OCR
RECOGNISING ACHIEVEMENT

**ADVANCED GCE** **4729/01**

**MATHEMATICS**

Mechanics 2

**MONDAY 16 JUNE 2008** Afternoon

Time: 1 hour 30 minutes

**Additional materials:** Answer Booklet (8 pages)
List of Formulae (MF1)

**INSTRUCTIONS TO CANDIDATES**

- Write your name, centre number and candidate number in the spaces provided on the answer booklet.
- Read each question carefully and make sure you know what you have to do before starting your answer.
- Answer **all** the questions.
- Give non-exact numerical answers correct to 3 significant figures unless a different degree of accuracy is specified in the question or is clearly appropriate.
- The acceleration due to gravity is denoted by $g\,\mathrm{m\,s^{-2}}$. Unless otherwise instructed, when a numerical value is needed, use $g = 9.8$.
- You are permitted to use a graphical calculator in this paper.

**INFORMATION FOR CANDIDATES**

- The number of marks is given in brackets [ ] at the end of each question or part question.
- The total number of marks for this paper is 72.
- **You are reminded of the need for clear presentation in your answers.**

This document consists of **6** printed pages and **2** blank pages.



**[Turn over**

**1** A car is pulled at constant speed along a horizontal straight road by a force of 200 N inclined at 35° to the horizontal. Given that the work done by the force is 5000 J, calculate the distance moved by the car. [3]

**2** A bullet of mass 9 grams passes horizontally through a fixed vertical board of thickness 3 cm. The speed of the bullet is reduced from 250 m s$^{-1}$ to 150 m s$^{-1}$ as it passes through the board. The board exerts a constant resistive force on the bullet. Calculate the magnitude of this resistive force. [4]

**3** The resistance to the motion of a car of mass 600 kg is $kv$ N, where $v$ m s$^{-1}$ is the car's speed and $k$ is a constant. The car ascends a hill of inclination $\alpha$, where $\sin\alpha = \frac{1}{10}$. The power exerted by the car's engine is 12 000 W and the car has constant speed 20 m s$^{-1}$.

**(i)** Show that $k = 0.6$. [3]

The power exerted by the car's engine is increased to 16 000 W.

**(ii)** Calculate the maximum speed of the car while ascending the hill. [3]

The car now travels on horizontal ground and the power remains 16 000 W.

**(iii)** Calculate the acceleration of the car at an instant when its speed is 32 m s$^{-1}$. [3]

**4** A golfer hits a ball from a point $O$ on horizontal ground with a velocity of 35 m s$^{-1}$ at an angle of $\theta$ above the horizontal. The horizontal range of the ball is $R$ metres and the time of flight is $t$ seconds.

**(i)** Express $t$ in terms of $\theta$, and hence show that $R = 125 \sin 2\theta$. [5]

The golfer hits the ball so that it lands 110 m from $O$.

**(ii)** Calculate the two possible values of $t$. [5]

**5**

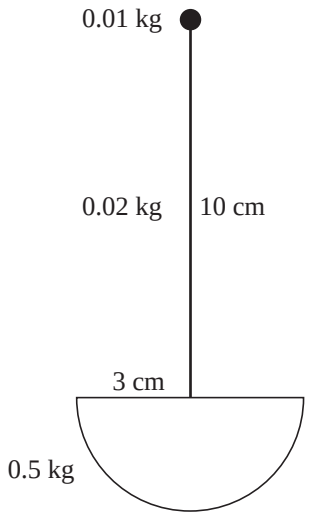



**Fig. 1**

A toy is constructed by attaching a small ball of mass 0.01 kg to one end of a uniform rod of length 10 cm whose other end is attached to the centre of the plane face of a uniform solid hemisphere with radius 3 cm. The rod has mass 0.02 kg, the hemisphere has mass 0.5 kg and the rod is perpendicular to the plane face of the hemisphere (see Fig. 1).

**(i)** Show that the distance from the ball to the centre of mass of the toy is 10.7 cm, correct to 1 decimal place. [4]

