6678/01

Edexcel GCE

Mechanics

Unit M2 Mock paper

Advanced Subsidiary / Advanced

Time: 1 hour 30 minutes

Materials required for the examination	Items included with these question papers
Answer Book (AB04) Graph Paper (GP02) Mathematical Formulae	Nil

Candidates may use any calculator EXCEPT **those with a facility for symbolic algebra, differentiation and/or integration. Thus candidates may** NOT **use calculators such as Texas TI 89, TI 92, Casio CFX 9970G, Hewlett Packard HP 48G.**

Instructions to Candidates

In the boxes on the Answer Book provided, write the name of the Examining Body (Edexcel), your Centre Number, Candidate Number, the Unit Title (Mechanics M2), the Paper Reference(6678), your surname, other names and signature.

Whenever a numerical value of g is required, take $g = 9.8$ m s^{-2}.

When a calculator is used, the answer should be given to an appropriate degree of accuracy.

Information for Candidates

A booklet 'Mathematical Formulae including Statistical Formulae and Tables' is provided.

Full marks may be obtained for answers to ALL questions.

This paper has 7 questions. Pages 6, 7 and 8 are blank.

Advice to Candidates

You must ensure that your answers to parts of questions are clearly labelled.

You must show sufficient working to make your methods clear to the Examiner. Answers without working will gain no credit

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1. A smooth sphere is moving with speed U in a straight line on a smooth horizontal plane. It strikes a fixed smooth vertical wall at right angles. The coefficient of restitution between the sphere and the wall is $\frac{1}{2}$.

Find the fraction of the kinetic energy of the sphere that is lost as a result of the impact.

(5 marks)

2.

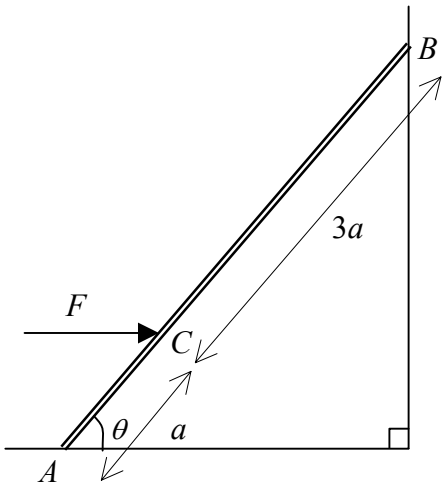

Fig.1

A uniform ladder AB has one end A on smooth horizontal ground. The other end B rests against a smooth vertical wall. The ladder is modelled as a uniform rod of mass m and length $4a$. The ladder is kept in equilibrium by a horizontal force F acting at a point C of the ladder where $AC = a$. The force F and the ladder lie in a vertical plane perpendicular to the wall. The ladder is inclined to the horizontal at an angle θ, where $\tan\theta = 2$, as shown in Fig. 1.

Find F in terms of m and g. **(6 marks)**

3.

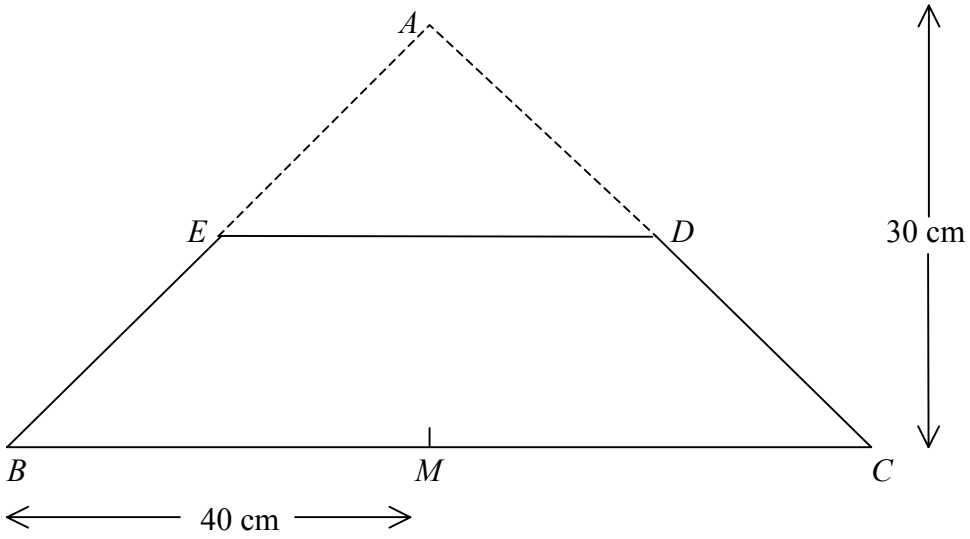

Fig. 2

A uniform plane lamina is in the shape of an isosceles triangle ABC, where $AB = AC$. The mid-point of BC is M, $AM = 30$ cm and $BM = 40$ cm. The mid-points of AC and AB are D and E respectively. The triangular portion ADE is removed leaving a uniform plane lamina $BCDE$ as shown in Fig. 2.

