

# OCR

Oxford Cambridge and RSA

## Tuesday 9 June 2015 – Morning

### AS GCE MATHEMATICS

4728/01 Mechanics 1

### QUESTION PAPER

Candidates answer on the Printed Answer Book.

**OCR supplied materials:**

- Printed Answer Book 4728/01
- 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 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  $g \text{ ms}^{-2}$ . 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 **12** pages. The Question Paper consists of **4** pages. Any blank pages are indicated.

### INSTRUCTION TO EXAMS OFFICER/INVIGILATOR

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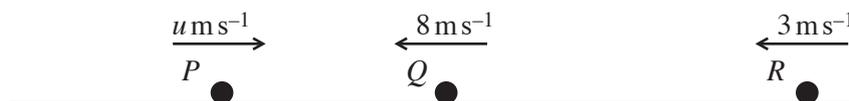
1 A particle  $P$  is projected vertically downwards with speed  $14 \text{ m s}^{-1}$  from a point  $30 \text{ m}$  above the ground.

(i) Calculate the speed of  $P$  when it reaches the ground. [2]

(ii) Find the distance travelled by  $P$  in the first  $0.4 \text{ s}$  of its motion. [2]

(iii) Calculate the time taken for  $P$  to travel the final  $15 \text{ m}$  of its descent. [3]

2



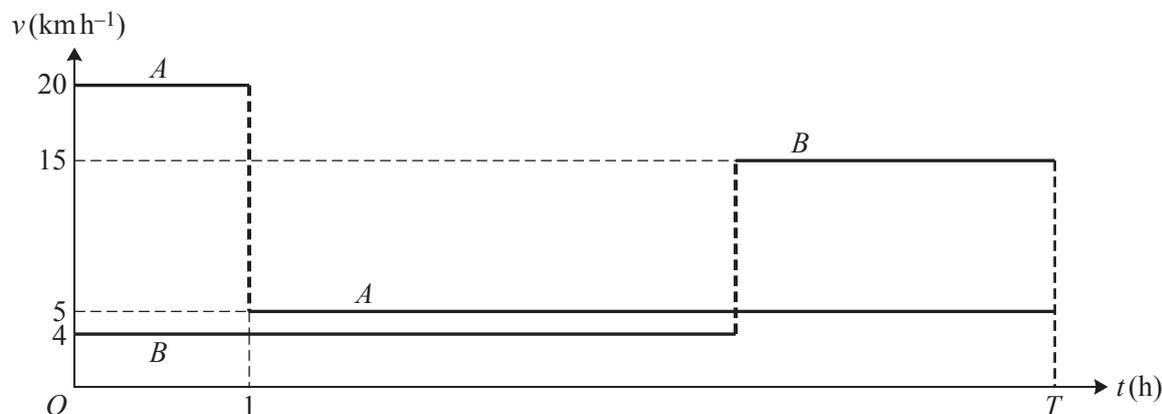
Three particles  $P$ ,  $Q$  and  $R$  with masses  $0.4 \text{ kg}$ ,  $0.3 \text{ kg}$  and  $m \text{ kg}$  are moving along the same straight line on a smooth horizontal surface.  $P$  and  $Q$  are moving towards each other with speeds  $u \text{ m s}^{-1}$  and  $8 \text{ m s}^{-1}$  respectively.  $R$  has speed  $3 \text{ m s}^{-1}$  and is moving in the same direction as  $Q$  (see diagram).

(i) Immediately after the collision between  $P$  and  $Q$  their directions of motion have been reversed, but their speeds are unchanged. Calculate  $u$ . [4]

The next collision is between  $Q$  and  $R$ . After the collision between  $Q$  and  $R$ , particle  $Q$  is at rest and  $R$  has speed  $9 \text{ m s}^{-1}$ .

(ii) Calculate  $m$ . [4]

3

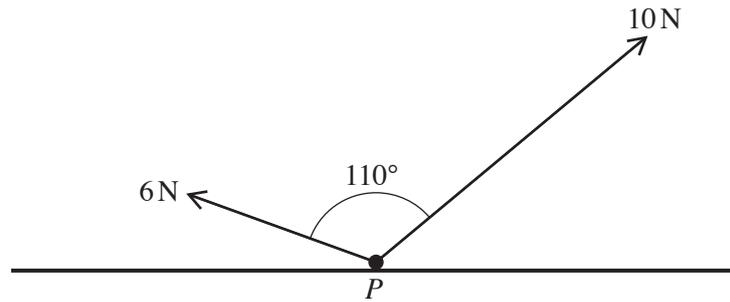


Two travellers  $A$  and  $B$  make the same journey on a long straight road. Each traveller walks for part of the journey and rides a bicycle for part of the journey. They start their journeys at the same instant, and they end their journeys simultaneously after travelling for  $T$  hours.  $A$  starts the journey cycling at a steady  $20 \text{ km h}^{-1}$  for 1 hour.  $A$  then leaves the bicycle at the side of the road, and completes the journey walking at  $5 \text{ km h}^{-1}$ .  $B$  begins the journey walking at a steady  $4 \text{ km h}^{-1}$ . When  $B$  finds the bicycle where  $A$  left it,  $B$  cycles at  $15 \text{ km h}^{-1}$  to complete the journey (see diagram).

