

2. An athlete runs along a straight road. She starts from rest and moves with constant acceleration for 5 seconds, reaching a speed of 8 m s^{-1} . This speed is then maintained for T seconds. She then decelerates at a constant rate until she stops. She has run a total of 500 m in 75 s.

(a) In the space below, sketch a speed-time graph to illustrate the motion of the athlete. (3)

(b) Calculate the value of T . (5)



4.

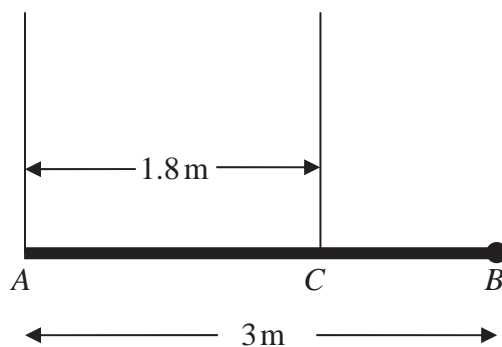


Figure 2

A pole AB has length 3 m and weight W newtons. The pole is held in a horizontal position in equilibrium by two vertical ropes attached to the pole at the points A and C where $AC = 1.8$ m, as shown in Figure 2. A load of weight 20 N is attached to the rod at B . The pole is modelled as a uniform rod, the ropes as light inextensible strings and the load as a particle.

(a) Show that the tension in the rope attached to the pole at C is $\left(\frac{5}{6}W + \frac{100}{3}\right)$ N. (4)

(b) Find, in terms of W , the tension in the rope attached to the pole at A . (3)

Given that the tension in the rope attached to the pole at C is eight times the tension in the rope attached to the pole at A ,

(c) find the value of W . (3)



5. A particle of mass 0.8 kg is held at rest on a rough plane. The plane is inclined at 30° to the horizontal. The particle is released from rest and slides down a line of greatest slope of the plane. The particle moves 2.7 m during the first 3 seconds of its motion. Find
- (a) the acceleration of the particle, (3)
- (b) the coefficient of friction between the particle and the plane. (5)

The particle is now held on the same rough plane by a horizontal force of magnitude X newtons, acting in a plane containing a line of greatest slope of the plane, as shown in Figure 3. The particle is in equilibrium and on the point of moving up the plane.

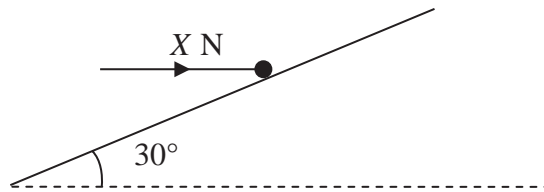


Figure 3

- (c) Find the value of X . (7)



6.

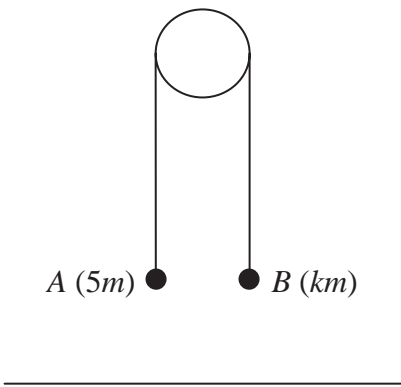


Figure 4

Two particles A and B have masses $5m$ and km respectively, where $k < 5$. The particles are connected by a light inextensible string which passes over a smooth light fixed pulley. The system is held at rest with the string taut, the hanging parts of the string vertical and with A and B at the same height above a horizontal plane, as shown in Figure 4. The system is released from rest. After release, A descends with acceleration $\frac{1}{4}g$.

- (a) Show that the tension in the string as A descends is $\frac{15}{4}mg$. (3)
- (b) Find the value of k . (3)
- (c) State how you have used the information that the pulley is smooth. (1)

After descending for 1.2 s, the particle A reaches the plane. It is immediately brought to rest by the impact with the plane. The initial distance between B and the pulley is such that, in the subsequent motion, B does not reach the pulley.

- (d) Find the greatest height reached by B above the plane. (7)



7. [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 along a straight line with constant velocity. At time t hours the position vector of S is \mathbf{s} km. When $t = 0$, $\mathbf{s} = 9\mathbf{i} - 6\mathbf{j}$. When $t = 4$, $\mathbf{s} = 21\mathbf{i} + 10\mathbf{j}$. Find

(a) the speed of S , (4)

(b) the direction in which S is moving, giving your answer as a bearing. (2)

(c) Show that $\mathbf{s} = (3t + 9)\mathbf{i} + (4t - 6)\mathbf{j}$. (2)

A lighthouse L is located at the point with position vector $(18\mathbf{i} + 6\mathbf{j})$ km. When $t = T$, the ship S is 10 km from L .

(d) Find the possible values of T . (6)



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Question 7 continued

Lined area for writing the answer to Question 7 continued, consisting of 28 horizontal lines.

Q7

(Total 14 marks)

TOTAL FOR PAPER: 75 MARKS

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