OXFORD CAMBRIDGE AND RSA EXAMINATIONS
AS GCE

4728/01

MATHEMATICS

Mechanics 1

QUESTION PAPER

THURSDAY 6 JUNE 2013: 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 (CW/SW) 1644243596 79685/1

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.**
- **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 $g = 9.8$.**

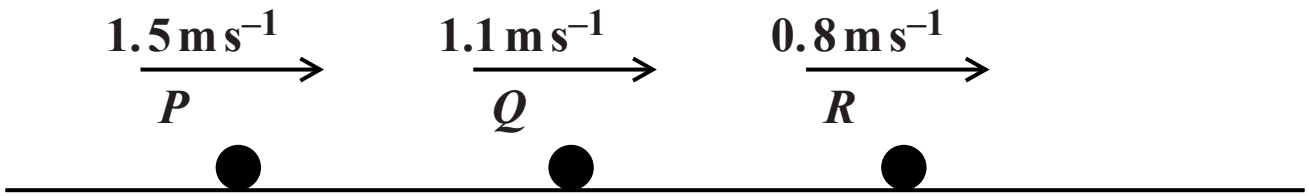
INFORMATION FOR CANDIDATES

- **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.**
- **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 Look at the following diagram.



Three particles *P*, *Q* and *R* have masses 0.1 kg, 0.3 kg and 0.6 kg respectively. The particles travel along the same straight line on a smooth horizontal table and have velocities 1.5 m s^{-1}, 1.1 m s^{-1} and 0.8 m s^{-1} respectively (see diagram above). *P* collides with *Q* and then *Q* collides with *R*. In the second collision *Q* and *R* coalesce and subsequently move with a velocity of 1 m s^{-1}.

(i) Find the speed of *Q* immediately before the second collision. [3]

(ii) Calculate the change in momentum of *P* in the first collision. [3]

2 A particle *P* is projected vertically upwards and reaches its greatest height 0.5 s after the instant of projection.

Calculate

(i) the speed of projection of *P*, [2]

(ii) the greatest height of *P* above the point of projection. [3]

It is given that the point of projection is 0.539 m above the ground.

(iii) Find the speed of *P* immediately before it strikes the ground. [3]

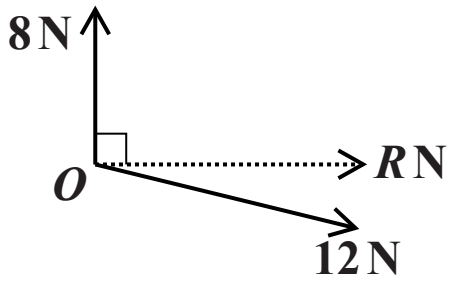
3 Two forces of magnitudes 8 N and 12 N act at a point *O*.

(i) Given that the two forces are perpendicular to each other, find

(a) the angle between the resultant and the 12 N force, [2]

(b) the magnitude of the resultant. [2]

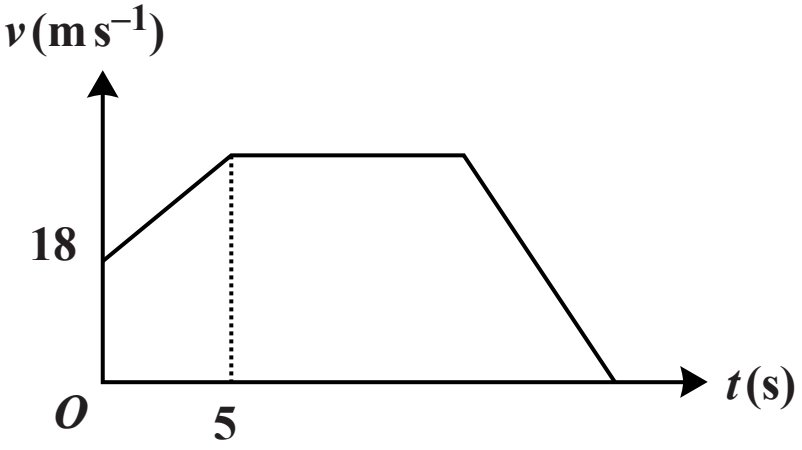
(ii) It is given instead that the resultant of the two forces has magnitude *R* N and acts in a direction perpendicular to the 8 N force (see diagram below).



