







2. A steel girder  $AB$ , of mass 200 kg and length 12 m, rests horizontally in equilibrium on two smooth supports at  $C$  and at  $D$ , where  $AC = 2$  m and  $DB = 2$  m. A man of mass 80 kg stands on the girder at the point  $P$ , where  $AP = 4$  m, as shown in Figure 1.

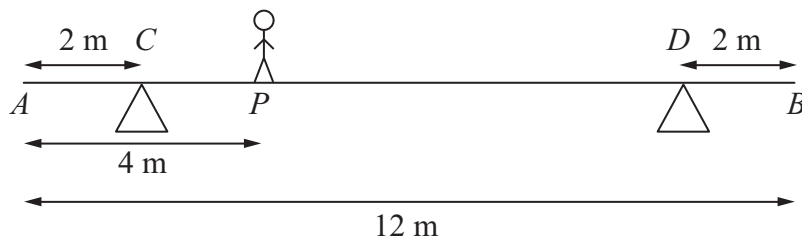


Figure 1

The man is modelled as a particle and the girder is modelled as a uniform rod.

- (a) Find the magnitude of the reaction on the girder at the support at  $C$ . (3)

The support at  $D$  is now moved to the point  $X$  on the girder, where  $XB = x$  metres. The man remains on the girder at  $P$ , as shown in Figure 2.

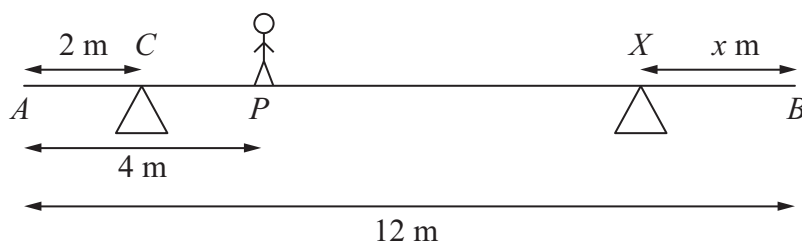


Figure 2

Given that the magnitudes of the reactions at the two supports are now equal and that the girder again rests horizontally in equilibrium, find

- (b) the magnitude of the reaction at the support at  $X$ , (2)
- (c) the value of  $x$ . (4)

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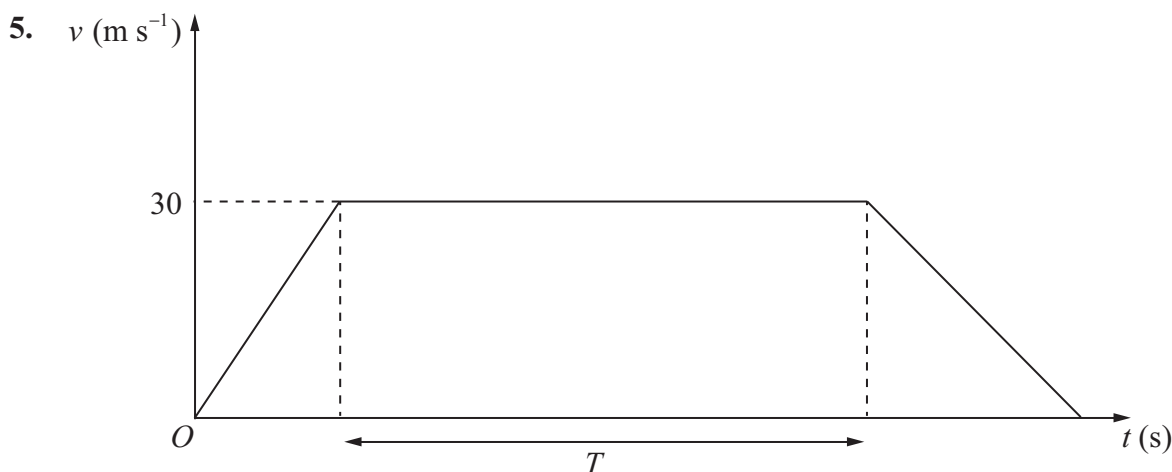












**Figure 4**

The velocity-time graph in Figure 4 represents the journey of a train  $P$  travelling along a straight horizontal track between two stations which are 1.5 km apart. The train  $P$  leaves the first station, accelerating uniformly from rest for 300 m until it reaches a speed of  $30 \text{ m s}^{-1}$ . The train then maintains this speed for  $T$  seconds before decelerating uniformly at  $1.25 \text{ m s}^{-2}$ , coming to rest at the next station.

(a) Find the acceleration of  $P$  during the first 300 m of its journey. (2)

(b) Find the value of  $T$ . (5)

A second train  $Q$  completes the same journey in the same total time. The train leaves the first station, accelerating uniformly from rest until it reaches a speed of  $V \text{ m s}^{-1}$  and then immediately decelerates uniformly until it comes to rest at the next station.

(c) Sketch on the diagram above, a velocity-time graph which represents the journey of train  $Q$ . (2)

(d) Find the value of  $V$ . (6)

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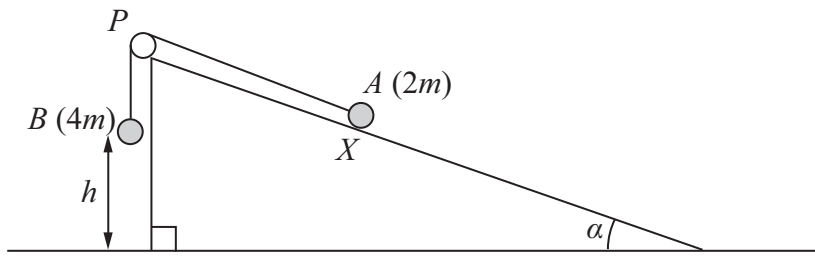








7.



**Figure 5**

Figure 5 shows two particles  $A$  and  $B$ , of mass  $2m$  and  $4m$  respectively, connected by a light inextensible string. Initially  $A$  is held at rest on a rough inclined plane which is fixed to horizontal ground. The plane is inclined to the horizontal at an angle  $\alpha$ , where  $\tan \alpha = \frac{3}{4}$ . The coefficient of friction between  $A$  and the plane is  $\frac{1}{4}$ . The string passes over a small smooth pulley  $P$  which is fixed at the top of the plane. The part of the string from  $A$  to  $P$  is parallel to a line of greatest slope of the plane and  $B$  hangs vertically below  $P$ . The system is released from rest with the string taut, with  $A$  at the point  $X$  and with  $B$  at a height  $h$  above the ground.

For the motion until  $B$  hits the ground,

(a) give a reason why the magnitudes of the accelerations of the two particles are the same, (1)

(b) write down an equation of motion for each particle, (4)

(c) find the acceleration of each particle. (5)

Particle  $B$  does not rebound when it hits the ground and  $A$  continues moving up the plane towards  $P$ . Given that  $A$  comes to rest at the point  $Y$ , without reaching  $P$ ,

(d) find the distance  $XY$  in terms of  $h$ . (6)

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