(a) Show that the centre of mass of the lamina $BCDE$ is $6\frac{2}{3}$ cm from BC.

(6 marks)

The lamina $BCDE$ is freely suspended from D and hangs in equilibrium.

(b) Find, in degrees to one decimal place, the angle which DE makes with the vertical.

(3 marks)

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4. The resistance to the motion of a cyclist is modelled as kv^2 N, where k is a constant and v m s^{-1} is the speed of the cyclist. The total mass of the cyclist and his bicycle is 100 kg. The cyclist freewheels down a slope inclined at an angle α to the horizontal, where $\sin \alpha = \frac{1}{20}$, at a constant speed of 3.5 m s^{-1}.

(a) Show that $k = 4$. **(3 marks)**

The cyclist ascends a slope inclined at an angle β to the horizontal, where $\sin \beta = \frac{1}{40}$, at a constant speed of 2 m s^{-1}.

(b) Find the rate at which the cyclist is working. **(6 marks)**

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5. A smooth sphere S of mass m is moving with speed u on a smooth horizontal plane. The sphere S collides with another smooth sphere T, of equal radius to S but of mass km, moving in the same straight line and in the same direction with speed λu, $0 < \lambda < \frac{1}{2}$. The coefficient of restitution between S and T is e.

Given that S is brought to rest by the impact,

(a) show that $e = \dfrac{1 + k\lambda}{k(1 - \lambda)}$. **(6 marks)**

(b) Deduce that $k > 1$. **(3 marks)**

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6. At time t seconds the acceleration, $\mathbf{a}$ m s^{-2}, of a particle P relative to a fixed origin O, is given by $\mathbf{a} = 2\mathbf{i} + 6t\mathbf{j}$. Initially the velocity of P is $(2\mathbf{i} - 4\mathbf{j})$ m s^{-1}.

(a) Find the velocity of P at time t seconds. **(3 marks)**

At time $t = 2$ seconds the particle P is given an impulse $(3\mathbf{i} - 1.5\mathbf{j})$ Ns. Given that the particle P has mass 0.5 kg,

(b) find the speed of P immediately after the impulse has been applied. **(6 marks)**

7.

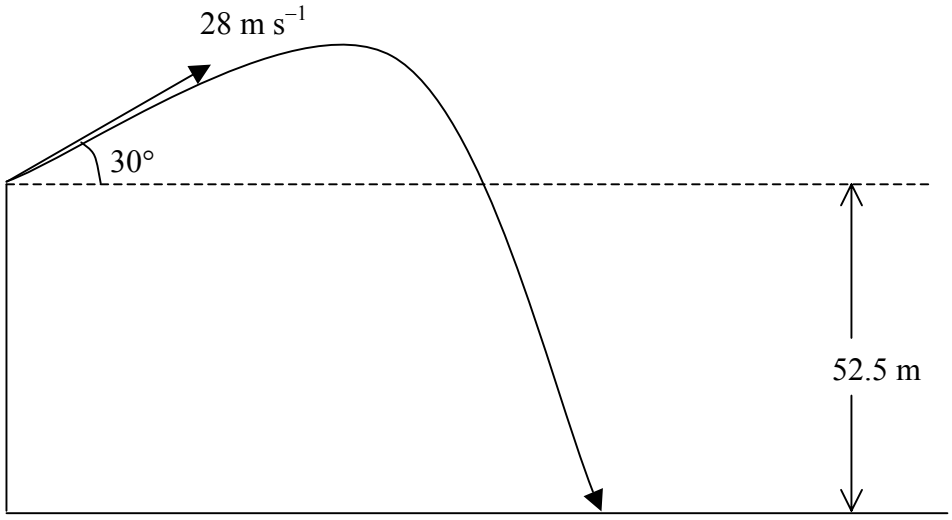

Fig. 3

A shot is projected upwards from the top of a cliff with a velocity of 28 m s^{-1} at an angle of 30° above the horizontal. It strikes the ground 52.5 m vertically below the level of the point of projection, as shown in Fig. 3. The motion of the shot is modelled as that of a particle moving freely under gravity.

Find, to 3 significant figures,

(*a*) the horizontal distance from the point of projection at which the shot strikes the ground, **(8 marks)**

(*b*) the speed of the shot as it strikes the ground. **(5 marks)**

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8. A particle P is projected up a line of greatest slope of a rough plane which is inclined at an angle α to the horizontal, where $\tan \alpha = \frac{3}{4}$. The coefficient of friction between P and the plane is $\frac{1}{2}$. The particle is projected from the point O with a speed of 10 m s^{-1} and comes to instantaneous rest at the point A.

By Using the Work-Energy principle, or otherwise,

(*a*) find, to 3 significant figures, the length OA. **(7 marks)**

(*b*) Show that P will slide back down the plane. **(3 marks)**

(*c*) Find, to 3 significant figures, the speed of P when it returns to O. **(5 marks)**

END