GCE Examinations

Advanced Subsidiary / Advanced Level

Mechanics
Module M1

Paper G

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.

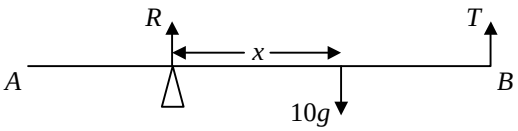
Accuracy marks (A) can only be awarded when a correct method has been used.

(B) marks are independent of method marks.

Written by Shaun Armstrong & Chris Huffer

M1 Paper G – Marking Guide

1.



resolve ↑: $R + T = 10g$; $R + \frac{3}{2}R = 10g$ — M2

$\frac{5}{2}R = 10g$; $\therefore R = 4g$ so $T = 6g$ — A1

moments about pivot: $10gx - 4(6g) = 0$ — M1

$10gx = 24g$, so $x = 2.4$ and hence c.o.m. is 4.4 m from A — M1 A1 **(6)**

---

2. *(a)* mass of ball remains constant, force is constant

$\boldsymbol{F} = m\boldsymbol{a}$ so $\boldsymbol{a}$ constant — B2

(b) (i) $\boldsymbol{a} = \frac{\Delta \boldsymbol{v}}{t} = \frac{1}{4}[(10\mathbf{i} + 9\mathbf{j}) - (2\mathbf{i} - 3\mathbf{j})] = 2\mathbf{i} + 3\mathbf{j}$ — M1 A1

mag. of $\boldsymbol{a} = \sqrt{(2^2 + 3^2)} = \sqrt{13} = 3.61\ \text{ms}^{-2}$ (3sf) — M1 A1

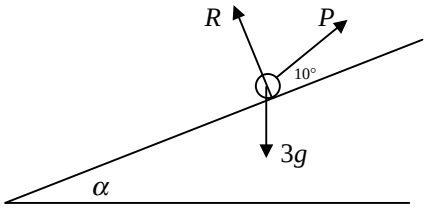
(ii) $\boldsymbol{F} = m\boldsymbol{a} = 2(2\mathbf{i} + 3\mathbf{j}) = 4\mathbf{i} + 6\mathbf{j}$ — M1

req'd angle $= \tan^{-1}\frac{3}{2} = 56.3°$ (3sf) — M1 A1 **(9)**

---

3. *(a)* particle — B1

(b)



resolve // to plane: $P\cos10° - 3g\sin\alpha = 0$ — M1 A1

$P\cos10° = 3g(\frac{3}{5})$ $\therefore$ P = 17.9 (1dp) — M1 A1

(c) resolve perp. to plane: $R + P\sin10° - 3g\cos\alpha = 0$ — M1 A1

$R = 3g(\frac{4}{5}) - P\sin10° = 20.4$ N (1dp) — M1 A1 **(9)**

---

4. *(a)* cons. of mom. $0.05(400) = (0.05 + 4.95)v$ — M2

$20 = 5v$ $\therefore$ $v = 4\ \text{ms}^{-1}$ — A1

(b) $R = mg$; $^{-}F = ma$ — M1

but $F = \mu R$; $\therefore a = \frac{-\mu R}{m} = \frac{-\mu mg}{m} = {}^{-}\mu g$ — M1 A1

use with $u = 4$, $v = 0$, $s = 4$ — M1

$v^2 = u^2 + 2as$, so $0 = 16 - 8\mu g$ — M1

$\mu = \frac{16}{8g} = \frac{2}{g}$ — A1 **(9)**

---

5. *(a)* disp. of F rel to G = $[(2t-3)-2]\mathbf{i} + (t-5)\mathbf{j} = (2t-5)\mathbf{i} + (t-5)\mathbf{j}$ M1 A1

(b) $d^2 = (2t-5)^2 + (t-5)^2$ M1

$= 4t^2 - 20t + 25 + t^2 - 10t + 25 = 5t^2 - 30t + 50$ M1 A1

$= 5(t^2 - 6t + 10) = 5[(t-3)^2 + 1]$ M2

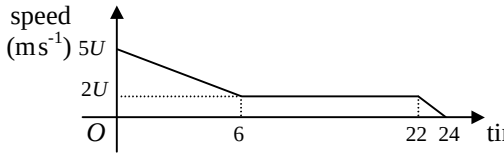
min. d^2 (and hence d) when $t = 3$ A1

(c) when $t = 3$, $d^2 = 5$ M1 A1

dist. $= \sqrt{5} = 2.24$ m (3sf) A1 **(11)**

---

6. *(a)*



B2

(b) using $v = u + at$ with $v = 2U$, $u = 5U$, $t = 6$ gives 1st decel. $= \frac{1}{2}U$ ms^{-2} M1 A1

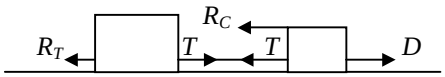
using $v = u + at$ with $v = 0$, $u = 2U$, $t = 2$ gives 2nd decel. $= U$ ms^{-2} M1 A1

(c) area under graph = dist. travelled = 220 m M1

$\frac{1}{2}(6)(3U) + 22(2U) + \frac{1}{2}(2)(2U) = 220$ M1 A2

$55U = 220 \ \therefore \ U = 4$ ms^{-1} M1 A1 **(12)**

7.



(a) $M_C : M_T = 1200 : 800 = 3 : 2 \quad R_C = 300$ N $\therefore R_T = 200$ N M1 A1

(b) for car and trailer, eqn. of motion is $3000 - 500 = 2000a$ M1

giving $a = \frac{5}{4}$ ms^{-2} M1 A1

(c) for car, eqn. of motion is $3000 - 300 - T = 1200 \times \frac{5}{4}$ M1

giving $T = 1200$ N M1 A1

(d) total of braking + resistive forces = 1500 N

$^{-}1500 = 2000a$ so $a = {}^{-}\frac{3}{4}$ ms^{-2} M1 A1

$u = 24$, $v = 0$, $a = {}^{-}\frac{3}{4}$ use $v^2 = u^2 + 2as$ M1

$0 = 576 - \frac{3}{2}s \ \therefore \ s = 384$ m M1 A1

(e) for car (←): $T + 1000 + 300 = 1200(\frac{3}{4})$ M1 A1

$T = {}^{-}400$ N $\therefore \ T = 400$ N, pushing the car M1 A1

(f) e.g. unlikely to be realistic, likely to decrease as speed decreases B2 **(19)**

Total **(75)**

Performance Record – M1 Paper G

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