OCR
RECOGNISING ACHIEVEMENT

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 m s^{-2}. Unless otherwise instructed, when a numerical value is needed, use $g = 9.8$.

INFORMATION FOR CANDIDATES

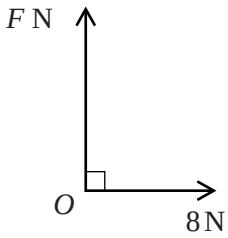
This information is the same on the Printed Answer Book and the Question Paper.

- 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 **12** 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



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

(i) Calculate F and find the angle which the resultant makes with the 8 N force. **[4]**

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

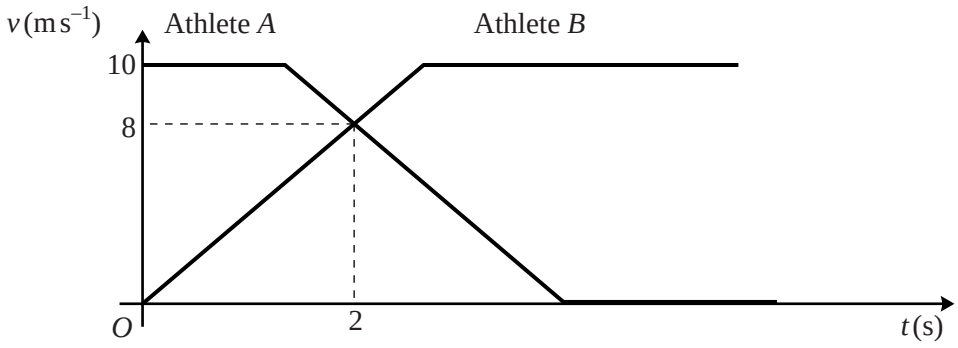
(ii) State the value of E and the angle between the directions of the E N and 8 N forces. **[2]**

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 s after projection. **[4]**

(ii) Find the total distance travelled by the particle in the first 0.9 s after projection. **[4]**

3



not to scale

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 s after B starts running, when both athletes have speed $8\,\text{m s}^{-1}$ and B is 1 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]**

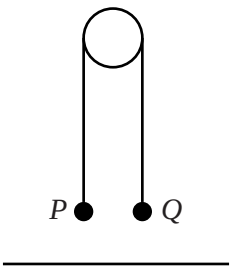
4 A block B of weight 28 N is pulled at constant speed across a rough horizontal surface by a force of magnitude 14 N inclined at 30° above the horizontal.

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

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

(ii) Calculate the speed of the block at the instant the 14 N force was removed. **[6]**

5



Particles P and Q, of masses 0.4 kg and m 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 $2.45\,\text{m}\,\text{s}^{-2}$ and reaches the surface 0.3 s after being released. Subsequently, Q remains at rest and P never reaches the pulley.

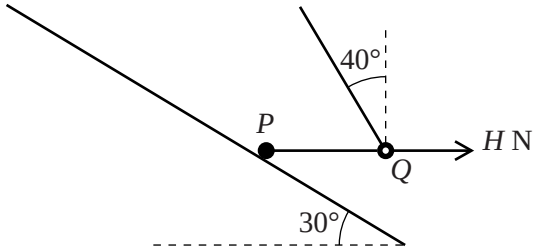
(i) Calculate the tension in the string while Q is in motion. **[3]**

(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.]

6



A particle P lies on a slope inclined at 30° 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° to the vertical. A horizontal force of magnitude H N, 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 $4\,\text{m s}^{-1}$ and Q has velocity $2.5\,\text{m s}^{-1}$.

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

At time t s after this collision the velocity $v\,\text{m s}^{-1}$ of C is given by $v = V_0 - 3t^2$ for $0 < t \leqslant 0.3$. 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]**