OCR
RECOGNISING ACHIEVEMENT

Monday 23 January 2012 – Morning

AS GCE MATHEMATICS

4728 Mechanics 1

QUESTION PAPER

4732900112

Candidates answer on the Printed Answer Book.

OCR supplied materials:
- Printed Answer Book 4728
- 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 in the centre of 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 **4** 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 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]**

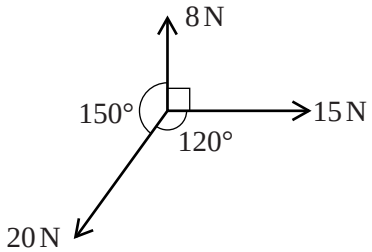
3 A car is travelling along a straight horizontal road with velocity $32.5\,\text{m s}^{-1}$. The driver applies the brakes and the car decelerates at $(8 - 0.6t)\,\text{m s}^{-2}$, where t s is the time which has elapsed since the brakes were first applied.

(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



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).

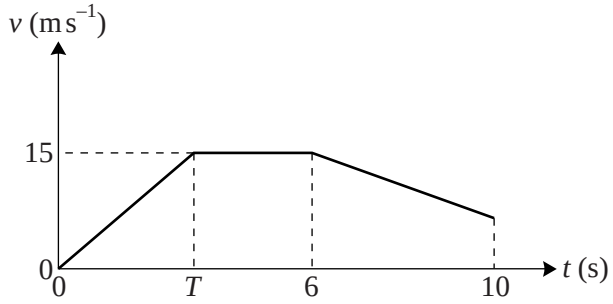
(i) Calculate the components of the resultant force in the directions of the 8 N and 15 N forces. **[3]**

(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



The diagram 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 $15\,\text{m s}^{-1}$ when $t = T$. He maintains this constant speed until he decelerates at a constant rate of $1.75\,\text{m s}^{-2}$ 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 $15\,\text{m s}^{-1}$ 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 $4\,\text{m s}^{-1}$ and the coefficient of friction is 0.15. The particle P comes to instantaneous rest before it reaches the top of the plane.

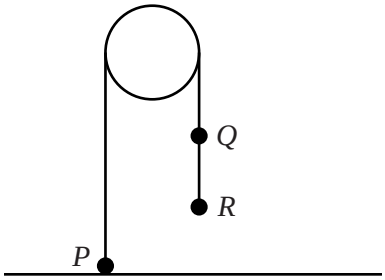
(i) Calculate the distance P moves up the plane. **[6]**

(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]**

[Question 7 is printed overleaf.]

7



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). 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]**