GCE Examinations

Advanced Subsidiary / Advanced Level

Mechanics
Module M1

Paper I

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 I – Marking Guide

1. $(2p\mathbf{i} - 3q\mathbf{j}) + (5q\mathbf{i} + 4p\mathbf{j}) = {}^{-}2\mathbf{i} + 9\mathbf{j}$ M1

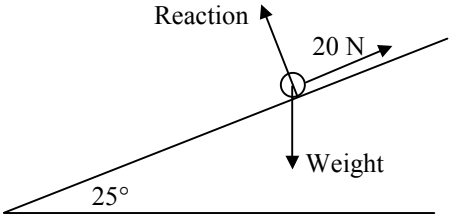
equating coeffs of **i** and **j** gives $2p + 5q = {}^{-}2$

$4p - 3q = 9$ M1 A1

solve simult. to give $p = \frac{3}{2}$, $q = {}^{-}1$ M1 A1 **(5)**

---

2. *(a)*



B2

(b) resolve // to plane: $20 - W\sin 25 = 0$ M1

$W = \frac{20}{\sin 25}$ so $W = 47.3$ N (3sf) A1

resolve perp. to plane: $R - W\cos 25 = 0$ M1

$R = 47.324 \times \cos 25 = 42.9$ N (3sf) A1

(c) (i) particle B1

(ii) inextensible B1

(d) W and R will both be lower B2 **(10)**

---

3. *(a)* mag. of impulse is same as cannon on shell B1

impulse = Δ mom = 3(200 – 0) = 600 Ns (towards cannon) M1 A1

(b) for cannon, $mv - mu = 600$

$600v = 600$ so $v = 1$ ms^{-1} M1 A1

(c) $R = mg$; ${}^{-}F = ma$ M1

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

use with $u = 1$, $v = 0$ M1

$v^2 = u^2 + 2as$, so $0 = 1 - 2(0.75)(9.8)s$ M1

$s = 0.0680$ m = 7 cm (nearest cm) A1 **(11)**

---

4. *(a)* displacement of plane = $(32\mathbf{i} + 19\mathbf{j}) - (80\mathbf{i} + 5\mathbf{j})$ M1

$= {}^{-}48\mathbf{i} + 14\mathbf{j}$ in 10 mins. A1

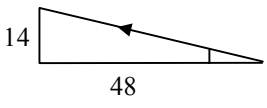
∴ in 30 mins, displacement = $3 \times ({}^{-}48\mathbf{i} + 14\mathbf{j}) = {}^{-}144\mathbf{i} + 42\mathbf{j}$ M1

so posn. vector at 2:30p.m. is $({}^{-}64\mathbf{i} + 47\mathbf{j})$ A1

(b) in 1 hr. displacement of plane = $6 \times ({}^{-}48\mathbf{i} + 14\mathbf{j}) = {}^{-}288\mathbf{i} + 84\mathbf{j}$ M1 A1

speed = $\sqrt{[({}^{-}288)^2 + 84^2]} = \sqrt{90000} = 300$ kmh^{-1} M1 A1

(c)



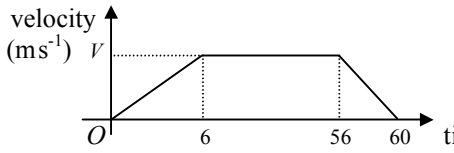
req'd angle = $\tan^{-1}\frac{14}{48} = 16.26°$ M1 A1

∴ bearing = 16.26 + 270 = 286° (nearest deg) A1 **(11)**

---

5. *(a)* e.g. since acc^n and decel^n are uniform, time for decel^n = $\frac{1}{1.5}$ time for acc^n M1

$\therefore$ decel^n = 4 seconds, so total time = 6 + 50 + 4 = 60 seconds M1 A1

(b) 

B3

(c) area under graph = $\frac{1}{2}(6)(V) + 50V + \frac{1}{2}(4)(V) = 1320$ M1

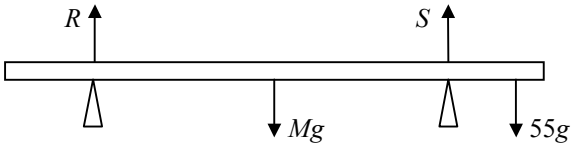
$55V = 1320$ so $V = 24$ ms^{-1} M1 A1

(d) car accelerates more quickly at first, but acceleration decreases throughout the six seconds B2 **(11)**

---

6. *(a)* uniform – same density throughout B1

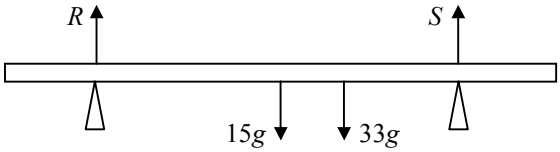
rod – bench probably fairly rigid, doesn't bend very much B1

(b) 

bench on pt. of tilting so $R = 0$ B1

moments about S : $55g(0.3) - Mg(1.1) = 0$ M2

$1.1M = 16.5$ $\therefore$ $M = 15$ kg A1

(c) 

resolve $\uparrow$: $R + S = 33g + 15g = 48g$ M1

moments about S : $33g(0.7) + 15g(1.1) - R(2.2) = 0$ M1

$2.2R = 23.1g + 16.5g$ $\therefore$ $R = 18g$ M1 A1

$S = 30g$ $\therefore$ $S : R = 30g : 18g = 5 : 3$ M1 A1 **(12)**

---

7. *(a)* for car + caravan, eqn. of motion is $3000 - 900 - 2100g\sin\alpha = 2100a$ M2 A1

$2100 - 1470 = 2100a$ $\therefore$ $a = 0.3$ ms^{-2} M1 A1

(b) for caravan, $T - 500 - 850g\sin\alpha = 850 \times 0.3$ M1

$T - 500 - 595 = 255$ $\therefore$ $T = 1350$ N M1 A1

(c) $u = 0$, $a = 0.3$, $s = 540$ use $v^2 = u^2 + 2as$ M1

$v^2 = 0 + 2(0.3)(540) = 324$ $\therefore$ $v = 18$ ms^{-1} M1 A1

(d) $D - 900 = 0$ $\therefore$ $D = 900$ N M1 A1

% reduction = $\frac{3000-900}{3000} \times 100 = 70$ % M1 A1 **(15)**

Total **(75)**

Performance Record – M1 Paper I

Question no.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	Total
Topic(s)	**i**, **j** , forces	statics	cons. of mom., impulse, friction	rel. posn. **i**, **j**	vel - time graph, uniform accel.	moments	connected bodies	
Marks	5	10	11	11	11	12	15	75
Student								