OCR RECOGNISING ACHIEVEMENT

Friday 22 June 2012 – Afternoon

A2 GCE MATHEMATICS

4729 Mechanics 2

QUESTION PAPER

Candidates answer on the Printed Answer Book.

OCR supplied materials:
- Printed Answer Book 4729
- 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 in the centre of 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 particle, of mass 0.8 kg, moves along a smooth horizontal surface. It hits a vertical wall, which is at right angles to the direction of motion of the particle, and rebounds. The speed of the particle as it hits the wall is $4\,\mathrm{m\,s^{-1}}$ and the coefficient of restitution between the particle and the wall is 0.3. Find

(i) the impulse that the wall exerts on the particle, **[3]**

(ii) the kinetic energy lost in the impact. **[2]**

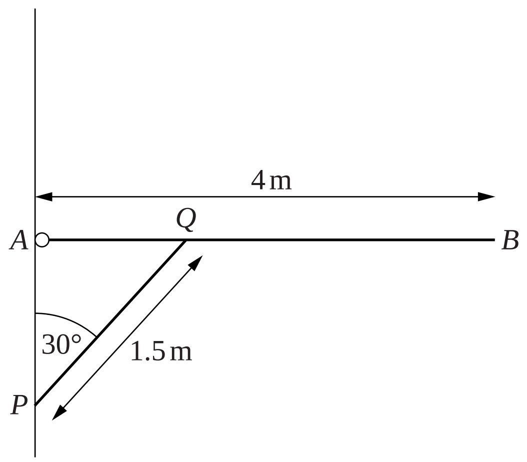
2 A car of mass 1600 kg moves along a straight horizontal road. The resistance to the motion of the car has constant magnitude 800 N and the car's engine is working at a constant rate of 20 kW.

(i) Find the acceleration of the car at an instant when the car's speed is $20\,\mathrm{m\,s^{-1}}$. **[4]**

The car now moves up a hill inclined at 4° to the horizontal. The car's engine continues to work at 20 kW and the magnitude of the resistance to motion remains at 800 N.

(ii) Find the greatest steady speed at which the car can move up the hill. **[4]**

3



A uniform beam *AB* of mass 15 kg and length 4 m is freely hinged to a vertical wall at *A*. The beam is held in equilibrium in a horizontal position by a light rod *PQ* of length 1.5 m. *P* is fixed to the wall vertically below *A* and *PQ* makes an angle of 30° with the vertical (see diagram). The force exerted on the beam at *Q* by the rod is in the direction *PQ*. Find

(i) the magnitude of the force exerted on the beam at *Q*, **[3]**

(ii) the magnitude and direction of the force exerted on the beam at *A*. **[6]**

4 A boy throws a small ball at a vertical wall. The ball is thrown horizontally, from a point O, at a speed of $14.4\,\text{m s}^{-1}$ and it hits the wall at a point which is 0.2 m below the level of O.

(i) Find the horizontal distance from O to the wall. **[4]**

The boy now moves so that he is 6 m from the wall. He throws the ball at an angle of 15° above the horizontal. The ball again hits the wall at a point which is 0.2 m below the level from which it was thrown.

(ii) Find the speed at which the ball was thrown. **[6]**

5 A particle P, of mass 2 kg, is attached to fixed points A and B by light inextensible strings, each of length 2 m. A and B are 3.2 m apart with A vertically above B. The particle P moves in a horizontal circle with centre at the mid-point of AB.

(i) Find the tension in each string when the angular speed of P is $4\,\text{rad s}^{-1}$. **[7]**

(ii) Find the least possible speed of P. **[6]**

6 Three particles A, B and C are in a straight line on a smooth horizontal surface. The particles have masses 0.2 kg, 0.4 kg and 0.6 kg respectively. B is at rest. A is projected towards B with a speed of $1.8\,\text{m s}^{-1}$ and collides with B. The coefficient of restitution between A and B is $\frac{1}{3}$.

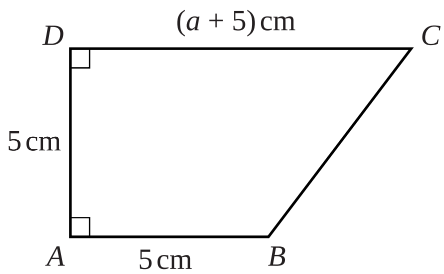
(i) Show that the speed of B after the collision is $0.8\,\text{m s}^{-1}$ and find the speed of A after the collision. **[6]**

C is moving with speed $0.2\,\text{m s}^{-1}$ in the same direction as B. Particle B subsequently collides with C. The coefficient of restitution between B and C is e.

(ii) Find the set of values for e such that B does not collide again with A. **[7]**

[Question 7 is printed overleaf.]

7



The diagram shows the cross-section through the centre of mass of a uniform solid prism. The cross-section is a trapezium *ABCD* with *AB* and *CD* perpendicular to *AD*. The lengths of *AB* and *AD* are each 5 cm and the length of *CD* is $(a + 5)$ cm.

(i) Show the distance of the centre of mass of the prism from *AD* is

$$\frac{a^2 + 15a + 75}{3(a + 10)} \text{ cm.}$$ **[5]**

The prism is placed with the face containing *AB* in contact with a horizontal surface.

(ii) Find the greatest value of a for which the prism does not topple. **[3]**

The prism is now placed on an inclined plane which makes an angle $\theta°$ with the horizontal. *AB* lies along a line of greatest slope with *B* higher than *A*.

(iii) Using the value for a found in part **(ii)**, and assuming the prism does not slip down the plane, find the greatest value of θ for which the prism does not topple. **[6]**