GCE Examinations

Advanced Subsidiary / Advanced Level

Mechanics
Module M2

Paper B

MARKING GUIDE

This guide is intended to be as helpful as possible to teachers by providing concise solutions and indicating how marks should be awarded. There are obviously alternative methods that would also gain full marks.

Method marks (M) are awarded for knowing and using a method.

Accuracy marks (A) can only be awarded when a correct method has been used.

(B) marks are independent of method marks.



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M2 Paper B – Marking Guide

1. *(a)* work done = force × dist. = $8000 \times 0.04 = 320$ J — M1 A1

(b) work done = change in KE = $\frac{1}{2}m(v^2 - u^2)$ — M1

$= \frac{1}{2}0.025(v^2 - 200^2)$ $\therefore v^2 - 40\,000 = {}^-25\,600$ — M2 A1

$v^2 = 14\,400$ $\therefore v = 120$ ms^{-1} — A1 **(7)**

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2. *(a)* at max. speed, $a = 0$, $\frac{P}{v} - R = 0$ $\therefore \frac{P}{30} - 2000 = 0$ — M1 A1

$P = 60\,000$ W $\therefore H = 60$ — A1

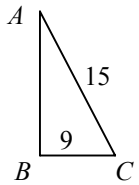
(b) $1.2 \times 60 = 72$ — A1

$\frac{P}{v} - R = ma$ $\therefore \frac{72000}{30} - 2000 = m \times 0.32$ — M1 A1

$400 = 0.32m$ $\therefore m = 1250$ kg — A1 **(7)**

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3. *(a)*



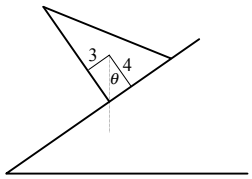
(i) c.o.m. = $\frac{1}{3}$ dist. from B to C = $\frac{1}{3} \times 9 = 3$ cm from AB — M1 A1

(ii) $AB = \sqrt{(15^2 - 9^2)} = 12$ cm — M1 A1

c.o.m. = $\frac{1}{3}$ dist. from B to A = $\frac{1}{3} \times 12 = 4$ cm from BC — M1 A1

(b) lamina will not topple if vertical through c.o.m. passes between B and C — B1

max. θ when it passes through B — B1



$\tan\theta = \frac{3}{4}$ $\therefore \theta = 36.9°$ (1dp) — M1 A1 **(10)**

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4. *(a)* $\mathbf{a} = \frac{d\mathbf{v}}{dt} = 3\mathbf{i} - 2t\mathbf{j}$ and when $t = 2$, $\mathbf{a} = 3\mathbf{i} - 4\mathbf{j}$ — M1 A1

mag. of $\mathbf{a} = \sqrt{[(3)^2 + ({}^-4)^2]} = 5$ ms^{-2} — M1 A1

(b) $s = \int v\,dt = \frac{3}{2}t^2\mathbf{i} - \frac{1}{3}t^3\mathbf{j} + A\mathbf{i} + B\mathbf{j}$ — M1 A1

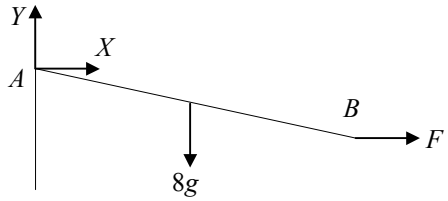
when $t = 0$, $s = 6\mathbf{i} + 12\mathbf{j}$ so $A = 6$, $B = 12$ — M1

$s = (\frac{3}{2}t^2 + 6)\mathbf{i} + (12 - \frac{1}{3}t^3)\mathbf{j}$ — A1

disp. when $t = 6$ is $60\mathbf{i} - 60\mathbf{j} = 60(\mathbf{i} - \mathbf{j})$ $\therefore k = 60$ — M1 A1 **(10)**

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5. *(a)*



mom. about A $\quad 8g(a\cos 20°) - F(2a\sin 20°) = 0$ — M1 A1

$F = \frac{4g}{\tan 20^\circ} = 108$ N (3sf) — M1 A1

(b) resolve $\rightarrow$: $\quad F + X = 0 \ \therefore X = {}^-108$ — A1

resolve $\uparrow$: $\quad Y - 8g = 0 \ \therefore Y = 78.4$ N — A1

mag. of reaction at hinge $= \sqrt{[({}^-108)^2 + (78.4)^2]} = 133$ N (3sf) — M1 A1

req'd angle $= \tan^{-1}\frac{108}{78.4} = 54°$ (nearest degree) to the vertical — M1 A1 **(10)**

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6. *(a)* $s_y = (ut\sin\alpha - \frac{1}{2}gt^2) = t(u\sin\alpha - \frac{1}{2}gt)$ — M1 A1

$s_y = 0$ when $t = 0$ (at A) and when $t = \frac{2u}{g}\sin\alpha$ (at B) — A1

$s_x = ut\cos\alpha = u(\frac{2u}{g}\sin\alpha)\cos\alpha$ (at B) — M1

$= \frac{u^2}{g}(2\sin\alpha\cos\alpha) = \frac{u^2}{g}\sin 2\alpha$ — M1 A1

(b) $\frac{u^2}{g}\sin 2\alpha = 80 \quad \therefore \frac{45^2}{9.8}\sin 2\alpha = 80$ — M1 A1

$\sin 2\alpha = 0.387$ $\quad$ giving $\alpha = 11.4°, 78.6°$ (1dp) — M2 A1

(c) 11.4° as larger horiz. component of vel. — B2

(d) $t = \frac{2\times 45}{g}\sin(11.4°) = 1.8$ seconds (1dp) — M1 A1 **(15)**

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7. *(a)* cons. of mom: $4m(u) + 0 = 4mv_1 + 5mv_2$ — M1

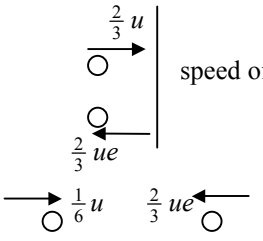
$4u = 4v_1 + 5v_2$ — A1

$\frac{v_2 - v_1}{u - 0} = \frac{1}{2} \ \therefore \ u = 2v_2 - 2v_1$ — M1 A1

solve sim. eqns. to get $v_1 = \frac{1}{6}u$, $v_2 = \frac{2}{3}u$ — M1 A1

$\therefore \ v_2 = \frac{4}{6}u = 4 \times v_1$ — A1

(b)



speed of B after collision with wall $= \frac{2}{3}ue$ — M1 A1

cons. of mom: $4m(\frac{1}{6}u) - 5m(\frac{2}{3}ue) = 4mw_1 + 0$ — M1 A1

$\frac{2}{3}u - \frac{10}{3}ue = 4w_1 \quad \therefore \ 12w_1 = 2u - 10ue$ — A1

$\frac{0 - w_1}{\frac{1}{6}u + \frac{2}{3}ue} = \frac{1}{2} \quad \therefore {}^-w_1 = \frac{1}{12}u + \frac{1}{3}ue$ $\quad$ giving $\quad {}^-12w_1 = u + 4ue$ — M1 A1

eliminating w_1 gives $u + 4ue + 2u - 10ue = 0$ — M1

$3u = 6ue \ \therefore \ e = \frac{1}{2}$ — A1 **(16)**

Total **(75)**

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Performance Record – M2 Paper B

Question no.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	Total
Topic(s)	work - energy	power	centre of mass, toppling	**i**, **j** calculus	statics	projectiles	collisions	
Marks	7	7	10	10	10	15	16	75
Student								

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