EXPERIMENT

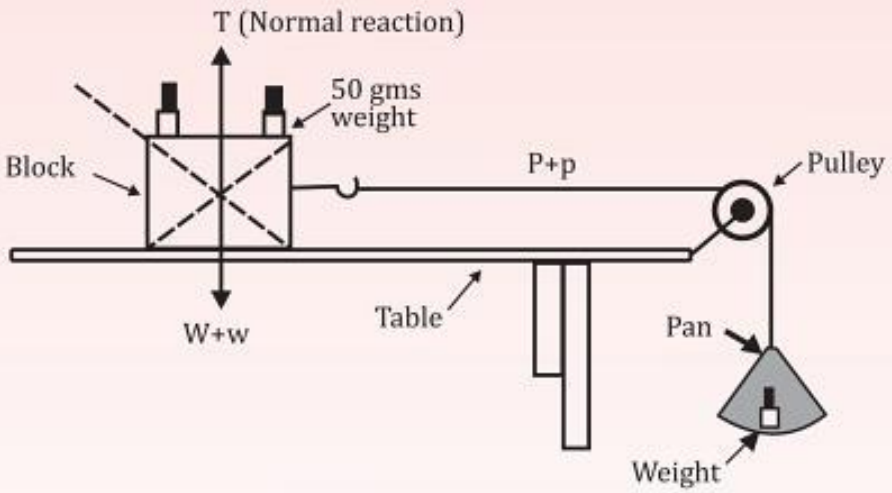
AIM

To study the relationship between the force of limiting friction and normal reaction and to find coefficient of limiting friction between a block and a horizontal surface.

MATERIAL REQUIRED

A plane wooden board with glass top, a wooden block with hook, pulley, thread, pan, weight's box, spring balance and spirit level.

DIAGRAM



THEORY

Sliding friction: It is the friction between two surfaces of the bodies in sliding motion.

Force of sliding friction: It is the least force required to make a body start sliding over a surface.

Force of friction,

$$F \propto R \qquad \ldots\ldots (1)$$

$$F = \mu R$$

Where, μ = co-efficient of friction, R is the normal reaction.

At equilibrium,

$$F = P + p \qquad \ldots (2)$$

And,

$$R = W + w \qquad \ldots (3)$$

PROCEDURE

1. Place the given board horizontally on a flat table surface. Use spirit level check to ensure that the top surface of the board is horizontal.
2. Find the least count and zero error of the spring balance. Find the weight of the wooden block using the

spring balance. Obtain the corrected reading of weight by considering the zero error of spring balance. Take at least three readings.

3. Check the pulley and ensure that it is frictionless and rotates freely. If required, lubricate the pulley with oil.
4. Take a string of suitable length and tie one end of it to the hook of the wooden block. Tie its other end to the scale pan. Pass the string through the pulley with a block placed on a horizontal surface and a pan hanging down the table.
5. Add some weights from the weight box to the pan. Tap the glass gently. Keep on adding weight till the block just begins to slide along the horizontal surface on tapping.

$$\text{Force of limiting friction (F)} = \text{Weight of pan} + \text{Total weight in the pan}$$

$$\text{Weight of block} = \text{Normal reaction} = W_1$$

6. Vary the value of the weight of the block by placing a known weight W_2 on W_1.
7. Repeat Step 5 again.
8. Vary the weight of the block in same manner at least three more times and take the observations.

OBSERVATION

Least count of spring balance = _____ g wt.

Zero error of spring balance = _____ g wt.

Table 1: Weight of block

S. No.	Observed weight (wt.)	Corrected weight (wt.)
Block 1		
Block 2		
Block 3		

Mean weight of block = W_1 = _____ g wt.

Mean value of u = _____.

