

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.



Written by Shaun Armstrong & Chris Huffer

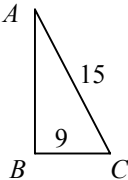
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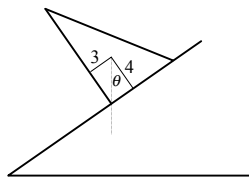
M2 Paper B – Marking Guide

1. (a) work done = force \times dist. = $8000 \times 0.04 = 320 \text{ J}$ M1 A1
- (b) work done = change in KE = $\frac{1}{2} m(v^2 - u^2)$ M1
 $= \frac{1}{2} \times 0.025(v^2 - 200^2) \therefore v^2 - 40000 = -25600$ M2 A1
 $v^2 = 14400 \therefore v = 120 \text{ ms}^{-1}$ 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
 $P = 60000 \text{ W} \therefore H = 60$ A1
- (b) $1.2 \times 60 = 72$ A1
 $\frac{P}{v} - R = ma \therefore \frac{72000}{30} - 2000 = m \times 0.32$ M1 A1
 $400 = 0.32m \therefore m = 1250 \text{ kg}$ A1 (7)
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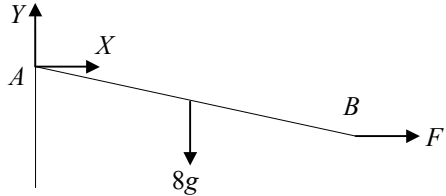
3. (a)  M1 A1
- (i) c.o.m. = $\frac{1}{3}$ dist. from B to C = $\frac{1}{3} \times 9 = 3 \text{ cm}$ from AB M1 A1
- (ii) $AB = \sqrt{(15^2 - 9^2)} = 12 \text{ cm}$ M1 A1
c.o.m. = $\frac{1}{3}$ dist. from B to A = $\frac{1}{3} \times 12 = 4 \text{ cm}$ from BC M1 A1

- (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

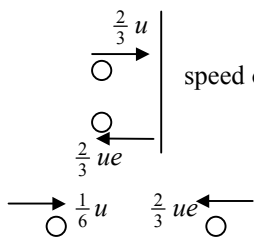


$\tan \theta = \frac{3}{4} \therefore \theta = 36.9^\circ \text{ (1dp)}$ M1 A1 (10)

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 $\mathbf{a} = \sqrt{(3)^2 + (-4)^2} = 5 \text{ ms}^{-2}$ 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 $8g(acos20^\circ) - F(2asin20^\circ) = 0$ M1 A1
 $F = \frac{4g}{\tan 20^\circ} = 108 \text{ N (3sf)}$ M1 A1
- (b) resolve \rightarrow : $F + X = 0 \therefore X = -108$ A1
 resolve \uparrow : $Y - 8g = 0 \therefore Y = 78.4 \text{ N}$ A1
 mag. of reaction at hinge = $\sqrt{(-108)^2 + (78.4)^2} = 133 \text{ N (3sf)}$ M1 A1
 req'd angle = $\tan^{-1} \frac{108}{78.4} = 54^\circ$ (nearest degree) to the vertical M1 A1 (10)

6. (a) $s_y = (ut\sin\alpha - \frac{1}{2}gt^2) = t(ut\sin\alpha - \frac{1}{2}gt)$ 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) $\frac{u^2}{g} \sin 2\alpha = 80 \therefore \frac{45^2}{9.8} \sin 2\alpha = 80$ M1 A1
 $\sin 2\alpha = 0.387$ giving $\alpha = 11.4^\circ, 78.6^\circ$ (1dp) M2 A1
- (c) 11.4° as larger horiz. component of vel. B2
- (d) $t = \frac{2 \times 45}{g} \sin(11.4^\circ) = 1.8$ seconds (1dp) M1 A1 (15)

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
 $\frac{2}{3}u - \frac{10}{3}ue = 4w_1 \therefore 12w_1 = 2u - 10ue$ A1
 $\frac{0 - w_1}{\frac{1}{6}u + \frac{2}{3}ue} = \frac{1}{2} \therefore -w_1 = \frac{1}{12}u + \frac{1}{3}ue$ giving $-12w_1 = u + 4ue$ M1 A1
 eliminating w_1 gives $u + 4ue + 2u - 10ue = 0$ M1
 $3u = 6ue \therefore e = \frac{1}{2}$ A1 (16)

Total (75)

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								