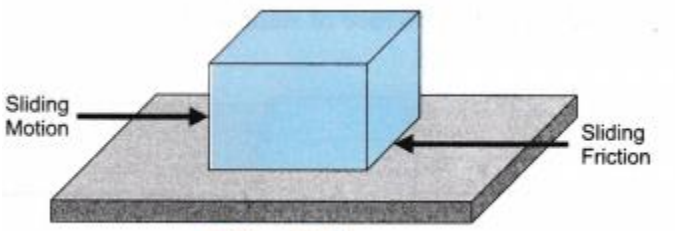
Relationship Between Weight Of a Body & Force Required to Just Move It – Experiment, Viva Voce

Introduction

1. **Friction** is a force that is created whenever two surfaces move or try to move across each other.
2. Friction always opposes the motion. Friction is dependent on the texture of both surfaces and on the contact area of two bodies.
3. On a leveled surface, the normal force is always equal and opposite to the weight of the object.
4. The force of friction depends upon both surfaces in contact and the normal force.
5. When the force is applied on an object to overcome its static friction, this force is called force of static friction.
6. To stop a moving object, a force must act in the opposite direction to the direction of motion. The force that opposes the motion of an object is called friction.
7. The maximum value of force of friction, acting between the two solid surfaces just before the object sets into motion is called limiting force of friction.
8. Limiting friction acts tangential to the surfaces in contact in opposite direction of motion.

Types of Friction

1. **Sliding friction:** When the object is kept on a surface and pushed with a force to slide on the surface, is called sliding friction. The weight of the object and the type of surface on which it has to move will determine the amount of force required to slide it. The weight of the object also decides the force it will take to slide. As heavy object will exert more pressure on the surface hence the sliding friction will be greater.



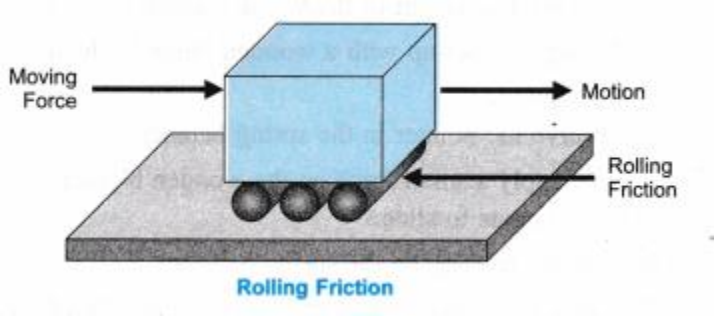
Sliding Friction

2. **Fluid friction:** All substances that flow are called the fluids. Air, water and oil are all fluids. When fluids offer resistance to the flow or motion of the bodies it is called

fluid friction. As an object falls, air resistance pushes the object upward.

Fluid Friction

3. **Rolling friction:** When an object rolls on a surface, the contact between the rolling body and the surface is called rolling friction. E.g., when riding a cycle the contact between the tires rolling on the road provides the rolling friction. The force needed to overcome this rolling friction is always less than the sliding friction. Hence, by reducing the surface of contact between two bodies its friction can be reduced.



Rolling Friction

EXPERIMENT

Aim

To establish a relationship between the weight of a rectangular wooden block lying on a horizontal table and the minimum force required to just move it using a spring balance.

Materials Required

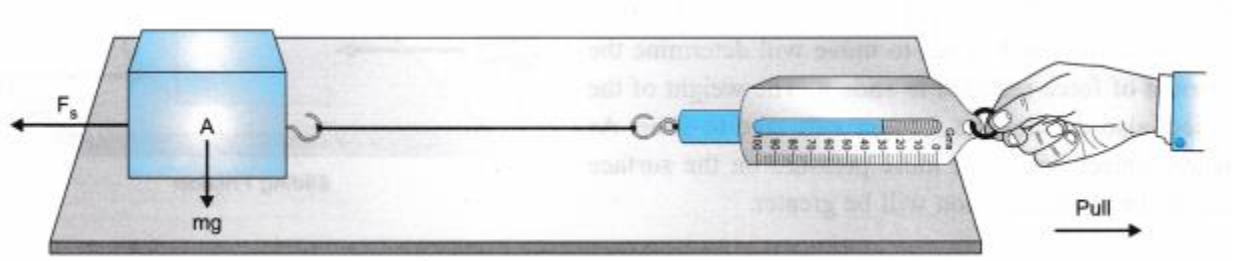
1. A bench, a wooden slab, a string, slotted weights, weight box, a spring balance etc.

