GCE Examinations

Advanced Subsidiary / Advanced Level

Mechanics
Module M1

Paper J

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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M1 Paper J – Marking Guide

1. *(a)* speed = 17 = mag. of vel. = $\sqrt{(8^2 + \lambda^2)}$ — M1
$\lambda^2 = 289 - 64 = 225$; $\lambda > 0$ so $\lambda = 15$ — M1 A1

(b) $\boldsymbol{a} = \frac{\Delta \boldsymbol{v}}{t} = \frac{1}{5}[(3\mathbf{i} + 5\mathbf{j}) - (8\mathbf{i} + 15\mathbf{j})] = {}^{-}\mathbf{i} - 2\mathbf{j}$ — M2 A1
$\mathbf{F} = m\boldsymbol{a} = 2({}^{-}\mathbf{i} - 2\mathbf{j}) = {}^{-}2(\mathbf{i} + 2\mathbf{j})$ so $\mu = {}^{-}2$ — M1 A1 **(8)**

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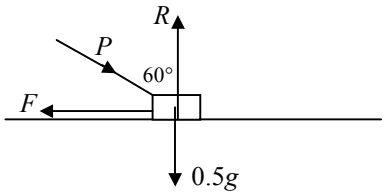
2. *(a)*



resolve ↑ : $R - P\cos60° - 0.5g = 0 \;\therefore\; R = 0.5g + P\cos60°$ — M1 A1
resolve → : $P\sin60° - F = 0$ — M1
$F = \mu R = \frac{1}{\sqrt{3}}(0.5g + 0.5P)$ — M1 A1
sub. in giving $\frac{\sqrt{3}}{2}P - \frac{1}{\sqrt{3}}(0.5g + 0.5P) = 0$ — M1
$3P - P - g = 0 \;\therefore\; 2P = g$ so $P = \frac{g}{2}$ — A1

(b) brush is moved slowly so very little air resistance — B1 **(8)**

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3. *(a)* cons. of mom: $1500(2) + 0 = (1500 + 750)V$ — M1
$3000 = 2250V \;\therefore\; V = \frac{4}{3}$ — M1 A1

(b) impulse = Δ mom $= 750(\frac{4}{3} - 0) = 1000$ Ns — M1 A1

(c) car has (27 + 9) m in which to stop and travels 18 m in first second — M1
must stop from 18 ms^{-1} in 18 m — A1
$u = 18$, $s = 18$, $v = 0$, $a = {}^{-}f$ — M1
$v^2 = u^2 + 2as$, so $0 = 324 - 36f$ — M1
$f = 9$ so to stop before hitting other car, $f > 9$ — A1 **(10)**

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4. *(a)* eqn. of motion for A: $T - 6g = 6a$ (1) — M1
eqn. of motion for B & C: $8g - T = 8a$ (2) — M1
(1) + (2) gives $2g = 14a$ i.e. $a = \frac{g}{7}$ ms^{-2} — M1 A1

(b) sub. a into (1) to get $T = 6a + 6g = \frac{6g}{7} + 6g$ — M1
force on pulley $= 2T = \frac{96g}{7}$ — M1 A1

(c) resolve ↓ for C: $3g - R = 3 \times \frac{g}{7}$ — M1
$R = 3g - \frac{3g}{7} = \frac{18g}{7}$ — M1 A1 **(10)**

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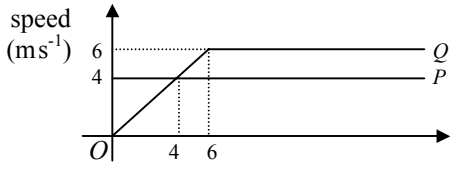
5. *(a)* For Q: $a = \frac{\Delta v}{t} = \frac{6-0}{6} = 1$ M1

$u = 0$, $v = 4$, use $v = u + at$: $4 = 0 + 1t$ i.e. $t = 4$ seconds M1 A1

(b)



B3

(c) Q will catch P when area under Q graph = area under P graph

$\therefore \frac{1}{2}(6)(6) + 6(t-6) = 4t$ M1

i.e. $18 + 6t - 36 = 4t \therefore 2t = 18 \therefore t = 9$ M1 A1

after 9 seconds, P has travelled $4 \times 9 = 36$ cm,

$\therefore Q$ reaches top first if $x > 36$ M1 A1 **(11)**

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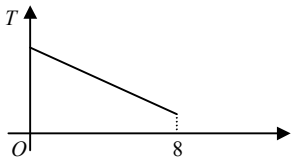
6. *(a)* as rock moves further from A, tension at A decreases linearly and is a minimum when rock reaches B.



B3

(b) max. tension when rock at one end (A, say) B1

moments about B : $50g(4) + Mg(8) - T_A(8) = 0$ M1

$8Mg = 8T_A - 200g \therefore Mg = T_A - 25g$ M1

given $T_A \le 40g$; $Mg \le 40g - 25g$ $(= 15g)$ M1

i.e. $M \le 15$ A1

(c) assume rock placed as close to A as poss. so that $T_A = 40g$

resolve (↑): $T_A + T_B = 50g + 20g = 70g \therefore T_B = 30g$ M1 A1

moments about centre of plank : $T_A(4) - T_B(4) - 20g(d) = 0$ M1

$160g - 120g - 20gd = 0 \therefore d = 2$ M1 A1

rock can be 2 m either side of centre i.e. 4 m out of 8 m = $\frac{1}{2}$ plank A1 **(14)**

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7. *(a)* cargo ship travels $(9t\mathbf{i} - 6t\mathbf{j})$ km in t hours

pos^n vector after t hours is $[(7\mathbf{i} + 56\mathbf{j}) + (9t\mathbf{i} - 6t\mathbf{j})]$ km M1

$= [(7 + 9t)\mathbf{i} + (56 - 6t)\mathbf{j}]$ km A1

pos^n vector of ferry after t hours is $(12t\mathbf{i} + 18t\mathbf{j})$ km A1

(b) they will collide if coeffs. of **i** and **j** in pos^n vectors are equal B1

$7 + 9t = 12t$ and $56 - 6t = 18t$ are both satisfied when $t = \frac{7}{3}$ M1 A1

collision after $\frac{7}{3}$ hrs or 2 hrs 20 mins i.e. at 8:20 a.m. A1

pos^n vector $= 12(\frac{7}{3})\mathbf{i} + 18(\frac{7}{3})\mathbf{j} = (28\mathbf{i} + 42\mathbf{j})$ M1 A1

(c) at 8 a.m. ferry at $(24\mathbf{i} + 36\mathbf{j})$

$\frac{1}{3}$ hr at $21\mathbf{i} + 6\mathbf{j} = 7\mathbf{i} + 2\mathbf{j}$ so at 8:20 a.m. ferry is at $31\mathbf{i} + 38\mathbf{j}$ M2 A1

at 8:20 a.m cargo ship is at $(28\mathbf{i} + 42\mathbf{j})$

dist. between $= \sqrt{(3^2 + 4^2)} = 5$ km M1 A1 **(14)**

Total **(75)**

Performance Record – M1 Paper J

Question no.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	Total
Topic(s)	**i**, **j** , $F = ma$	statics, friction	cons. of mom., impulse, uniform accel.	connected bodies	speed - time graph, uniform accel.	moments	rel. posn. **i**, **j**	
Marks	8	8	10	10	11	14	14	75
Student								