{8\sqrt{2}}{5 \times 0.4}, (= 4\sqrt{2}) = a\omega$	M1,M1
	$a = \frac{4\sqrt{2}}{\sqrt{50}} (= 0.8 \text{ m})$	A1
	$0.4 = 0.8 \sin(\sqrt{50}t)$	M1
	$t = \frac{1}{\sqrt{50}} \sin^{-1}\left(\frac{1}{2}\right)$	A1
	$4t = kS$	
	$\frac{4}{\sqrt{50}} \times \frac{\pi}{6} = k \frac{2\pi}{\sqrt{50}}$	DM1
	$k = \frac{1}{3}$	A1 (7) [16]
Notes		
(a)M1	HL for either string	
A1	Correct equations for both strings	
M1	Equate tensions and solve for the extension in one string	
A1	Correct extension for either string	
A1	Obtain the 2 required (correct) lengths –decimal or exact	
(b)M1	Attempt an equation of motion with the difference of 2 tensions. \ddot{y} or a for acceleration	
A1	Correct equation. \ddot{y} or a for acceleration	
DM1	Simplified equation. Must have \ddot{y} now. Depends on the previous M mark	
A1	Correct result for \ddot{y} and conclusion	
(c)M1	Use impulse-momentum equation to obtain the max speed	
M1	Equate their max speed to $a\omega$	
A1	Correct result for a. Need not be simplified.	
M1	Use $x = a \sin \omega t$ or $x = a \cos \omega t$ with their a and ω	
A1	Correct time for their choice of equation	
DM1	Correct method to complete to a value for k. Method used will depend on their choice of equation for time. Depends on all M marks in (c)	
A1	Correct k	