Specific Objectives

1. Learn about the force in taut strings called as Tension.
2. Learn about the presence of friction in an object even at rest – Static Friction.
3. Learn about the way the tension changes as more and more weight is added to the pan.
4. Learn about how the static friction varies as more and more weight is added to the pan.
5. Learn to handle a set-up with vertical and horizontal movement.

Theory

1. The force of friction always acts in a direction opposite to the direction of applied force. As the force applied on the wooden block to be moved increases, the force of friction also increases accordingly to balance it. This indicates the presence of static friction—friction when an object is at rest.



2. But the force of friction can increase upto a certain limit. Once the applied force exceeds this limit, the object moves. The maximum value of force of friction, acting between the two solid surfaces just before the object sets into motion is called limiting force of friction or limiting friction. The force is directly proportional to the weight of the object.

Procedure

1. Find the range and the least count of the spring balance.
2. Measure the weight of the wooden block using a spring balance.
3. Arrange the set-up with a wooden block in the horizontal surface and connect it with a spring balance as shown
4. Observe the pointer in the spring balance.
5. Now apply a small force on the wooden block by pulling the spring balance. Gradually increase the force till the block begins to slide.
6. Note the reading on the spring balance.
7. Repeat the experiment with increasing weight of 50 g on wooden block and record your observations.

Observations

1. Range of the spring balance = 0 – 500 g = 0 – 5 N

2. Least count of the spring balance = 10 g

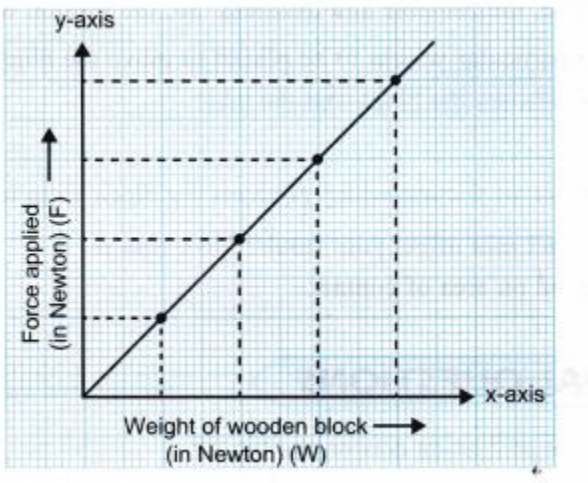
3. Mass of the wooden block with hook, R = 50 g

4. Value of ‘g’ = 9.8 m/s^2

S. No.	Mass placed on the wooden block (q)	Total weight of wooden block (W = q + R)	Total Force required to pull the block (F) (Reading on Spring balance)	F/W
1.	0	50 g i.e. 0.5 N	0.01 N	0.02
2.	50 g	100 g i.e. 1 N	0.02 N	0.02
3.	100 g	150 g i.e. 1.5 N	0.03 N	0.02
4.	150 g	200 g i.e. 2 N	0.04 N	0.02
5.	200 g	250 g i.e. 2.5 N	0.05 N	0.02

Graph

1. Plot a graph between weight of wooden block, W on V axis and the reading on spring balance, F on 'y' axis.
2. The graph obtained is a straight line as shown in the figure.



Result

1. The force required was found to increase with the increase in the weight of the block.
2. The ratio F/W is constant.
3. The constant ratio of F/W and the straight line graph indicates the maximum force required to just move the block is directly proportional to the weight of the block.

Precautions

1. Reading in spring balance should be noted as soon as the wooden block starts moving.
2. The horizontal surface must be clean and dry.
3. The spring balance should not touch the wall or any surface.
4. The force applied on the wooden block by pulling the string should be gently and gradually increased.
5. The string should be inextensible.

