OCR

Thursday 12 June 2014 – Afternoon

AS GCE MATHEMATICS

4728/01 Mechanics 1

QUESTION PAPER

3134601401

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 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 **8** 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 A particle P is projected vertically downwards with initial speed $3.5\,\text{m s}^{-1}$ from a point A which is 5 m above horizontal ground.

(i) Find the speed of P immediately before it strikes the ground. **[2]**

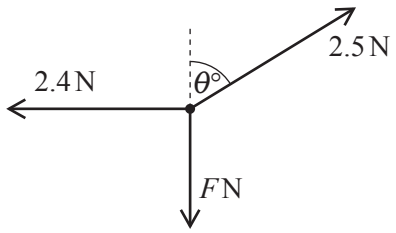
After striking the ground, P rebounds and moves vertically upwards and 0.87 s after leaving the ground P passes through A.

(ii) Calculate the speed of P immediately after it leaves the ground. **[3]**

It is given that the mass of P is 0.2 kg.

(iii) Calculate the change in the momentum of P as a result of its collision with the ground. **[2]**

2



A particle rests on a smooth horizontal surface. Three horizontal forces of magnitudes 2.5 N, F N and 2.4 N act on the particle on bearings $\theta°$, 180° and 270° respectively (see diagram). The particle is in equilibrium.

(i) Find θ and F. **[4]**

The 2.4 N force suddenly ceases to act on the particle, which has mass 0.2 kg.

(ii) Find the magnitude and direction of the acceleration of the particle. **[3]**

3 A particle P travels in a straight line. The velocity of P at time t seconds after it passes through a fixed point A is given by $(0.6t^2 + 3)\,\text{m s}^{-1}$. Find

(i) the velocity of P when it passes through A, **[1]**

(ii) the displacement of P from A when $t = 1.5$, **[4]**

(iii) the velocity of P when it has acceleration $6\,\text{m s}^{-2}$. **[3]**

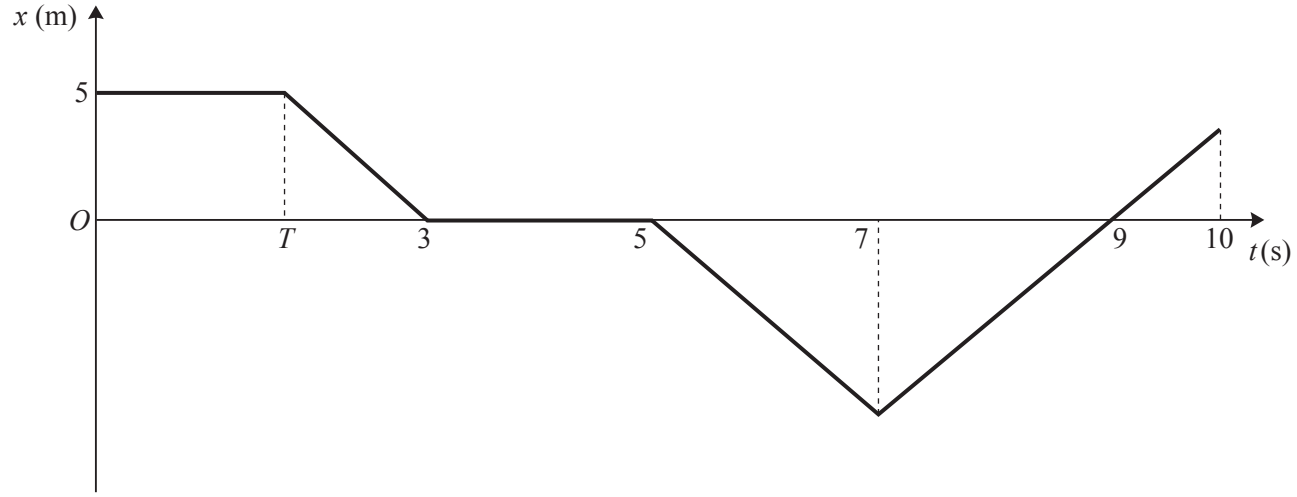
4

Particles P and Q are moving towards each other with constant speeds $4\,\text{m s}^{-1}$ and $2\,\text{m s}^{-1}$ along the same straight line on a smooth horizontal surface (see diagram). P has mass 0.2 kg and Q has mass 0.3 kg. The two particles collide.

