OCR
RECOGNISING ACHIEVEMENT

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

* 4 7 2 8 *

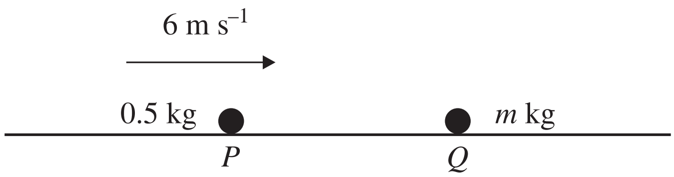
INSTRUCTIONS TO CANDIDATES

- 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 $g\,\text{m}\,\text{s}^{-2}$. 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 kg is travelling with speed 6 m s^{-1} on a smooth horizontal plane towards a stationary particle Q of mass m kg (see diagram). The particles collide, and immediately after the collision P has speed 0.8 m s^{-1} and Q has speed 4 m s^{-1}.

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

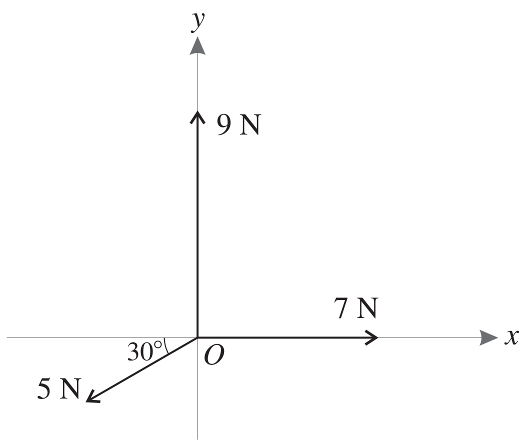
(ii) Given instead that the particles are moving in opposite directions after the collision, calculate m. **[3]**

2 A trailer of mass 500 kg is attached to a car of mass 1250 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 N and the resistance to motion of the car is 900 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 m s^{-2}. **[6]**

3

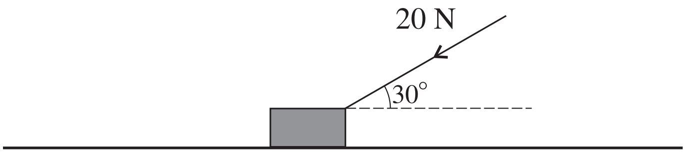


Three horizontal forces act at the point O. One force has magnitude 7 N and acts along the positive x-axis. The second force has magnitude 9 N and acts along the positive y-axis. The third force has magnitude 5 N and acts at an angle of 30° below the negative x-axis (see diagram).

(i) Find the magnitudes of the components of the 5 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° 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 $13\,\mathrm{m\,s^{-1}}$ along a straight road when it passes a point A at time $t = 0$, where t is in seconds. For $0 \leqslant t \leqslant 6$, the car accelerates at $0.8t\,\mathrm{m\,s^{-2}}$.

(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 $0 \leqslant t \leqslant 6$.

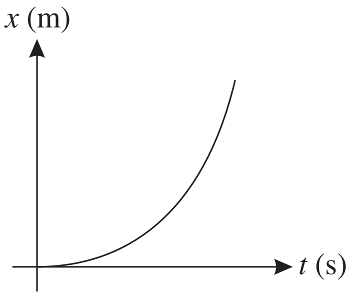


Fig. 1

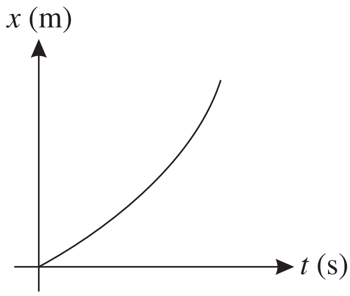


Fig. 2

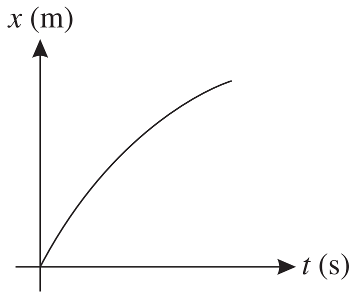


Fig. 3

(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.]

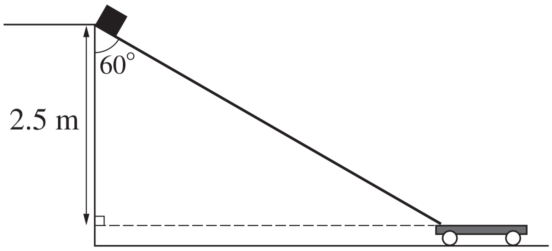
6 Small parcels are being loaded onto a trolley. Initially the parcels are 2.5 m above the trolley.

(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]**

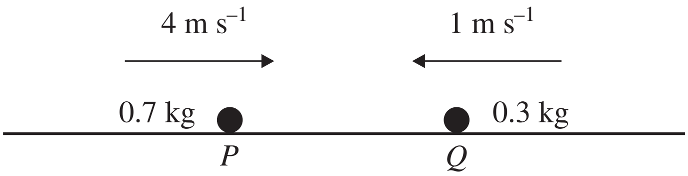
(b) the speed of a parcel when it strikes the trolley. **[2]**

(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° 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 m s^{-1} and 1 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 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 $0 \leqslant t < 3$, **[3]**

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