

GCE Examinations
Advanced Subsidiary / Advanced Level

Mechanics
Module M2

Paper A

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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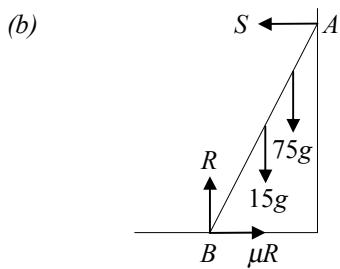
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M2 Paper A – Marking Guide

1. cons. of mom: $m(5) - m(3) = mv_1 + mv_2$ M1
 $v_1 + v_2 = 2$ A1
 $\frac{v_2 - v_1}{5 - (-3)} = \frac{1}{2} \therefore v_2 - v_1 = 4$ M1 A1
 solve simul. giving $v_1 = -1 \text{ ms}^{-1}$ so speed is 1 ms^{-1} , $v_2 = 3 \text{ ms}^{-1}$ M1 A1 **(6)**
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2. (a) $\mathbf{v} = \frac{d\mathbf{r}}{dt} = (2t - 3)\mathbf{i} + \frac{1}{2}t^2\mathbf{j}$ M1 A1
 when $t = 0$, $\mathbf{v} = -3\mathbf{i} \text{ ms}^{-1}$ A1
 (b) at $t = 2$, $\mathbf{v} = \mathbf{i} + 2\mathbf{j} \therefore |\mathbf{v}| = \sqrt{(1^2 + 2^2)} = \sqrt{5}$ M2 A1
 KE lost = $\frac{1}{2}(3)(3^2 - 5) = 6\text{J}$ M1 A1 **(8)**
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3. (a) (i) uniform rod B1
 (ii) particle B1



resolve \uparrow : $R - 15g - 75g = 0 \therefore R = 90g$ M1
 resolve \rightarrow : $\mu R - S = 0 \therefore S = 30g$ M1 A1
 mom. about B $S.8\sin\theta - 15g.4\cos\theta - 75g.d\cos\theta = 0$ M1 A1
 $8S\tan\theta - 60g = 75gd$ M1
 $d = \frac{420g}{75g} = 5.6 \therefore AP = 8 - 5.6 = 2.4 \text{ m}$ M1 A1 **(10)**

4. (a) $a \propto (3t^2 - 5) \therefore a = k(3t^2 - 5)$ M1
 $v = \int a dt = k(t^3 - 5t) + c$ M1 A1
 when $t = 0$, $v = 0$ so $c = 0$ A1
 when $t = 3$, $v = 3$ so $3 = k(27 - 15) \therefore k = \frac{1}{4}$ M1 A1
 $a = \frac{1}{4}(3t^2 - 5)$ A1

- (b) $s = \int v dt = \frac{1}{4}(\frac{1}{4}t^4 - \frac{5}{2}t^2) + c$ M1 A1
 when $t = 0$, $s = 0$ so $c = 0 \therefore s = \frac{1}{4}(\frac{1}{4}t^4 - \frac{5}{2}t^2)$ M1
 $s = \frac{1}{4}t^2(\frac{1}{4}t^2 - \frac{10}{4}) = \frac{1}{16}t^2(t^2 - 10)$ A1 **(11)**
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5. (a), (b)

portion	mass	x	y	mx	my
$ABFG$	256ρ	4	16	1024ρ	4096ρ
$CDEF$	128ρ	16	4	2048ρ	512ρ
total	384ρ	\bar{x}	\bar{y}	3072ρ	4608ρ

ρ = mass per unit area x, y coords. taken horiz. / vert. from G

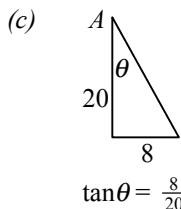
M3 A2

$$\bar{x} = \frac{3072\rho}{384\rho} = 8 \text{ so must lie on } BF$$

M1 A1

$$\bar{y} = \frac{4608\rho}{384\rho} = 12 \therefore \text{dist. from } AB = 20 \text{ cm}$$

M1 A1



$$\tan\theta = \frac{8}{20} \therefore \theta = 21.8^\circ \text{ (1dp)}$$

M1

M1 A1 (12)

6. (a) $\frac{P}{v} - R = ma \therefore \frac{90000}{20} - 1800 = 1200a$
 $\therefore a = 2.25 \text{ ms}^{-2}$

M2 A1

A1

(b) at max. speed, $a = 0$, $\frac{P}{v} - R = 0 \therefore \frac{90000}{v} - 1800 = 0$ so $v = 50 \text{ ms}^{-1}$
 $\text{KE} = \frac{1}{2} \times 1200 \times 50^2 = 1500000 \text{ J} = 1500 \text{ kJ}$

M1 A1

M1 A1

(c) $\frac{P}{v} - R - mg\sin\alpha = 0 \therefore \frac{90000}{25} - 1800 - 1200(9.8)\sin\alpha = 0$
 $\sin\alpha = \frac{1.5}{9.8} \therefore \alpha = 8.8^\circ \text{ (1dp)}$

M2 A1

M1 A1 (13)

7. (a) particle moving freely under gravity

B2

(b) vert. disp. = 0 $\therefore t(u \sin\alpha - \frac{1}{2}gt) = 0$
 $t = 0$ at O , we require $49\sin30^\circ - 4.9t = 0 \therefore t = 5$
horiz. disp. = $ut\cos\alpha = 49(5)\cos30^\circ = 212.17$
i.e. $212 - 170$ beyond hole = 42.2 m (3sf)

M1

M1 A1

M1 A1

A1

(c) when horiz. disp. = 170, $ut\cos\alpha = 170 \therefore t = 4.006$
horiz. vel. = $ucos\alpha = 42.44$ vert. vel. = $usin\alpha - gt = -14.76$
mag. of vel = $\sqrt{(42.44)^2 + (-14.76)^2} = 44.9 \text{ ms}^{-1}$ (3sf)
req'd angle = $\tan^{-1} \frac{-14.76}{42.44} = 19.2^\circ$ below horizontal (3sf)

M1

A2

M1 A1

M1 A1 (15)

Total (75)

Performance Record – M2 Paper A