

Name:

Total Marks:

A level Applied Mathematics Paper 3B Mechanics



Practice Paper M13

Time: 2 hours

Information for Candidates

- This practice paper is an adapted legacy old paper for the Edexcel GCE A Level Specifications
- There are 10 questions in this question paper
- The total mark for this paper is 106.
- The marks for **each** question are shown in brackets.
- Full marks may be obtained for answers to ALL questions

Advice to candidates:

- You must ensure that your answers to parts of questions are clearly labelled.
- You must show sufficient working to make your methods clear to the Examiner
- Answers without working may not gain full credit



Question 1

A lorry is moving along a straight horizontal road with constant acceleration. The lorry passes a point A with speed $u \text{ m s}^{-1}$, ($u < 34$), and 10 seconds later passes a point B with speed 34 m s^{-1} . Given that $AB = 240 \text{ m}$, find

- (a) the value of u , (3)
- (b) the time taken for the lorry to move from A to the mid-point of AB . (6)

(Total 9 marks)

Question 2

A car is travelling along a straight horizontal road. The car takes 120 s to travel between two sets of traffic lights which are 2145 m apart. The car starts from rest at the first set of traffic lights and moves with constant acceleration for 30 s until its speed is 22 m s^{-1} . The car maintains this speed for T seconds. The car then moves with constant deceleration, coming to rest at the second set of traffic lights.

- (a) Sketch, in the space below, a speed-time graph for the motion of the car between the two sets of traffic lights. (2)
- (b) Find the value of T . (3)

A motorcycle leaves the first set of traffic lights 10 s after the car has left the first set of traffic lights. The motorcycle moves from rest with constant acceleration, $a \text{ m s}^{-2}$, and passes the car at the point A which is 990 m from the first set of traffic lights. When the motorcycle passes the car, the car is moving with speed 22 m s^{-1} .

- (c) Find the time it takes for the motorcycle to move from the first set of traffic lights to the point A . (4)
- (d) Find the value of a . (2)

(Total 11 marks)

Question 3

A woman travels in a lift. The mass of the woman is 50 kg and the mass of the lift is 950 kg. The lift is being raised vertically by a vertical cable which is attached to the top of the lift. The lift is moving upwards and has constant deceleration of 2 m s^{-2} . By modelling the cable as being light and inextensible, find

- (a) the tension in the cable, (3)
- (b) the magnitude of the force exerted on the woman by the floor of the lift. (3)

(Total 6 marks)

Question 4

A beam AB has length 15 m. The beam rests horizontally in equilibrium on two smooth supports at the points P and Q , where $AP = 2 \text{ m}$ and $QB = 3 \text{ m}$. When a child of mass 50 kg stands on the beam at A , the beam remains in equilibrium and is on the point of tilting about P . When the same child of mass 50 kg stands on the beam at B , the beam remains in equilibrium and is on the point of tilting about Q . The child is modelled as a particle and the beam is modelled as a non-uniform rod.

- (a)(i) Find the mass of the beam.
- (ii) Find the distance of the centre of mass of the beam from A . (8)

When the child stands at the point X on the beam, it remains horizontal and in equilibrium. Given that the reactions at the two supports are equal in magnitude,

- (b) find AX . (6)

(Total 14 marks)

