GCE Examinations

Advanced Subsidiary / Advanced Level

Mechanics
Module M1

Paper K

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 K – Marking Guide

1. *(a)* impulse = Δ mom = 800(0 – 15) = ⁻12 000 ∴ mag. = 12 000 Ns — M1 A1

(b) $Ft = 12\,000$, so $t = \frac{12000}{60000} = 0.2$ s — M1 A1

(c) use $v = u + at$ with $v = 0$, $u = 15$ $t = 0.2$ — M1
$0 = 15 + 0.2a$ ∴ $a = ⁻75$ so decel. = 75 ms^{-2} — M1 A1 **(7)**

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2. *(a)* moments about O (clockwise +ve): 90(1.2) + 70(1.2) – 80(1.2) – 60(1.2) — M1
= 20(1.2) = 24 Ns (clockwise) — M1 A1

(b) moments about O : 90(d) + 70(1.2) – 80(1.2) – 60(1) = 0 — M2 A1
$90d = 72$ ∴ $d = 0.8$ m ∴ $x = 0.4$ m — M1 A1 **(8)**

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3. *(a)* $\mathbf{r} = 4t\mathbf{i}$ m — A1
$\mathbf{s} = (30\mathbf{i} – 60\mathbf{j}) + (⁻8t\mathbf{i} + 24t\mathbf{j})$ — M1
$(30 – 8t)\mathbf{i} + (24t – 60)\mathbf{j}$ m — A1

(b) they will collide if coeffs. of **i** and **j** in **r** and **s** are equal — B1
$4t = 30 – 8t$ and $24t – 60 = 0$ — M1
both are satisfied when $t = \frac{5}{2}$ so ball hits batsman — M1 A1
batsman is at $(4 \times 2.5)\mathbf{i} = 10\mathbf{i}$ — A1

(c) ball travelling fast ∴ air resistance significant — B1
ball will be affected by gravity ∴ not horizontal (may go over batsman) — B1 **(10)**

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4. *(a)* cons. of mom. $4m \times 2 – 3m \times 2 = 0 + 3mv$ — M1
$2m = 3mv$ so $v = \frac{2}{3}$ ms^{-1} — M1 A1

(b) $R = mg$; $⁻F = ma$ — M1
but $F = \mu R$; so $a = \frac{-\mu R}{m} = \frac{-\mu mg}{m} = ⁻\mu g$ — M1 A1
use with $u = \frac{2}{3}$, $v = 0$, $s = 0.2$ — M1
$v^2 = u^2 + 2as$, ∴ $0 = \frac{4}{9} – 0.4\mu g$ — M1
$\mu = \frac{10}{9g} = 0.113$ (3dp) — M1 A1 **(10)**

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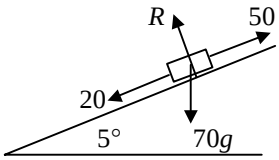
5. *(a)*



resolve // to plane: $50 – 20 – 70g\sin5° = 70a$ — M1 A1
$a = ⁻0.43$, ∴ decel. = 0.43 ms^{-2} (2dp) — M1 A1

(b) use of $s = ut + \frac{1}{2}at^2$ with $u = 3$ for $t = 4$ and $t = 5$ — M1
to give $s = 12 + 8a$ and $s = 15 + 12.5a$ — M1 A1
∴ $15 + 12.5a = 12 + 8a + 12$ — M1
$4.5a = 9$ ∴ $a = 2$ — M1 A1
use $v = u + at$ with $u = 3$, $a = 2$, $t = 5$ — M1
$v = 3 + 2 \times 5 = 13$ ms^{-1} — A1 **(12)**

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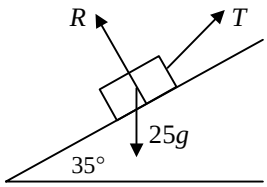
6. *(a)* eqn. of motion for A: $T = 5a$ (1) — M1
eqn. of motion for Q: $2g - T = 2a$ (2) — M1
(1) + (2) gives $2g = 7a$ i.e. $a = \frac{2g}{7}$ — A1
from (1), $T = 5a = \frac{10}{7}g$ N — A1
so force on pulley = $\sqrt{T^2 + T^2} = T\sqrt{2}$ — M1

$= \frac{10\sqrt{2}}{7}g$ N — M1 A1

(b) $s = 0.3$, $u = 0$, $a = \frac{2}{7}g$ use $v^2 = u^2 + 2as$ — M1
$v^2 = \frac{6}{35}g$ i.e. $v = \sqrt{\frac{6}{35}g} = \sqrt{1.68} = 1.30$ ms^{-1} (3sf) — M1 A1

(c) B has 0.2 m left to fall — B1
for B: $u^2 = \frac{6}{35}g$, $s = 0.2$, $a = g$ use $v^2 = u^2 + 2as$ — M1
$v^2 = \frac{6}{35}g + 2g(0.2)$ $\therefore v^2 = 5.6$; $v = 2.4$ ms^{-1} (1dp) — M1 A1 **(14)**

7.



(a) resolve // to plane: $T\cos 15 - 25g\sin 35 = 0$ — M2
so $T = 145.48 = 145$ N (3sf) — A1

(b) resolve perp. to plane: $R + T\sin 15 - 25g\cos 35 = 0$ — M1 A1
$R = 25g\cos 35 - 145.48 \times \sin 15 = 163.038 = 163$ N (3sf) — M1 A1

(c) resolve // to plane: $200\cos 15 - F - 25g\sin 35 = 0$ — M2
F = 52.7 N (3sf) down the slope — A2

(d) decrease — B1
e.g. perp. to plane, same force "down", more from T "up" $\therefore R$ less — B2 **(14)**

Total **(75)**

Performance Record – M1 Paper K

Question no.	**1**	**2**	**3**	**4**	**5**	**6**	**7**	Total
Topic(s)	impulse, uniform accel	moments	rel. posn. **i**, **j**	cons. of mom. friction	uniform accel., $F = ma$	connected bodies	statics	
Marks	7	8	10	10	12	14	14	75
Student								