



Thursday 31 May 2012 – Morning

## AS GCE MATHEMATICS

4728 Mechanics 1

### QUESTION PAPER

Candidates answer on the Printed Answer Book.

**OCR supplied materials:**

- Printed Answer Book 4728
- 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.

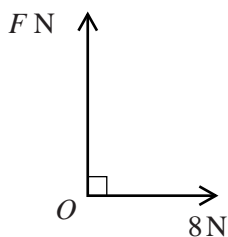
- The number of marks is given in brackets [ ] at the end of each question or part question on the Question Paper.
- **You are reminded of the need for clear presentation in your answers.**
- The total number of marks for this paper is **72**.
- The Printed Answer Book consists of **12** pages. The Question Paper consists of **4** pages. Any blank pages are indicated.

### INSTRUCTION TO EXAMS OFFICER/INVIGILATOR

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2

1



Two perpendicular forces of magnitudes  $F\text{ N}$  and  $8\text{ N}$  act at a point  $O$  (see diagram). Their resultant has magnitude  $17\text{ N}$ .

(i) Calculate  $F$  and find the angle which the resultant makes with the  $8\text{ N}$  force. [4]

A third force of magnitude  $E\text{ N}$ , acting in the same plane as the two original forces, is now applied at the point  $O$ . The three forces of magnitudes  $E\text{ N}$ ,  $F\text{ N}$  and  $8\text{ N}$  are in equilibrium.

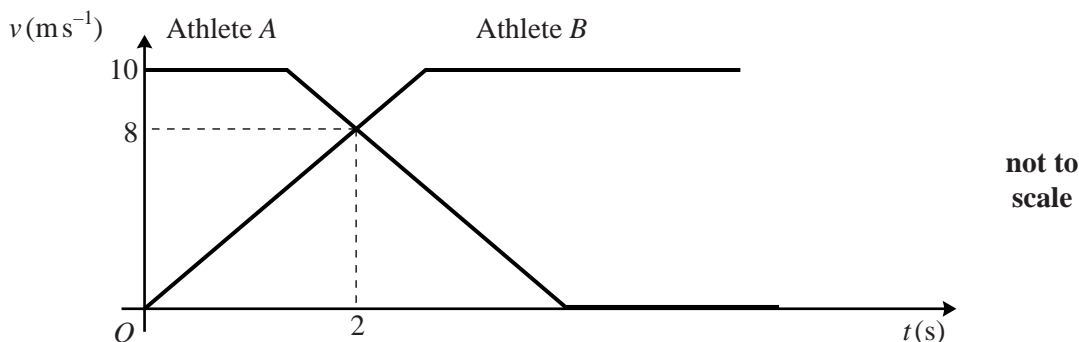
(ii) State the value of  $E$  and the angle between the directions of the  $E\text{ N}$  and  $8\text{ N}$  forces. [2]

2 A particle is projected vertically upwards with speed  $7\text{ m s}^{-1}$  from a point on the ground.

(i) Find the speed of the particle and its distance above the ground  $0.4\text{ s}$  after projection. [4]

(ii) Find the total distance travelled by the particle in the first  $0.9\text{ s}$  after projection. [4]

3



The diagram shows the  $(t, v)$  graphs for two athletes,  $A$  and  $B$ , who run in the same direction in the same straight line while they exchange the baton in a relay race.  $A$  runs with constant velocity  $10\text{ m s}^{-1}$  until he decelerates at  $5\text{ m s}^{-2}$  and subsequently comes to rest.  $B$  has constant acceleration from rest until reaching his constant speed of  $10\text{ m s}^{-1}$ . The baton is exchanged  $2\text{ s}$  after  $B$  starts running, when both athletes have speed  $8\text{ m s}^{-1}$  and  $B$  is  $1\text{ m}$  ahead of  $A$ .

(i) Find the value of  $t$  at which  $A$  starts to decelerate. [2]

(ii) Calculate the distance between  $A$  and  $B$  at the instant when  $B$  starts to run. [5]

## 3

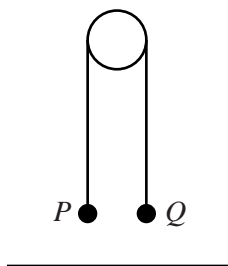
- 4 A block  $B$  of weight  $28\text{N}$  is pulled at constant speed across a rough horizontal surface by a force of magnitude  $14\text{N}$  inclined at  $30^\circ$  above the horizontal.