**(ii)**

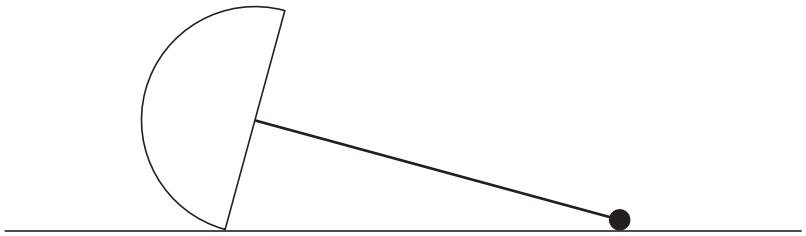


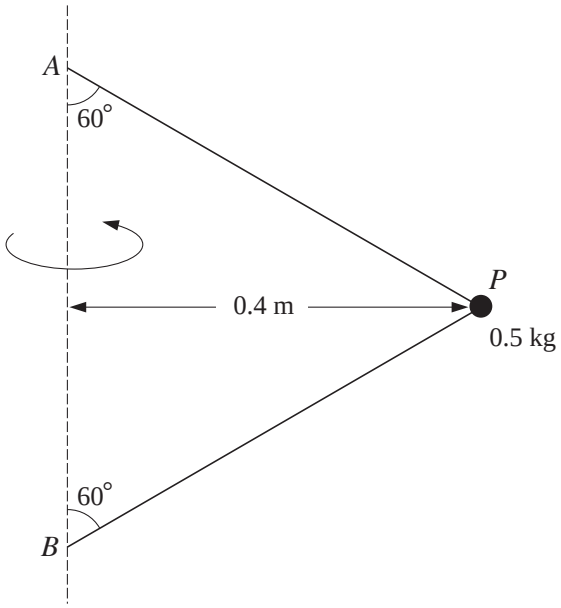
**Fig. 2**

The toy lies on horizontal ground in a position such that the ball is touching the ground (see Fig. 2). Determine whether the toy is lying in equilibrium or whether it will move to a position where the rod is vertical. [4]



**[Turn over**

**6**




A particle $P$ of mass 0.5 kg is attached to points $A$ and $B$ on a fixed vertical axis by two light inextensible strings of equal length. Both strings are taut and each is inclined at $60^\circ$ to the vertical (see diagram). The particle moves with constant speed $3\,\text{m}\,\text{s}^{-1}$ in a horizontal circle of radius 0.4 m.

**(i)** Calculate the tensions in the two strings. [7]

The particle now moves with constant angular speed $\omega\,\text{rad}\,\text{s}^{-1}$ and the string $BP$ is on the point of becoming slack.

**(ii)** Calculate $\omega$. [5]

**7**


Two small spheres $A$ and $B$ of masses 2 kg and 3 kg respectively lie at rest on a smooth horizontal platform which is fixed at a height of 4 m above horizontal ground (see diagram). Sphere $A$ is given an impulse of 6 N s towards $B$, and $A$ then strikes $B$ directly. The coefficient of restitution between $A$ and $B$ is $\frac{2}{3}$.

**(i)** Show that the speed of $B$ after it has been hit by $A$ is $2\,\text{m}\,\text{s}^{-1}$. [6]

Sphere $B$ leaves the platform and follows the path of a projectile.

**(ii)** Calculate the speed and direction of motion of $B$ at the instant when it hits the ground. [7]

**8 (i)**

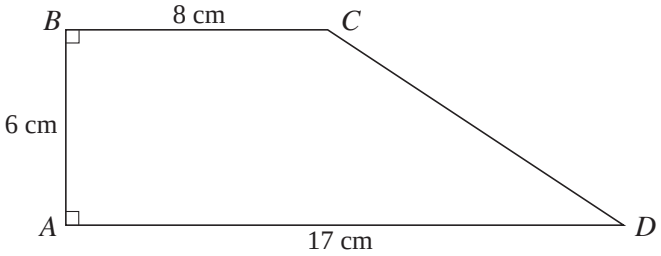



**Fig. 1**

A uniform lamina $ABCD$ is in the form of a right-angled trapezium. $AB = 6$ cm, $BC = 8$ cm and $AD = 17$ cm (see Fig. 1). Taking $x$- and $y$-axes along $AD$ and $AB$ respectively, find the coordinates of the centre of mass of the lamina. [8]

**(ii)**

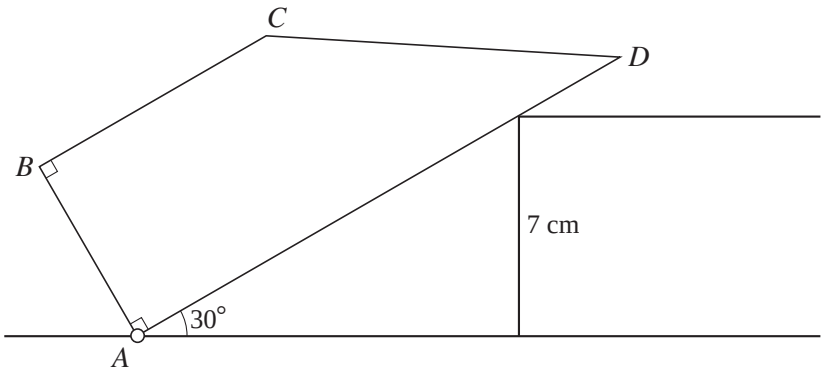



**Fig. 2**

The lamina is smoothly pivoted at $A$ and it rests in a vertical plane in equilibrium against a fixed smooth block of height 7 cm. The mass of the lamina is 3 kg. $AD$ makes an angle of $30^\circ$ with the horizontal (see Fig. 2). Calculate the magnitude of the force which the block exerts on the lamina. [5]

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