Table 2: Weight of pan

S. No.	Observed weight (wt.)	Corrected weight (wt.)
Pan 1		
Pan 2		
Pan 3		

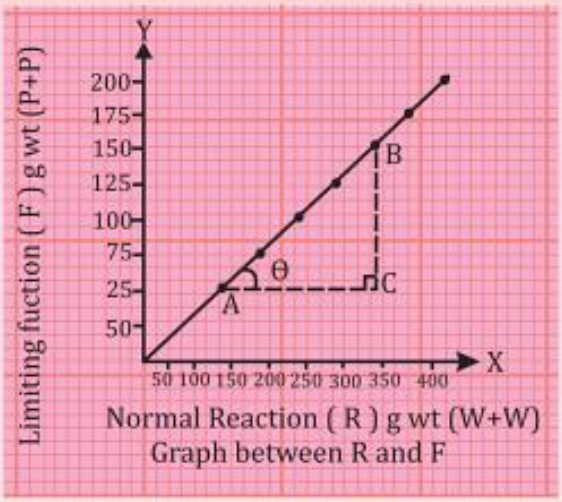
Mean weight of pan = W_p =_____ g wt.

Table 3: Normal reaction and limiting friction.

S. No.	Weight placed on block (W_2) (g wt.)	Total normal reaction, $W_1 + W_2$ (N) (g wt.)	Weights in pan W (g wt.)	F = (W_P+W) g wt.	$U = \frac{F}{N}$
1.					
2.					
3.					

CALCULATION

1. The graph between limiting friction and normal reaction is a linear graph which shows.
2. The value of coefficient of limiting friction between block and surface is:



Graph between R and F

RESULT

As the total pulled weight rises, there is a corresponding increase in the force of limiting friction, and this increase occurs in a direct proportion. The graph illustrates a direct proportionality between the limiting friction force (F) and the normal reaction (R), aligning with the law of limiting friction. This experimental observation serves as a verification of the law.

The constant ratio,

$$\frac{F}{R}$$

It is referred to as the coefficient of friction (μ) and its calculation involves determining the slope of the graph. Slope of straight line,

$$AB = \tan\theta = \frac{BC}{AC} = \frac{F}{R} = \frac{150-50}{300-100} \quad \text{..... (1)}$$

or,

$$\tan\theta = \frac{F}{R} = \frac{100}{200} = \frac{1}{2} = 0.5$$

But,

$$F = \mu R$$

$$\frac{F}{R} = \mu \quad \text{..... (2)}$$

From equation (1) and (2),

$$\mu = \tan\theta = 0.5$$

$$\mu = 0.5$$

PRECAUTIONS

1. The pulley should be frictionless.
2. The surface should be horizontal.
3. Any dust, if present on horizontal surface or block, must be wiped off.
4. Least count and zero error must be carefully accounted for while measuring the weight of pan and block.
5. Tapping of the surface should be done very gently.
6. The pan should not touch the ground or table. Similarly, the thread should not be touching the table legs or horizontal surface.
7. Weight must be carefully placed to note the value of limiting friction correctly.

SOURCES OF ERROR

1. The pulley may not be completely frictionless.
2. Adjustment of weights might not have been done.
3. The surface may not be perfectly horizontal.

VIVA VOCE

Q1. Why is the thread part between the block and pulley kept horizontal?

Ans. Keeping the thread part horizontal ensures that the combined weight of the pan and weights effectively pulls the block horizontally.

Q2. Why is the pulley kept frictionless?

Ans. Maintaining a frictionless pulley ensures that the weight of the pan and its contents remains fully effective. Introducing friction to the pulley would diminish its effectiveness by reducing the applied force.

Q3. Why do roads become slippery after rain?

Ans. After rainfall, a thin layer of water forms between our feet and the road, acting as a lubricant. This layer prevents interlocking of irregularities on the wheel and road surfaces, reducing friction and causing slipping.

Q4. Why are brake surfaces kept flat, even though increasing the surface area does not increase friction?

Ans. Keeping brake surfaces flat, despite not increasing friction, distributes the force over a larger area, reducing pressure. This helps avoid scratching the surface being braked.

Q5. What is limiting friction?

Ans. Limiting friction refers to the maximum value of static friction that prevents the initiation of motion.

Q6. What is friction, static, and kinetic?

Ans. Static friction is the force that arises between two bodies before one begins moving. It occurs due to impending motion. Kinetic friction is the force that comes into play when a body is already in motion over another body.

Q7. What is sliding friction?

Ans. Sliding friction is the force that occurs when a body slides over the surface of another body. For instance, when a block is pulled or pushed on a surface.

Q8. What is rolling friction?

Ans. Rolling friction is the force that comes into play when a body rolls over the surface of another body, as seen when a wheel rolls over a road.