GCE Examinations

Advanced Subsidiary / Advanced Level

# Mechanics
# Module M1

## Paper F

# 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.




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# M1 Paper F – Marking Guide

**1.** *(a)* resolve ↑: $R\cos 15 - 4g = 0$ — M2
$R = \frac{4g}{\cos 15} = 40.6$ N (3sf) — M1 A1

*(b)* resolve // to slope: $F\cos 15 - 4g\sin 15 = 0$ — M1
$F = 4g\tan 15 = 10.5$ N — M1 A1 **(7)**

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**2.** *(a)* cons. of mom.: $2u = 0.03\,(100)$ — M2
$u = 1.5$ ms$^{-1}$ — A1

*(b)* $v^2 = u^2 + 2as$ so $0 = 6400 + 2a(0.02)$ — M1 A1
$a = {}^{-}160000$ ms$^{-2}$ so $F = 0.03\,({}^{-}160000) = 4800$ N (opp. dir$^{n.}$ to bullet) — M1 A1 **(7)**

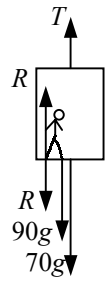
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**3.** *(a)* moments about $A$ (anticlockwise +ve) $= 3(2) - 2(2)$ — M2
$= 2$ Nm (anticlockwise) — A1

*(b)* dist. of $X$ from $D$ is $2\sqrt{2}$ (by Pythagoras) — M1
moments about $D$: $X(2\sqrt{2}) = 5(2) + 3(2)$ — M1
$X = \frac{8}{\sqrt{2}} = 4\sqrt{2}$ — M1 A1 **(7)**

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**4.**




*(a)* resolve ↓ for man: $90g - R = 90(0.5)$ so $R = 837$ N — M2 A1

*(b)* resolve ↓ for lift: $R + 70g - T = 70(0.5)$ — M2 A1
$837 + 686 - T = 35$ so $T = 1488$ N — A1

*(c)* impulse = Δ mom. $= 160(0 - 2) = 320$ Ns — M1 A1

*(d)* $Ft = 320$, so $F = \frac{320}{2} = 160$ N — M1 A1 **(11)**

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**5.** *(a)* initially, $A$ is at $6\mathbf{i}$ and travels $({}^{-}4T\mathbf{i} + T\mathbf{j})$ km in $T$ hours — M2
$T$ hours after midday, $A$ is at $(6 - 4T)\mathbf{i} + T\mathbf{j}$ km — A1
initially $B$ is at $3\mathbf{j}$ and travels $(4T\mathbf{i} - 3T\mathbf{j})$ km in $T$ hours — M2
$T$ hours after midday, $B$ is at $4T\mathbf{i} + (3 - 3T)\mathbf{j}$ km — A1

*(b)* pos$^{n.}$ $B$ rel. to $A$ is $[4T - (6 - 4T)]\mathbf{i} + [(3 - 3T) - T]\mathbf{j}$ — M1
i.e. $[(8T - 6)\mathbf{i} + (3 - 4T)\mathbf{j}]$ km — A1

*(c)* they will collide if coeffs. of **i** and **j** in part *(b)* are both zero — M1
$8T - 6 = 0$ and $3 - 4T = 0$ are both satisfied when $T = \frac{3}{4}$ — A1
i.e. collision at 12:45 p.m. — A1 **(11)**

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**6.** *(a)* $u = 0$, $s = 2200 - 240 = 1960$, $a = 9.8$ use $v^2 = u^2 + 2as$ — M2
$v^2 = 0 + 2(9.8)(1960)$ so $v = 196$ ms$^{-1}$ — M1 A1

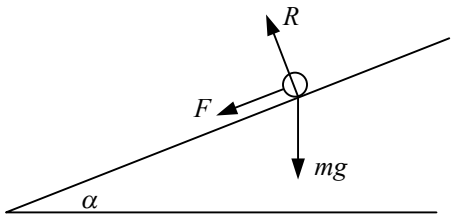
*(b)* $s = ut + \frac{1}{2}at^2$ — M1
$1960 = 0 + 4.9t^2 \Rightarrow t = 20$ seconds — M1 A1

*(c)* $140 - 20 = 120$ seconds to travel 240 m — M1
speed $= 2$ ms$^{-1}$ — A1

*(d)* e.g. no air resistance;
velocity on opening parachute will not immediately reduce — B2
e.g. if air resistance included, value in *(a)* would be much lower
and consequently value in *(b)* much higher — B2 **(13)**

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**7.**




*(a)* $\sin\alpha = \frac{3}{5}$ (3,4,5 Pythag. triple) so $\cos\alpha = \frac{4}{5}$ — B1
resolve perp. to plane: $R - mg\cos\alpha = 0$ so $R = \frac{4}{5}mg$ — M1 A1
$F = \mu R = \frac{1}{5}mg$ — M1 A1
Resolve up the plane: $^{-}F - mg\sin\alpha = ma$ — M1
$^{-}\frac{1}{5}mg - \frac{3}{5}mg = ma$ so $a = {}^{-}\frac{4}{5}g$ — A1
i.e. $a = \frac{4}{5}g$ and is directed down the slope — A1

*(b)* $u = 20$, $v = 0$, $a = {}^{-}\frac{4}{5}g$ use $v^2 = u^2 + 2as$ — M1
$0 = 400 - \frac{8}{5}gs \Rightarrow s = 25.51$ m, i.e. 4.49 m (nearest cm) from top — M2 A1

*(c)* friction now acts up slope but $R$ (and hence $F$) as in part *(a)* — B1
$mg\sin\alpha - F = ma \Rightarrow \frac{3}{5}mg - \frac{1}{5}mg = ma$ — M2
$a = \frac{2}{5}g$ — A1
$u = 0$, $s = 25.51$, $a = \frac{2}{5}g$, $s = ut + \frac{1}{2}at^2$ — M1
$25.51 = \frac{1}{5}gt^2$ i.e. $t = 3.61$ seconds — M1 A1 **(19)**

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Total **(75)**

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# Performance Record – M1 Paper F

| Question no. | **1** | **2** | **3** | **4** | **5** | **6** | **7** | Total |
|---|---|---|---|---|---|---|---|---|
| Topic(s) | statics, | cons. of mom., $F = ma$ | moments | connected bodies | **i**, **j** , rel. posn. | accel.-time graph | uniform accel., friction | |
| Marks | 7 | 7 | 7 | 11 | 11 | 13 | 19 | 75 |
| Student | | | | | | | | |
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