

**ADVANCED SUBSIDIARY GCE**  
**MATHEMATICS**  
Mechanics 1

**4728**

Candidates answer on the Answer Booklet

**OCR Supplied Materials:**

- 8 page Answer Booklet
- List of Formulae (MF1)

**Other Materials Required:**

None

**Monday 19 January 2009**  
**Afternoon**

**Duration:** 1 hour 30 minutes



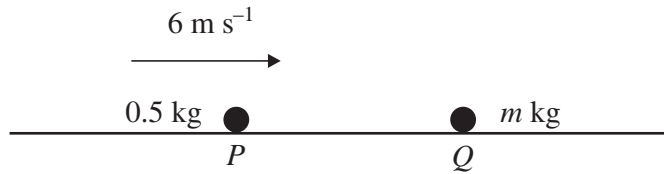
**INSTRUCTIONS TO CANDIDATES**

- Write your name clearly in capital letters, your Centre Number and Candidate Number in the spaces provided on the Answer Booklet.
- Use black ink. Pencil may be used for graphs and diagrams only.
- Read each question carefully and make sure that you know what you have to do before starting your answer.
- Answer **all** the questions.
- Do **not** write in the bar codes.
- 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  $g = 9.8$ .
- You are permitted to use a graphical calculator in this paper.

**INFORMATION FOR CANDIDATES**

- The number of marks is given in brackets [ ] at the end of each question or part question.
- **You are reminded of the need for clear presentation in your answers.**
- The total number of marks for this paper is **72**.
- This document consists of **4** pages. Any blank pages are indicated.

1



A particle  $P$  of mass  $0.5 \text{ kg}$  is travelling with speed  $6 \text{ m s}^{-1}$  on a smooth horizontal plane towards a stationary particle  $Q$  of mass  $m \text{ kg}$  (see diagram). The particles collide, and immediately after the collision  $P$  has speed  $0.8 \text{ m s}^{-1}$  and  $Q$  has speed  $4 \text{ m s}^{-1}$ .

(i) Given that both particles are moving in the same direction after the collision, calculate  $m$ . [3]

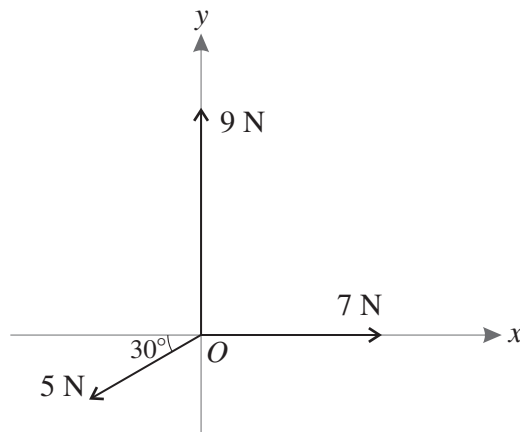
(ii) Given instead that the particles are moving in opposite directions after the collision, calculate  $m$ . [3]

2 A trailer of mass  $500 \text{ kg}$  is attached to a car of mass  $1250 \text{ kg}$  by a light rigid horizontal tow-bar. The car and trailer are travelling along a horizontal straight road. The resistance to motion of the trailer is  $400 \text{ N}$  and the resistance to motion of the car is  $900 \text{ N}$ . Find both the tension in the tow-bar and the driving force of the car in each of the following cases.

(i) The car and trailer are travelling at constant speed. [3]

(ii) The car and trailer have acceleration  $0.6 \text{ m s}^{-2}$ . [6]

3

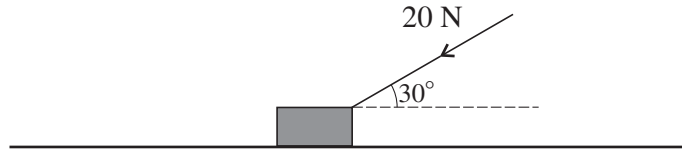


Three horizontal forces act at the point  $O$ . One force has magnitude  $7 \text{ N}$  and acts along the positive  $x$ -axis. The second force has magnitude  $9 \text{ N}$  and acts along the positive  $y$ -axis. The third force has magnitude  $5 \text{ N}$  and acts at an angle of  $30^\circ$  below the negative  $x$ -axis (see diagram).

(i) Find the magnitudes of the components of the  $5 \text{ N}$  force along the two axes. [2]

(ii) Calculate the magnitude of the resultant of the three forces. Calculate also the angle the resultant makes with the positive  $x$ -axis. [6]

4



A block of mass 3 kg is placed on a horizontal surface. A force of magnitude 20 N acts downwards on the block at an angle of  $30^\circ$  to the horizontal (see diagram).

