

OXFORD CAMBRIDGE AND RSA EXAMINATIONS

A2 GCE

4729/01

MATHEMATICS

Mechanics 2

QUESTION PAPER

WEDNESDAY 13 MAY 2015: Morning

**DURATION: 1 hour 30 minutes
plus your additional time allowance**

MODIFIED ENLARGED

Candidates answer on the Printed Answer Book or any suitable paper provided by the centre. The Printed Answer Book may be enlarged by the centre.

OCR SUPPLIED MATERIALS:

Printed Answer Book 4729/01

List of Formulae (MF1)

OTHER MATERIALS REQUIRED:

Scientific or graphical calculator

READ INSTRUCTIONS OVERLEAF

INSTRUCTIONS TO CANDIDATES

Write your name, centre number and candidate number in the spaces provided on the Printed Answer Book or on the paper provided by the centre. Please write clearly and in capital letters.

IF YOU USE THE PRINTED ANSWER BOOK, WRITE YOUR ANSWER TO EACH QUESTION IN THE SPACE PROVIDED. Additional paper may be used if necessary but you must clearly show your candidate number, centre number and question number(s).

Use black ink. HB pencil may be used for graphs and diagrams only.

Answer ALL the questions.

Read each question carefully. Make sure you know what you have to do before starting your answer.

You are permitted to use a scientific or graphical calculator in this paper.

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 $g \text{ m s}^{-2}$. Unless otherwise instructed, when a numerical value is needed, use $g = 9.8$.

INFORMATION FOR CANDIDATES

This information is the same on the Printed Answer Book and the Question Paper.

The number of marks is given in brackets [] at the end of each question or part question on the Question Paper.

YOU ARE REMINDED OF THE NEED FOR CLEAR PRESENTATION IN YOUR ANSWERS.

The total number of marks for this paper is 72.

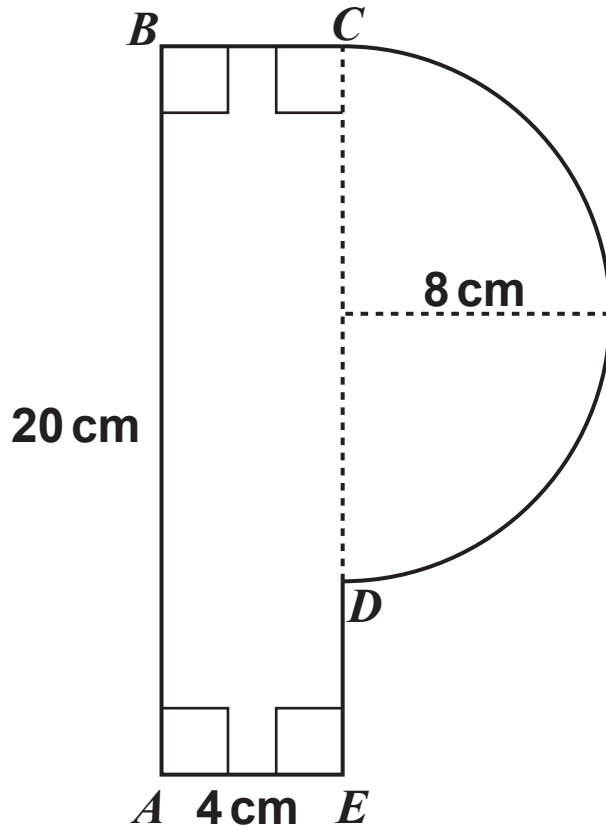
Any blank pages are indicated.