Question 5

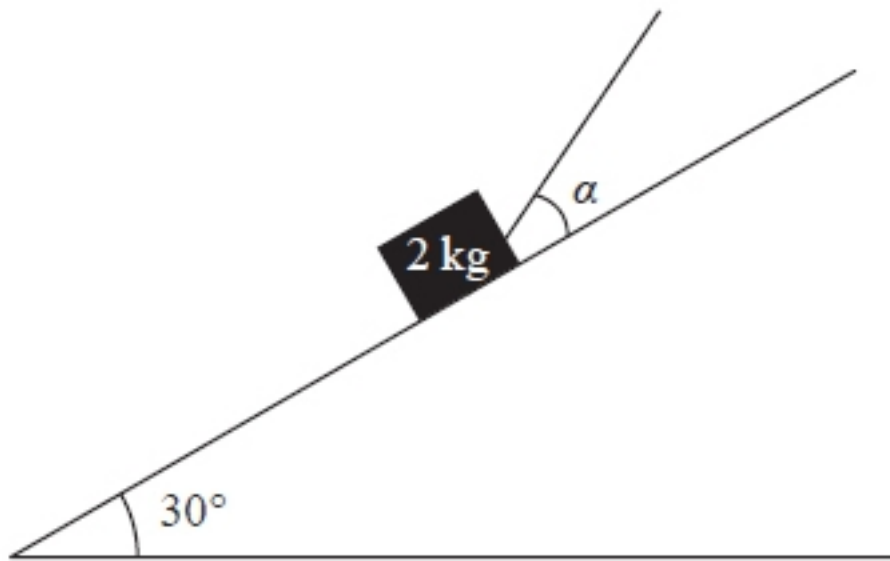


Figure 1

A box of mass 2 kg is held in equilibrium on a fixed rough inclined plane by a rope. The rope lies in a vertical plane containing a line of greatest slope of the inclined plane. The rope is inclined to the plane at an angle α , where $\tan \alpha = \frac{3}{4}$, and the plane is at an angle of 30° to the horizontal, as shown in Figure 1.

The coefficient of friction between the box and the inclined plane is $\frac{1}{3}$ and the box is on the point of slipping up the plane. By modelling the box as a particle and the rope as a light inextensible string, find the tension in the rope.

(8)

(Total 8 marks)

Question 6

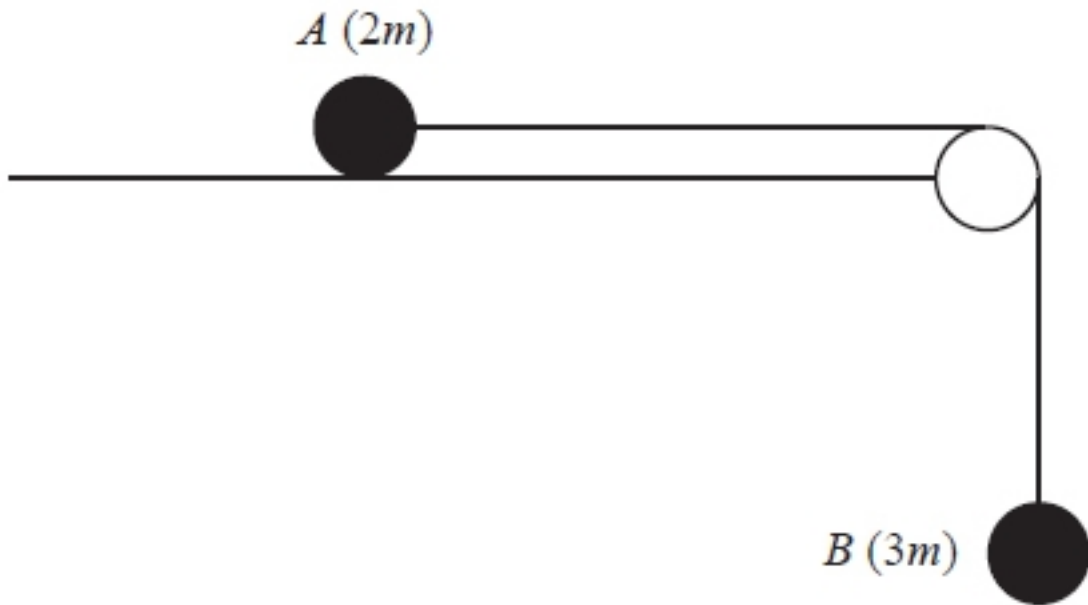


Figure 2

Two particles A and B have masses $2m$ and $3m$ respectively. The particles are attached to the ends of a light inextensible string. Particle A is held at rest on a smooth horizontal table. The string passes over a small smooth pulley which is fixed at the edge of the table. Particle B hangs at rest vertically below the pulley with the string taut, as shown in Figure 2. Particle A is released from rest. Assuming that A has not reached the pulley, find

