OXFORD CAMBRIDGE AND RSA EXAMINATIONS

AS GCE

4728/01

MATHEMATICS

Mechanics 1

QUESTION PAPER

THURSDAY 12 JUNE 2014: Afternoon

DURATION: 1 hour 30 minutes
plus your additional time allowance

MODIFIED ENLARGED

Candidates answer on the Printed Answer Book or any suitable paper provided by the centre. The Printed Answer Book may be enlarged by the centre.

OCR SUPPLIED MATERIALS:

Printed Answer Book 4728/01
List of Formulae (MF1)

OTHER MATERIALS REQUIRED:

Scientific or graphical calculator

READ INSTRUCTIONS OVERLEAF

DC (SJF/AR) 4026016945 96901

INSTRUCTIONS TO CANDIDATES

Write your name, centre number and candidate number in the spaces provided on the Printed Answer Book or on the paper provided by the centre. Please write clearly and in capital letters.

If you use the Printed Answer Book, write your answer to each question in the space provided. 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.

Read each question carefully. Make sure you know what you have to do before starting your answer.

Answer ALL the questions.

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

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.

INSTRUCTION TO EXAMS OFFICER / INVIGILATOR

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

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

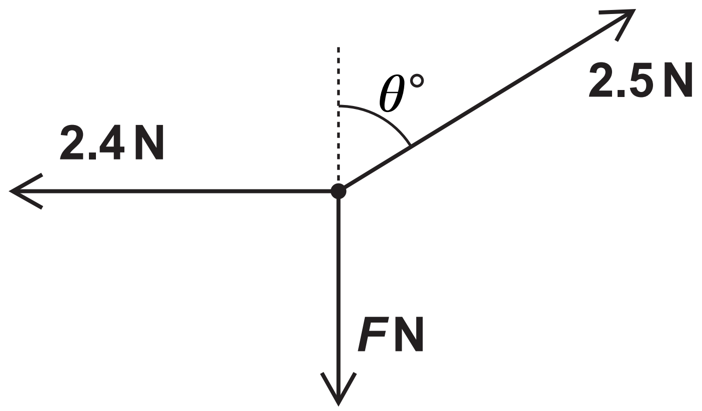
After striking the ground, P rebounds and moves vertically upwards and 0.87 s after leaving the ground P passes through A.

(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 **Look at the following diagram.**



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 θ°, 180° and 270° respectively (see diagram above). 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 $(0.6t^2 + 3)$ 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 m s^{-2}. [3]

