

# EDEXCEL FOUNDATION

Stewart House 32 Russell Square London WC1B 5DN

JUNE 2001

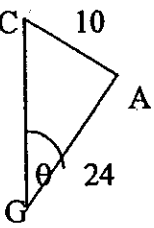
Advanced Supplementary/Advanced Level

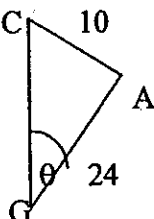
General Certificate of Education

Subject MECHANICS 6678

Paper No. M2

Find Scheme  
for Examiners.

Question number	Scheme				Marks
1.	Finding $\dot{\mathbf{r}}$	$[(2t + 2)\mathbf{i} + (1 - 4t)\mathbf{j}]$			B1
	Differentiating again to give $\ddot{\mathbf{r}}$	$\ddot{\mathbf{r}} = 2\mathbf{i} - 4\mathbf{j}$ (any notation)			M1A1
	Method for magnitude:	$\sqrt{2^2 + (-4)^2} ; = \sqrt{20}$ or 4.47 (ms <sup>-2</sup> )			M1A1 (5)
	[Note: use of consecutive <sup>integer</sup> values of t substituted and "second differences found", giving $2\mathbf{i} - 4\mathbf{j}$ scores 30M0, but allow M1A0 for magnitude.]				
2.	(a)	Shape	Small circle	Large circle	Decoration
	Relative masses	100 $\pi$ (1)	400 $\pi$ (4)	500 $\pi$ (5)	M1A1
	Centre of mass from B	30	0	$\bar{y}$	B1
	[Other likely alternatives: from D : (10, 20); A : (0, 40) tangent to larger circle at lowest point "E": (50, 20)]				
	Appropriate moments equation:				M1
	[Most likely: using B : $30 = 5\bar{y}$ ; using D : $4 \times 20 - 1 \times 10 = 5\bar{y}$ (14) using A : $4 \times 30 = 5\bar{y}$ (24) ; using E : $4 \times 20 + 1 \times 50 = 5\bar{y}$ (26)]				
	Answer: 6 cm				A1 (5)
	(b)		CG drawn vertical or CGA		M1
		Method to find $\theta$ [or (90 - $\theta$ )]			M1
		$\tan \theta = \frac{10}{\frac{AG}{30-6c}}$ or $\tan (90 - \theta) = \frac{AG}{10}$ , or equivalent			A1 $\sqrt{}$
		Answer: $\sim 22.6^\circ$ (this answer only)			A1 (4)
	[Note: If finding AC to vertical, then can score first three marks]				



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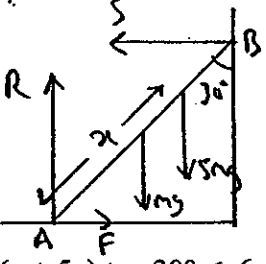
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Advanced Supplementary/Advanced Level

