OXFORD CAMBRIDGE AND RSA EXAMINATIONS
AS GCE

4728/01

MATHEMATICS

Mechanics 1

QUESTION PAPER

TUESDAY 9 JUNE 2015: Morning
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 (LK/SG) 5302425064 108740/1

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.

Answer ALL the questions.

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

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.

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.

Answer ALL the questions.

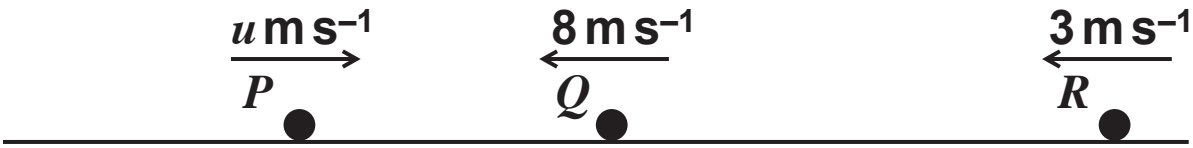
1 A particle P is projected vertically downwards with speed $14\,\text{m s}^{-1}$ from a point 30 m above the ground.

(i) Calculate the speed of P when it reaches the ground. [2]

(ii) Find the distance travelled by P in the first 0.4 s of its motion. [2]

(iii) Calculate the time taken for P to travel the final 15 m of its descent. [3]

2 Three particles P, Q and R with masses 0.4 kg, 0.3 kg and m kg are moving along the same straight line on a smooth horizontal surface. P and Q are moving towards each other with speeds $u\,\text{m s}^{-1}$ and $8\,\text{m s}^{-1}$ respectively. R has speed $3\,\text{m s}^{-1}$ and is moving in the same direction as Q (see diagram below).

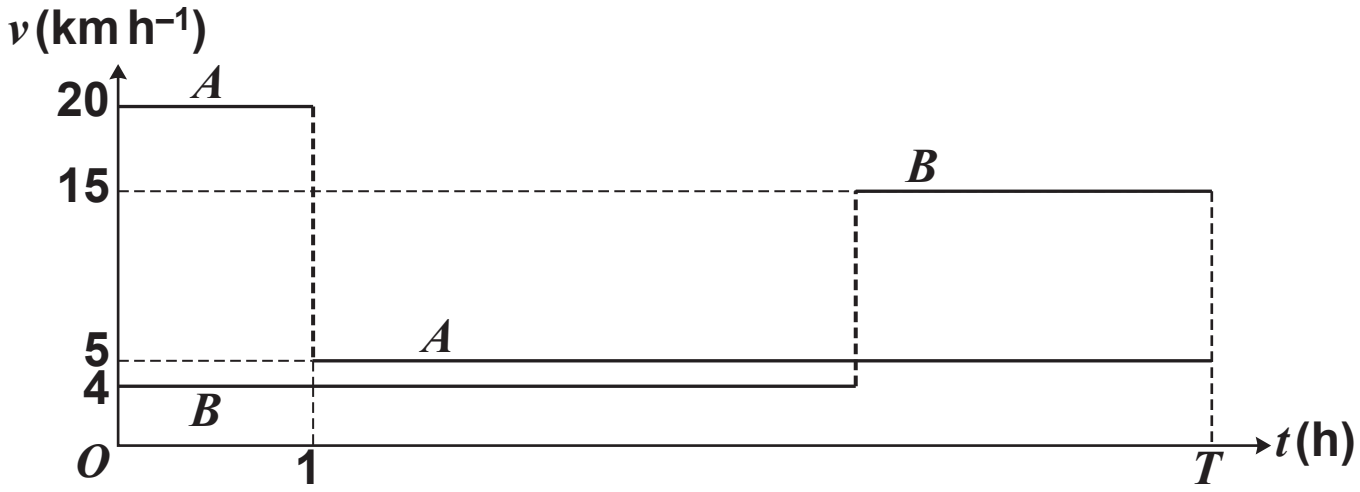


(i) Immediately after the collision between P and Q their directions of motion have been reversed, but their speeds are unchanged. Calculate u. [4]

The next collision is between Q and R. After the collision between Q and R, particle Q is at rest and R has speed $9\,\text{m s}^{-1}$.

