

2.

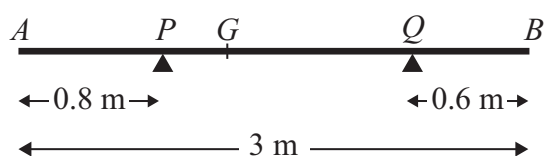


Figure 1

A non-uniform rod AB has length 3 m and mass 4.5 kg . The rod rests in equilibrium, in a horizontal position, on two smooth supports at P and at Q , where $AP = 0.8\text{ m}$ and $QB = 0.6\text{ m}$, as shown in Figure 1. The centre of mass of the rod is at G . Given that the magnitude of the reaction of the support at P on the rod is twice the magnitude of the reaction of the support at Q on the rod, find

(a) the magnitude of the reaction of the support at Q on the rod, **(3)**

(b) the distance AG . **(4)**



Question 2 continued

Lined writing area for the answer to Question 2.

(Total 7 marks)

Q2



3.

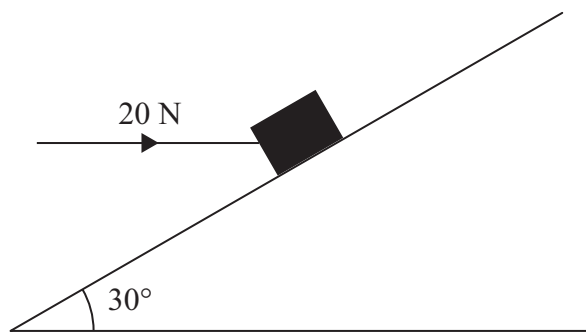


Figure 2

A box of mass 5 kg lies on a rough plane inclined at 30° to the horizontal. The box is held in equilibrium by a horizontal force of magnitude 20 N, as shown in Figure 2. The force acts in a vertical plane containing a line of greatest slope of the inclined plane. The box is in equilibrium and on the point of moving down the plane. The box is modelled as a particle.

Find

(a) the magnitude of the normal reaction of the plane on the box, (4)

(b) the coefficient of friction between the box and the plane. (5)



Question 3 continued

A series of 30 horizontal lines provided for writing the answer to Question 3.



Question 3 continued

A large area consisting of numerous horizontal lines for writing or drawing answers, extending across the width of the page below the question header.



4. A car is moving on a straight horizontal road. At time $t = 0$, the car is moving with speed 20 m s^{-1} and is at the point A . The car maintains the speed of 20 m s^{-1} for 25 s. The car then moves with constant deceleration 0.4 m s^{-2} , reducing its speed from 20 m s^{-1} to 8 m s^{-1} . The car then moves with constant speed 8 m s^{-1} for 60 s. The car then moves with constant acceleration until it is moving with speed 20 m s^{-1} at the point B .

(a) Sketch a speed-time graph to represent the motion of the car from A to B . (3)

(b) Find the time for which the car is decelerating. (2)

Given that the distance from A to B is 1960 m,

(c) find the time taken for the car to move from A to B . (8)



5. A particle P is projected vertically upwards from a point A with speed $u \text{ m s}^{-1}$. The point A is 17.5 m above horizontal ground. The particle P moves freely under gravity until it reaches the ground with speed 28 m s^{-1} .

(a) Show that $u = 21$ **(3)**

At time t seconds after projection, P is 19 m above A .

(b) Find the possible values of t . **(5)**

The ground is soft and, after P reaches the ground, P sinks vertically downwards into the ground before coming to rest. The mass of P is 4 kg and the ground is assumed to exert a constant resistive force of magnitude 5000 N on P .

(c) Find the vertical distance that P sinks into the ground before coming to rest. **(4)**



6. [In this question \mathbf{i} and \mathbf{j} are horizontal unit vectors due east and due north respectively and position vectors are given with respect to a fixed origin.]

A ship S is moving with constant velocity $(-12\mathbf{i} + 7.5\mathbf{j})$ km h⁻¹.

- (a) Find the direction in which S is moving, giving your answer as a bearing. **(3)**

At time t hours after noon, the position vector of S is \mathbf{s} km. When $t = 0$, $\mathbf{s} = 40\mathbf{i} - 6\mathbf{j}$.

- (b) Write down \mathbf{s} in terms of t . **(2)**

A fixed beacon B is at the point with position vector $(7\mathbf{i} + 12.5\mathbf{j})$ km.

- (c) Find the distance of S from B when $t = 3$ **(4)**

- (d) Find the distance of S from B when S is due north of B . **(4)**



Question 6 continued

Lined writing area for Question 6 continued. The area contains 35 horizontal lines for student response.

Q6

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(Total 13 marks)



7.



Figure 3

Two particles P and Q , of mass 0.3 kg and 0.5 kg respectively, are joined by a light horizontal rod. The system of the particles and the rod is at rest on a horizontal plane. At time $t = 0$, a constant force F of magnitude 4 N is applied to Q in the direction PQ , as shown in Figure 3. The system moves under the action of this force until $t = 6 \text{ s}$. During the motion, the resistance to the motion of P has constant magnitude 1 N and the resistance to the motion of Q has constant magnitude 2 N .

Find

- (a) the acceleration of the particles as the system moves under the action of F , (3)
- (b) the speed of the particles at $t = 6 \text{ s}$, (2)
- (c) the tension in the rod as the system moves under the action of F . (3)

At $t = 6 \text{ s}$, F is removed and the system decelerates to rest. The resistances to motion are unchanged. Find

- (d) the distance moved by P as the system decelerates, (4)
- (e) the thrust in the rod as the system decelerates. (3)



Question 7 continued

Lined area for writing the answer to Question 7.

(Total 15 marks)

Q7

Grading box for Question 7, consisting of two adjacent empty boxes.

TOTAL FOR PAPER: 75 MARKS

END

