GCE Examinations

Advanced Subsidiary / Advanced Level

Mechanics

Module M1

Paper B

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 B – Marking Guide

1. *(a)* $\boldsymbol{a} = \frac{\Delta \boldsymbol{v}}{t} = \frac{1}{2}[(4\mathbf{i} - 7\mathbf{j}) - (-2\mathbf{i} + \mathbf{j})] = 3\mathbf{i} - 4\mathbf{j}$ — M1 A1

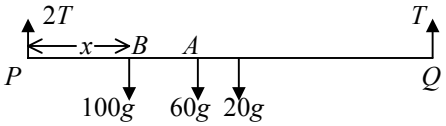
(b) $\boldsymbol{F} = m\boldsymbol{a} = 5(3\mathbf{i} - 4\mathbf{j})$ — M1
mag. of $\boldsymbol{F} = 5\sqrt{(3^2 + 4^2)} = 25$ N — M1 A1
req'd angle $= \tan^{-1}\frac{3}{4} = 37°$ to nearest degree — M1 A1 **(7)**

---

2. *(a)* cons. of mom: $3mu - 2mu = 2mv$ (dir^n of B after coll. taken as +ve) — M2
$mu = 2mv \therefore v = \frac{1}{2}u$ — A1
hence, speed of B halved and change of sign means dir^n has reversed — B1

(b) impulse = Δ mom: i.e. for A, $9m = 0 - (^-3mu)$ — M2
$9m = 3mu \therefore u = 3$ — A1 **(7)**

3.



(a) resolve ↑: $3T = 180g$ — M1
$T = 60g$, so tension in cable at $P = 120g$. — A1

(b) moments about P: $100gx + 60g(1.25) + 20g(1.5) = 3T$ — M2 A1
$100gx = 75g$, so $x = 0.75$ and hence $BP = 0.75$m — M1 A1

(c) (i) weight acts at middle of platform — B1
(ii) platform doesn't bend — B1 **(9)**

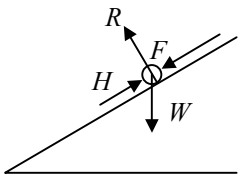
---

4. *(a)* use of $s = ut + \frac{1}{2}at^2$ for OL (54m, $t = 1$) and OM (144m, $t = 4$) — M2
to give $54 = u + \frac{1}{2}a$ and $144 = 4u + 8a$ — A1
solve simult. to give $a = {}^-12\text{m s}^{-2}$ — M1 A1

(b) for ON, $u = 60$, $a = {}^-12$, $v = 0$ — M1
$v^2 = u^2 + 2as$, so $0 = 3600 - 24s$ — M1
$s = 150$m, so $MN = 150 - 144 = 6$m. — M1 A1 **(9)**

---

5. *(a)*

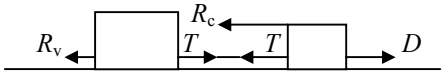


B2

(b) resolve perp. to plane: $R - 2g\cos 30° = 0 \therefore R = g\sqrt{3}$ — M1 A1
$F = \mu R = \frac{1}{\sqrt{3}}g\sqrt{3} = g$ — M1 A1
resolve // to plane: $H - F - 2g\sin 30° = 0$ — M1
$H - g - g = 0 \therefore H = 2g$ — A1
$F : H = g : 2g = 1 : 2$ — A1

(c) friction varies between μR up plane (to prevent movement down plane)
and μR down plane (to prevent movement up plane) — B2 **(11)**

6.



(a)	acc^n $= \frac{25-0}{20} = \frac{5}{4}$ ms^{-2}	M1 A1	
	for car and van, eqn. of motion is $D - 1200 = 2000 \times \frac{5}{4}$	M1	
	$D = 3700$ N	A1	
(b)	1200 divided in ratio 1.25 : 0.75 i.e. 5 : 3	M1	
	car resistance $= \frac{5}{8} \times 1200 = 750$ N, so caravan resistance is 450 N	A1	
	for car, eqn. of motion is $3700 - 750 - T = 1250 \times \frac{5}{4}$	M1	
	$T = 1387.5$ N	A1	
(c)	for van, $^-450 = 750a$ $\therefore a = {}^-\frac{3}{5}$ ms^{-2}	M1A1	
	$u = 25$, $v = 0$, $a = {}^-\frac{3}{5}$ use $v^2 = u^2 + 2as$	M1	
	$0 = 625 - \frac{6}{5}s$ $\therefore s = 520.8$ m	M1 A1	
(d)	e.g. caravan may nose down at front, may not stay in a straight line	B1	
	so dist. likely to be less than that calculated in *(c)*	B1	**(15)**

7.

(a)	dist. between Alison and Bill $= \sqrt{[(^-5)^2 + 12^2)]} = 13$ km	M1 A1	
(b)	$\lvert 3\mathbf{i} + \mathbf{j} \rvert = \sqrt{10}$; speed $= 2\sqrt{10}$	M1	
	$\therefore \mathbf{v} = 2(3\mathbf{i} + \mathbf{j}) = 6\mathbf{i} + 2\mathbf{j}$	M1 A1	
(c)	after t hours, Alison is at $(2t)\mathbf{i} + (5t)\mathbf{j}$	M1 A1	
	Bill is at $(6t - 5)\mathbf{i} + (2t + 12)\mathbf{j}$	A1	
	rel to A, pos^n vector of B is $(6t - 5 - 2t)\mathbf{i} + (2t + 12 - 5t)\mathbf{j}$	M1	
	$= (4t - 5)\mathbf{i} + (12 - 3t)\mathbf{j}$ km	A1	
(d)	$d^2 = (4t - 5)^2 + (12 - 3t)^2$	M1	
	$= 16t^2 - 40t + 25 + 144 - 72t + 9t^2 = 25t^2 - 112t + 169$	A1	
(e)	$d^2 < 121$ $\therefore 25t^2 - 112t + 169 < 121$	M1	
	$25t^2 - 112t + 48 < 0$, so $(25t - 12)(t - 4) < 0$	A1 M1	
	suitable method to get $\frac{12}{25} < t < 4$	A1	
	length of time $= 3\frac{13}{25}$ hours $= 3$ hours 31 minutes (to nearest minute)	A1	**(17)**

Total **(75)**

Performance Record – M1 Paper B

Question no.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	Total
Topic(s)	**i** , **j** vectors, $F = ma$	cons. of mom., impulse	moments, modelling	uniform accel.	statics incl. friction	connected bodies	speed, rel. posn.	
Marks	7	7	9	9	11	15	17	75
Student								