



**ADVANCED SUBSIDIARY GCE  
MATHEMATICS**

Mechanics 1

**4728**

**QUESTION PAPER**

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

**Monday 20 June 2011  
Morning**

**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. 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.
- 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  $g \text{ m s}^{-2}$ . 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 destroyed.

2

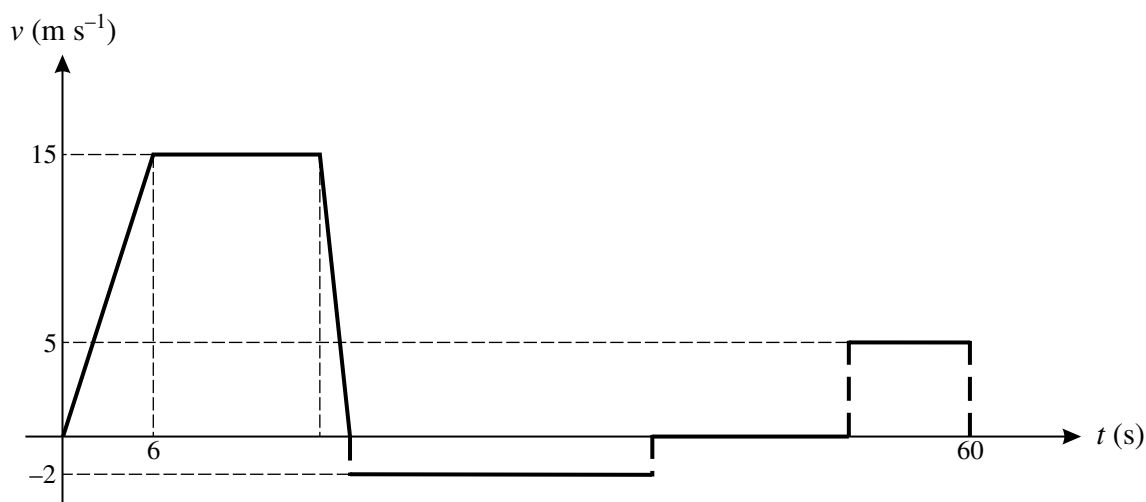
- 1 Two perpendicular forces have magnitudes 8 N and 15 N. Calculate the magnitude of the resultant force, and the angle which the resultant makes with the larger force. [4]
- 2 Particles  $P$  and  $Q$ , of masses 0.45 kg and  $m$  kg respectively, are attached to the ends of a light inextensible string which passes over a small smooth pulley. The particles are released from rest with the string taut and both particles 0.36 m above a horizontal surface.  $Q$  descends with acceleration  $0.98 \text{ m s}^{-2}$ . When  $Q$  strikes the surface, it remains at rest.
- (i) Calculate the tension in the string while both particles are in motion. [2]
  - (ii) Find the value of  $m$ . [3]
  - (iii) Calculate the speed at which  $Q$  strikes the surface. [2]
  - (iv) Calculate the greatest height of  $P$  above the surface. (You may assume that  $P$  does not reach the pulley.) [3]

- 3 A block  $B$  of mass 0.8 kg is pulled across a horizontal surface by a force of 6 N inclined at an angle of  $60^\circ$  to the upward vertical. The coefficient of friction between the block and the surface is 0.2. Calculate
- (i) the vertical component of the force exerted on  $B$  by the surface, [2]
  - (ii) the acceleration of  $B$ . [4]

The 6 N force is removed when  $B$  has speed  $4.9 \text{ m s}^{-1}$ .

- (iii) Calculate the time taken for  $B$  to decelerate from a speed of  $4.9 \text{ m s}^{-1}$  to rest. [4]

4

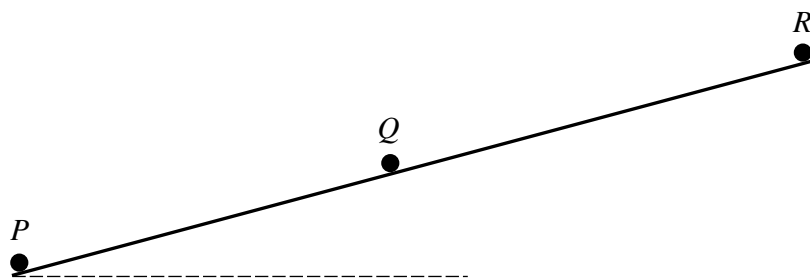


A car travelling on a straight road accelerates from rest to a speed of  $15 \text{ m s}^{-1}$  in 6 s. It continues at constant speed for 11 s and then decelerates to rest in 2 s. The driver gets out of the car and walks at a speed of  $2 \text{ m s}^{-1}$  for 20 s back to a shop which he enters. Some time later he leaves the shop and jogs to the car at a speed of  $5 \text{ m s}^{-1}$ . He arrives at the vehicle 60 s after it began to accelerate from rest. The diagram, which has six straight line segments, shows the  $(t, v)$  graph for the motion of the driver.