- (a) the acceleration of B , (5)
- (b) the tension in the string, (1)
- (c) the magnitude and direction of the force exerted on the pulley by the string. (4)

(Total 10 marks)

Question 7

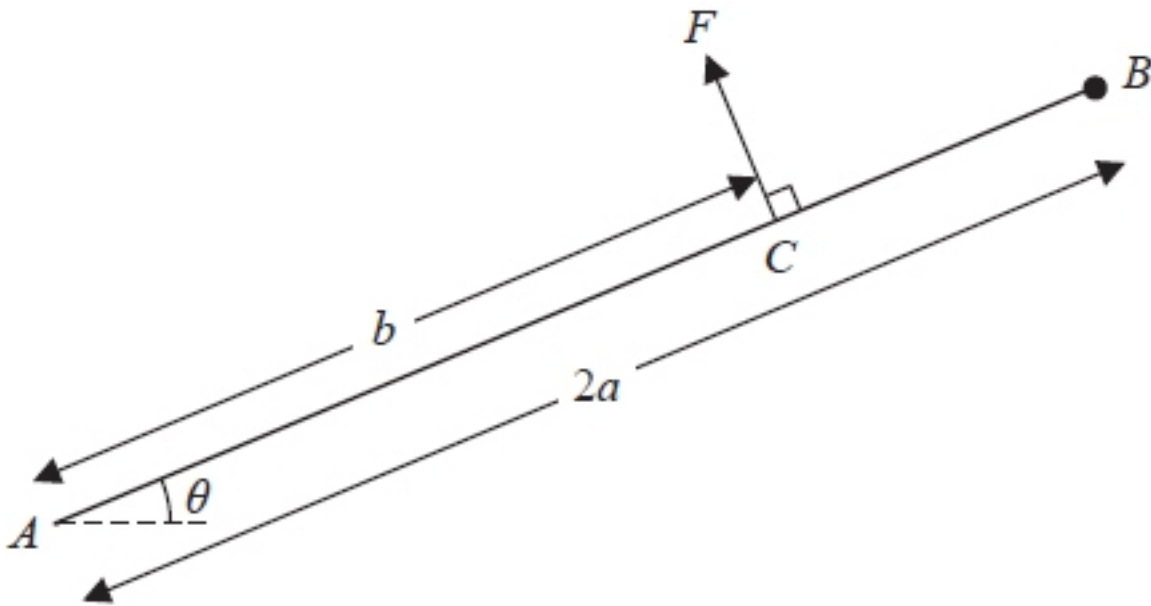


Figure 3

A uniform rod AB , of mass m and length $2a$, is freely hinged to a fixed point A . A particle of mass m is attached to the rod at B . The rod is held in equilibrium at an angle θ to the horizontal by a force of magnitude F acting at the point C on the rod, where $AC = b$, as shown in Figure 3. The force at C acts at right angles to AB and in the vertical plane containing AB .

$$\frac{3amg \cos \theta}{b}$$

(a) Show that $F = \frac{3amg \cos \theta}{b}$. (4)

(b) Find, in terms of a , b , g , m and θ ,

(i) the horizontal component of the force acting on the rod at A ,

(ii) the vertical component of the force acting on the rod at A . (5)

Given that the force acting on the rod at A acts along the rod,

$$\frac{a}{b}$$

(c) find the value of $\frac{a}{b}$ (4)

(Total 13 marks)

Question 8

[In this question, the horizontal unit vectors \mathbf{i} and \mathbf{j} are directed due east and due north respectively.]

The velocity, \mathbf{v} m s⁻¹, of a particle P at time t seconds is given by

$$\mathbf{v} = (1 - 2t)\mathbf{i} + (3t - 3)\mathbf{j}$$

- (a) Find the speed of P when $t = 0$ (3)
- (b) Find the bearing on which P is moving when $t = 2$ (2)
- (c) Find the value of t when P is moving
- (i) parallel to \mathbf{j} ,
- (ii) parallel to $(-\mathbf{i} - 3\mathbf{j})$. (6)

(Total 11 marks)