INSTRUCTION TO EXAMS OFFICER/INVIGILATOR

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- 1 A cyclist travels along a straight horizontal road. The total mass of the cyclist and her bicycle is 80 kg and the resistance to motion is a constant 60 N.**
- (i) The cyclist travels at a constant speed working at a constant rate of 480 W. Find the speed at which she travels. [3]**
- (ii) The cyclist now instantaneously increases her power to 600 W. After travelling at this power for 14.2 s her speed reaches 9.4 m s^{-1} . Find the distance travelled at this power. [4]**
- 2 A particle of mass 0.3 kg is attached to one end of a light inextensible string. The other end of the string is attached to a fixed point A . The particle moves in a horizontal circle of radius 0.343 m, with centre vertically below A , at a constant angular speed of 6 rad s^{-1} . Find the tension in the string and the angle at which the string is inclined to the vertical. [6]**
- 3 A car of mass 1500 kg travels along a straight horizontal road with its engine working at a constant rate of P W. There is a constant resistance to motion of R N. Points A and B are on the road. At point A the car's speed is 16 m s^{-1} and its acceleration is 0.3875 m s^{-2} . At point B the car's speed is 25 m s^{-1} and its acceleration is 0.2 m s^{-2} . Find the values of P and R . [6]**

- 4 A uniform solid prism shown below has cross-section $ABCDE$ in the shape of a rectangle measuring 20 cm by 4 cm joined to a semicircle of radius 8 cm as shown in the diagram. The centre of mass of the solid lies in this cross-section.



- (i) Find the distance of the centre of mass of the solid from AB . [5]

The solid is placed with AE on rough horizontal ground (so the object does not slide) and is in equilibrium with a horizontal force of magnitude 4 N applied along CB .

- (ii) Find the greatest and least possible values for the weight of the solid. [5]

- 5 A small sphere of mass 0.2 kg is projected vertically downwards with a speed of 5 m s^{-1} from a height of 1.6 m above horizontal ground. It hits the ground and rebounds vertically upwards coming to instantaneous rest at a height of $h\text{ m}$ above the ground. The coefficient of restitution between the sphere and the ground is 0.7 .

(i) Find h . [4]

(ii) Find the magnitude and direction of the impulse exerted on the sphere by the ground. [3]

(iii) Find the loss of energy of the sphere between the instant of projection and the instant it comes to instantaneous rest at height $h\text{ m}$. [3]

- 6 A particle is projected with speed $v\text{ m s}^{-1}$ from a point O on horizontal ground. The angle of projection is θ° above the horizontal. At time t seconds after the instant of projection the horizontal displacement of the particle from O is $x\text{ m}$ and the upward vertical displacement from O is $y\text{ m}$.

