

**ADVANCED SUBSIDIARY GCE UNIT  
MATHEMATICS**

Mechanics 1

**WEDNESDAY 10 JANUARY 2007**

**4728/01**

Afternoon

Time: 1 hour 30 minutes

Additional Materials: Answer Booklet (8 pages)  
List of Formulae (MF1)

**INSTRUCTIONS TO CANDIDATES**

- Write your name, centre number and candidate number in the spaces provided on the answer booklet.
- Answer **all** the questions.
- 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.
- The total number of marks for this paper is 72.

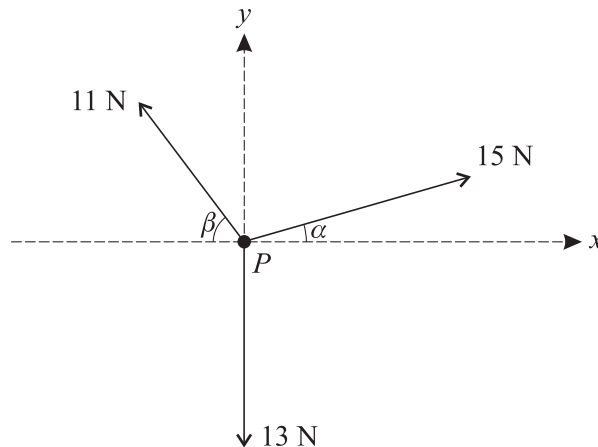
**ADVICE TO CANDIDATES**

- Read each question carefully and make sure you know what you have to do before starting your answer.
- **You are reminded of the need for clear presentation in your answers.**

This document consists of **4** printed pages.

- 1 A trailer of mass 600 kg is attached to a car of mass 1100 kg by a light rigid horizontal tow-bar. The car and trailer are travelling along a horizontal straight road with acceleration  $0.8 \text{ m s}^{-2}$ .
- (i) Given that the force exerted on the trailer by the tow-bar is 700 N, find the resistance to motion of the trailer. [4]
- (ii) Given also that the driving force of the car is 2100 N, find the resistance to motion of the car. [3]

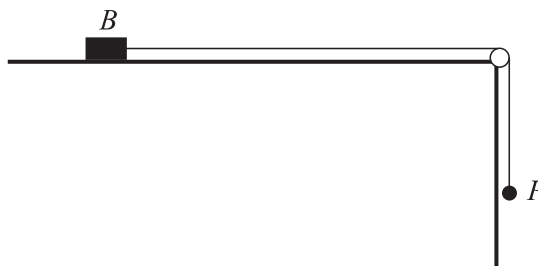
2



Three horizontal forces of magnitudes 15 N, 11 N and 13 N act on a particle  $P$  in the directions shown in the diagram. The angles  $\alpha$  and  $\beta$  are such that  $\sin \alpha = 0.28$ ,  $\cos \alpha = 0.96$ ,  $\sin \beta = 0.8$  and  $\cos \beta = 0.6$ .

- (i) Show that the component, in the  $y$ -direction, of the resultant of the three forces is zero. [4]
- (ii) Find the magnitude of the resultant of the three forces. [3]
- (iii) State the direction of the resultant of the three forces. [1]

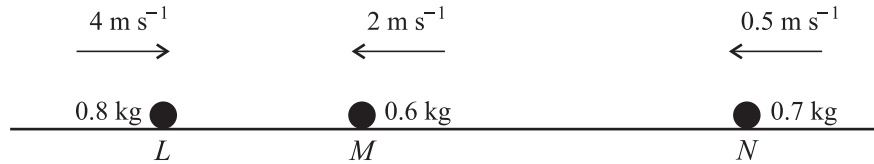
3



A block  $B$  of mass 0.4 kg and a particle  $P$  of mass 0.3 kg are connected by a light inextensible string. The string passes over a smooth pulley at the edge of a rough horizontal table.  $B$  is in contact with the table and the part of the string between  $B$  and the pulley is horizontal.  $P$  hangs freely below the pulley (see diagram).

- (i) The system is in limiting equilibrium with the string taut and  $P$  on the point of moving downwards. Find the coefficient of friction between  $B$  and the table. [5]
- (ii) A horizontal force of magnitude  $X$  N, acting directly away from the pulley, is now applied to  $B$ . The system is again in limiting equilibrium with the string taut, and with  $P$  now on the point of moving **upwards**. Find the value of  $X$ . [3]

4



Three uniform spheres  $L$ ,  $M$  and  $N$  have masses 0.8 kg, 0.6 kg and 0.7 kg respectively. The spheres are moving in a straight line on a smooth horizontal table, with  $M$  between  $L$  and  $N$ . The sphere  $L$  is moving towards  $M$  with speed  $4 \text{ m s}^{-1}$  and the spheres  $M$  and  $N$  are moving towards  $L$  with speeds  $2 \text{ m s}^{-1}$  and  $0.5 \text{ m s}^{-1}$  respectively (see diagram).

