

### Goals

1. To learn about friction.
2. To practice calculations.

### Equipment:

Notebook (draw diagrams directly inside)

### Static Friction

1. At one point, Asa's friend Josh tries to move his brick collection. Estimate the mass of the box of bricks. List any sources that helped with your estimate.
2. Since it took two people to move the box, it makes sense that a single person can push with a force half of that. When one person is pushing on the box, what is the force of static friction acting on the box?
3. What happens to the force of static friction when you push harder on the box (before it starts to move)?

### Calculating Friction

The force of friction depends upon the mass of the object and on the type of surface it is moving on. To quantify how "easy" it is to slide things, we use the term "coefficient of friction" which is represented by the lowercase Greek letter mu,  $\mu$ . To calculate the force of friction, we use  $F = \mu N$ , where  $N$  is the apparent weight of the object (how hard it is pushing on the ground, it pushes less if the ground is tilted or if something is pulling it upward).

4. In the movie, we see Asa sitting stationary on a dry water slide. The slope at that point appears to be about  $45^\circ$ . At this slope, Asa's apparent weight ( $N$ ) is about 70% of his actual weight. Estimate  $N$ .
5. If there was no friction, what would happen to Asa?
6. But, in the movie, he just sits there, so there must be zero total force acting on him. What is the force that is counteracting gravity? Calculate the strength of this force. Note that because of the slope, Asa doesn't feel the full force of gravity pulling him along the slide, instead he feels about 70% of it.
7. If we increase the slope to  $60^\circ$ , the force of gravity he feels is 86% of normal and his apparent weight is half of normal. At this slope, static friction fails and he begins to move. Calculate the coefficient of static friction for the surface Asa sits on.

### Kinetic Friction

8. Why is it easier to push a couch on a rug rather than on concrete? What does this say about the coefficient of static friction of each?

### Rides

- Golden Horseshoe, Railroad, Big Thunder Mountain Railroad