- (i) Given that the surface is smooth, calculate the acceleration of the block. [3]
- (ii) Given instead that the block is in limiting equilibrium, calculate the coefficient of friction between the block and the surface. [5]

5 A car is travelling at  $13 \text{ m s}^{-1}$  along a straight road when it passes a point A at time  $t = 0$ , where  $t$  is in seconds. For  $0 \leq t \leq 6$ , the car accelerates at  $0.8t \text{ m s}^{-2}$ .

- (i) Calculate the speed of the car when  $t = 6$ . [5]
- (ii) Calculate the displacement of the car from A when  $t = 6$ . [5]
- (iii) Three  $(t, x)$  graphs are shown below, for  $0 \leq t \leq 6$ .

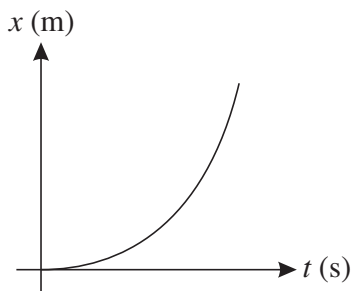


Fig. 1

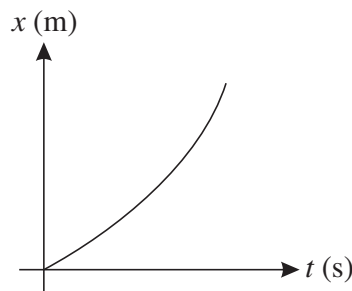


Fig. 2

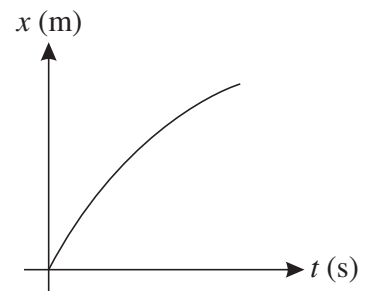


Fig. 3

- (a) State which of these three graphs is most appropriate to represent the motion of the car. [1]
- (b) For each of the two other graphs give a reason why it is not appropriate to represent the motion of the car. [2]

[Questions 6 and 7 are printed overleaf.]

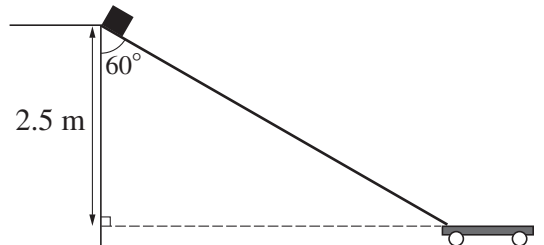
6 Small parcels are being loaded onto a trolley. Initially the parcels are 2.5 m above the trolley.

(i) A parcel is released from rest and falls vertically onto the trolley. Calculate

(a) the time taken for a parcel to fall onto the trolley, [2]

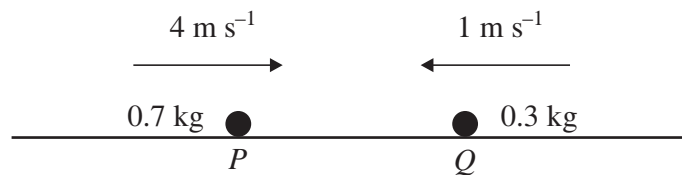
(b) the speed of a parcel when it strikes the trolley. [2]

(ii)



Parcels are often damaged when loaded in the way described, so a ramp is constructed down which parcels can slide onto the trolley. The ramp makes an angle of  $60^\circ$  to the vertical, and the coefficient of friction between the ramp and a parcel is 0.2. A parcel of mass 2 kg is released from rest at the top of the ramp (see diagram). Calculate the speed of the parcel after sliding down the ramp. [9]

7



Two particles  $P$  and  $Q$  have masses 0.7 kg and 0.3 kg respectively.  $P$  and  $Q$  are simultaneously projected towards each other in the same straight line on a horizontal surface with initial speeds of  $4 \text{ m s}^{-1}$  and  $1 \text{ m s}^{-1}$  respectively (see diagram). Before  $P$  and  $Q$  collide the only horizontal force acting on each particle is friction and each particle decelerates at  $0.4 \text{ m s}^{-2}$ . The particles coalesce when they collide.

(i) Given that  $P$  and  $Q$  collide 2 s after projection, calculate the speed of each particle immediately before the collision, and the speed of the combined particle immediately after the collision. [6]

(ii) Given instead that  $P$  and  $Q$  collide 3 s after projection,

(a) sketch on a single diagram the  $(t, v)$  graphs for the two particles in the interval  $0 \leq t < 3$ , [3]

(b) calculate the distance between the two particles at the instant when they are projected. [6]