

**CAMBRIDGE INTERNATIONAL EXAMINATIONS**  
**General Certificate of Education Advanced Subsidiary Level**  
**General Certificate of Education Advanced Level**

**MATHEMATICS**

**9709/4**

PAPER 4 Mechanics 1 (M1)

**OCTOBER/NOVEMBER SESSION 2002**

1 hour 15 minutes

Additional materials:  
Answer paper  
Graph paper  
List of Formulae (MF9)

**TIME** 1 hour 15 minutes

**INSTRUCTIONS TO CANDIDATES**

Write your name, Centre number and candidate number in the spaces provided on the answer paper/answer booklet.

Answer **all** the questions.

Give non-exact numerical answers correct to 3 significant figures, or 1 decimal place in the case of angles in degrees, unless a different level of accuracy is specified in the question.

Where a numerical value for the acceleration due to gravity is needed, use  $10 \text{ m s}^{-2}$ .

**INFORMATION FOR CANDIDATES**

The number of marks is given in brackets [ ] at the end of each question or part question.

The total number of marks for this paper is 50.

Questions carrying smaller numbers of marks are printed earlier in the paper, and questions carrying larger numbers of marks later in the paper.

The use of an electronic calculator is expected, where appropriate.

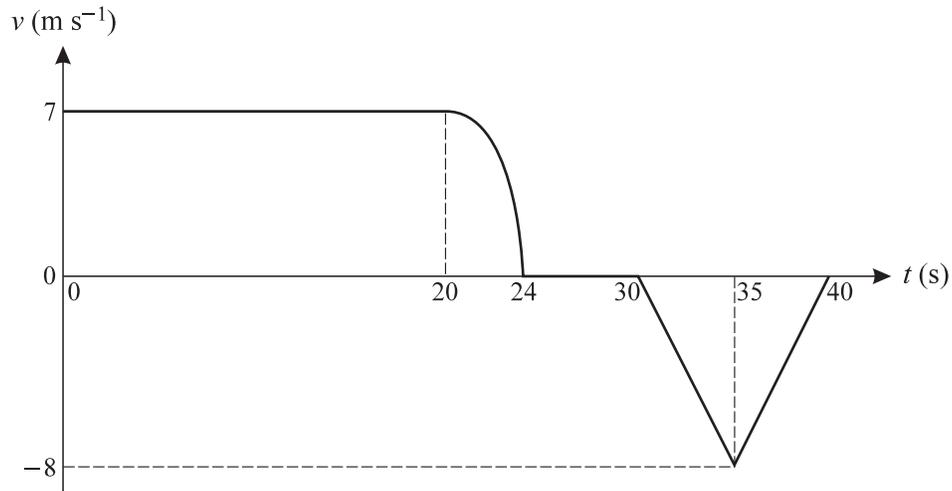
You are reminded of the need for clear presentation in your answers.

---

**This question paper consists of 4 printed pages.**

- 1 A car of mass 1000 kg travels along a horizontal straight road with its engine working at a constant rate of 20 kW. The resistance to motion of the car is 600 N. Find the acceleration of the car at an instant when its speed is  $25 \text{ m s}^{-1}$ . [3]

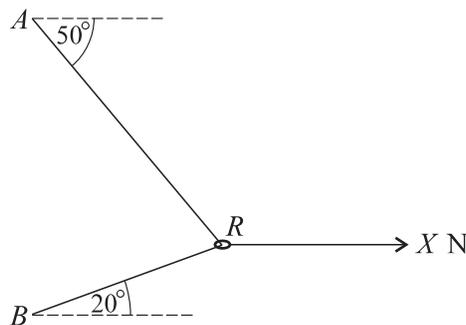
2



A man runs in a straight line. He passes through a fixed point  $A$  with constant velocity  $7 \text{ m s}^{-1}$  at time  $t = 0$ . At time  $t$  s his velocity is  $v \text{ m s}^{-1}$ . The diagram shows the graph of  $v$  against  $t$  for the period  $0 \leq t \leq 40$ .

