GCE Examinations

Advanced Subsidiary / Advanced Level

Mechanics
Module M1

Paper L

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 L – Marking Guide

1. *(a)* cons. of mom: $m(3u) - km(2u) = {}^{-}m(\frac{3}{2}u) + km(u)$ M1 A1

$3mu + \frac{3}{2}mu = kmu + 2kmu$ M1

$\frac{9}{2}mu = 3kmu \ \therefore k = \frac{3}{2}$ A1

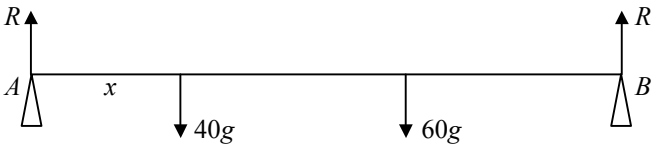
(b) impulse = Δ mom = $m[({}^{-}\frac{3}{2}u) - 3u] = {}^{-}\frac{9}{2}mu \ \therefore$ mag. = $\frac{9}{2}mu$ M2 A1 **(7)**

---

2. *(a)* (i) non-uniform rod B2

(ii) particle B1

(b)



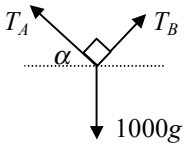
resolve ↑: $2R = 40g + 60g = 100g \ \therefore R = 50g$ M1 A1

(c) moments about A : $40g(x) + 60g(4) - 50g(6) = 0$ M1 A1

$40gx = 300g - 240g = 60g \ \therefore x = 1.5$ hence, c.o.m. is 1.5 m from A M1 A1 **(9)**

---

3. *(a)*



$\tan\alpha = \frac{3}{4}$ (3,4,5 Pythag. triple) so $\sin\alpha = \frac{3}{5}$, $\cos\alpha = \frac{4}{5}$ B1

resolve →: $T_B\sin\alpha - T_A\cos\alpha = 0$ M1

$\frac{3}{5}T_B = \frac{4}{5}T_A \ \therefore \ T_B = \frac{4}{3}T_A$ A1

resolve ↑ : $T_A\sin\alpha + T_B\cos\alpha - 1000g = 0$ M1

$\frac{3}{5}T_A + \frac{4}{3}T_A(\frac{4}{5}) = 1000g$ M1

$\frac{5}{3}T_A = 1000g \ \therefore \ T_A = 600g = 5880$ N A1

hence $T_B = \frac{4}{3}T_A = 7840$ N A1

(b) tension in both cables will increase B2 **(9)**

---

4. *(a)* $u = 21$, $v = 0$ (at max. ht.), $a = {}^{-}g$ use $v^2 = u^2 + 2as$ M1

$0 = 21^2 - 2gs \ \therefore s = 22.5$ m M1 A1

ball starts from 1.9 m, so it reaches 24.4 m above ground level A1

(b) $s = 7.5 - 1.9 = 5.6$, $u = 21$, $a = {}^{-}g$, use $s = ut + \frac{1}{2}at^2$ M1

$5.6 = 21t - 4.9t^2$ i.e. $7t^2 - 30t + 8 = 0$ M1 A1

$(7t - 2)(t - 4) = 0$ giving $t = \frac{2}{7}$, $t = 4$ M1 A1

$\therefore$ Barbara waits for $3\frac{5}{7}$ (≈ 3.71) seconds A1 **(10)**

---

5. *(a)* e.g. string is inextensible so B moves down same dist. A moves up — B1
$\therefore$ acceleration of B is $\frac{1}{4}g$ ms^{-2} downwards — B1

(b) eqn. of motion for A: $kmg - T = kma$ (1) — M1
eqn. of motion for B: $T - mg = ma$ (2) — M1
(1) + (2) gives $kmg - mg = kma + ma$ — M1 A1
$k(g-a) = g + a \therefore k = \frac{g+a}{g-a} = \frac{5g/4}{3g/4} \therefore k = \frac{5}{3}$ — M1 A1

(c) $u = 0$, $s = 0.5$, $a = \frac{1}{4}g$ use $v^2 = u^2 + 2as$ — M1
$v^2 = 0 + 2(0.25g)0.5 = 2.45 \therefore v = 1.57$ ms^{-1} (3sf) — M1 A1 **(11)**

---

6. *(a)* vel. of $B = \lambda(5\mathbf{i} + 12\mathbf{j})$
mag. of vel. $= \sqrt{[\lambda^2(5^2 + 12^2)]} \therefore 52 = 13\lambda$ i.e. $\lambda = 4$ — M1 A1
vel. of $B = 20\mathbf{i} + 48\mathbf{j}$ — A1

(b) at 10:15, A is at $20\mathbf{i}$, B is at $(5\mathbf{i} + 12\mathbf{j})$ — M1
disp. vector of B from $A = 5\mathbf{i} + 12\mathbf{j} - 20\mathbf{j} = {}^-15\mathbf{i} + 12\mathbf{j}$ — M1 A1

(c) disp. vector of B from A at time t minutes $= \frac{1}{15}({}^-15\mathbf{i} + 12\mathbf{j}) \times t$ — M1 A1
$= {}^-t\mathbf{i} + 0.8t\mathbf{j}$ — A1
at time t, dist. between A and $B = \sqrt{[({}^-t)^2 + (0.8t)^2]}$ — M1
$23 = t\sqrt{1.64} \therefore t = 17.96$ i.e. $t = 18$ minutes (nearest minute) — M1 A1 **(12)**

---

7. *(a)* resolve for P down slope $mg\cos 30 = ma$ — M1 A1
$a = \frac{g\sqrt{3}}{2} = 8.49$ ms^{-2} — A1

(b) $s = \frac{3}{\cos 30} = 2\sqrt{3}$, $u = 0$, $a = \frac{g\sqrt{3}}{2}$, use $s = ut + \frac{1}{2}at^2$ — B1 M1
$2\sqrt{3} = 0 + \frac{1}{2}(\frac{g\sqrt{3}}{2})t^2 \therefore t^2 = \frac{8}{g}$ and so $t = 0.904$ seconds (3sf) — M2 A1

(c) resolving perp. to plane: $R - mg\sin 60 = 0$ so $R = \frac{\sqrt{3}}{2}mg$ — M1
$F = \mu R = \mu\frac{\sqrt{3}}{2}mg$ — A1
resolving down the plane: $mg\cos 60 - F = ma$ — M1
$\frac{1}{2}mg - \mu\frac{\sqrt{3}}{2}mg = 3m \therefore \mu g\sqrt{3} = g - 6$ — M1
giving $\mu = \frac{(g-6)\sqrt{3}}{3g} = 0.224$ (3sf) — A1

(d) $s = \frac{3}{\sin 30} = 6$, $u = 0$, $a = 3$, use $s = ut + \frac{1}{2}at^2$ — M1
$6 = 0 + \frac{1}{2}(3)t^2 \therefore t^2 = 4$ and so $t = 2$ seconds — M1 A1
for P and Q to arrive at the same time, "t" $= 2 - 0.904 = 1.10$ (2dp) — A1 **(17)**

Total **(75)**

Performance Record – M1 Paper L

Question no.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	Total
Topic(s)	cons. of mom., impulse	moments	statics	uniform accel.	connected bodies	rel. posn. **i**, **j**	friction, uniform accel.	
Marks	7	9	9	10	11	12	17	75
Student								