Energy and the Physical Setting

Simple Machines, Part 3: Inclined Plane 1

In the past few weeks we looked at trade-off and the benefits and costs of using simple machines. Last week we left you with this question:

> We see ramps that access many buildings; these are common and obvious examples of **inclined planes**.
>
> What are some other examples of **inclined planes** that you come across regularly?

What is the inclined plane family?

An **inclined plane** is the simplest of the simple machines; there are no moving parts. Basically, a plane is a flat surface, and if it's inclined, one end of it is raised; think of a ramp. Other examples include a sloped road or driveway, a path up a hill, and the up or down sections of a roller coaster.

Advantages to using inclined plane

How does an **inclined plane** make a job seem easier? The following investigation addresses this…

Force: An investigation

For this investigation we'll need:

- A board
- A heavy block
- A rope
- A spring scale

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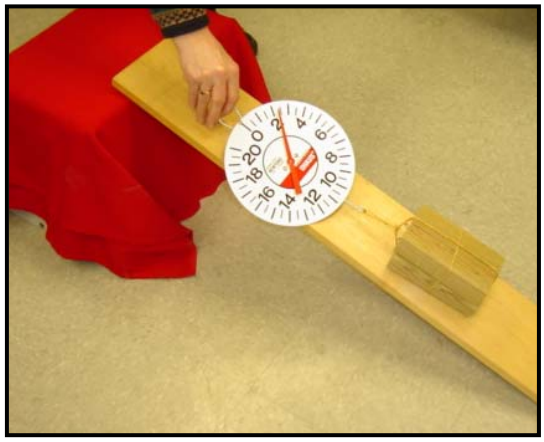
First we:

1. Attach the spring scale to the block, then pull straight up by the rope (just enough to lift the block).
2. How much force just sets the block in motion?
   - **5 Newtons**

Then we:

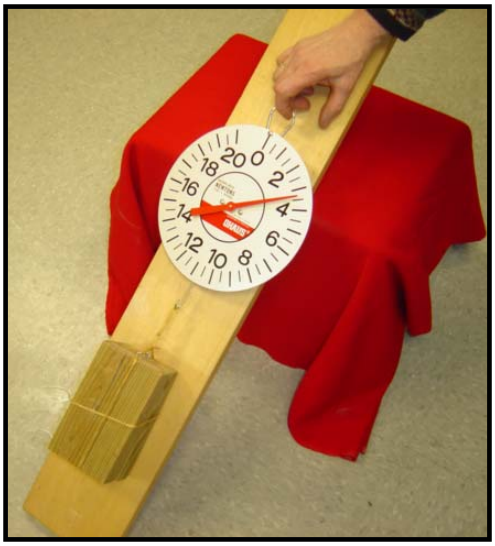
1. Place the block at the bottom of the board.
2. Attach the spring scale to the block and pull it along the incline so that it is just set into motion.
3. How much force just sets the block in motion?
   - **2 Newtons**

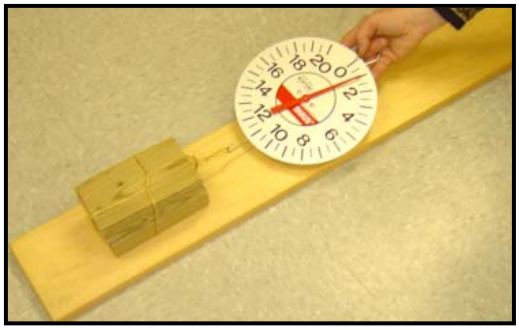


Force to lift blocks = 5 Newtons
Force to slide blocks up the incline = 2 Newtons

It takes less force to slide the blocks along the incline than to lift them straight up. But you must exert the smaller force through a larger distance to get them to the top of the table.

What do you predict?





1. Suppose you make the incline steeper, that is, make the angle of incline greater. How will that change the force you must exert to move the block along the incline?
2. Now suppose you make the incline less steep, that is, lay the board flat on the floor. How will that change the force you must exert to move the block along the board?