(i) Show that Q must change its direction of motion in the collision. **[3]**

(ii) Given that P and Q move with equal speed after the collision, calculate both possible values for their speed after they collide. **[5]**

5



A particle P can move in a straight line on a horizontal surface. At time t seconds the displacement of P from a fixed point A on the line is x m. The diagram shows the (t, x) graph for P. In the interval $0 \leqslant t \leqslant 10$, either the speed of P is $4\,\text{m s}^{-1}$, or P is at rest.

(i) Show by calculation that $T = 1.75$. **[2]**

(ii) State the velocity of P when

(a) $t = 2$, **[1]**

(b) $t = 8$, **[1]**

(c) $t = 9$. **[1]**

(iii) Calculate the distance travelled by P in the interval $0 \leqslant t \leqslant 10$. **[3]**

For $t > 10$, the displacement of P from A is given by $x = 20t - t^2 - 96$.

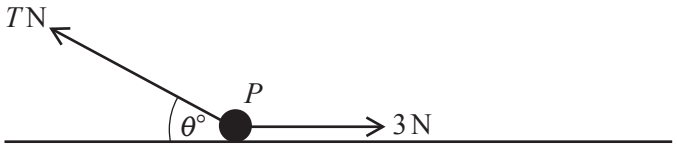
(iv) Calculate the value of t, where $t > 10$, for which the speed of P is $4\,\text{m s}^{-1}$. **[4]**

6 A particle P of weight 8 N rests on a horizontal surface. A horizontal force of magnitude 3 N acts on P, and P is in limiting equilibrium.

(i) Calculate the coefficient of friction between P and the surface. **[2]**

(ii) Find the magnitude and direction of the contact force exerted by the surface on P. **[4]**

(iii)

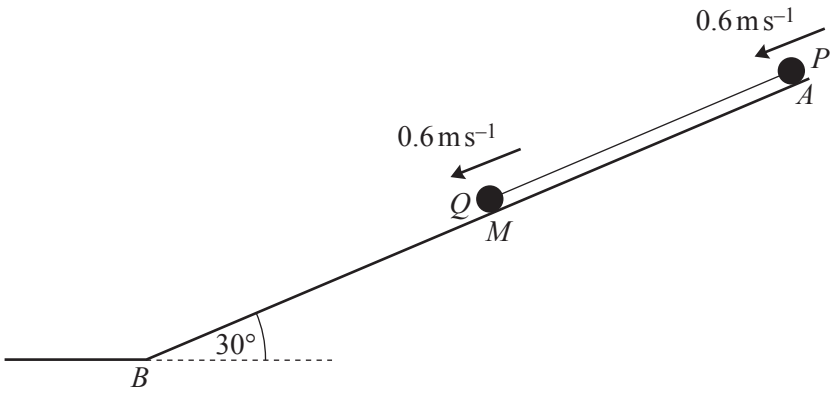


The initial 3 N force continues to act on P in its original direction. An additional force of magnitude T N, acting in the same vertical plane as the 3 N force, is now applied to P at an angle of $\theta°$ above the horizontal (see diagram). P is again in limiting equilibrium.

(a) Given that $\theta = 0$, find T. **[2]**

(b) Given instead that $\theta = 30$, calculate T. **[6]**

7



A and *B* are points at the upper and lower ends, respectively, of a line of greatest slope on a plane inclined at 30° to the horizontal. *M* is the mid-point of *AB*. Two particles *P* and *Q*, joined by a taut light inextensible string, are placed on the plane at *A* and *M* respectively. The particles are simultaneously projected with speed $0.6\,\mathrm{m\,s^{-1}}$ down the line of greatest slope (see diagram). The particles move down the plane with acceleration $0.9\,\mathrm{m\,s^{-2}}$. At the instant 2 s after projection, *P* is at *M* and *Q* is at *B*. The particle *Q* subsequently remains at rest at *B*.

(i) Find the distance *AB*. **[3]**

The plane is rough between *A* and *M*, but smooth between *M* and *B*.

(ii) Calculate the speed of *P* when it reaches *B*. **[4]**

P has mass 0.4 kg and *Q* has mass 0.3 kg.

(iii) By considering the motion of *Q*, calculate the tension in the string while both particles are moving down the plane. **[3]**

(iv) Calculate the coefficient of friction between *P* and the plane between *A* and *M*. **[6]**

END OF QUESTION PAPER

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