- (i) Calculate the initial acceleration and final deceleration of the car. [3]
- (ii) Calculate the distance the car travels. [3]
- (iii) Calculate the length of time the driver is in the shop. [4]

3

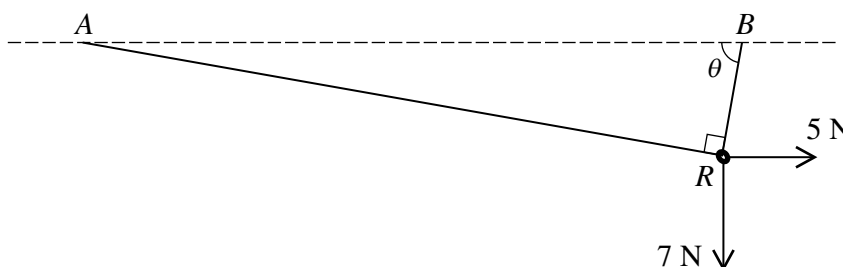
5



Three particles  $P$ ,  $Q$  and  $R$  lie on a line of greatest slope of a smooth inclined plane.  $P$  has mass  $0.5\text{ kg}$  and initially is at the foot of the plane.  $R$  has mass  $0.3\text{ kg}$  and initially is at the top of the plane.  $Q$  has mass  $0.2\text{ kg}$  and is between  $P$  and  $R$  (see diagram).  $P$  is projected up the line of greatest slope with speed  $3\text{ m s}^{-1}$  at the instant when  $Q$  and  $R$  are released from rest. Each particle has an acceleration of  $2.5\text{ m s}^{-2}$  down the plane.

- (i)  $P$  and  $Q$  collide  $0.4\text{ s}$  after being set in motion. Immediately after the collision  $Q$  moves up the plane with speed  $3.2\text{ m s}^{-1}$ . Find the speed and direction of motion of  $P$  immediately after the collision. [5]
- (ii)  $0.6\text{ s}$  after its collision with  $P$ ,  $Q$  collides with  $R$  and the two particles coalesce. Find the speed and direction of motion of the combined particle immediately after the collision [5]

6



A small smooth ring  $R$  of weight  $7\text{ N}$  is threaded on a light inextensible string. The ends of the string are attached to fixed points  $A$  and  $B$  at the same horizontal level. A horizontal force of magnitude  $5\text{ N}$  is applied to  $R$ . The string is taut. In the equilibrium position the angle  $ARB$  is a right angle, and the portion of the string attached to  $B$  makes an angle  $\theta$  with the horizontal (see diagram).

- (i) Explain why the tension  $T\text{ N}$  is the same in each part of the string. [1]
- (ii) By resolving horizontally and vertically for the forces acting on  $R$ , form two simultaneous equations in  $T \cos \theta$  and  $T \sin \theta$ . [4]
- (iii) Hence find  $T$  and  $\theta$ . [6]

[Question 7 is printed overleaf.]

## 4

7 A particle  $P$  is projected from a fixed point  $O$  on a straight line. The displacement  $x$  m of  $P$  from  $O$  at time  $t$  s after projection is given by  $x = 0.1t^3 - 0.3t^2 + 0.2t$ .

(i) Express the velocity and acceleration of  $P$  in terms of  $t$ . [4]

(ii) Show that when the acceleration of  $P$  is zero,  $P$  is at  $O$ . [3]

(iii) Find the values of  $t$  when  $P$  is stationary. [3]

At the instant when  $P$  first leaves  $O$ , a particle  $Q$  is projected from  $O$ .  $Q$  moves on the same straight line as  $P$  and at time  $t$  s after projection the velocity of  $Q$  is given by  $(0.2t^2 - 0.4)$  m s<sup>-1</sup>.  $P$  and  $Q$  collide first when  $t = T$ .

(iv) Show that  $T$  satisfies the equation  $t^2 - 9t + 18 = 0$ , and hence find  $T$ . [7]

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