(ii) Calculate m. [4]

3 Two travellers A and B make the same journey on a long straight road. Each traveller walks for part of the journey and rides a bicycle for part of the journey. They start their journeys at the same instant, and they end their journeys simultaneously after travelling for T hours. A starts the journey cycling at a steady 20 km h^{-1} for 1 hour. A then leaves the bicycle at the side of the road, and completes the journey walking at 5 km h^{-1}. B begins the journey walking at a steady 4 km h^{-1}. When B finds the bicycle where A left it, B cycles at 15 km h^{-1} to complete the journey (see diagram below).

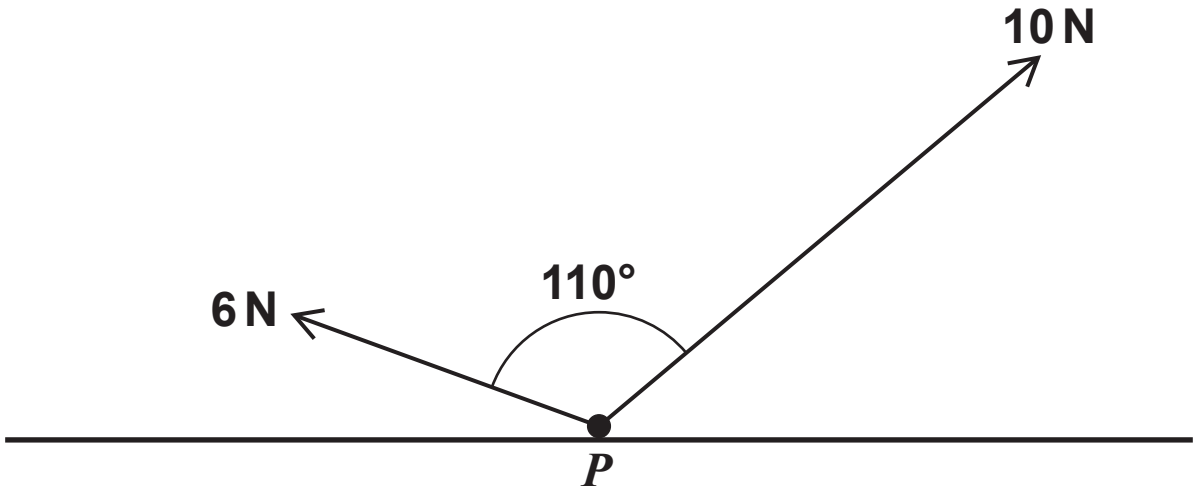


(i) Calculate the distance A cycles, and hence find the period of time for which B walks before finding the bicycle. [3]

(ii) Find T. [3]

(iii) Calculate the distance A and B each travel. [2]

4 Two forces of magnitudes 6 N and 10 N separated by an angle of 110° act on a particle P, which rests on a horizontal surface (see diagram below).



(i) Find the magnitude of the resultant of the 6 N and 10 N forces, and the angle between the resultant and the 10 N force. [6]

The two forces act in the same vertical plane. The particle P has weight 20 N and rests in equilibrium on the surface. Given that the surface is smooth, find

(ii) the magnitude of the force exerted on P by the surface, [1]

(iii) the angle between the surface and the 10 N force. [2]

5 A particle P of mass 0.4 kg is at rest on a horizontal surface. The coefficient of friction between P and the surface is 0.2. A force of magnitude 1.2 N acting at an angle of $\theta°$ above the horizontal is then applied to P. Find the acceleration of P in each of the following cases:

(i) $\theta = 0$; [3]

(ii) $\theta = 20$; [3]

(iii) $\theta = 70$; [3]

(iv) $\theta = 90$. [2]

6 A particle P moves in a straight line on a horizontal surface. P passes through a fixed point O on the line with velocity 2 m s^{-1}. At time t s after passing through O, the acceleration of P is $(4 + 12t)$ m s^{-2}.