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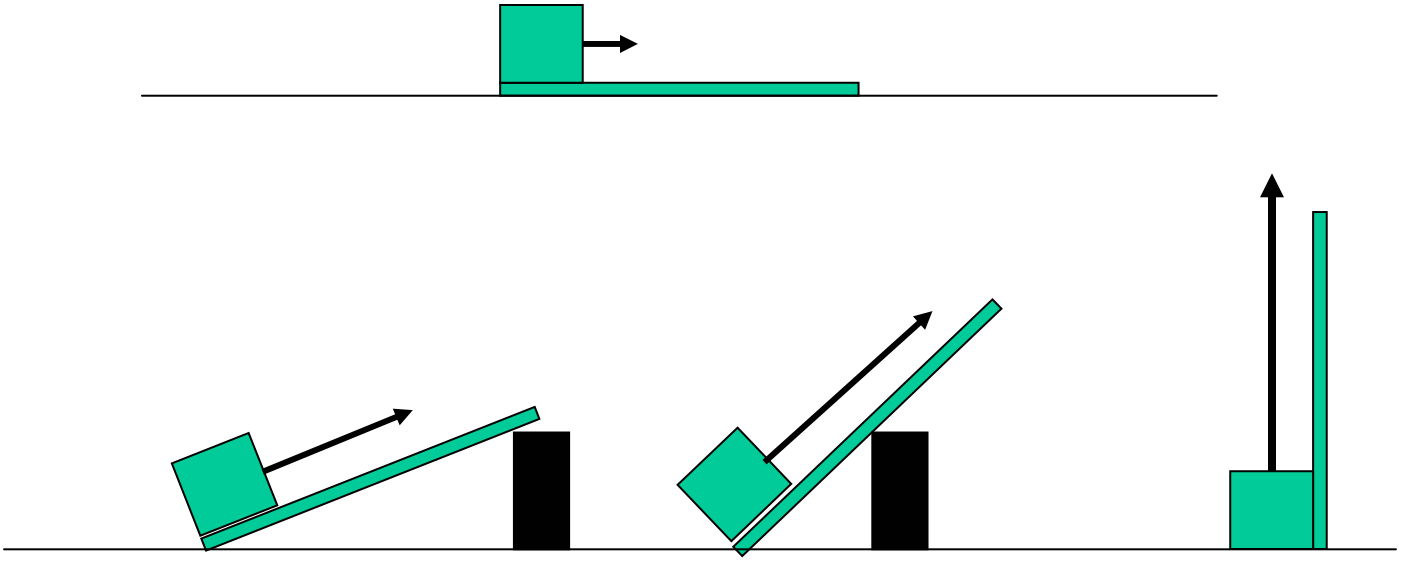
The demonstrations show that as the angle of incline increases, the force required to move the blocks at constant speed increases, also.



As the angle of incline increases, the force to move the block upward at a constant speed increases.

Distance: A thought investigation

So, you want to get the block to the top of the table. You know that you need to exert a smaller force to push or pull the blocks up the incline when the angle of incline is smaller. But what is the trade-off?

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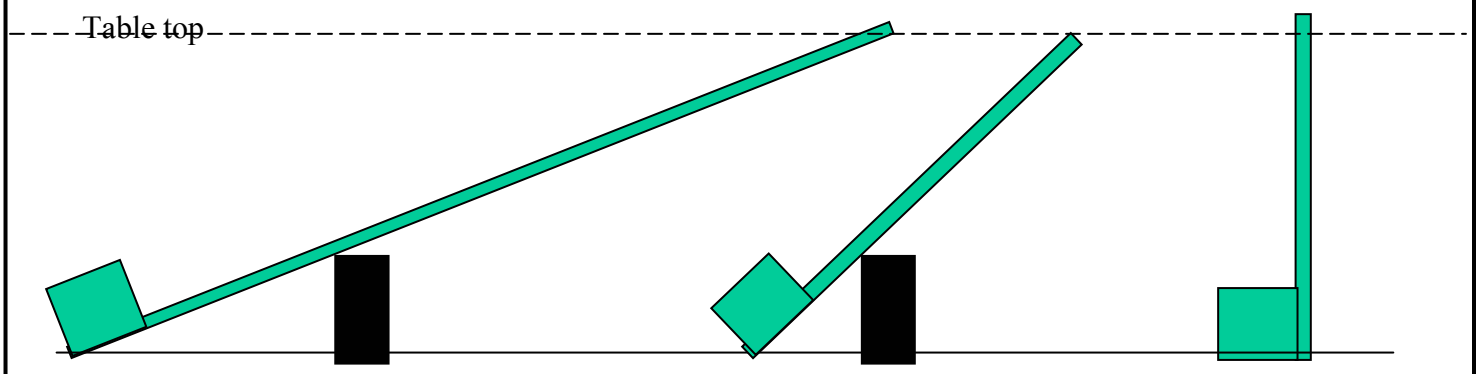

As the angle of incline increases, the distance to move the block to the top of the table decreases.

The diagram above illustrates that you must exert the greatest force to lift the block to the table top when the angle in incline is the greatest. However, the distance through which you exert the force is the shortest.

Coming up:

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

What do the NYS standards say?

Elementary Core Curriculum, Standard 4, The Physical Setting,

Major Understanding states:

- 5.1f Mechanical 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.

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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