- (i) Show that the man runs more than 154 m in the first 24 s. [2]
- (ii) Given that the man runs 20 m in the interval  $20 \leq t \leq 24$ , find how far he is from  $A$  when  $t = 40$ . [2]

3



A light inextensible string has its ends attached to two fixed points  $A$  and  $B$ , with  $A$  vertically above  $B$ . A smooth ring  $R$ , of mass 0.8 kg, is threaded on the string and is pulled by a horizontal force of magnitude  $X$  newtons. The sections  $AR$  and  $BR$  of the string make angles of  $50^\circ$  and  $20^\circ$  respectively with the horizontal, as shown in the diagram. The ring rests in equilibrium with the string taut. Find

- (i) the tension in the string, [3]
- (ii) the value of  $X$ . [3]

4 Two particles  $A$  and  $B$  are projected vertically upwards from horizontal ground at the same instant. The speeds of projection of  $A$  and  $B$  are  $5 \text{ m s}^{-1}$  and  $8 \text{ m s}^{-1}$  respectively. Find

(i) the difference in the heights of  $A$  and  $B$  when  $A$  is at its maximum height, [4]

(ii) the height of  $A$  above the ground when  $B$  is  $0.9 \text{ m}$  above  $A$ . [4]

5

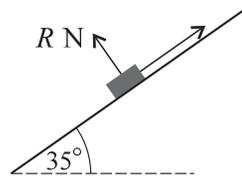
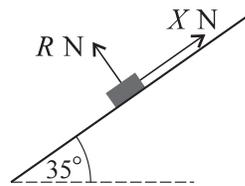


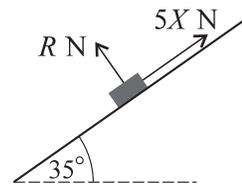
Fig. 1

A force, whose direction is upwards parallel to a line of greatest slope of a plane inclined at  $35^\circ$  to the horizontal, acts on a box of mass  $15 \text{ kg}$  which is at rest on the plane. The normal component of the contact force on the box has magnitude  $R$  newtons (see Fig. 1).

(i) Show that  $R = 123$ , correct to 3 significant figures. [1]



about to move down



about to move up

Fig. 2

When the force parallel to the plane acting on the box has magnitude  $X$  newtons the box is about to move *down* the plane, and when this force has magnitude  $5X$  newtons the box is about to move *up* the plane (see Fig. 2).

(ii) Find the value of  $X$  and the coefficient of friction between the box and the plane. [7]

[Questions 6 and 7 are printed overleaf.]

- 6 (i) A particle  $P$  of mass 1.2 kg is released from rest at the top of a slope and starts to move. The slope has length 4 m and is inclined at  $25^\circ$  to the horizontal. The coefficient of friction between  $P$  and the slope is  $\frac{1}{4}$ . Find
- (a) the frictional component of the contact force on  $P$ , [2]
  - (b) the acceleration of  $P$ , [2]
  - (c) the speed with which  $P$  reaches the bottom of the slope. [2]
- (ii) After reaching the bottom of the slope,  $P$  moves freely under gravity and subsequently hits a horizontal floor which is 3 m below the bottom of the slope.
- (a) Find the loss in gravitational potential energy of  $P$  during its motion from the bottom of the slope until it hits the floor. [1]
  - (b) Find the speed with which  $P$  hits the floor. [3]
- 7 A particle  $P$  starts to move from a point  $O$  and travels in a straight line. At time  $t$  s after  $P$  starts to move its velocity is  $v$  m s<sup>-1</sup>, where  $v = 0.12t - 0.0006t^2$ .
- (i) Verify that  $P$  comes to instantaneous rest when  $t = 200$ , and find the acceleration with which it starts to return towards  $O$ . [3]
  - (ii) Find the maximum speed of  $P$  for  $0 \leq t \leq 200$ . [3]
  - (iii) Find the displacement of  $P$  from  $O$  when  $t = 200$ . [3]
  - (iv) Find the value of  $t$  when  $P$  reaches  $O$  again. [2]