OXFORD CAMBRIDGE AND RSA EXAMINATIONS

AS GCE

4728

MATHEMATICS

Mechanics 1

QUESTION PAPER

MONDAY 23 JANUARY 2012: Morning
DURATION: 1 hour 30 minutes

SUITABLE FOR VISUALLY IMPAIRED CANDIDATES

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
List of Formulae (MF1)

OTHER MATERIALS REQUIRED:

Scientific or graphical calculator

READ INSTRUCTIONS OVERLEAF

DC (LEO/SW) 12MEP01012 55338

INSTRUCTIONS TO CANDIDATES

- **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.**
- **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.**

INSTRUCTION TO EXAMS OFFICER / INVIGILATOR

- **Please contact OCR Copyright should you wish to re-use this document.**

1 Particles P and Q, of masses 0.3 kg and 0.5 kg respectively, are moving in the same direction along the same straight line on a smooth horizontal surface. P is moving with speed $2.2\,\text{m s}^{-1}$ and Q is moving with speed $0.8\,\text{m s}^{-1}$ immediately before they collide. In the collision, the speed of P is reduced by 50% and its direction of motion is unchanged.

(i) Calculate the speed of Q immediately after the collision. [4]

(ii) Find the distance PQ at the instant 3 seconds after the collision. [2]

2 In the sport of curling, a heavy stone is projected across a horizontal ice surface. One player projects a stone of weight 180 N, which moves 36 m in a straight line and comes to rest 24 s after the instant of projection. The only horizontal force acting on the stone after its projection is a constant frictional force between the stone and the ice.

(i) Calculate the deceleration of the stone. [2]

(ii) Find the magnitude of the frictional force acting on the stone, and calculate the coefficient of friction between the stone and the ice. [4]

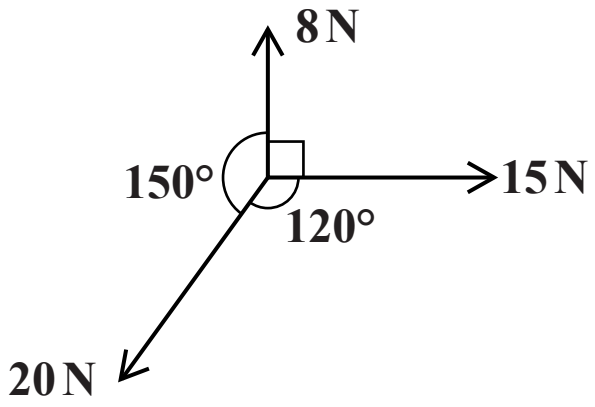
3 A car is travelling along a straight horizontal road with velocity $32.5\,\text{m s}^{-1}$. The driver applies the brakes and the car decelerates at $(8 - 0.6t)\,\text{m s}^{-2}$, where t s is the time which has elapsed since the brakes were first applied.

(i) Show that, while the car is decelerating, its velocity is $(32.5 - 8t + 0.3t^2)\,\text{m s}^{-1}$. [3]

(ii) Find the time taken to bring the car to rest. [2]

(iii) Show that the distance travelled while the car is decelerating is 75 m. [4]

4 Look at the following diagram.



Three horizontal forces of magnitudes 8 N, 15 N and 20 N act at a point. The 8 N and 15 N forces are at right angles. The 20 N force makes an angle of 150° with the 8 N force and an angle of 120° with the 15 N force (see diagram above).

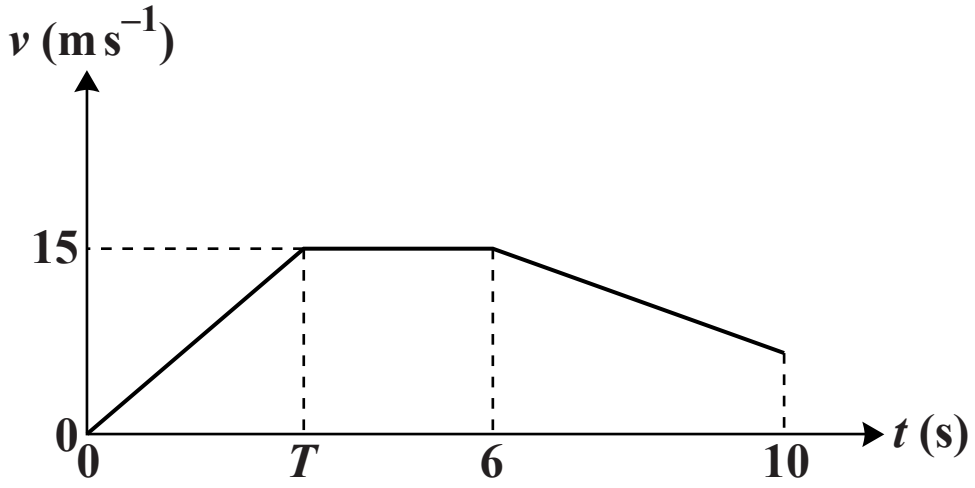
(i) Calculate the components of the resultant force in the directions of the 8 N and 15 N forces. [3]

