HUGK12 Activity

TITLE:

How can friction be reduced?

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DCPS STANDARDS:

8.1.7

Use tables, charts, and graphs in making arguments and claims in presentations about lab work.

8.1.8

Read analog and digital meters on instruments used to make direct measurements of length, volume, weight, elapsed time, rates, or temperatures, and choose appropriate units. Explain how to interpolate on analog scales.

8.7.1

Recognize that a force has both magnitude and direction.

8.7.2

Observe and explain that when the forces on an object are balanced (equal and opposite forces that add up to zero), the motion of the object does not change.

8.7.3

Explain why an unbalanced force acting on an object changes the object's speed or direction of motion or both.

GOALS:

Students will understand that friction is actually a force.

Students will learn that friction can be reduced in a measurable way.

OBJECTIVES:

Students will measure the amount of force necessary to start the motion of a box.

Students will measure the amount of force necessary to start the motion of the box with pencils under it.

PREREQUISITE KNOWLEDGE:
Newton's first law states that an object at rest will remain at rest and an object moving in a straight line at a constant speed will continue to move in a straight line at a constant speed unless acted on by an outside force. In equation form, this is written as
$\Sigma F = 0$.

Newton's second law states that the acceleration of an object is proportional to the total force on an object with the mass of the object serving as the factor of proportionality between the acceleration and the net force. (1)

In equation form this is stated as
$\Sigma F = ma$.

"Mass is that property of an object that causes it to resist any change in its velocity." (2)

Forces are exerted when an object is in contact with another object. Theses forces are actually electromagnetic forces in the atoms making up an object and keep one object spatially separate from another object. These are called contact forces. The contact force of an object 1 with a flat surface that is touching the flat surface of a 2nd object can be resolved into two components. These are the component of the force of object 1 on object 2 that is perpendicular to its point of contact with object 2 (the normal force) and the component of the force of object 1 on object 2 that is parallel to the point of contact with object 2 (the frictional force).

Consider an object at rest on a surface. The force of gravity is acting on the object towards the center of the earth, but it is not moving in this (vertical direction). Hence, there must be a force of equal magnitude to the gravitational force but in the opposite direction of the gravitational force. This is the normal force exerted by the surface.

When a force is exerted on the object and it is moving parallel to the surface, a contact force parallel to the surface resists the applied force on the object. This is called the frictional force. The frictional force reduces or even eliminates the acceleration of the object in the direction of the applied force. The frictional force is proportional to the normal force and is thus proportional to the mass of the object.

ESSENTIAL QUESTIONS:

1) Is friction an actual force?
2) How can friction be measured?
3) How can friction be reduced?

LABORATORY MATERIALS:

1) String

2) Hole puncher
3) Small sturdy boxes that are open at the top
4) Books (to serve as weights)
5) Balance
6) Spring scales

DIFFERENTIATING INSTRUCTION:

None is necessary.

RATIONALE:

The frictional force is applicable whenever one is analyzing the motion of any two objects in contact with each other.

RESEARCH ACTIVITY:

A.

1) Use the hole puncher to make a hole in the box.
2) Attach a piece of string to the hole.
3) Add several books to the box.
4) Weigh the box with books on the balance.
5) Attach the spring scale to the string.
6) Put the box containing the books on a table.
7) Pull the spring scale and string exactly parallel to the floor.
8) Determine how much force is needed to start motion in the box.

B.

1) Now, place four pencils (or some other number which will remain fixed for different trials) under the box containing the same books.
2) Again, pull the spring scale and string exactly parallel to the floor.
3) Determine how much force is needed to start motion in the box.

C.

Run several trials of the experiment using about five different weights.

EVALUATION AND ASSESSMENT:

Have students prepare a table with the mass of the box, the force necessary to move the box without pencils, and the force necessary to move the box with pencils.

Have students graph force vs. mass for no pencils and force vs. mass with pencils on the same chart.

Have students to describe the relationship between the mass of the books and the force necessary to move them.

Ask students how much frictional force was exerted by the table.

Explain to the students that at the precise point at which the box started to move, the applied force was just enough to overcome the frictional force. Before the box started to move, applied force was equal to frictional force and Newton's first law was applicable.

NOTES:

1. Keller, Frederick J., Gettys, W. Edward, Skove, Malcolm J. Physics. New York: McGraw-Hill Inc., 1993.
2. Ibid, p. 95.

ADDITIONAL REFERENCES:

UNESCO. 700 Science Experiments for Everyone. New York: Doubleday, 1962.