

OXFORD CAMBRIDGE AND RSA EXAMINATIONS**Advanced Subsidiary General Certificate of Education
Advanced General Certificate of Education****MATHEMATICS****4728**

Mechanics 1

Friday **21 JANUARY 2005** Afternoon 1 hour 30 minutesAdditional materials:
Answer booklet
Graph paper
List of Formulae (MF1)**TIME** 1 hour 30 minutes**INSTRUCTIONS TO CANDIDATES**

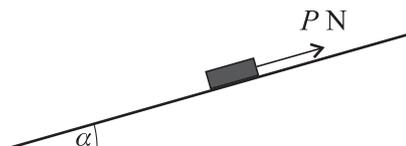
- Write your name, centre number and candidate number in the spaces provided on the answer booklet.
- Answer **all** the questions.
- Give non-exact numerical answers correct to 3 significant figures unless a different degree of accuracy is specified in the question or is clearly appropriate.
- The acceleration 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.
- Questions carrying smaller numbers of marks are printed earlier in the paper, and questions carrying larger numbers of marks later in the paper.
- **You are reminded of the need for clear presentation in your answers.**

This question paper consists of 5 printed pages and 3 blank pages.

1



A box of weight 100 N rests in equilibrium on a plane inclined at an angle α to the horizontal. It is given that $\sin \alpha = 0.28$ and $\cos \alpha = 0.96$. A force of magnitude $P\text{ N}$ acts on the box parallel to the plane in the upwards direction (see diagram). The coefficient of friction between the box and the plane is 0.25 .

(i) Find the magnitude of the normal force acting on the box. [2]

(ii) Given that the equilibrium is limiting, show that the magnitude of the frictional force acting on the box is 24 N . [1]

(iii) Find the value of P for which the box is on the point of slipping

(a) down the plane,

(b) up the plane.

[3]

2

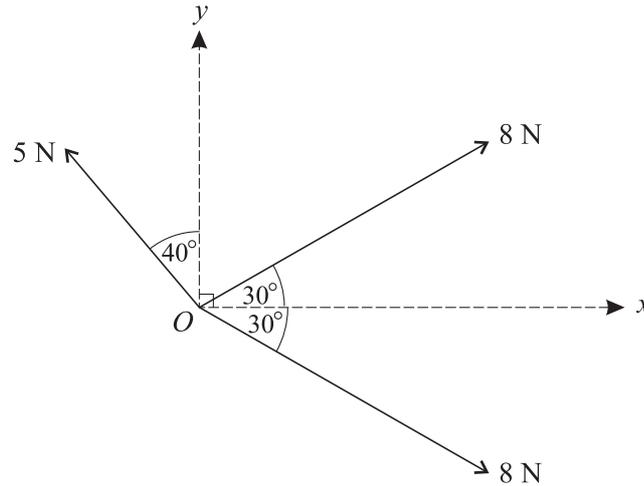


Three small uniform spheres A , B and C have masses 0.4 kg , 1.2 kg and $m\text{ kg}$ respectively. The spheres move in the same straight line on a smooth horizontal table, with B between A and C . Sphere A is moving towards B with speed 6 m s^{-1} , B is moving towards A with speed 2 m s^{-1} and C is moving towards B with speed 4 m s^{-1} (see diagram). Spheres A and B collide. After this collision B moves with speed 1 m s^{-1} towards C .

(i) Find the speed with which A moves after the collision and state the direction of motion of A . [5]

(ii) Spheres B and C now collide and move away from each other with speeds 0.5 m s^{-1} and 2 m s^{-1} respectively. Find the value of m . [3]

3



Three coplanar forces of magnitudes 5 N, 8 N and 8 N act at the origin O of rectangular coordinate axes. The directions of the forces are as shown in the diagram.

(i) Find the component of the resultant of the three forces in

- (a) the x -direction,
- (b) the y -direction.

[5]

(ii) Find the magnitude and direction of the resultant.

[4]

4 A particle moves in a straight line. Its velocity t s after leaving a fixed point on the line is v m s⁻¹, where $v = t + 0.1t^2$. Find

- (i) an expression for the acceleration of the particle at time t , [2]
- (ii) the distance travelled by the particle from time $t = 0$ until the instant when its acceleration is 2.8 m s⁻². [7]

5 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 7 m s⁻¹ and 10.5 m s⁻¹ respectively.

