OCR
RECOGNISING ACHIEVEMENT

ADVANCED SUBSIDIARY GCE UNIT

4728/01

MATHEMATICS

Mechanics 1

WEDNESDAY 10 JANUARY 2007

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 $g\,\mathrm{m\,s^{-2}}$. 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.**

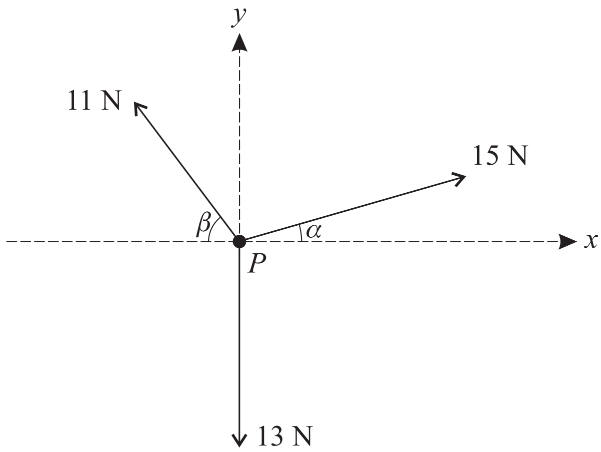
This document consists of **4** printed pages.

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 $0.8\,\mathrm{m\,s^{-2}}$.

(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 α and β 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]

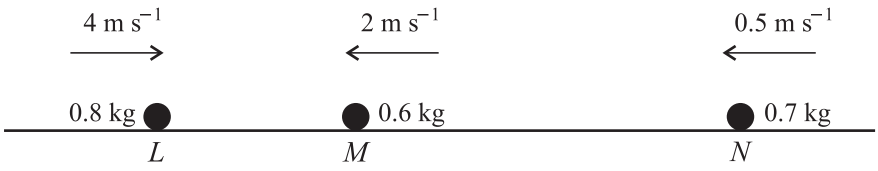
3

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 $4\,\text{m}\,\text{s}^{-1}$ and the spheres M and N are moving towards L with speeds $2\,\text{m}\,\text{s}^{-1}$ and $0.5\,\text{m}\,\text{s}^{-1}$ 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 $2\,\text{m}\,\text{s}^{-1}$. 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 $0 \leqslant t \leqslant 4$ the acceleration is $1.8t\ \text{m}\,\text{s}^{-2}$, and for $4 \leqslant t \leqslant 7$ the particle has constant acceleration $7.2\,\text{m}\,\text{s}^{-2}$.

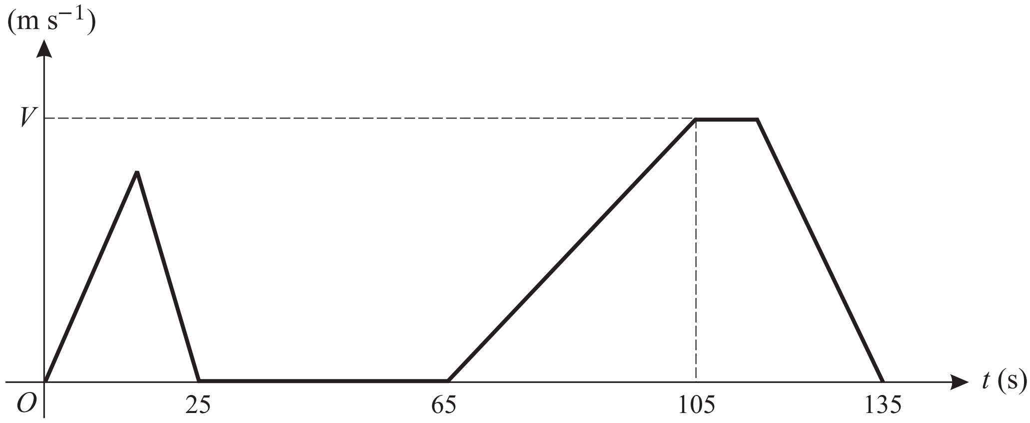
(i) Find an expression for the velocity of the particle in terms of t, valid for $0 \leqslant t \leqslant 4$. [3]

(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 m s^{-2} for the first 40 s of the third stage, reaching a speed of V 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° 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 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]