

June 2004

GCE A AND AS LEVEL

MARK SCHEME

MAXIMUM MARK: 50

SYLLABUS/COMPONENT: 9709/05, 8719/05

**MATHEMATICS AND HIGHER MATHEMATICS
Paper 5 (Mechanics 2)**



UNIVERSITY of CAMBRIDGE
International Examinations

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Mechanics 2

- 1** For taking moments about the edge of the platform M1
 $(75g \times 0.9 = 25g \times x + 10g \times 1.1)$ (3 term equation)
Two terms correct (unsimplified) A1
Completely correct (unsimplified) A1
Distance $MC = 3.16\text{m}$ A1 **4**
- NB:** If moments taken about other points, the force of the platform on the plank must be present at the edge of the platform for M1
- 2 (i)** Evaluates $\frac{2r \sin \alpha}{3\alpha} \times \cos \frac{\pi}{4}$ M1
Obtains given answer correctly A1 **2**
- (ii)** For taking moments about AB M1
 $\{(5 \times 10 + \frac{1}{4}\pi 5^2)\bar{x} = (5 \times 10) \times 5 + \frac{1}{4}\pi 5^2(10 + \frac{20}{3\pi})\}$
For the total area correct and the moment of the rectangle correct (unsimplified) A1
For the moment of CDE correct (unsimplified) A1
Distance is 7.01 cm A1 **4**
- 3** For applying Newton's 2nd law and using $a = v \frac{dv}{dx}$ M1
 $0.6v \frac{dv}{dx} = -\frac{3}{x^3}$ A1
For separating the variables and integrating M1
 $0.3v^2 = -\frac{3x^{-2}}{(-2)} \quad (+C)$ A1 ft
(ft omission of minus sign in line 2 only)
For using $v = 0$ when $x = 10$ M1
 $v^2 = \frac{5}{x^2} - \frac{1}{20} \quad (\text{aef})$ A1 ft
(ft wrong sign in line 4 only)
Speed is $\frac{\sqrt{3}}{2} \text{ms}^{-1}$ ($=0.866$) A1 **7**

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- 4 (i) Distance of the rod from the hinge is $\frac{2.4}{2.5}(0.7)$ or $0.7\cos 16.26^\circ (=0.672)$ B1
[May be implied in moment equation]
For taking moments about the hinge (3 term equation) M1
 $0.672F = 68 \times 1.2 + 750 \times 2.4$ A1 ft
Force is 2800 N A1 **4**
- (ii) $X = 784$ (ft for $0.28F$) B1 ft
For resolving vertically (4 term equation) M1
 $Y = 1870$ (ft for $0.96F - 818$) A1 ft **3**

SR: For use of 680 N for weight of the beam: (i) B1, M1, A0. In (ii) ft 680, so 3/3 possible.

- 5 (i) For using $EPE = \frac{\lambda x^2}{2L}$ M1
 $EPE \text{ gain} = 2\left(\frac{200x^2}{2 \times 4}\right)$ ($=50x^2$) A1
 $GPE \text{ loss} = 10g(4 + x)$ B1
For using the principle of conservation of energy to form an equation M1
containing EPE, GPE and KE terms
 $[\frac{1}{2}10^2 + 50x^2 = 10g(4 + x)]$
Given answer obtained correctly A1 **5**

ALTERNATIVE METHOD:

- $T = \frac{200x}{4}$ B1
 $100 - 2\left(\frac{200x}{4}\right) = 10v \frac{dv}{dx}$ M1
 $\frac{1}{2}v^2 = 10x - 5x^2$ (+C) A1
Use $x = 0, v^2 = 8g$ M1
 $v^2 = 10(8 + 2x - x^2)$ A1
- (ii) For using $v = 0$ and factorizing or using formula method for solving M1
 $x = 4$ (only) A1 **2**

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- 6 (i) $2 = VT \sin 35^\circ - 5T^2$ or $2 = 25 \tan 35^\circ - \frac{25^2 \times 10}{2V^2 \cos^2 35^\circ}$ B1
- $25 = VT \cos 35^\circ$ B1
- For obtaining V^2 or T^2 in $AV^2 = B$ or $CT^2 = D$ form where A, B, C, D are numerical M1
- $[(25 \tan 35^\circ - 2) \cos^2 35^\circ] V^2 = 3125$ (aef) or
- $5T^2 = 25 \tan 35^\circ - 2$ (aef)]
- $V = 17.3$ or $T = 1.76$ A1
- $T = 1.76$ or $V = 17.3$ (ft $VT = 30.519365$) B1 ft 5
- (ii) For using $\dot{y} = V \sin 35^\circ - gT$ (must be component of V for M1) M1
- $\dot{y}_M (= 9.94 - 17.61 = -7.67) < 0 \rightarrow$ moving downwards A1 ft
- (ft on V and T)
- For using $v_M^2 = (V \cos 35^\circ)^2 + \dot{y}_M^2$ M1
- $(v_M^2 = ((14.20)^2 + (-7.67)^2)$ or
- For using the principle of conservation of energy
- $(\frac{1}{2} m (v_M^2 - 17.3^2) = -mg \times 2)$
- $v_M = 16.1 \text{ ms}^{-1}$ A1 4
- LINES 1 AND 2 ALTERNATIVE METHODS
- EITHER Compare 25 with $\frac{1}{2} R \left(\frac{v^2 \sin 70^\circ}{g} \right)$ M1
- $25 > 14.1 \rightarrow$ moving downwards A1
- OR Compare 1.76 with time to greatest height $\left(\frac{V \sin 35^\circ}{g} \right)$ M1
- $1.76 > 0.994 \rightarrow$ moving downwards A1
- OR $\frac{dy}{dx} = \tan 35^\circ - \frac{g \cdot 10}{V^2 \cos^2 35^\circ} (= -0.54)$ used M1
- As $\tan \phi$ is negative $\rightarrow$ moving downwards A1

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- 7 (i) $T \cos 60^\circ = 0.5g$ ($T = 10$) B1
- For applying Newton's 2nd law horizontally and using $a = \frac{v^2}{r}$ M1
- (must be a component of T for M1)
- $T \sin 60^\circ = \frac{0.5v^2}{0.15 \sin 60^\circ}$ (for an equation in V^2) A1
- For substituting for T M1
- $= 1.5$ A1 **5**

ALTERNATIVELY:

- $a = \frac{v^2}{0.15 \sin 60^\circ}$ B1
- For applying Newton's 2nd law perpendicular to the string M1
- $0.5g \cos 30^\circ = 0.5(a \cos 60^\circ)$ A1
- For substituting for a M1
- $(5 \cos 30^\circ = 0.5^2 / 0.15 \tan 60^\circ)$ (for an equation in V^2)
- $= 1.5$ A1
- (ii) (a) $T \sin 45^\circ = \frac{0.5(0.9)^2}{0.15 \sin 45^\circ}$ B1
- Tension is 5.4 N B1 **2**
- (b) For resolving forces vertically M1
- $5.4 \cos 45^\circ + R = 0.5g$ A1 ft
- Force is 1.18 N A1 **3**