6. The string should be kept horizontal while the force is applied on the block.

VIVA VOCE

Question 1:
Can a mass be moved using a string which is not taut?
Answer:
No, taut string has tension.

Question 2:
What is the SI unit of tension?
Answer:
Newton, as tension is a force.

Question 3:
Why does the block not move if we pull the spring balance with less force?
Answer:
Due to the presence of friction on the block.

Question 4:
Is friction experienced by the block a constant force?
Answer:
No, it increases from zero to a particular value equal to the weight at which the slab slides.

Question 5:
In what way dust affects our reading?
Answer:
Dust increases the friction.

Question 6:
Will your result hold good if the string is heavy?
Answer:
No, as the tension varies from point to point in the string if it is heavy.

PRACTICAL BASED QUESTIONS

Question 1:
Why is the tension on the vertical and horizontal string equal?
Answer:
The string is incompressible, inextensible and massless. So, the tension will be the same at both the sides.

Question 2:
Why is it necessary for a particular weight to be placed to move the block?
Answer:
To overcome the friction between the block and the table.

Question 3:
What is limiting friction?
Answer:
The maximum value of force of friction which prevents the block from moving is called limiting friction.

Question 4:
Does the value of the contact area affect your result? Give reason.
Answer:
No, friction does not depend on area of contact.

NCERT LAB MANUAL QUESTIONS

Question 1:
In which direction the force of friction acts on the block?
Answer:
The force of friction acts in opposite direction to the direction of the motion of the block.

Question 2:
Why is the thread used to move the block kept horizontal to the surface and the wooden block you are using?
Answer:
To find the friction force, we need to slide the body horizontally on the surface, hence it is pulled horizontally.

Question 3:
How is the limiting friction between two surfaces in contact affected when grease or oil is put between them?
Answer:
On applying fluids, a surface becomes smooth as fluids reduce the friction and the force required to move the object would be less.

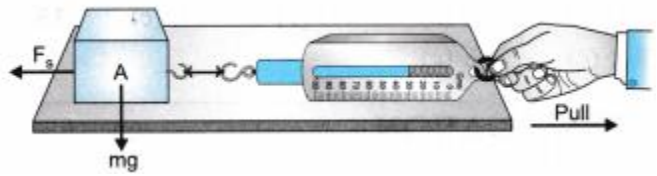
Question 4:
How can you use the concept of limiting friction to measure a force?
Answer:
When an object is kept on the surface, it experiences a frictional force due to the surface and hence on applying some force it does not move. But when the force applied is unbalanced, the object just overcomes the frictional force and moves. This way we can measure the limiting friction.

MULTIPLE CHOICE QUESTIONS (MCQs)
Question based on Procedural and Manipulative Skills

Question 1:
The mass and weight of a body
(a) are the same physical quantities expressed in different units
(b) are identical
(c) differ by a factor of 9.8
(d) are both a direct measure of the inertia of the body.

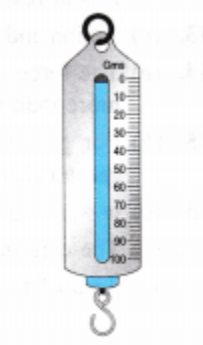
Question 2:
Three students used different kinds of attachments while measuring limiting friction of a block placed over a table. Student A used a rubber band; B used a woollen thread; and C used a cotton thread. The best choice is
(a) that of A
(b) that of B
(c) that of C
(d) independent of the kind of attachment used. Questions based on Observational Skills

Question 3:
The spring balance in the following set-up indicates



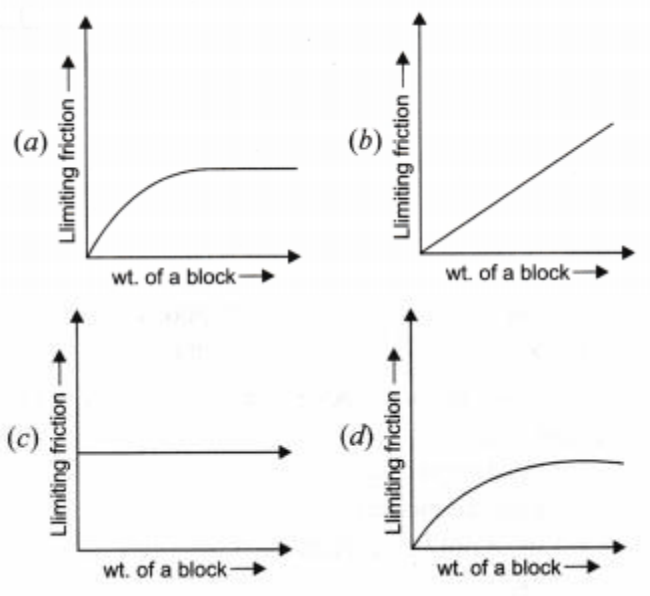
(a) $F_{s(\text{static frictional force})}$
(b) 2F
(c) F/2
(d) F/4

