CAMBRIDGE
INTERNATIONAL EXAMINATIONS

June 2003

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
Local Examinations Syndicate

Page 1	Mark Scheme	Syllabus	Paper
	A AND AS LEVEL – JUNE 2003	9709/8719	5

Mechanics 2

1 The distance from the centre to the rod is $\sqrt{25^2 - 24^2}$ B1

For taking moments about the centre of the ring or about the mid-point of the rod, or C.O.M. of frame (correct number of terms required in equation) M1

(1.5 + 0.6)$\bar{x}$ = 0.6 x 7 or (1.5 + 0.6)(7 - $\bar{x}$) =1.5 x 7
1.5$\bar{x}$ = 0.6 (7 - $\bar{x}$) A1

Distance is 2cm A1
SR Allow M1 for 48.7 = (50π + 48) $\bar{x}$

4

2 **(i)** *OQ* = 4 tan 20° (=1.456) B1

OG = 1.5 B1

G not between *O* and *Q* (all calculations correct) B1

3

(ii) Hemisphere does not fall on to its plane face *B1 ft

Because the moment about *P* is clockwise or the centre of mass is to right of *PQ* (dep)* B1 ft

2

3 **(i)** Rope is at 30° to wall, or beam is at 0° to the horizontal or a correct trig. ratio used B1

For taking moments about *A* or
For taking moments about *P* and resolving horizontally M1

2.5*T* = 45*g* x 3cos 30° or
5*H* = 45*g* x 3cos 30° and *H* = *T*sin30° A1 ft

Tension is 468 N A1

4

(ii) Horizontal component is 234 N (ft ½ *T*) B1 ft

For resolving forces vertically (*V* = 45*g* - *T*cos 30°) M1

Magnitude of vertical component is 45 N A1 ft
SR angle incorrect **(i)** B0, M1, A1 ft A0, **(ii)** B1 ft (*T* and angle), M1, A0

3

4 **(i)** For using Newton's second law with $a = v\frac{dv}{dx}$ M1

$-\frac{1}{3v} = 0.2v\frac{dv}{dx}$ A1

$3v^2\frac{dv}{dx} = -5$ from correct working A1

3

(ii) For separating the variables and attempting to integrate M1

$v^3 = (A) - 5x$ A1

For using $x = 0$ and $v = 4$ to find A, and then substituting $x = 7.4$ (or equivalent using limits) M1

$v = 3$ A1

4

5 **(i)** For resolving forces vertically (3 term equation) M1

$T\cos 60^0 + 0.5 \times 10 = 8$ A1

Tension is 6 N A1

3

(ii) Radius of circle is $9\sin 60°$ (7.7942) B1

For using Newton's second law horizontally with $a = \frac{v^2}{r}$ M1

$6 \sin 60^o = 0.5\frac{v^2}{(9\sin 60^\circ)}$ A1 ft

Alternative for the above 2 marks:

For using Newton's second law perpendicular to the string with $a = \frac{v^2}{r}$ M1

$(8 - 0.5 \times 10)\sin 60° = 0.5\frac{v^2}{(9\sin 60^\circ)}\cos 60°$ A1 ft

Speed is 9 ms^{-1} A1

4

NB Use of $mr\omega^2$, the M1 is withheld until $v = r\omega$ is used
SR Lift perpendicular to the string:
(i) $8\sin 60^o = 0.5g + T\cos 60^o \rightarrow T = 3.86$: M1, A1, A1 (-1 MR) (2 out of 3 max);
(ii) $3.86\sin 60^o + 8\cos 60^o = \frac{0.5v^2}{9\sin 60^\circ}$: B1, M1, A1√, A1 (-1 MR) (3 out of 4 max)
$\Rightarrow \underline{10}.7$

Page 3	Mark Scheme	Syllabus	Paper
	A AND AS LEVEL – JUNE 2003	9709/8719	5

6 **(i)** For using $y = \dot{y}_0 t - \frac{1}{2}gt^2$ with $y = 0$ and $t = 10$ or

$\dot{y} = \dot{y}_0 - gt$ with $\dot{y} = 0$ and $t = 5$ M1

$0 = 60\sin\alpha \times 10 - \frac{1}{2} \times 10 \times 10^2$ or $0 = 60\sin\alpha - 10 \times 5$ A1

$\alpha = 56.4°$ A1

3

(ii) For substituting $t = 5$ into $y = \dot{y}_0 t - \frac{1}{2}gt^2$ or $\dot{y} = 0$ into

$\dot{y}^2 = \dot{y}_0^2 - 2gy$ or $\dot{y} = 0$ and $t = 5$ into $y = \frac{\dot{y}_0 + \dot{y}}{2} t$ M1

Greatest height is 125m A1

2

(iii) $\dot{y} = 60\sin\alpha - gT$ B1

$\dot{x} = 60\cos\alpha$ B1

For attempting to solve $\dot{x} = \dot{y}$, or a complete method for an equation in T using $\dot{x} = \dot{y}$ M1

$T = 1.68$ A1

4

NB. Use of $\dot{y}_0 = 60$ in **(i)** and **(ii)** is M0

7 **(i)** For using $T = \frac{\lambda x}{L}$ $\left(\frac{130\times 3}{10} \text{ or } \frac{130\times 1.5}{5}\right)$ M1

Tension is 39 N A1

2

(ii) For resolving forces vertically (mg = 2 x 39 x $\frac{5}{13}$) M1

Mass is 3kg A1

2

(iii) Extension = 20 - 10 (or 10 - 5) B1

For using EPE = $\frac{\lambda x^2}{2L}$
(L must be 10 or 5; must be attempt at extension, e.g. x = 20 or x = 8 - 2.5 is M0)

[EPE = $\frac{130\times 10^2}{2\times 10}$ or EPE = 2 x $\frac{130\times 5^2}{2\times 5}$]
(Allow M1 only for x = 2 or 3) M1

EPE is 650 J (ft attempted extension in lowest position) A1 ft

3

(iv) Change in GPE = 3 x 10 x 8 B1 ft

For using the principle of conservation of energy with KE, GPE and EPE all represented M1

650 = ½3v^2 + 3 x 10 x 8 + $\frac{130\times 2^2}{2\times 10}$ A1 ft

Speed is 16 ms^{-1} A1

4