Question 9

A particle P moves on the x -axis. At time t seconds the velocity of P is v m s⁻¹ in the direction of x increasing, where

$$v = 2t^2 - 14t + 20, \quad t \geq 0$$

Find

- (a) the times when P is instantaneously at rest, (3)
- (b) the greatest speed of P in the interval $0 \leq t \leq 4$ (5)
- (c) the total distance travelled by P in the interval $0 \leq t \leq 4$ (5)

(Total 13 marks)

Question 10

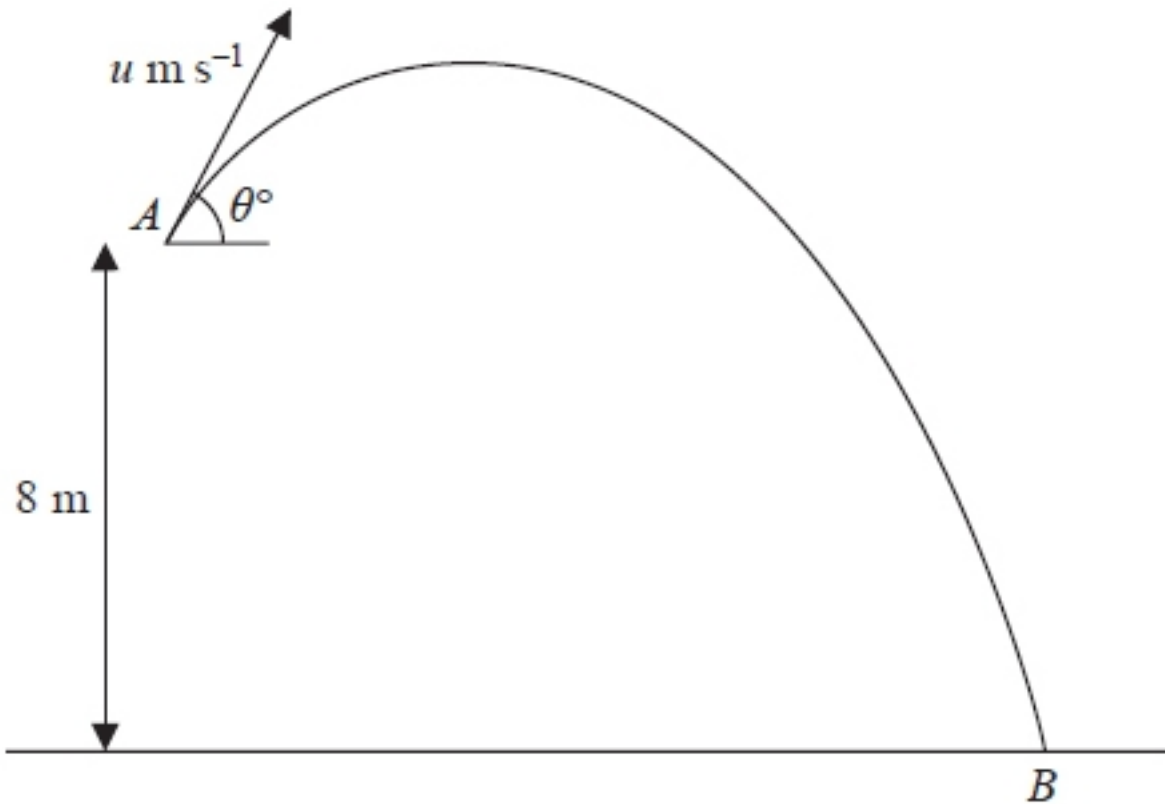


Figure 4

A ball is projected from a point A which is 8 m above horizontal ground as shown in Figure 4. The ball is projected with speed $u \text{ m s}^{-1}$ at an angle θ° above the horizontal. The ball moves freely under gravity and hits the ground at the point B . The speed of the ball immediately before it hits the ground is $2u \text{ m s}^{-1}$.

(a) By considering energy, find the value of u . (5)

The time taken for the ball to move from A to B is 2 seconds. Find

(b) the value of θ , (4)

(c) the minimum speed of the ball on its path from A to B . (2)

(Total 11 marks)

TOTAL FOR PAPER IS 106 MARKS