OCR
Oxford Cambridge and RSA

Wednesday 13 May 2015 – Morning

A2 GCE MATHEMATICS

4729/01 Mechanics 2

QUESTION PAPER

Candidates answer on the Printed Answer Book.

OCR supplied materials:
- Printed Answer Book 4729/01
- List of Formulae (MF1)

Other materials required:
- Scientific or graphical calculator

Duration: 1 hour 30 minutes

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INSTRUCTIONS TO CANDIDATES

These instructions are the same on the Printed Answer Book and the Question Paper.

- The Question Paper will be found inside the Printed Answer Book.
- Write your name, centre number and candidate number in the spaces provided on the Printed Answer Book. Please write clearly and in capital letters.
- **Write your answer to each question in the space provided in the Printed Answer Book**. 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.
- Do **not** write in the bar codes.
- 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 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**.
- The Printed Answer Book consists of **16** pages. The Question Paper consists of **4** pages. Any blank pages are indicated.

INSTRUCTION TO EXAMS OFFICER / INVIGILATOR

- Do not send this Question Paper for marking; it should be retained in the centre or recycled. Please contact OCR Copyright should you wish to re-use this document.

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.

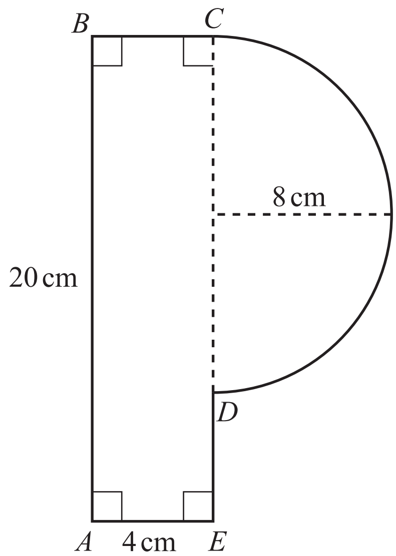
(i) The cyclist travels at a constant speed working at a constant rate of 480 W. Find the speed at which she travels. **[3]**

(ii) The cyclist now instantaneously increases her power to 600 W. After travelling at this power for 14.2 s her speed reaches $9.4\,\mathrm{m\,s^{-1}}$. 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 $6\,\mathrm{rad\,s^{-1}}$. 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 $16\,\mathrm{m\,s^{-1}}$ and its acceleration is $0.3875\,\mathrm{m\,s^{-2}}$. At point *B* the car's speed is $25\,\mathrm{m\,s^{-1}}$ and its acceleration is $0.2\,\mathrm{m\,s^{-2}}$. Find the values of *P* and *R*. **[6]**

4



A uniform solid prism 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 $5\,\mathrm{m\,s^{-1}}$ 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 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 m. **[3]**

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

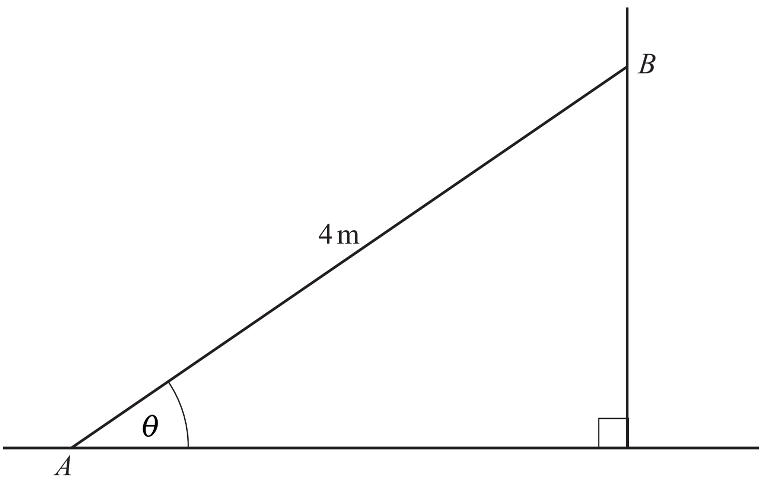
(i) Show that

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

A stone is thrown from the top of a vertical cliff 100 m high. The initial speed of the stone is $16\,\mathrm{m\,s^{-1}}$ and the angle of projection is $\theta°$ 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



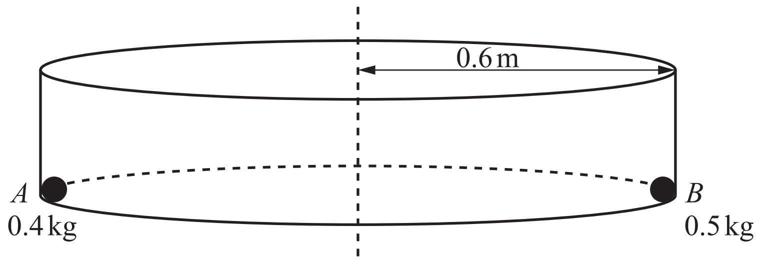
A uniform ladder AB of weight W N and length 4 m rests with its end A on rough horizontal ground and its end B against a smooth vertical wall. The ladder is inclined at an angle θ to the horizontal where $\tan\theta = \frac{1}{2}$ (see diagram). A small object S of weight $2W$ N is placed on the ladder 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). 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