(ii) Calculate the magnitude of the resultant force, and the angle it makes with the direction of the 8 N force. [4]

The directions in which the three horizontal forces act can be altered.

(iii) State the greatest and least possible magnitudes of the resultant force. [2]

5 Look at the following diagram.



The diagram above shows the (t, v) graph of an athlete running in a straight line on a horizontal track in a 100 m race. He starts from rest and has constant acceleration until he reaches a speed of 15 m s^{-1} when $t = T$. He maintains this constant speed until he decelerates at a constant rate of 1.75 m s^{-2} for the final 4 s of the race. He completes the race in 10 s.

(i) Calculate T. [5]

The athlete races against a robot which has a displacement from the starting line of ($3t^2 - 0.2t^3$) m, at time t s after the start of the race.

(ii) Show that the speed of the robot is 15 m s^{-1} when $t = 5$. [3]

(iii) Find the value of t for which the decelerations of the robot and the athlete are equal. [3]

(iv) Verify that the athlete and the robot reach the finish line simultaneously. [2]

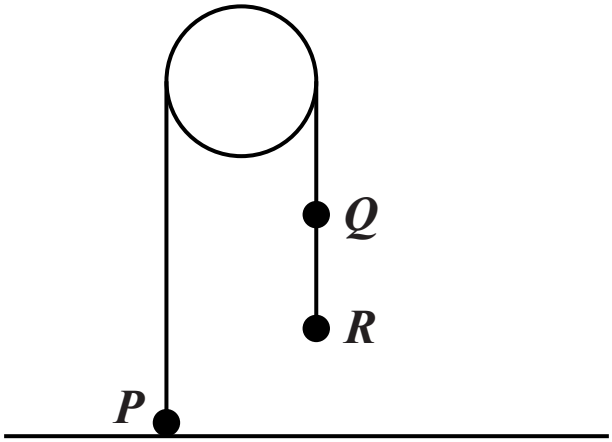
6 **A particle *P* of mass 0.3 kg is projected upwards along a line of greatest slope from the foot of a plane inclined at 30° to the horizontal. The initial speed of *P* is 4 m s^{-1} and the coefficient of friction is 0.15. The particle *P* comes to instantaneous rest before it reaches the top of the plane.**

(i) **Calculate the distance *P* moves up the plane. [6]**

(ii) **Find the time taken by *P* to return from its highest position on the plane to the foot of the plane. [4]**

(iii) **Calculate the change in the momentum of *P* between the instant that *P* leaves the foot of the plane and the instant that *P* returns to the foot of the plane. [3]**

7 Look at the following diagram.



Particles *P* and *Q*, of masses *m* kg and 0.05 kg respectively, are attached to the ends of a light inextensible string which passes over a smooth pulley. *Q* is attached to a particle *R* of mass 0.45 kg by a light inextensible string. The strings are taut, and the portions of the strings not in contact with the pulley are vertical. *P* is in contact with a horizontal surface when the particles are released from rest (see diagram above). The tension in the string *QR* is 2.52 N during the descent of *R*.

(i) (a) Find the acceleration of *R* during its descent. [2]

(b) By considering the motion of *Q*, calculate the tension in the string *PQ* during the descent of *R*. [3]

(ii) Find the value of *m*. [3]

***R* strikes the surface 0.5 s after release and does not rebound. During their subsequent motion, *P* does not reach the pulley and *Q* does not reach the surface.**

(iii) Calculate the greatest height of *P* above the surface. [8]

BLANK PAGE

BLANK PAGE