



**ADVANCED SUBSIDIARY GCE UNIT
MATHEMATICS**

4728/01

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 $g \text{ m s}^{-2}$. 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.

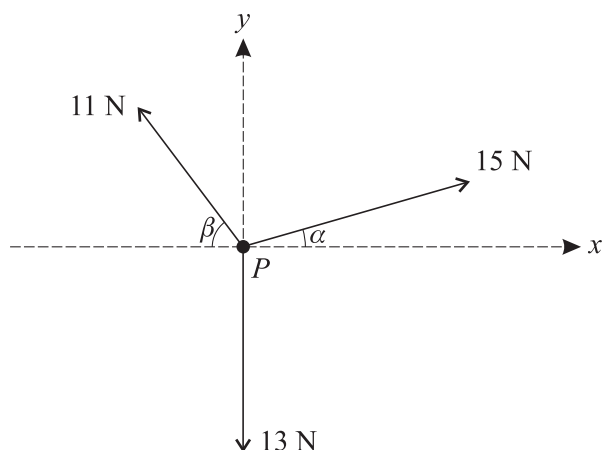
ADVICE TO CANDIDATES

- 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 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]

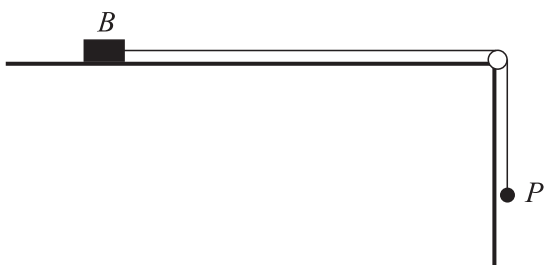
2



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]

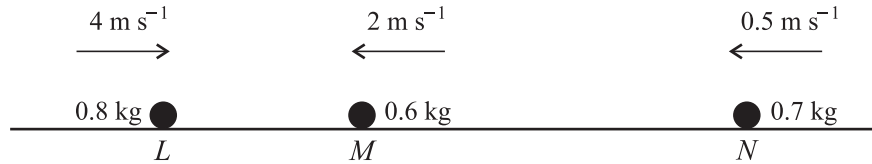
3



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 m s^{-1} and the spheres M and N are moving towards L with speeds 2 m s^{-1} and 0.5 m s^{-1} respectively (see diagram).

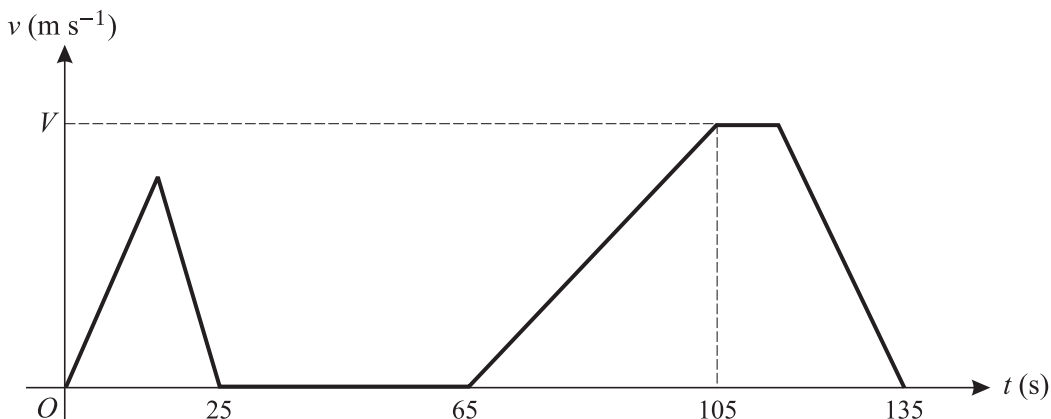
- (i) L collides with M . As a result of this collision the direction of motion of M is reversed, and its speed remains 2 m s^{-1} . Find the speed of L after the collision. [4]
- (ii) M then collides with N .
 - (a) Find the total momentum of M and N in the direction of M 's motion before this collision 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 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 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° 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]

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