(i) Calculate the velocity of P when $t = 3$. [4]

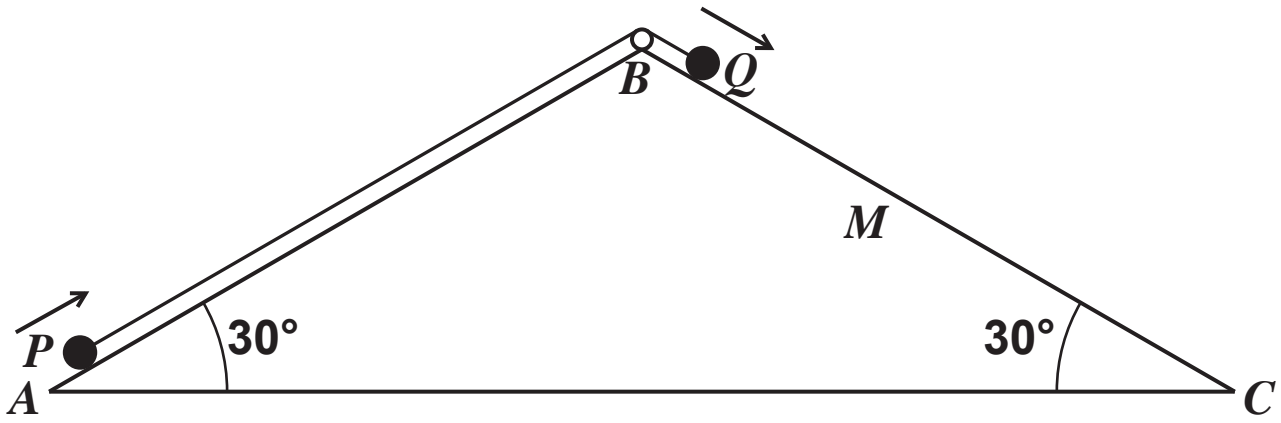
(ii) Find the distance OP when $t = 3$. [4]

A second particle Q, having the same mass as P, moves along the same straight line. The displacement of Q from O is $(k - 2t^3)$ m, where k is a constant. When $t = 3$ the particles collide and coalesce.

(iii) Find the value of k. [1]

(iv) Find the common velocity of the particles immediately after their collision. [5]

7 AB and BC are lines of greatest slope on a fixed triangular prism, and M is the mid-point of BC. AB and BC are inclined at 30° to the horizontal. The surface of the prism is smooth between A and B, and between B and M. Between M and C the surface of the prism is rough. A small smooth pulley is fixed to the prism at B. A light inextensible string passes over the pulley. Particle P of mass 0.3 kg is fixed to one end of the string, and is placed at A. Particle Q of mass 0.4 kg is fixed to the other end of the string and is placed next to the pulley on BC. The particles are released from rest with the string taut. P begins to move towards the pulley, and Q begins to move towards M (see diagram below).



(i) Show that the initial acceleration of the particles is 0.7 m s^{-2}, and find the tension in the string. [5]

The particle Q reaches M 1.8 s after being released from rest.

(ii) Find the speed of the particles when Q reaches M. [2]

After Q passes through M, the string remains taut and the particles decelerate uniformly. Q comes to rest between M and C 1.4 s after passing through M.

(iii) Find the deceleration of the particles while Q is moving from M towards C. [2]

(iv) (a) By considering the motion of P, find the tension in the string while Q is moving from M towards C. [3]

(b) Calculate the magnitude of the frictional force which acts on Q while it is moving from M towards C. [3]

END OF QUESTION PAPER

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