

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



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 $g \text{ ms}^{-2}$. 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

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- 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 ms^{-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]

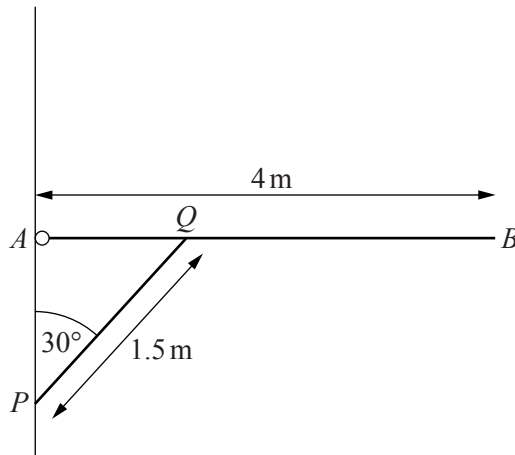
- 2 A car of mass 1600 kg moves along a straight horizontal road. The resistance to the motion of the car has constant magnitude 800 N and the car's engine is working at a constant rate of 20 kW .

(i) Find the acceleration of the car at an instant when the car's speed is 20 ms^{-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 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 rad s^{-1} . [7]

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

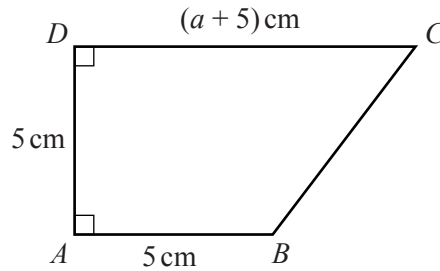
- 6 Three particles A , B and C are in a straight line on a smooth horizontal surface. The particles have masses 0.2 kg , 0.4 kg and 0.6 kg respectively. B is at rest. A is projected towards B with a speed of 1.8 m s^{-1} and collides with B . The coefficient of restitution between A and B is $\frac{1}{3}$.

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

C is moving with speed 0.2 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.]



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

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

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 θ° 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]

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