Question 4:
The least count of the given spring balance is

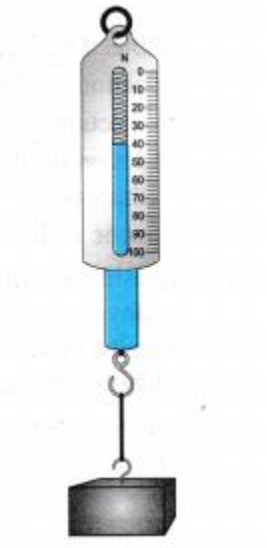


(a) lg
(b) 2g
(c) 4g
(d) 5g

Question 5:
The graph of weight of a block and limiting friction will be



Question 6:
The weight of the object shown in the figure is: (zero error)



(a) 400N
(b) 60N
(c) 0.4N
(d) 40N

Question 7:
The streamlined bodies of fish helps them to
(a) swim easily
(b) reduce friction
(c) increase friction
(d) reduce contact force

Questions based on Reporting and Interpretation Skills

Question 8:
A block rests on a table, exerting a downward force on the table. The reaction to this force is
(a) the force of Earth on the block
(b) the force of the table on the block
(c) the force of Earth on the table
(d) the force of the block on Earth.

Question 9:
The 'reaction' force does not cancel the 'action' force because
(a) the action force is greater than the reaction force
(b) they are in the same direction
(c) they act on the two different bodies in contact
(d) the reaction force exists only after the action force is removed.

Question 10:
A force F larger than the largest possible force of static friction is applied to the left of an object moving to the right on a horizontal surface. Then
(a) the object must be moving at constant speed
(b) F and the friction force act in opposite directions
(c) the object must be slowing down
(d) the object must be speeding up.

Question 11:
A 400 N steel ball is suspended by a light rope from the ceiling. The tension in the rope is
(a) 400 N
(b) 800 N
(c) zero
(d) 200 N

Question 12:
If the set of forces acting on an object are balanced, then object
(a) must be at rest
(b) must be moving

(c) must not be accelerating
(d) none of these.

Question 13:
A wooden block is lying on the horizontal surface of a table. The forces acting on this wooden block are
(a) action on the surface of the table
(b) reaction on the wooden block
(c) action on the surface of the table and reaction on the wooden block
(d) none of these.

Question 14:
By using a spring balance we apply a force of 200 N to move wooden cabinet across a floor at a constant velocity. What will be the frictional force that will be extended on the cabinet?
(a) No frictional force
(b) Frictional force of 200N
(c) Frictional force < 200N
(d) Frictional force > 200N

Question 15:
How much force is required to move an object with a constant velocity?
(a) No force is required.
(b) Force should be greater than frictional force.
(c) Force should be less than frictional force.
(d) Force just equal to the frictional force.

Question 16:
A spring balance measured the object as 20g. Its weight is
(a) 20g x 10N
(b) 200 x 10N
(c) 0.02 x 10N
(d) 0.02 x 980N

Question 17:
A car weight 9000 N. For this car, the recommended pressure is 18 N/cm2. What is the area of each type in contact with the ground?
(a) 500 cm^2
(b) 250 cm^2
(c) 125 cm^2
(d) 1.62 x 105 cm^2

Answers :

(1) C
(2) C
(3) A
(4) B
(5) B
(6) D
(7) B
(8) B
(9) C
(10) B
(11) A
(12) C
(13) C
(14) C
(15) B
(16) C
(17) C