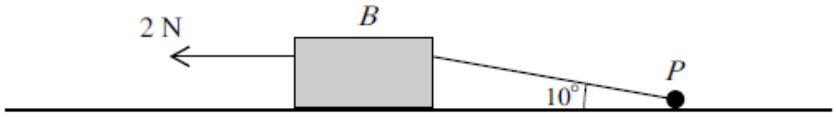
# Topic X9 Mechanics (Pre-TT B) [52]

***Covering chapters 21 and 22..***

1.




A block $B$ of mass 0.8 kg and a particle $P$ of mass 0.3 kg are connected by a light inextensible string inclined at 10° to the horizontal. They are pulled across a horizontal surface with acceleration $0.2\,\text{m s}^{-2}$, by a horizontal force of 2 N applied to $B$ (see diagram).

**(i)** Given that contact between $B$ and the surface is smooth, calculate the tension in the string. **[3]**

**(ii)** Calculate the coefficient of friction between $P$ and the surface. **[7]**

2.

A particle $P$ of mass 0.5 kg moves upwards along a line of greatest slope of a rough plane inclined at an angle of 40° to the horizontal. $P$ reaches its highest point and then moves back down the plane. The coefficient of friction between $P$ and the plane is 0.6.

**(i)** Show that the magnitude of the frictional force acting on $P$ is 2.25 N, correct to 3 significant figures. [3]

**(ii)** Find the acceleration of $P$ when it is moving

**(a)** up the plane,

**(b)** down the plane.

[4]

**(iii)** When $P$ is moving up the plane, it passes through a point $A$ with speed $4\,\text{m s}^{-1}$.

**(a)** Find the length of time before $P$ reaches its highest point.

**(b)** Find the total length of time for $P$ to travel from the point $A$ to its highest point and back to $A$.

[8]

3.

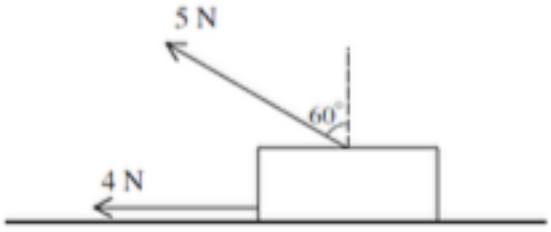



**Fig. 1**

A rectangular block $B$ of weight 12 N lies in limiting equilibrium on a horizontal surface. A horizontal force of 4 N and a coplanar force of 5 N inclined at 60° to the vertical act on $B$ (see Fig. 1).

**(i)** Find the coefficient of friction between $B$ and the surface. **[6]**

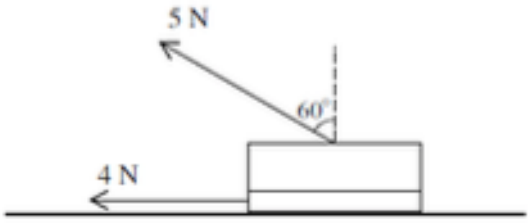



**Fig. 2**

$B$ is now cut horizontally into two smaller blocks. The upper block has weight 9 N and the lower block has weight 3 N. The 5 N force now acts on the upper block and the 4 N force now acts on the lower block (see Fig. 2). The coefficient of friction between the two blocks is $\mu$.

**(ii)** Given that the upper block is in limiting equilibrium, find $\mu$. **[2]**

**(iii)** Given instead that $\mu = 0.1$, find the accelerations of the two blocks. **[6]**

4.

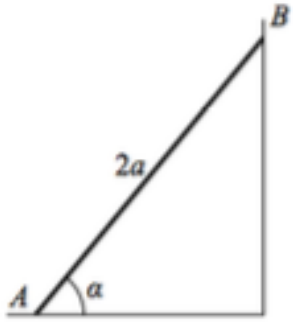



**Figure 1**

A uniform ladder $AB$, of length $2a$ and weight $W$, has its end $A$ on rough horizontal ground.

The coefficient of friction between the ladder and the ground is $\frac{1}{4}$.

The end $B$ of the ladder is resting against a smooth vertical wall, as shown in Figure 1.

A builder of weight $7W$ stands at the top of the ladder.
To stop the ladder from slipping, the builder's assistant applies a horizontal force of magnitude $P$ to the ladder at $A$, towards the wall.
The force acts in a direction which is perpendicular to the wall.

The ladder rests in equilibrium in a vertical plane perpendicular to the wall and makes an angle $\alpha$ with the horizontal ground, where $\tan \alpha = \frac{5}{2}$.

The builder is modelled as a particle and the ladder is modelled as a uniform rod.

(a) Show that the reaction of the wall on the ladder at $B$ has magnitude $3W$.

**(5)**

(b) Find, in terms of $W$, the range of possible values of $P$ for which the ladder remains in equilibrium.

**(5)**

Often in practice, the builder's assistant will simply stand on the bottom of the ladder.

(c) Explain briefly how this helps to stop the ladder from slipping.

**(3)**