(i) Show that the coefficient of friction between the block and the surface is  $0.577$ , correct to 3 significant figures. [4]

The  $14\text{N}$  force is suddenly removed, and the block decelerates, coming to rest after travelling a further  $3.2\text{m}$ .

(ii) Calculate the speed of the block at the instant the  $14\text{N}$  force was removed. [6]

## 5



Particles  $P$  and  $Q$ , of masses  $0.4\text{kg}$  and  $m\text{kg}$  respectively, are joined by a light inextensible string which passes over a smooth pulley. The particles are released from rest at the same height above a horizontal surface; the string is taut and the portions of the string not in contact with the pulley are vertical (see diagram).  $Q$  begins to descend with acceleration  $2.45\text{ m s}^{-2}$  and reaches the surface  $0.3\text{ s}$  after being released. Subsequently,  $Q$  remains at rest and  $P$  never reaches the pulley.

(i) Calculate the tension in the string while  $Q$  is in motion. [3]

(ii) Calculate the momentum lost by  $Q$  when it reaches the surface. [5]

(iii) Calculate the greatest height of  $P$  above the surface. [5]

[Questions 6 and 7 are printed overleaf.]

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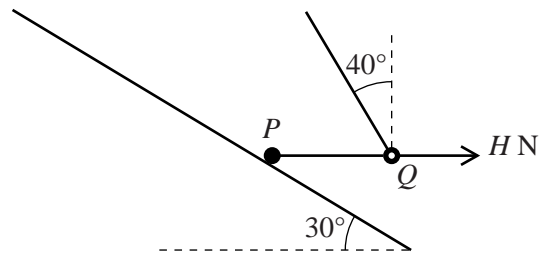
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4

6



A particle  $P$  lies on a slope inclined at  $30^\circ$  to the horizontal.  $P$  is attached to one end of a taut light inextensible string which passes through a small smooth ring  $Q$  of mass  $m$  kg. The portion  $PQ$  of the string is horizontal and the other portion of the string is inclined at  $40^\circ$  to the vertical. A horizontal force of magnitude  $HN$ , acting away from  $P$ , is applied to  $Q$  (see diagram). The tension in the string is  $6.4$  N, and the string is in the vertical plane containing the line of greatest slope on which  $P$  lies. Both  $P$  and  $Q$  are in equilibrium.

(i) Calculate  $m$ . [2]

(ii) Calculate  $H$ . [2]

(iii) Given that the weight of  $P$  is  $32$  N, and that  $P$  is in limiting equilibrium, show that the coefficient of friction between  $P$  and the slope is  $0.879$ , correct to 3 significant figures. [6]

$Q$  and the string are now removed.

(iv) Determine whether  $P$  remains in equilibrium. [3]

7



The diagram shows two particles  $P$  and  $Q$ , of masses  $0.2$  kg and  $0.3$  kg respectively, which move on a horizontal surface in the same direction along a straight line. A stationary particle  $R$  of mass  $1.5$  kg also lies on this line.  $P$  and  $Q$  collide and coalesce to form a combined particle  $C$ . Immediately before this collision  $P$  has velocity  $4 \text{ ms}^{-1}$  and  $Q$  has velocity  $2.5 \text{ ms}^{-1}$ .

(i) Calculate the velocity of  $C$  immediately after this collision. [3]

At time  $t$  s after this collision the velocity  $v \text{ ms}^{-1}$  of  $C$  is given by  $v = V_0 - 3t^2$  for  $0 < t \leq 0.3$ .  $C$  strikes  $R$  when  $t = 0.3$ .

(ii) (a) State the value of  $V_0$ . [1]

(b) Calculate the distance  $C$  moves before it strikes  $R$ . [4]

(c) Find the acceleration of  $C$  immediately before it strikes  $R$ . [3]

Immediately after  $C$  strikes  $R$ , the particles have equal speeds but move in opposite directions.

(iii) Find the speed of  $C$  immediately after it strikes  $R$ . [4]