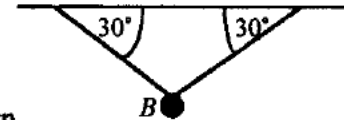


Take $g = 9.8 \text{ ms}^{-2}$ and give all answers correct to 3 significant figures where necessary.

1. A bee flies in a straight line from A to B , where $\vec{AB} = (3\frac{1}{2}\mathbf{i} - 12\mathbf{j}) \text{ m}$, in 5 seconds at a constant speed. Find
- (a) the straight-line distance AB , (2 marks)
 - (b) the speed of the bee, (2 marks)
 - (c) the velocity vector of the bee. (2 marks)

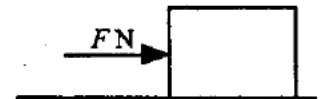
2. A small ball B , of mass 0.8 kg , is suspended from a horizontal ceiling by two light inextensible strings. B is in equilibrium under gravity with both strings inclined at 30° to the horizontal, as shown.



- (a) Find the tension, in N, in either string. (3 marks)
- (b) Calculate the magnitude of the least horizontal force that must be applied to B in this position to cause one string to become slack. (4 marks)

3. A particle P moves in a straight line through a fixed point O with constant acceleration $a \text{ ms}^{-2}$. 3 seconds after passing through O , P is 6 m from O . After a further 6 seconds, P has travelled a further 33 m in the same direction. Calculate
- (a) the value of a , (5 marks)
 - (b) the speed with which P passed through O . (2 marks)

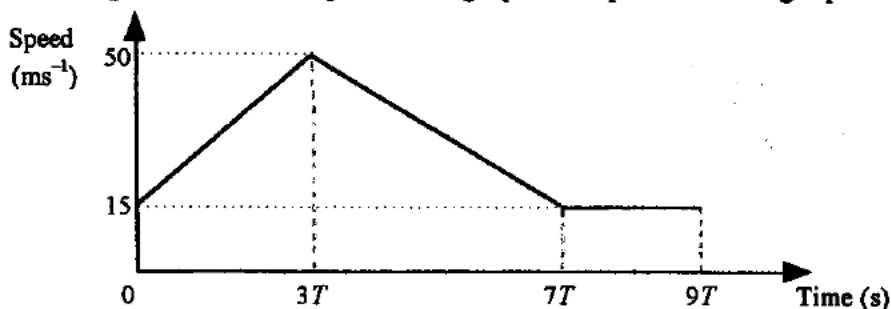
4. A force of magnitude $F \text{ N}$ is applied to a block of mass $M \text{ kg}$ which is initially at rest on a horizontal plane. The block starts to move with acceleration 3 ms^{-2} . Modelling the block as a particle,



- (a) if the plane is smooth, find an expression for F in terms of M . (2 marks)
- If the plane is rough, and the coefficient of friction between the block and the plane is μ ,
- (b) express F in terms of M , μ and g . (2 marks)
- (c) Calculate the value of μ if $F = \frac{1}{2}Mg$. (3 marks)

5. Two metal weights A and B , of masses 2.4 kg and 1.8 kg respectively, are attached to the ends of a light inextensible string which passes over a smooth fixed pulley so that the string hangs vertically on each side. The system is released from rest with the string taut.
- (a) Calculate the acceleration of each weight and the tension in the string. (6 marks)
 - A is now replaced by a different weight of mass $m \text{ kg}$, where $m < 1.8$, and the system is again released from rest. The magnitude of the acceleration has half of its previous value.
 - (b) Calculate the value of m . (6 marks)

6. The diagram shows the speed-time graph for a particle during a period of $9T$ seconds.



- (a) If $T = 5$, find
- (i) the acceleration for each section of the motion, (2 marks)
 - (ii) the total distance travelled by the particle. (2 marks)
- (b) Sketch, for this motion, (i) an acceleration-time graph, (2 marks)
(ii) a displacement-time graph. (2 marks)
- (c) Calculate the value of T for which the distance travelled over the $9T$ seconds is 3.708 km. (4 marks)

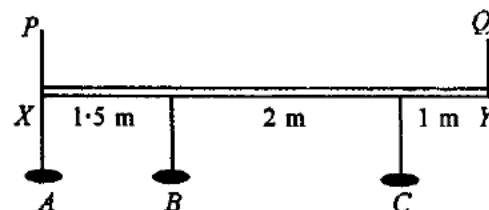
7. Two smooth spheres A and B , of masses 60 grams and 90 grams respectively, are at rest on a smooth horizontal table. A is projected towards B with speed 4 ms^{-1} and the particles collide. After the collision, A and B move in the same direction as each other, with speeds $u \text{ ms}^{-1}$ and $6u \text{ ms}^{-1}$ respectively. Calculate

- (a) the value of u , (4 marks)
(b) the magnitude of the impulse exerted by A on B , stating the units of your answer. (3 marks)

A and B are now replaced in their original positions and projected towards each other with speeds 2 ms^{-1} and 8 ms^{-1} respectively. They collide again, after which A moves with speed 7 ms^{-1} , its direction of motion being reversed.

- (c) Find the speed of B after this collision and state whether its direction of motion has been reversed. (5 marks)

8. In a theatre, three lights A , B and C are suspended from a horizontal beam XY of length 4.5 m. A and C are each of mass 8 kg and B is of mass 6 kg. The beam XY is held in place by vertical ropes PX and QY , as shown.



In a simple mathematical model of this situation, XY is modelled as a light rod.

- (a) Calculate the tension in each of PX and QY . (6 marks)

In a refined model, XY is modelled as a uniform rod of mass m kg.

- (b) If the tension in PX is 1.5 times that in QY , calculate the value of m . (6 marks)