

# ACTIVITY 4

## A<sub>IM</sub>

To measure the force of limiting rolling friction for a roller (wooden block) on a horizontal plane.

## A<sub>PPARATUS AND MATERIAL REQUIRED</sub>

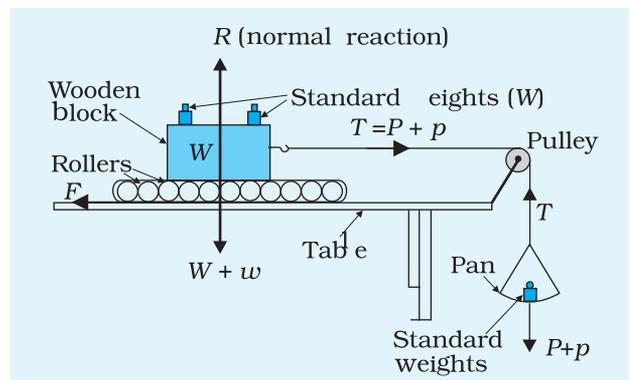
Wooden block with a hook on one side, set of weights, horizontal plane fitted with a frictionless pulley at one end, pan, spring balance, thread, spirit level, weight box and lead shots (rollers).

## P<sub>RINCIPLE</sub>

Rolling friction is the least force required to make a body start rolling over a surface. Rolling friction is less than the sliding friction.

## P<sub>ROCEDURE</sub>

1. Check that the pulley is almost frictionless otherwise oil it to reduce friction.
2. Check the horizontal surface with a spirit level and spread a layer of lead shots on it as shown in Fig. A 4.1.
3. Weigh the wooden block.
4. Find the weight of the pan. Tie one end of the thread to the pan and let it hang over the pulley.
5. Now put the block over the layer of lead shots and tie the other end of the thread to its hook.
6. Put a small weight in the pan and observe whether the wooden block kept on rollers begin to move.



**Fig. A 4.1:** Setup to study rolling friction

7. If the block does not start rolling, put some more weights on the pan from the weight box increasing weights in the pan gradually till the block just starts rolling.
8. Note the total weight put in the pan, including the weight of the pan and record them in the observation table.
9. Put a 100 g weight over the wooden block and repeat Steps (7) to (9).
10. Increase the weights in steps over the wooden block and repeat Steps (7) to (9).

## OBSERVATIONS

Mass of wooden block  $m = \dots \text{ g} = \dots \text{ kg}$

Weight of wooden block,  $W (mg) = \dots \text{ N}$

Weight on the pan

= (Mass of the pan + weight)  $\times$  acceleration due to gravity ( $g$ )

=  $\dots \text{ N}$

**Table A 4.1: Table for additional weights**

S. No.	Mass of standard weights on wooden block, $W$	Total weight being pulled = $(W + w) \times g$ = Normal Reaction, $R$ (N)	Mass on pan ( $p$ ) (kg)	Total weight (force) pulling the block and standard weights ( $P+p$ ) $g$
1				
2				
3				
4				

## RESULT

As the total weight being pulled increases limiting value of rolling friction increases/decreases.

## PRECAUTIONS

1. The pulley should be frictionless. It should be lubricated, if necessary.
2. The portion of the string between the pulley and the hook should be horizontal.

- The surfaces of lead shots as well as the plane and the block should be clean, dry and smooth.
- The weights in the pan should be placed carefully and very gently.

## SOURCES OF ERROR

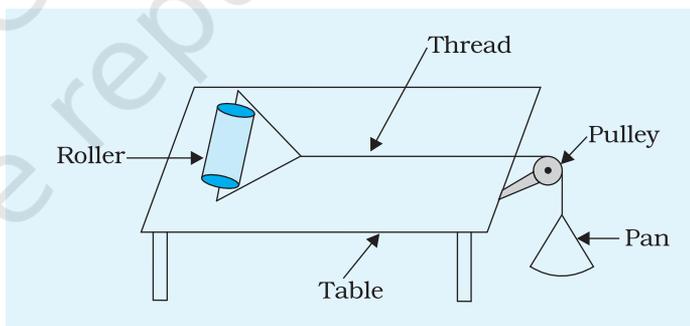
- Friction at the pulley tends to give larger value of limiting friction.
- The plane may not be exactly horizontal.

## DISCUSSION

- The two segments of the thread joining the block and the pan passing over the pulley should lie in mutually perpendicular planes.
- The total weight pulling the block (including that of pan) should be such that the system just rolls without acceleration.
- While negotiating a curve on a road, having sand spread over it, a two wheeler has to be slowed down to avoid skidding, why?

### SUGGESTED ADDITIONAL EXPERIMENTS/ACTIVITIES

- Find the co-efficient of rolling friction  $\mu_r$  by plotting the graph between rolling friction,  $F$  and normal reaction,  $R$ .
- What will be the effect of greasing the lead shots, and the horizontal surface on which they are placed.
- Study the rolling motion of a roller as shown in Fig. A 4.2 and compare it with the motion in the arrangement for the above Activity.



**Fig. A 4.2:**