GCE Examinations

Advanced Subsidiary / Advanced Level

Mechanics
Module M1

Paper H

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 H – Marking Guide

1. *(a)* resolve ↑ : $T\cos 30 - W = 0$ M1

$\frac{\sqrt{3}}{2}T = 10 \ \therefore \ T = \frac{20\sqrt{3}}{3} = 11.5$ N (3sf) M1 A1

(b) resolve → : $H - T\sin 30 = 0$ M1

$H = \frac{1}{2}T$ so $T : H = 1 : \frac{1}{2} = 2 : 1$ M1 A1 **(6)**

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2. *(a)* $\mathbf{R} = (5\mathbf{i} - 3\mathbf{j}) + (3\mathbf{i} + 2\mathbf{j}) + (4\mathbf{i} - 5\mathbf{j}) = 12\mathbf{i} - 6\mathbf{j}$ M1 A1

mag. of $\mathbf{R} = \sqrt{[12^2 + (^-6)^2]} = \sqrt{180} = 6\sqrt{5}$ M1 A1

(b) $\boldsymbol{a} = \frac{\mathbf{F}}{m} = \frac{1}{8}(12\mathbf{i} - 6\mathbf{j}) = \frac{3}{2}\mathbf{i} - \frac{3}{4}\mathbf{j}$ M1 A1

req'd angle $= \tan^{-1}\frac{3/4}{3/2} = \tan^{-1}\frac{1}{2} = 26.6°$ (1dp) M1 A1 **(8)**

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3. *(a)* use of $s = (\frac{u+v}{2})t$ with $u = 5$, $v = 20$ and $t = 30$ M1

$s = \frac{25}{2} \times 30 = 375$ m M1 A1

(b) $a = \frac{\Delta v}{t} = \frac{20-5}{30} = 0.5$, $s = 187.5$, $u = 5$ use $s = ut + \frac{1}{2}at^2$ M1 A1

$187.5 = 5t + 0.25t^2 \ \therefore \ t^2 + 20t - 750 = 0$ M1

use quadratic formula to give $t = ^-10 \pm 5\sqrt{34}$ M1 A1

take +ve root $\therefore \ t = 19.15$ seconds (2dp) A1 **(9)**

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4. *(a)* // to $\mathbf{i} - \mathbf{j}$ $\therefore \ 2q^2 - 3 = ^-(q + 2)$ M1

$2q^2 + q - 1 = 0 \ \therefore \ (2q - 1)(q + 1) = 0$ M1 A1

$q = \frac{1}{2}, q = ^-1$ A1

(b) $q = ^-1 \ \therefore$ vel $= ^-\mathbf{i} + \mathbf{j}$ B1

at time t, pos$^{n.}$ vector is $(6\mathbf{i} - \mathbf{j}) + t(^-\mathbf{i} + \mathbf{j}) = (6 - t)\mathbf{i} + (t - 1)\mathbf{j}$ A1

$d^2 = (6 - t)^2 + (t - 1)^2$ and $d^2 < 5^2$ M1

$\therefore \ t^2 - 12t + 36 + t^2 - 2t + 1 < 25$ M1

$t^2 - 7t + 6 < 0 \ \therefore \ (t - 1)(t - 6) < 0$ A1

$1 < t < 6$ i.e. 5 seconds A1 **(10)**

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5. *(a)* $u = 0$, $s = 0.5$, $a = 16$ use $v^2 = u^2 + 2as$ M1

$v^2 = 0 + 2(16)(0.5) \ \therefore \ v = 4$ ms^{-1} M1 A1

(b) cons. of mom. $12(4) = (12 + 4)V$ M1

$48 = 16V \ \therefore \ V = 3$ ms^{-1} A1

(c) eqn. of motion: $16g - 1500 = 16a$ M1 A1

$\therefore \ a = ^-83.95$ A1

use with $u = 3$, $v = 0$ in $v^2 = u^2 + 2as$ M1

$v^2 = 3^2 - 167.9s$ giving $s = 0.054$ m $= 5.4$ cm M1 A1 **(11)**

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6. *(a)*

resolve ↑: $R_1 + R_2 = 135g$		M1
moments about A: $60g(0.6) - R_2(1.2) + 75g(1.6) = 0$		M1 A1
$1.2R_2 = 156g \ \therefore R_2 = 130g = 1274$ N		M1 A1
$R_1 = 5g = 49$ N		A1
(b) when $R_1 = 0$, moments about B: $20g(0.6) + 40g(x) - 75g(0.4) = 0$		M1 A1
$12g + 40gx = 30g \ \therefore 40x = 18$		A1
$x = 0.45$ but x is dist. L of $B \ \therefore$ Luigi can move to 0.85 m from mother		M1 A1
(c) bench is on point of tilting		B1 **(12)**

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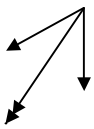
7. *(a)*

eqn. of motion for 5 kg mass: $5g - T = 5a$	(1)	M1
eqn. of motion for 4 kg mass: $T - \mu R - 4g\sin 30 = 4a$	(2)	M1
but resolving perp. to plane: $R - 4g\cos 30 = 0 \ \therefore R = 2g\sqrt{3}$		M1 A1
sub. for R in (2) gives $T - 2\mu g\sqrt{3} - 2g = 4a$	(3)	A1
(1) + (3) gives $3g - 2\mu g\sqrt{3} = 9a \ \therefore a = \frac{1}{9}(3 - 2\mu\sqrt{3})g$		M1 A1
(b) since motion takes place, $a > 0$		B1
i.e. $3 - 2\mu\sqrt{3} > 0 \ \therefore \mu < \frac{\sqrt{3}}{2}$		M1 A1
(c) $\mu = \frac{1}{2}$ means $a = \frac{3-\sqrt{3}}{9}g$		B1
$T = 5g - 5a = 5g - 5(\frac{3-\sqrt{3}}{9})g$		M1
$T = \frac{5}{9}(6 + \sqrt{3})g$		M1 A1

(d)



force on pulley $= 2T\cos 30$		M1 A1
$= \frac{10}{9}(6 + \sqrt{3})g\frac{\sqrt{3}}{2} = \frac{5}{9}(6\sqrt{3} + 3)g$		M2
$= \frac{5}{3}(2\sqrt{3} + 1)g$ N		A1 **(19)**

Total **(75)**

Performance Record – M1 Paper H

Question no.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	Total
Topic(s)	statics	**i**, **j** , $F = ma$	uniform accel	rel. posn. **i**, **j**	cons. of mom.	moments	connected bodies, friction	
Marks	6	8	9	10	11	12	19	75
Student								