GCE Examinations

Advanced Subsidiary / Advanced Level

# Mechanics
# Module M1

Paper D

# 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 D – Marking Guide

**1.** *(a)* cons. of mom. $5(3) = 5(v) + 2(2v)$ M2
$15 = 9v$ so $v = \frac{5}{3}$ A1

*(b)* impulse received by $Q = 2[(2 \times \frac{5}{3}) - 0] = \frac{20}{3}$ Ns M1 A1 **(5)**

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**2.** *(a)* req'd angle $= \tan^{-1}\frac{2}{3} = 33.7°$ M1 A1

*(b)* when $t = 2$, posn. vector of $A$ is $= (2 + 6)\mathbf{i} + (11 + 4)\mathbf{j} = 8\mathbf{i} + 15\mathbf{j}$ M1 A1
$OP = \sqrt{8^2 + 15^2} = 17$ m M1 A1 **(6)**

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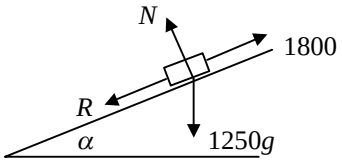
**3.** *(a)*




resolve // to plane: $1800 - 1250g\sin\alpha - R = 0$ M1 A1
$R = 1800 - 1250(9.8)\frac{1}{10} = 575$ N M1 A1

*(b)* at instant car reaches top of hill, $F = 1800$, $R = 575$ M1
$1800 - 575 = 1250a \Rightarrow a = 0.98$ ms$^{-2}$ M1 A1 **(7)**

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**4.** *(a)* (i) rod B1
(ii) particle B1

*(b)* resolve ↑: $R + 35g - 60g - 20g = 0$ M1
reaction at $B = 45g$ N A1

*(c)* non-uniform means weight not evenly distributed throughout plank
i.e. c.o.m. not necessarily in middle of plank B2

*(d)* moments about $A$ : $20gx + 60g(4) = 45g(6)$ M2 A1
so $x = 1.5$ m ⇒ c.o.m. is 1.5 m from $A$ A1 **(10)**

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**5.** for $P$: $x = 0 + \frac{3}{2}t^2$ M1
for $Q$: $x + 20 = 3t + 2t^2$ M1 A1
eliminating $x$: $\frac{1}{2}t^2 + 3t - 20 = 0$ M1 A1
$t^2 + 6t - 40 = 0$ i.e. $(t + 10)(t - 4) = 0$ M1 A1
$t = 4$ (only +ve answer) A1
when $t = 4$, $x = \frac{3}{2}(4)^2 = 24$ M1 A1 **(10)**

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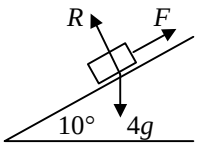
**6.** *(a)*




| | | |
|---|---|---|
| resolve perp. to plane: $R - 4g\cos10 = 0 \Rightarrow R = 4g\cos10$ | M1 A1 | |
| resolve // to plane: $F - 4g\sin10 = 0 \Rightarrow F = 4g\sin10$ | M1 A1 | |
| $\mu = \frac{F}{R} = \tan10 = 0.176$ (3sf) | M1 A1 | |
| *(b)* let extra force be $P$ | | |
| resolve perp. to plane: $R - 4g\cos30 = 0 \Rightarrow R = 4g\cos30$ | M1 | |
| $F = \mu R = 5.986$ | A1 | |
| resolve // to plane: $F + P - 4g\sin30 = 0$ | M1 A1 | |
| $P = 2g - F = 13.6$ N | A1 | **(11)** |

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**7.** *(a)* $s = 122.5$, $u = 0$, $a = g$ use $s = ut + \frac{1}{2}at^2$ M1

$122.5 = 4.9t^2 \Rightarrow t = 5$ M1 A1

*(b)* $v^2 = u^2 + 2as = 0 + 2g(122.5)$ M1

$v = 49$ m s$^{-1}$ A1

*(c)* $s = u(t-2) + \frac{1}{2}a(t-2)^2$ M1

Jim must hit before $t = 5$ i.e. $122.5 = 3u + 4.9(3)^2$ M2 A1

$3u = 78.4 \Rightarrow u = 26.1$ m s$^{-1}$ A1

*(d)* e.g. $u$ larger as tennis ball would have experienced more air resistance due to greater speed / large surface area for mass B2 **(12)**

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**8.** *(a)* eqn. of motion for $P$: $3g - T = 3a$ (1) M1

eqn. of motion for $Q$: $T - 2g = 2a$ (2) M1

(1) + (2) gives $g = 5a$ i.e. $a = \frac{g}{5}$ m s$^{-2}$ M1 A1

*(b)* from (2), $T = 2a + 2g = \frac{12}{5}g$ N (= 23.52 N) M1 A1

*(c)* $s = 1.5$, $u = 0$, $a = \frac{1}{5}$g use $v^2 = u^2 + 2as$ M1

$v^2 = \frac{3}{5}g$ i.e. $v = 2.42$ m s$^{-1}$ M1 A1

*(d)* $P$ hits ground → string goes slack → $Q$ moves freely under gravity M1

for $Q$: $u^2 = \frac{3}{5}g$, $v = 0$, $a = -$g use $v^2 = u^2 + 2as$ M1

$0 = \frac{3}{5}g - 2gs \Rightarrow s = 0.3$ m M1 A1

$Q$ moves 1.5 m before $P$ hits ground + 0.3 m = 1.8 m upwards

$\therefore$ closest to pulley = 0.2 m A1 **(14)**

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Total **(75)**

# Performance Record – M1 Paper D

| Question no. | **1** | **2** | **3** | **4** | **5** | **6** | **7** | 8 | Total |
|---|---|---|---|---|---|---|---|---|---|
| Topic(s) | cons. of mom., impulse, | **i**, **j**, dist. | dynamics | modelling, moments | uniform accel. | statics, coeff. of friction | kinematics | connected bodies | |
| Marks | 5 | 6 | 7 | 10 | 10 | 11 | 12 | 14 | 75 |
| Student | | | | | | | | | |
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