OCR
Oxford Cambridge and RSA

Tuesday 9 June 2015 – Morning

AS GCE MATHEMATICS

4728/01 Mechanics 1

QUESTION PAPER

Candidates answer on the Printed Answer Book.

OCR supplied materials:
- Printed Answer Book 4728/01
- 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 inside 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.

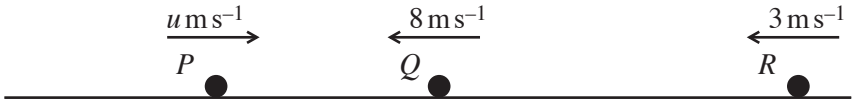
1 A particle P is projected vertically downwards with speed $14\,\text{m s}^{-1}$ from a point 30 m above the ground.

(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



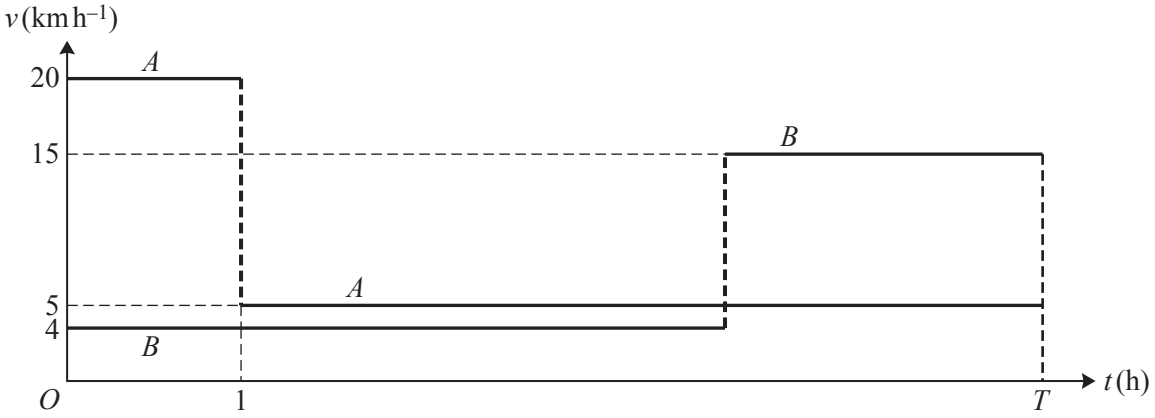
Three particles P, Q and R with masses 0.4 kg, 0.3 kg and m kg are moving along the same straight line on a smooth horizontal surface. P and Q are moving towards each other with speeds $u\,\text{m s}^{-1}$ and $8\,\text{m s}^{-1}$ respectively. R has speed $3\,\text{m s}^{-1}$ and is moving in the same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

(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



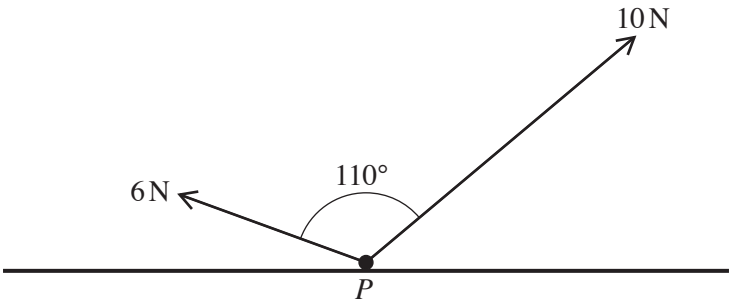
Two travellers A and B make the same journey on a long straight road. Each traveller walks for part of the journey and rides a bicycle for part of the journey. They start their journeys at the same instant, and they end their journeys simultaneously after travelling for T hours. A starts the journey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

(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).

(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 $2\,\text{m s}^{-1}$. At time t s after passing through O, the acceleration of P is $(4 + 12t)\,\text{m s}^{-2}$.

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

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

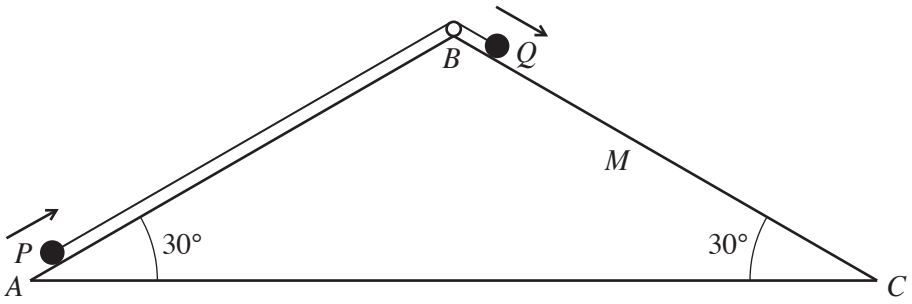
A second particle Q, having the same mass as P, moves along the same straight line. The displacement of Q from O is $(k - 2t^3)$ m, where k is a constant. When $t = 3$ the particles collide and coalesce.

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

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

Question 7 begins on page 4.

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).

(i) Show that the initial acceleration of the particles is $0.7\,\mathrm{m\,s^{-2}}$, 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