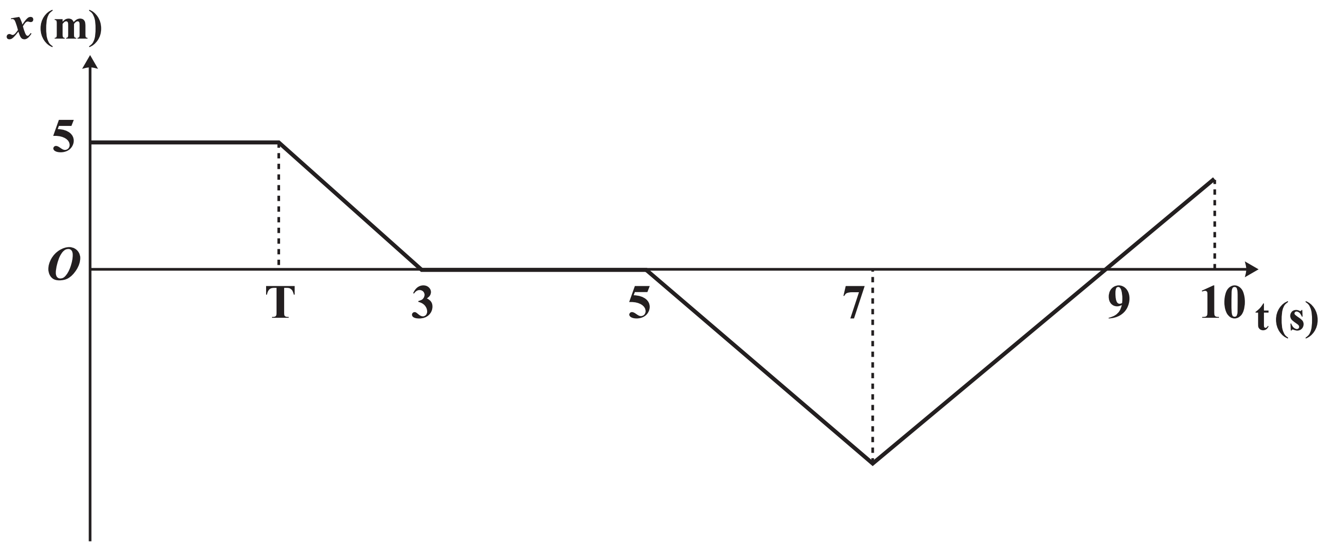
4 **Look at the following diagram.**

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 above). *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 **Look at the following diagram.**



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 above shows the (t, x) graph for P. In the interval $0 \leqslant t \leqslant 10$, either the speed of P is 4 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 $x = 20t - t^2 - 96$.

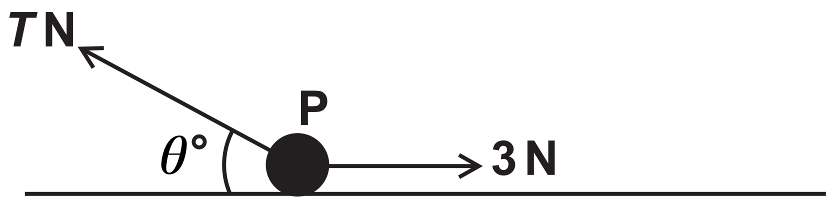
(iv) Calculate the value of t, where $t > 10$, for which the speed of P is 4 m s^{-1}. [4]

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) Look at the following diagram.

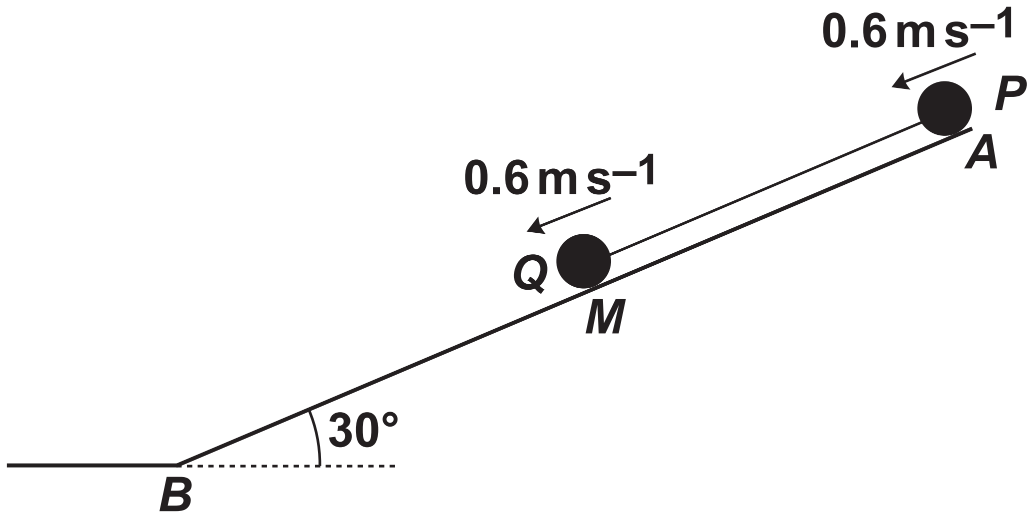


The initial 3 N force continues to act on *P* in its original direction. An additional force of magnitude *T* N, acting in the same vertical plane as the 3 N force, is now applied to *P* at an angle of $\theta°$ above the horizontal (see diagram above). *P* is again in limiting equilibrium.

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

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

7 Look at the following diagram.



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 m s^{-1} down the line of greatest slope (see diagram above). The particles move down the plane with acceleration 0.9 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