

Thursday 6 June 2013 – 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 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**

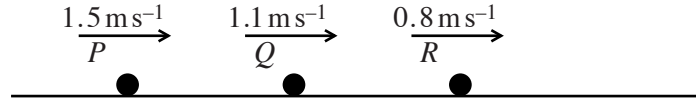
This information is the same on the Printed Answer Book and the Question Paper.

- 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**

- 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



Three particles  $P$ ,  $Q$  and  $R$  have masses  $0.1 \text{ kg}$ ,  $0.3 \text{ kg}$  and  $0.6 \text{ kg}$  respectively. The particles travel along the same straight line on a smooth horizontal table and have velocities  $1.5 \text{ m s}^{-1}$ ,  $1.1 \text{ m s}^{-1}$  and  $0.8 \text{ m s}^{-1}$  respectively (see diagram).  $P$  collides with  $Q$  and then  $Q$  collides with  $R$ . In the second collision  $Q$  and  $R$  coalesce and subsequently move with a velocity of  $1 \text{ m s}^{-1}$ .

(i) Find the speed of  $Q$  immediately before the second collision. [3]

(ii) Calculate the change in momentum of  $P$  in the first collision. [3]

2 A particle  $P$  is projected vertically upwards and reaches its greatest height  $0.5 \text{ s}$  after the instant of projection. Calculate

(i) the speed of projection of  $P$ , [2]

(ii) the greatest height of  $P$  above the point of projection. [3]

It is given that the point of projection is  $0.539 \text{ m}$  above the ground.

(iii) Find the speed of  $P$  immediately before it strikes the ground. [3]

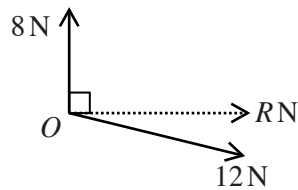
3 Two forces of magnitudes  $8 \text{ N}$  and  $12 \text{ N}$  act at a point  $O$ .

(i) Given that the two forces are perpendicular to each other, find

(a) the angle between the resultant and the  $12 \text{ N}$  force, [2]

(b) the magnitude of the resultant. [2]

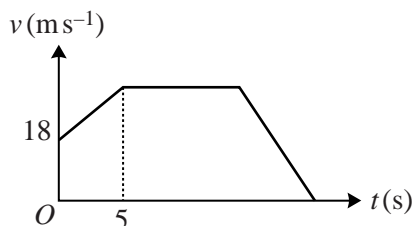
(ii) It is given instead that the resultant of the two forces has magnitude  $R \text{ N}$  and acts in a direction perpendicular to the  $8 \text{ N}$  force (see diagram).



(a) Calculate the angle between the resultant and the  $12 \text{ N}$  force. [3]

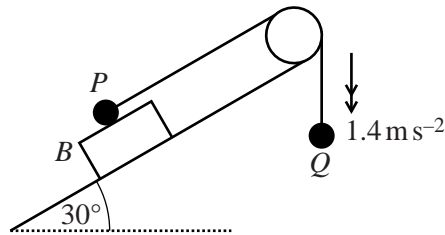
(b) Find  $R$ . [2]

4



The diagram shows the  $(t, v)$  graph of a car moving along a straight road, where  $v \text{ m s}^{-1}$  is the velocity of the car at time  $t \text{ s}$  after it passes through the point  $A$ . The car passes through  $A$  with velocity  $18 \text{ m s}^{-1}$ , and moves with constant acceleration  $2.4 \text{ m s}^{-2}$  until  $t = 5$ . The car subsequently moves with constant velocity until it is  $300 \text{ m}$  from  $A$ . When the car is more than  $300 \text{ m}$  from  $A$ , it has constant deceleration  $6 \text{ m s}^{-2}$ , until it comes to rest.

- (i) Find the greatest speed of the car. [2]
- (ii) Calculate the value of  $t$  for the instant when the car begins to decelerate. [5]
- (iii) Calculate the distance from  $A$  of the car when it is at rest. [3]
- 5 A particle  $P$  is projected with speed  $u \text{ m s}^{-1}$  from the top of a smooth inclined plane of length  $2d$  metres. After its projection  $P$  moves downwards along a line of greatest slope with acceleration  $4 \text{ m s}^{-2}$ . At the instant  $3 \text{ s}$  after projection  $P$  has moved half way down the plane.  $P$  reaches the foot of the plane  $5 \text{ s}$  after the instant of projection.
- (i) Form two simultaneous equations in  $u$  and  $d$ , and hence calculate the speed of projection of  $P$  and the length of the plane. [6]
- (ii) Find the inclination of the plane to the horizontal. [2]
- (iii) Given that the contact force exerted on  $P$  by the plane has magnitude  $6 \text{ N}$ , calculate the mass of  $P$ . [2]
- 6 A particle  $P$  moves in a straight line. At time  $t \text{ s}$  after passing through a point  $O$  of the line, the displacement of  $P$  from  $O$  is  $x \text{ m}$ . Given that  $x = 0.06t^3 - 0.45t^2 - 0.24t$ , find
- (i) the velocity and the acceleration of  $P$  when  $t = 0$ , [6]
- (ii) the value of  $x$  when  $P$  has its minimum velocity, and the speed of  $P$  at this instant, [5]
- (iii) the positive value of  $t$  when the direction of motion of  $P$  changes. [3]



A block  $B$  is placed on a plane inclined at  $30^\circ$  to the horizontal. A particle  $P$  of mass  $0.6 \text{ kg}$  is placed on the upper surface of  $B$ . The particle  $P$  is attached to one end of a light inextensible string which passes over a smooth pulley fixed to the top of the plane. A particle  $Q$  of mass  $0.5 \text{ kg}$  is attached to the other end of the string. The portion of the string attached to  $P$  is parallel to a line of greatest slope of the plane, the portion of the string attached to  $Q$  is vertical and the string is taut. The particles are released from rest and start to move with acceleration  $1.4 \text{ m s}^{-2}$  (see diagram). It is given that  $B$  is in equilibrium while  $P$  moves on its upper surface.

- (i) Find the tension in the string while  $P$  and  $B$  are in contact. [3]
- (ii) Calculate the coefficient of friction between  $P$  and  $B$ . [5]
- (iii) Given that the weight of  $B$  is  $7 \text{ N}$ , calculate the set of possible values of the coefficient of friction between  $B$  and the plane. [7]

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