General Certificate of Education

Subject MECHANICS 6618

Paper No. M2

Question number	Scheme	Marks
3.	<p>[Wherever <math>\leq</math> or <math>\geq</math> used in scheme, can be replaced by <math>=</math>]</p>  <p>Resolve <math>\rightarrow</math>: <math>S = F</math>  Resolve <math>\uparrow</math>: <math>R = 6mg</math></p> <p>M(A): <math>S 2a \cos 30^\circ = mg \sin 30^\circ (a + 5x)</math>  "<math>F \leq 0.5 R</math>" <math>\Rightarrow S \leq 3mg</math></p> <p><math>\Rightarrow (a + 5x) \tan 30^\circ \leq 6a, \quad x \leq \frac{(6\sqrt{3}-1)a}{5} \Rightarrow k = \frac{(6\sqrt{3}-1)}{5} \text{ or } 1.88</math></p> <p>[Alternatives:  M(B): <math>R 2a \sin 30^\circ = F 2a \cos 30^\circ + mga \sin 30^\circ + 5mgd \sin 30^\circ</math> M1A1A1  <math>d = 2a - x</math> B1; "<math>F \leq 0.5 R</math>" <math>\Rightarrow F \leq 3mg</math> M1, rest as scheme.</p> <p>M(centre): <math>Ra \sin 30^\circ + 5mg(x-a) \sin 30^\circ = (F+S) a \cos 30^\circ</math>; <math>S \leq 3mg</math> etc.  Mark as scheme.]</p> <p>[Note (i): MR - <math>30^\circ</math> to the ground - gives <math>k = \frac{(6-\sqrt{3})}{5}</math> or 0.493</p> <p>(ii) The same answer is obtained if only error is sin/cos confusion; both score 7/9.  (iii) m used for mg throughout, no penalty; inconsistent, as scheme but max -2]</p>	<p>B1  M1A1  M1A1A1  M1  M1A1 (9)</p>
4.	<p>(a) Impulse = change in momentum  <math>3.5 \mathbf{i} + 3 \mathbf{j} = 0.1[(10 \mathbf{i} + 25 \mathbf{j}) - (u \mathbf{i} + v \mathbf{j})]</math>  Answer: <math>u \mathbf{i} + v \mathbf{j} = (-25 \mathbf{i} - 5 \mathbf{j}) \text{ ms}^{-1}</math></p> <p>(b) Complete method to find height <math>s</math> above hit position  Correct equation in <math>s</math> only: <math>0 = 625 - 2(9.8)s</math>; <math>s = 25(25/g) - \frac{1}{2}g(25/g)^2</math>  Answer: <math>32.9 \text{ m}</math> or <math>33 \text{ m}</math></p> <p>(c) Method for total time: <math>0 = 25t - 4.9t^2 \Rightarrow t = 5.10 \text{ s}</math>  or "half time" <math>0 = 25 - 9.8t' \Rightarrow t' = 2.55 \text{ s}</math>  Horizontal distance = <math>10 \times t = 51 \text{ m}</math> [<math>\sqrt{\text{for } 10t \text{ or } 20t'}</math>]</p> <p>[Notes: If <math>\mathbf{i}</math> and <math>\mathbf{j}</math> interchanged, then can score Ms in (b) and (c); allow <math>\sqrt{\phantom{x}}</math> for <math>25 \times 2.04 = 51</math>.  [Use of answer in (a) can score M marks in (b)(c) only  [Use of <math>\frac{V^2 \sin^2 \theta}{2g}</math> and <math>\frac{V^2 \sin 2\theta}{g}</math>: M1 method for <math>V</math> or <math>\theta</math>, A1 both correct for first two marks]</p>	<p>M1A1  A1 (3)</p> <p>M1  A1  A1 (3)</p> <p>M1A1  M1A1 <math>\sqrt{\phantom{x}}</math> (4)</p>