(i) Calculate the distance  $A$  cycles, and hence find the period of time for which  $B$  walks before finding the bicycle. [3]

(ii) Find  $T$ . [3]

(iii) Calculate the distance  $A$  and  $B$  each travel. [2]



Two forces of magnitudes 6N and 10N separated by an angle of  $110^\circ$  act on a particle  $P$ , which rests on a horizontal surface (see diagram).

- (i) Find the magnitude of the resultant of the 6N and 10N forces, and the angle between the resultant and the 10N force. [6]

The two forces act in the same vertical plane. The particle  $P$  has weight 20N and rests in equilibrium on the surface. Given that the surface is smooth, find

- (ii) the magnitude of the force exerted on  $P$  by the surface, [1]

- (iii) the angle between the surface and the 10N force. [2]

- 5 A particle  $P$  of mass 0.4kg is at rest on a horizontal surface. The coefficient of friction between  $P$  and the surface is 0.2. A force of magnitude 1.2N acting at an angle of  $\theta^\circ$  above the horizontal is then applied to  $P$ . Find the acceleration of  $P$  in each of the following cases:

- (i)  $\theta = 0$ ; [3]

- (ii)  $\theta = 20$ ; [3]

- (iii)  $\theta = 70$ ; [3]

- (iv)  $\theta = 90$ . [2]

- 6 A particle  $P$  moves in a straight line on a horizontal surface.  $P$  passes through a fixed point  $O$  on the line with velocity  $2 \text{ m s}^{-1}$ . At time  $t$  s after passing through  $O$ , the acceleration of  $P$  is  $(4 + 12t) \text{ m s}^{-2}$ .

- (i) Calculate the velocity of  $P$  when  $t = 3$ . [4]

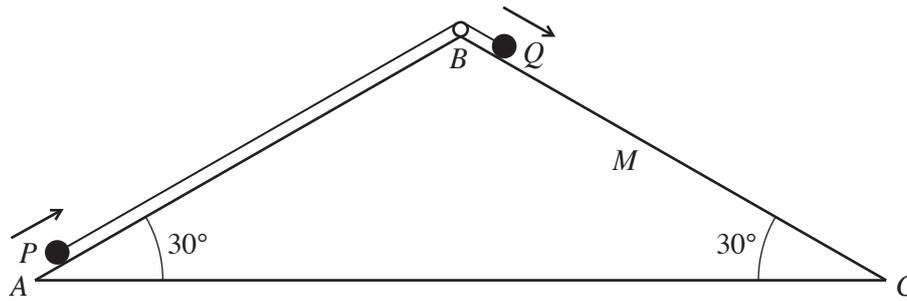
- (ii) Find the distance  $OP$  when  $t = 3$ . [4]

A second particle  $Q$ , having the same mass as  $P$ , moves along the same straight line. The displacement of  $Q$  from  $O$  is  $(k - 2t^3) \text{ m}$ , where  $k$  is a constant. When  $t = 3$  the particles collide and coalesce.

- (iii) Find the value of  $k$ . [1]

- (iv) Find the common velocity of the particles immediately after their collision. [5]

**Question 7 begins on page 4.**



$AB$  and  $BC$  are lines of greatest slope on a fixed triangular prism, and  $M$  is the mid-point of  $BC$ .  $AB$  and  $BC$  are inclined at  $30^\circ$  to the horizontal. The surface of the prism is smooth between  $A$  and  $B$ , and between  $B$  and  $M$ . Between  $M$  and  $C$  the surface of the prism is rough. A small smooth pulley is fixed to the prism at  $B$ . A light inextensible string passes over the pulley. Particle  $P$  of mass  $0.3\text{ kg}$  is fixed to one end of the string, and is placed at  $A$ . Particle  $Q$  of mass  $0.4\text{ kg}$  is fixed to the other end of the string and is placed next to the pulley on  $BC$ . The particles are released from rest with the string taut.  $P$  begins to move towards the pulley, and  $Q$  begins to move towards  $M$  (see diagram).

- (i) Show that the initial acceleration of the particles is  $0.7\text{ ms}^{-2}$ , and find the tension in the string. [5]

The particle  $Q$  reaches  $M$   $1.8\text{ s}$  after being released from rest.

- (ii) Find the speed of the particles when  $Q$  reaches  $M$ . [2]

After  $Q$  passes through  $M$ , the string remains taut and the particles decelerate uniformly.  $Q$  comes to rest between  $M$  and  $C$   $1.4\text{ s}$  after passing through  $M$ .

- (iii) Find the deceleration of the particles while  $Q$  is moving from  $M$  towards  $C$ . [2]

- (iv) (a) By considering the motion of  $P$ , find the tension in the string while  $Q$  is moving from  $M$  towards  $C$ . [3]

- (b) Calculate the magnitude of the frictional force which acts on  $Q$  while it is moving from  $M$  towards  $C$ . [3]

**END OF QUESTION PAPER**

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