Energy and the Physical Setting

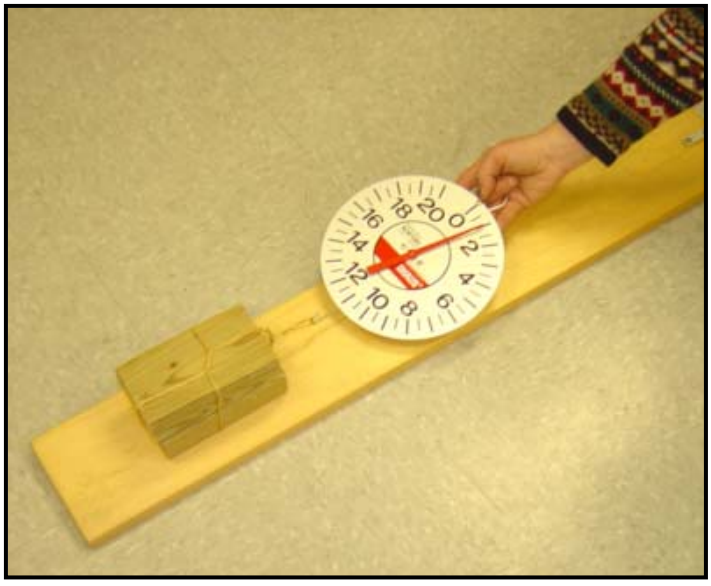
Simple Machines, Part 4:
Friction, Work, and Energy in the Inclined Plane

We've been looking at forces involved with simple machines. Last week we left you with these questions:

What about **friction** in the inclined plane?
Does the friction increase or decrease as the angle of incline increases?

Friction in inclined planes

Friction is an important factor in inclined planes. If you lift an object upward through the air without an inclined plane, there is a little bit of friction between the object and the air. The friction force is, however, very small. The friction force is greater if the object is in contact with the board. How much is that force? You got part of the answer to that question last week during the force investigation. The force you measure to just set the block in motion when the board is flat is the force of friction between the block and the board.



BUT, the force of friction between the block and the board changes with the angle of inclination. Does the force of friction increase or decrease? This is a challenging question. We'll try to help you think through answer here, but it may be too difficult for your students to understand.

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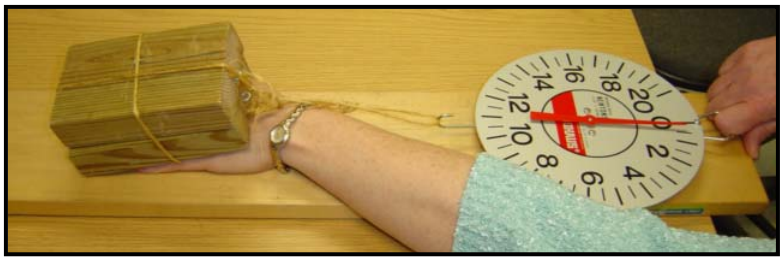
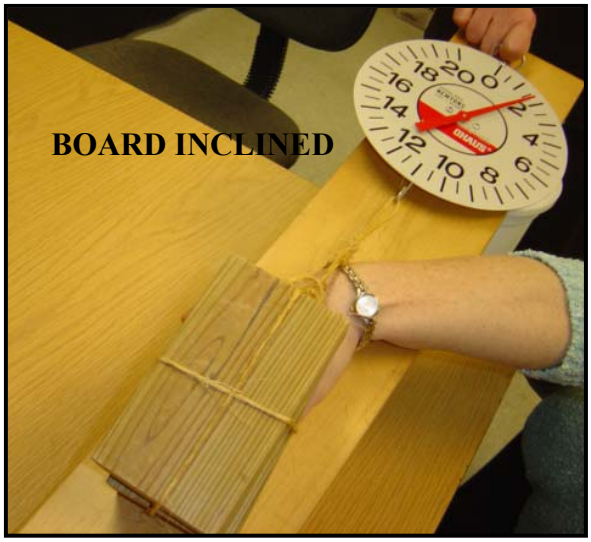
Imagine that your hand is between the block and the board. As the board is inclined, what happens to the push of the block on your hand? Think about the extreme cases first. When the board is flat, what is force of the block on your hand? When the board is straight up and down what is the force of the block on your hand? When the board is straight up, there is no force.





Remember your hand is between the block and the board. In fact, the push of the block on your hand and on the board decreases as the angle of incline increases. Because the force of friction depends on the force the block is exerting on the board, the force of friction decreases as the incline increases.

Work and the inclined plane

Whether the block is lifted to the tabletop or slid to the top of the table, the work done **on** the block is the same. However, the work you do to lift the block is greater when the inclined plane is used. Why? It's the friction. When you use an inclined plane, some of the work you do is work to overcome friction.

Wait! What about energy input and output?

Because of friction, it takes more of your energy to slide the block up the incline than if you just lifted it up. However, if the block is too heavy for you to lift, that added energy is worth the cost of the heat you generated because of the friction force between the block and the board.

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Coming up

Next week we will think about two familiar simple machines: the wedge and the screw, so we leave you with this question:

> The **wedge** and the **screw** are members of the inclined plane family.
>
> True or False? Explain your answer.

If you're not sure, check the following websites out:

- **http://teacher.scholastic.com/dirtrep/simple/wedge.htm**
- **http://teacher.scholastic.com/dirtrep/simple/screw.htm**

What do the NYS standards say?

In the Elementary Core Curriculum, Standard 4, The Physical Setting, one Major Understanding states:

- 5.1f Mechanic al energy may cause change in motion through the application of force and through the use of simple machines such as pulleys, levers and inclined planes.

In the Intermediate Core Curriculum, Standard 4, The Physical Setting, Major Understandings state:

- 5.2f Machines can change the direction or amount of force, or the distance or speed of force required to do work.

- 5.2g Simple machines include a lever, a pulley, a wheel and axle, and an inclined plane. A complex machine uses a combination of interacting simple machines, e.g., a bicycle.

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