THE FORCE OF FRICTION

11 FEBRUARY 2014

Lesson Description

In this lesson we:

- Define the normal force
- Show the relationship between friction and normal force
- Explain the types of frictional force

Summary

The Normal Force (N)

An object lying on a surface experiences a force due to gravity. This force acts perpendicularly downwards and it is called the **weight** of the object. It is given by $F_g = m \times g$; where m is the mass of the object in kg and g acceleration due to gravity = 9.8 $m.s^{-2}$. In response to the force of gravity, the surface on which an object lies exerts a force on the object which is perpendicular to the surface. This force is called the normal force. If an object is lying on a horizontal surface, the normal force will be equal in magnitude to the gravitational force. However, if an object lies on an inclined surface, the normal force will be equal to the perpendicular component of the gravitational force.

Types of Friction

Frictional force is a force exerted by a surface on an object that opposes the motion of the object. It therefore acts parallel to the surface.

Static Friction is the force that a stationary object must overcome in order to start moving.

Dynamic friction is the force between two surfaces that exists due to one surface sliding over the other. This is also called kinetic friction.

The type of surfaces on which objects lie will determine the amount of friction that the objects will experience. Some surfaces are rougher than others and therefore will offer more friction than those that are smoother. The measure of a surface to offer friction to an object is given by its coefficient of friction (μ). The same surface will have different coefficients of friction for static and dynamic friction.

Calculating Friction

A crate of mass 12 kg is at rest on a rough horizontal surface. The coefficient of static friction is 0.22.

1. Calculate the force that is required to set the crate in motion.
2. If the dynamic (kinetic) force is 18 N, what is the coefficient of kinetic friction?

Test Yourself

Question 1

In which direction does friction always act?

A   in the direction of motion

B   in the direction of the normal force

C   perpendicular to the direction of motion

D   opposite the direction of motion

Question 2

The coefficient of dynamic friction for the same surface is ….

A   less than the coefficient of static friction

B   equal to the coefficient of static friction

C   greater than the coefficient of static friction

D   zero

Question 3

For a smooth surface (frictionless), the coefficient of dynamic friction is …

A   less than the coefficient of static friction

B   equal to the coefficient of static friction

C   greater than the coefficient of static friction

D   zero

Question 4

What is the coefficient of friction for a smooth (frictionless) surface?

A   one

B   greater than one

C   less than one

D   zero

Question 5

A 20 kg block is at rest on a horizontal surface. What is the normal that is exerted on the block by the surface?

A   196 N downwards

B   196 N upwards

C   196 N to the right

D   196 N to the left

A 40 kg brick is at rest on a surface inclined at 30^0 to the horizontal.

Question 6

What is the magnitude of the normal force acting on the brick?

A   392 N

B   40 N

C   196 N

D   339.47 N

Question 7

If the maximum static friction on the brick is 196 N, what is the coefficient of static friction for this surface?

A   0.87

B   0.58

C   0.5

D   0.12

Question 8

Give one word or phrase for the following:

a.)   the perpendicular force exerted by a surface on an object.

b.)   the force exerted by the earth on an object

c.)   the property of a surface that determines the amount of friction an object will experience whilst it moves on it.

Improve your Skills

Question 1

A 200 N force is applied on a 5 kg crate at an angle of 40^0 to the horizontal as shown. As the crate moves to the right it experiences a frictional force of 18 N.
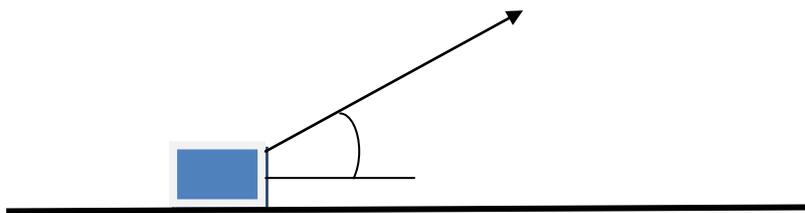
1.1 Draw a labelled free body diagram showing all the forces acting on the crate whilst on motion.

1.2 Calculate the horizontal component of the force.

1.3 What is the magnitude and direction of the resultant force acting on the crate?
1.4 Find the coefficient of kinetic friction of the surface.

Question 2

Thabo pulls a 10 kg block on a rough incline at 30^0 to the horizontal using a force of 280 N. The force friction between the block and the surface is 48 N.

2.1 Draw a labelled free body diagram showing all the forces acting on the block.
2.2 Calculate the
2.2.1   Resultant force acting on the block.
2.2.2   Normal force exerted on the block by the surface.