

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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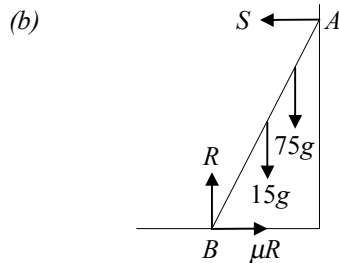
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M2 Paper A – Marking Guide

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)

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)

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 $S \cdot 8 \sin \theta - 15g \cdot 4 \cos \theta - 75g \cdot d \cos \theta = 0$ 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)

5. (a), (b)

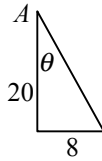
| portion | mass | x | y | mx | my |
|---------|-----------|-----------|-----------|------------|------------|
| $ABFG$ | 256ρ | 4 | 16 | 1024ρ | 4096ρ |
| $CDEF$ | 128ρ | 16 | 4 | 2048ρ | 512ρ |
| total | 384ρ | \bar{x} | \bar{y} | 3072ρ | 4608ρ |

ρ = mass per unit area x, y coords. taken horiz. / vert. from G M3 A2

$\bar{x} = \frac{3072\rho}{384\rho} = 8$ so must lie on BF M1 A1

$\bar{y} = \frac{4608\rho}{384\rho} = 12$ \therefore dist. from $AB = 20$ cm M1 A1

(c)



$\tan\theta = \frac{8}{20} \therefore \theta = 21.8^\circ$ (1dp) M1 M1 A1 (12)

6. (a) $\frac{P}{v} - R = ma \therefore \frac{90000}{20} - 1800 = 1200a$ M2 A1
 $\therefore a = 2.25 \text{ ms}^{-2}$ A1

(b) at max. speed, $a = 0$, $\frac{P}{v} - R = 0 \therefore \frac{90000}{v} - 1800 = 0$ so $v = 50 \text{ ms}^{-1}$ M1 A1
 $\text{KE} = \frac{1}{2} \times 1200 \times 50^2 = 1\,500\,000 \text{ J} = 1500 \text{ kJ}$ M1 A1

(c) $\frac{P}{v} - R - mg\sin\alpha = 0 \therefore \frac{90000}{25} - 1800 - 1200(9.8)\sin\alpha = 0$ M2 A1
 $\sin\alpha = \frac{1.5}{9.8} \therefore \alpha = 8.8^\circ$ (1dp) M1 A1 (13)

7. (a) particle moving freely under gravity B2

(b) vert. disp. = 0 $\therefore t(u \sin\alpha - \frac{1}{2}gt) = 0$ M1
 $t = 0$ at O , we require $49\sin 30^\circ - 4.9t = 0 \therefore t = 5$ M1 A1
 horiz. disp. = $ut\cos\alpha = 49(5)\cos 30^\circ = 212.17$ M1 A1
 i.e. $212 - 170$ beyond hole = 42.2 m (3sf) A1

(c) when horiz. disp. = 170, $ut\cos\alpha = 170 \therefore t = 4.006$ M1
 horiz. vel. = $u\cos\alpha = 42.44$ vert. vel. = $u\sin\alpha - gt = -14.76$ A2
 mag. of vel = $\sqrt{(42.44)^2 + (-14.76)^2} = 44.9 \text{ ms}^{-1}$ (3sf) M1 A1
 req'd angle = $\tan^{-1} \frac{14.76}{42.44} = 19.2^\circ$ below horizontal (3sf) M1 A1 (15)

Total (75)

