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 x 0.9 = 25g x x + 10g x 1.1 (3 term equation)

Two terms correct (unsimplified) A1

Completely correct (unsimplified) A1

Distance *MC* = 3.16m 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 x 10 + $\frac{1}{4}\pi 5^2)\bar{x}$ = (5 x 10) x 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

$0.3v^2 = -\frac{3x^{-2}}{(-2)}$ (+C) A1 ft

(ft omission of minus sign in line 2 only)

For using = 0 when x = 10 M1

$v^2 = \frac{5}{x^2} - \frac{1}{20}$ (aef) A1 ft

(ft wrong sign in line 4 only)

Speed is $\frac{\sqrt{3}}{2}$ ms^{-1} (=0.866) A1 **7**

4 **(i)** Distance of the rod from the hinge is $\frac{2.4}{2.5}(0.7)$ or 0.7cos16.26° (=0.672) B1

[May be implied in moment equation]

For taking moments about the hinge (3 term equation) M1

0.672*F* = 68 x 1.2 + 750 x 2.4 A1 ft

Force is 2800 N A1 **4**

(ii) *X* = 784 (ft for 0.28*F*) B1 ft

For resolving vertically (4 term equation) M1

Y = 1870 (ft for 0.96*F* – 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 gain = $2\left(\frac{200x^2}{2\times 4}\right)$ (=50x^2) A1

GPE loss = 10g (4 + *x*) B1

For using the principle of conservation of energy to form an equation containing EPE, GPE and KE terms M1

[½10 ^{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, ^{2} = 8g M1

^{2} = 10(8 + 2*x* – x^2) A1

(ii) For using = 0 and factorizing or using formula method for solving M1

x = 4 (only) A1 **2**

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6 **(i)** $2 = VT\sin35° - 5T^2$ or $2 = 25\tan35° - \dfrac{25^2 \times 10}{2V^2\cos^2 35°}$ B1

$25 = VT\cos35°$ 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

$[(25\tan35° - 2)\cos^2 35°]V^2 = 3125$ (aef) or

$5T^2 = 25\tan35° - 2$ (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 $\dot{y} = V\sin35° - gT$ (must be component of V for M1) M1

$\dot{y}_M$ (= 9.94 – 17.61 = -7.67) < 0 → moving downwards A1 ft

(ft on V and T)

For using $_M^2 = (V\cos35°)^2 + \dot{y}_M{}^2$ M1

($_M^2 = ((14.20)^2 + (-7.67)^2)$ or

For using the principle of conservation of energy

$(\tfrac{1}{2}m(v_M{}^2 - 17.3^2) = -mg \times 2)$

$_M = 16.1$ ms^{-1} A1 **4**

LINES 1 AND 2 ALTERNATIVE METHODS

<u>EITHER</u> Compare 25 with $\frac{1}{2}R\left(\frac{1}{2}\dfrac{v^2\sin70°}{g}\right)$ M1

25 > 14.1 → moving downwards A1

<u>OR</u> Compare 1.76 with time to greatest height $\left(\dfrac{V\sin35°}{g}\right)$ M1

1.76 > 0.994 → moving downwards A1

<u>OR</u> $\dfrac{dy}{dx} = \tan35° - \dfrac{g.10}{V^2\cos^2 35°}\left(= -0.54\right)$ used M1

As $\tan\phi$ is negative → moving downwards A1

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7 **(i)** $T\cos 60° = 0.5g$ ($T = 10$) B1

For applying Newton's 2nd law horizontally and using $a = \frac{v^2}{r}$ M1

(must be a component of T for M1)

$T\sin 60° = \frac{0.5v^2}{0.15\sin 60°}$ (for an equation in V^2) A1

For substituting for T M1

= 1.5 A1 **5**

ALTERNATIVELY:

$a = \frac{v^2}{0.15\sin 60°}$ B1

For applying Newton's 2nd law perpendicular to the string M1

$0.5g\cos 30° = 0.5(a\cos 60°)$ A1

For substituting for a M1

($5\cos 30° = 0.5\ ^2/0.15\tan 60°$) (for an equation in V^2)

= 1.5 A1

(ii) **(a)** $T\sin 45° = \frac{0.5(0.9)^2}{0.15\sin 45°}$ B1

Tension is 5.4 N B1 **2**

(b) For resolving forces vertically M1

$5.4\cos 45° + R = 0.5g$ A1 ft

Force is 1.18 N A1 **3**