- (i) Write down expressions for the heights above the ground of A and B at time t seconds after projection. [1]
- (ii) Hence find a simplified expression for the difference in the heights of A and B at time t seconds after projection. [1]
- (iii) Find the difference in the heights of A and B when A is at its maximum height. [3]

At the instant when B is 3.5 m above A , find

- (iv) whether A is moving upwards or downwards, [3]
- (v) the height of A above the ground. [2]

6

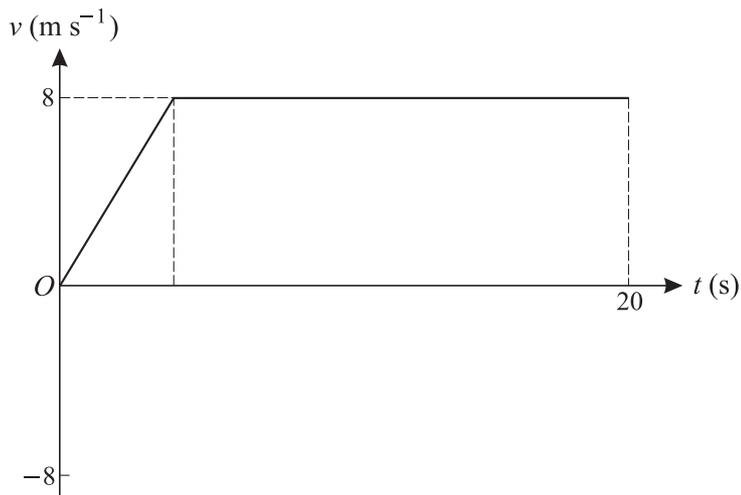


Fig. 1

A cyclist P travels along a straight road starting from rest at A and accelerating at 2 m s^{-2} up to a speed of 8 m s^{-1} . He continues at a constant speed of 8 m s^{-1} , passing through the point B 20 s after leaving A . Fig. 1 shows the (t, v) graph of P 's journey for $0 \leq t \leq 20$. Find

- (i) the time for which P is accelerating, [2]
- (ii) the distance AB . [3]

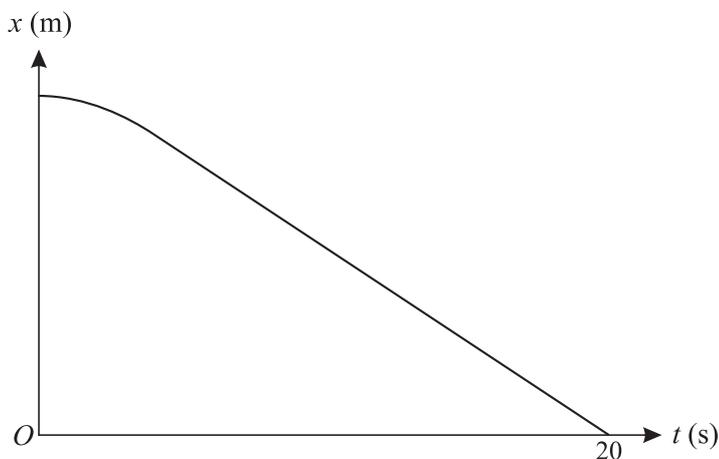
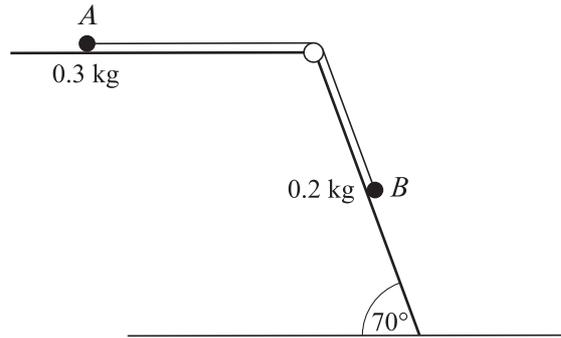


Fig. 2

Another cyclist Q travels along the same straight road in the opposite direction. She starts at rest from B at the same instant that P leaves A . Cyclist Q accelerates at 2 m s^{-2} up to a speed of 8 m s^{-1} and continues at a constant speed of 8 m s^{-1} , passing through the point A 20 s after leaving B . Fig. 2 shows the (t, x) graph of Q 's journey for $0 \leq t \leq 20$, where x is the displacement of Q from A towards B .

- (iii) Sketch a copy of Fig. 1 and add to your copy a sketch of the (t, v) graph of Q 's journey for $0 \leq t \leq 20$. [2]
- (iv) Sketch a copy of Fig. 2 and add to your copy a sketch of the (t, x) graph of P 's journey for $0 \leq t \leq 20$. [3]
- (v) Find the value t at the instant that P and Q pass each other. [3]

7



The upper edge of a smooth plane inclined at 70° to the horizontal is joined to an edge of a rough horizontal table. Particles A and B , of masses 0.3 kg and 0.2 kg respectively, are attached to the ends of a light inextensible string. The string passes over a smooth pulley which is fixed at the top of the smooth inclined plane. Particle A is held in contact with the rough horizontal table and particle B is in contact with the smooth inclined plane with the string taut (see diagram). The coefficient of friction between A and the horizontal table is 0.4 . Particle A is released from rest and the system starts to move.

- (i) Find the acceleration of A and the tension in the string. [8]

The string breaks when the speed of the particles is 1.5 m s^{-1} .

- (ii) Assuming A does not reach the pulley, find the distance travelled by A after the string breaks. [3]
- (iii) Assuming B does not reach the ground before A stops, find the distance travelled by B from the time the string breaks to the time that A stops. [6]

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