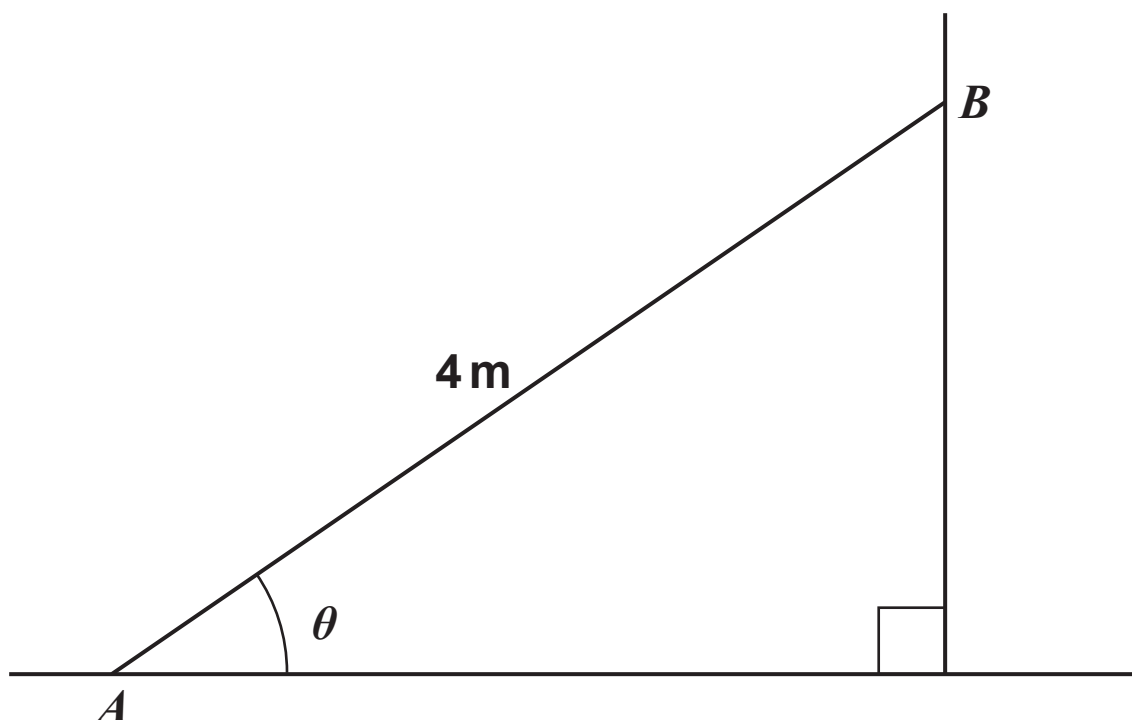
(i) Show that

$$y = x \tan \theta - \frac{4.9x^2}{v^2 \cos^2 \theta}. \quad [4]$$

A stone is thrown from the top of a vertical cliff 100 m high. The initial speed of the stone is 16 m s^{-1} and the angle of projection is θ° to the horizontal. The stone hits the sea 40 m from the foot of the cliff.

(ii) Find the two possible values of θ . [6]

- 7 A uniform ladder AB of weight W N and length 4 m rests with its end A on rough horizontal ground and its end B against a smooth vertical wall. The ladder is inclined at an angle θ to the horizontal where $\tan \theta = \frac{1}{2}$ (see diagram below). A small object S of weight $2W$ N is placed on the ladder at a point C , which is 1 m from A . The coefficient of friction between the ladder and the ground is μ and the system is in limiting equilibrium.

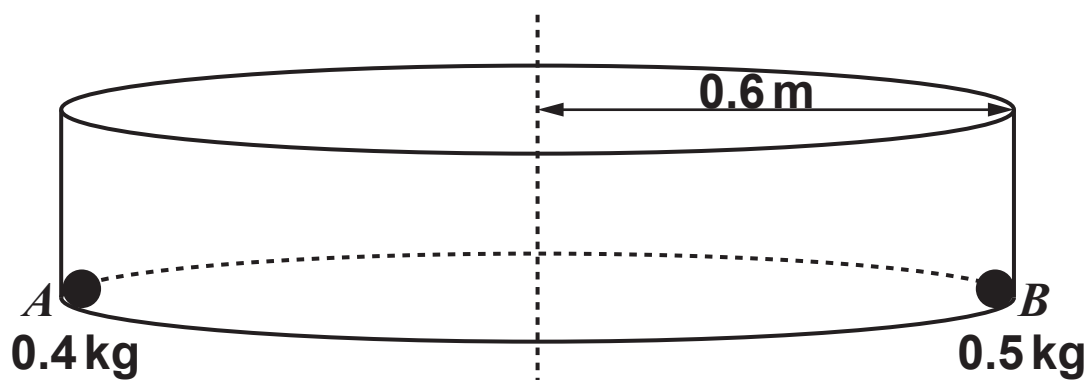


- (i) Show that $\mu = \frac{2}{3}$. [6]

A small object of weight aW N is placed on the ladder at its mid-point and the object S of weight $2W$ N is placed on the ladder at its lowest point A .

- (ii) Given that the system is in equilibrium, find the set of possible values of a . [5]

- 8 Two small spheres, A and B , are free to move on the inside of a smooth hollow cylinder, in such a way that they remain in contact with both the curved surface of the cylinder and its horizontal base. The mass of A is 0.4 kg , the mass of B is 0.5 kg and the radius of the cylinder is 0.6 m (see diagram below). The coefficient of restitution between A and B is 0.35 . Initially, A and B are at opposite ends of a diameter of the base of the cylinder with A travelling at a constant speed of $v\text{ m s}^{-1}$ and B stationary. The magnitude of the force exerted on A by the curved surface of the cylinder is 6 N .



- (i) Show that $v = 3$. [2]
- (ii) Calculate the speeds of the particles after A 's first impact with B . [6]

Sphere B is removed from the cylinder and sphere A is now set in motion with constant angular speed $\omega\text{ rad s}^{-1}$. The magnitude of the total force exerted on A by the cylinder is 4.9 N .

- (iii) Find ω . [4]

END OF QUESTION PAPER

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