(a) Calculate the angle between the resultant and the 12 N force. [3]

(b) Find *R*. [2]

4 Look at the following diagram.



The diagram above shows the (t, v) graph of a car moving along a straight road, where v m s^{-1} is the velocity of the car at time t s after it passes through the point A. The car passes through A with velocity 18 m s^{-1}, and moves with constant acceleration 2.4 m s^{-2} until $t = 5$. The car subsequently moves with constant velocity until it is 300 m from A. When the car is more than 300 m from A, it has constant deceleration 6 m s^{-2}, until it comes to rest.

(i) Find the greatest speed of the car. [2]

(ii) Calculate the value of t for the instant when the car begins to decelerate. [5]

(iii) Calculate the distance from A of the car when it is at rest. [3]

5 A particle P is projected with speed $u\,\text{m s}^{-1}$ from the top of a smooth inclined plane of length $2d$ metres. After its projection P moves downwards along a line of greatest slope with acceleration $4\,\text{m s}^{-2}$. At the instant 3 s after projection P has moved half way down the plane. P reaches the foot of the plane 5 s after the instant of projection.

(i) Form two simultaneous equations in u and d, and hence calculate the speed of projection of P and the length of the plane. [6]

(ii) Find the inclination of the plane to the horizontal. [2]

(iii) Given that the contact force exerted on P by the plane has magnitude 6 N, calculate the mass of P. [2]

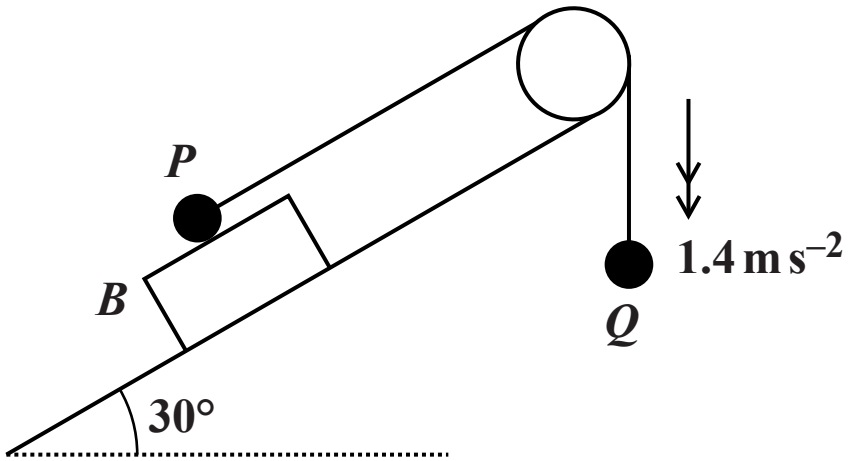
6 A particle P moves in a straight line. At time t s after passing through a point O of the line, the displacement of P from O is x m. Given that $x = 0.06t^3 - 0.45t^2 - 0.24t$, find

(i) the velocity and the acceleration of P when $t = 0$, [6]

(ii) the value of x when P has its minimum velocity, and the speed of P at this instant, [5]

(iii) the positive value of t when the direction of motion of P changes. [3]

7 Look at the following diagram.



A block *B* is placed on a plane inclined at 30° to the horizontal. A particle *P* of mass 0.6 kg is placed on the upper surface of *B*. The particle *P* is attached to one end of a light inextensible string which passes over a smooth pulley fixed to the top of the plane. A particle *Q* of mass 0.5 kg is attached to the other end of the string. The portion of the string attached to *P* is parallel to a line of greatest slope of the plane, the portion of the string attached to *Q* is vertical and the string is taut. The particles are released from rest and start to move with acceleration 1.4 m s^{-2} (see diagram above). It is given that *B* is in equilibrium while *P* moves on its upper surface.

(i) Find the tension in the string while *P* and *B* are in contact. [3]

(ii) Calculate the coefficient of friction between *P* and *B*. [5]

(iii) Given that the weight of *B* is 7 N, calculate the set of possible values of the coefficient of friction between *B* and the plane. [7]

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