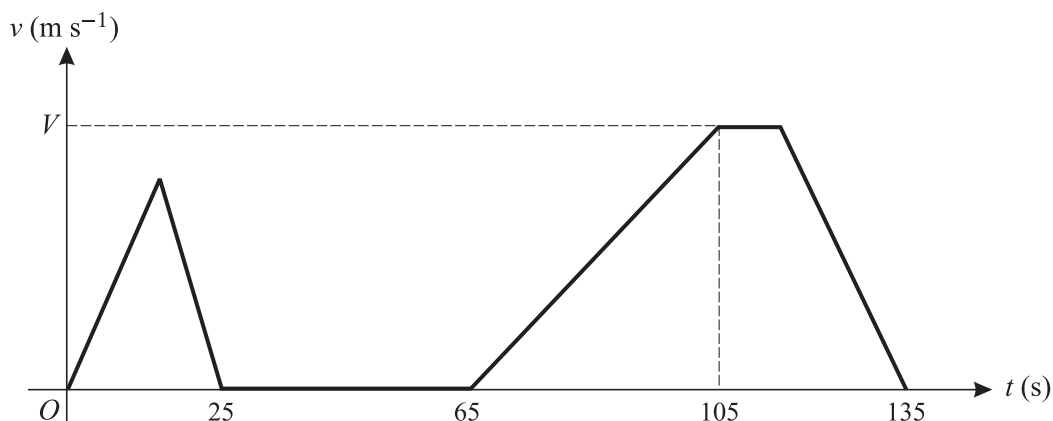
- (i)  $L$  collides with  $M$ . As a result of this collision the direction of motion of  $M$  is reversed, and its speed remains  $2 \text{ m s}^{-1}$ . Find the speed of  $L$  after the collision. [4]
- (ii)  $M$  then collides with  $N$ .
- (a) Find the total momentum of  $M$  and  $N$  in the direction of  $M$ 's motion before this collision takes place, and deduce that the direction of motion of  $N$  is reversed as a result of this collision. [4]
- (b) Given that  $M$  is at rest immediately after this collision, find the speed of  $N$  immediately after this collision. [2]

5 A particle starts from rest at a point  $A$  at time  $t = 0$ , where  $t$  is in seconds. The particle moves in a straight line. For  $0 \leq t \leq 4$  the acceleration is  $1.8t \text{ m s}^{-2}$ , and for  $4 \leq t \leq 7$  the particle has constant acceleration  $7.2 \text{ m s}^{-2}$ .

- (i) Find an expression for the velocity of the particle in terms of  $t$ , valid for  $0 \leq t \leq 4$ . [3]
- (ii) Show that the displacement of the particle from  $A$  is 19.2 m when  $t = 4$ . [4]
- (iii) Find the displacement of the particle from  $A$  when  $t = 7$ . [5]

**[Questions 6 and 7 are printed overleaf.]**

6



The diagram shows the  $(t, v)$  graph for the motion of a hoist used to deliver materials to different levels at a building site. The hoist moves vertically. The graph consists of straight line segments. In the first stage the hoist travels upwards from ground level for 25 s, coming to rest 8 m above ground level.

- (i) Find the greatest speed reached by the hoist during this stage. [2]

The second stage consists of a 40 s wait at the level reached during the first stage. In the third stage the hoist continues upwards until it comes to rest 40 m above ground level, arriving 135 s after leaving ground level. The hoist accelerates at  $0.02 \text{ m s}^{-2}$  for the first 40 s of the third stage, reaching a speed of  $V \text{ m s}^{-1}$ . Find

- (ii) the value of  $V$ , [3]

- (iii) the length of time during the third stage for which the hoist is moving at constant speed, [4]

- (iv) the deceleration of the hoist in the final part of the third stage. [3]

7 A particle  $P$  of mass 0.5 kg moves upwards along a line of greatest slope of a rough plane inclined at an angle of  $40^\circ$  to the horizontal.  $P$  reaches its highest point and then moves back down the plane. The coefficient of friction between  $P$  and the plane is 0.6.

- (i) Show that the magnitude of the frictional force acting on  $P$  is 2.25 N, correct to 3 significant figures. [3]

- (ii) Find the acceleration of  $P$  when it is moving

(a) up the plane,

(b) down the plane. [4]

- (iii) When  $P$  is moving up the plane, it passes through a point  $A$  with speed  $4 \text{ m s}^{-1}$ .

(a) Find the length of time before  $P$  reaches its highest point.

(b) Find the total length of time for  $P$  to travel from the point  $A$  to its highest point and back to  $A$ . [8]

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