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5.	<p>(a) Using work/energy equation:</p> <p>(i) P.E. = <math>\pm 0.5gh</math>, = <math>\pm g \sin 20^\circ</math> ; (ii) K.E. = <math>\frac{1}{2} \times 0.5 \times 25</math></p> <p><math>\frac{1}{2} \times 0.5 \times 25 = 0.5 gh + 2R</math></p> <p>Solving for R; <math>R = 1.45</math> or <math>1.4</math></p> <p>[ Note: <math>2(R + 0.5 \times 9.8 \times \sin 20^\circ) = \frac{1}{2} (0.5)25</math> scores first 5 marks, mark as scheme ]</p> <p><i>Alternative method:</i></p> <p>Speed equation for a : <math>0 = 25 \pm 2a</math> (2) (<math>a = \pm 6.25</math>)</p> <p>Equation of motion: <math>(R + 0.5 \times 9.8 \times \sin 20^\circ) = \pm 0.5a</math></p> <p>Totally correct equation: <math>-(R + 0.5 \times 9.8 \times \sin 20^\circ) = 0.5a</math>, a -ve</p> <p>Solving for R</p> <p>(b) Complete method for s</p> <p>[Work/energy equation: <math>\frac{1}{2} \times 0.5 \times 25 = s R + 0.5 \times 9.8 \times s \sin 40^\circ</math></p> <p>or <math>-(R + 0.5g \sin 40^\circ) = 0.5a</math> (<math>a = -9.2</math>) and <math>0 = 25 + 2as</math> ]</p> <p>Answer: <math>s = 1.36</math> m or <math>1.4</math> m</p>	<p>M1,A1;B1</p> <p>M1A1</p> <p>M1A1 (7)</p> <p>M1A1</p> <p>M1A1</p> <p>A1</p> <p>M1A1</p> <p>M1A1✓</p> <p>A1 (3)</p>
6.	<p>(a) <math>\rightarrow v_1</math> <math>\rightarrow v_2</math> CoM: <math>4mu + 4mu = 2m v_1 + 4m v_2</math></p> <p><math>\rightarrow 2u</math> <math>\rightarrow u</math> <math>\Rightarrow 4u = v_1 + 2 v_2</math></p> <p>A <math>\bigcirc</math> B <math>\bigcirc</math></p> <p>2m 4m</p> <p>NEL: <math>\frac{1}{2} (2u - u) = v_2 - v_1</math></p> <p>Solving to find <math>v_2</math>; <math>v_2 = \frac{3u}{2}</math></p> <p>(b) Substitute for <math>v_2</math> in one equation; <math>v_1 = v_2 - \frac{1}{2} u = u</math></p> <p>(c) <math>\rightarrow w_1</math> <math>\rightarrow w_2</math> CoM: <math>4m(\frac{3}{2}u) = 4m w_1 + m w_2</math></p> <p><math>\rightarrow \frac{3}{2}u</math> <math>\rightarrow 0</math> <math>\Rightarrow 6u = 4w_1 + w_2</math></p> <p><math>\bigcirc</math> B <math>\bigcirc</math> C</p> <p>4m m</p> <p>NEL: <math>e(\frac{3}{2}u) = w_2 - w_1</math></p> <p>Solving for <math>w_1</math> as f(e) : <math>w_1 = \frac{3u(4-e)}{10}</math> or e as f(<math>w_1</math>): <math>e = \frac{2(6u-5w_1)}{3u}</math></p> <p>Requirement is that <math>w_1 \geq</math> candidate's <math>v_1 = u</math>; <math>\Rightarrow e \leq \frac{2}{3}</math></p> <p>[Note: If <math>w_1</math> or e not found (not asked for): Setting <math>w_1 = v = u \Rightarrow w_2 = 2u \Rightarrow e = \frac{2}{3}</math> is M1A1 but need to deal with inequality for final M1A1]</p>	<p>M1A1</p> <p>M1A1</p> <p>M1A1cso(6)</p> <p>M1A1 (2)</p> <p>M1A1</p> <p>M1A1</p> <p>M1A1</p> <p>M1;A1 (8)</p>

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7.	<p>(a) <math>U_y = 23.75 \sin \alpha (= 19)</math></p> <p>Complete method to find time, e.g. <math>-2.4 = 23.75 \sin \alpha t - \frac{1}{2}gt^2</math></p> <p>Solving to find <math>t</math>; <math>t = 4</math></p> <p>(b) <math>\frac{dv}{dt} = -\frac{1}{4}t^2</math></p> $\Rightarrow v = -\frac{1}{12}t^3 + c$ <p><math>t = 0, v = 18 \Rightarrow v = 18 - \frac{1}{12}t^3</math></p> <p>(c) Putting <math>v = 0</math> expression in (b)</p> <p>Solving equation [dependent on previous M1 and M1 in (b)]</p> <p>Finding <math>T = 6</math>, with no wrong working seen [Allow verification]</p> <p>(d) Distance <math>\rightarrow</math> travelled by package <math>= 23.75 \cos \alpha \times 4_c = 57</math> m [✓ only on <math>14.25 \times 4_c</math>]</p> <p>For lorry <math>s = 18t - \frac{1}{48}t^4</math></p> <p>Showing <math>s = 66\frac{2}{3}</math> for lorry, and distance them between is just under 10m</p> <p>[If lorry moving in direction CA, allow final answer of just under 124m]</p>	<p>B1</p> <p>M1A1</p> <p>M1A1 (5)</p> <p>M1A1</p> <p>A1 (3)</p> <p>M1</p> <p>M1</p> <p>A1 cso (3)</p> <p>M1A1✓</p> <p>M1;A1✓</p> <p>A1 cso (5)</p>
<p>Geoff Staley 25/6/01</p>		