Virtual Learning

Physics

Newton's Laws of Motion Sim Part IV

April 24, 2020

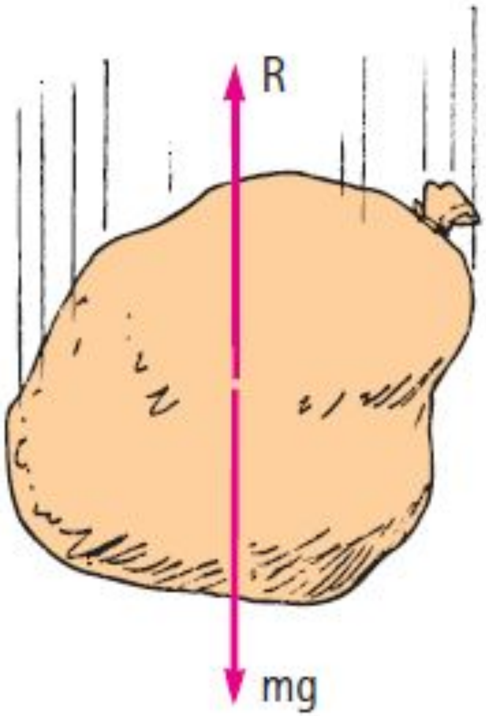
Physics

Newton's Laws of Motion Sim Part IV: April 24,2020

Objective/Learning Target:

Students will use a computer simulation to examine Newton's Laws of Motion and Friction.

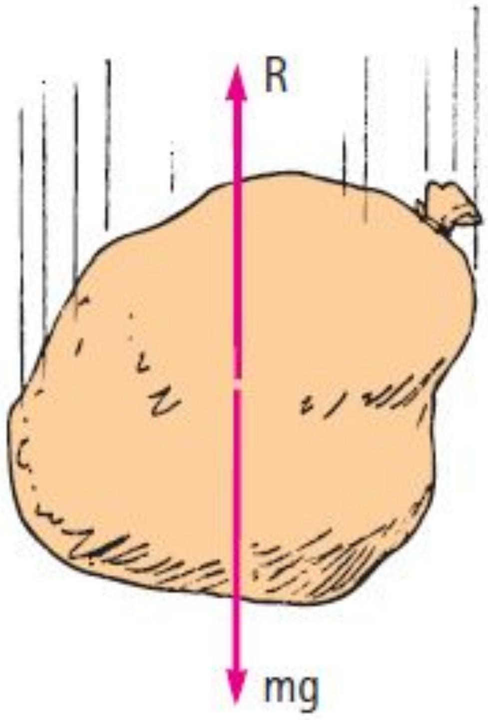
Quick Review #1



When the force due to gravity mg is greater than the air resistance R, the falling sack of mail accelerates. As speed increases, R increases as the bag collides with more and more air particles.

Describe what happens to the bag when mg = R.

Quick Review #1 Answer



When R = mg, the acceleration reaches zero, and the sack reaches its terminal velocity.

Quick Review #2

Nancy Nofear skydives from a high-flying helicopter. As she falls faster and faster through the air, does her acceleration increase, decrease, or remain the same? Explain using Newton's Laws.

Quick Review #2 Answer

Acceleration decreases because the net force on Nancy decreases. Net force is equal to the force of gravity minus the air resistance on her, and since air resistance increases with increasing speed, net force and, hence, acceleration decrease. By Newton's second law,

$$a = \frac{F_{net}}{m} = \frac{mg - R}{m}$$

where mg is the force of gravity and R is the air resistance she encounters. As R increases, acceleration decreases. Note that if Nancy falls fast enough so that R = mg, a = 0, then with no acceleration she falls at constant speed.

Newton's Laws of Motion

Introduction

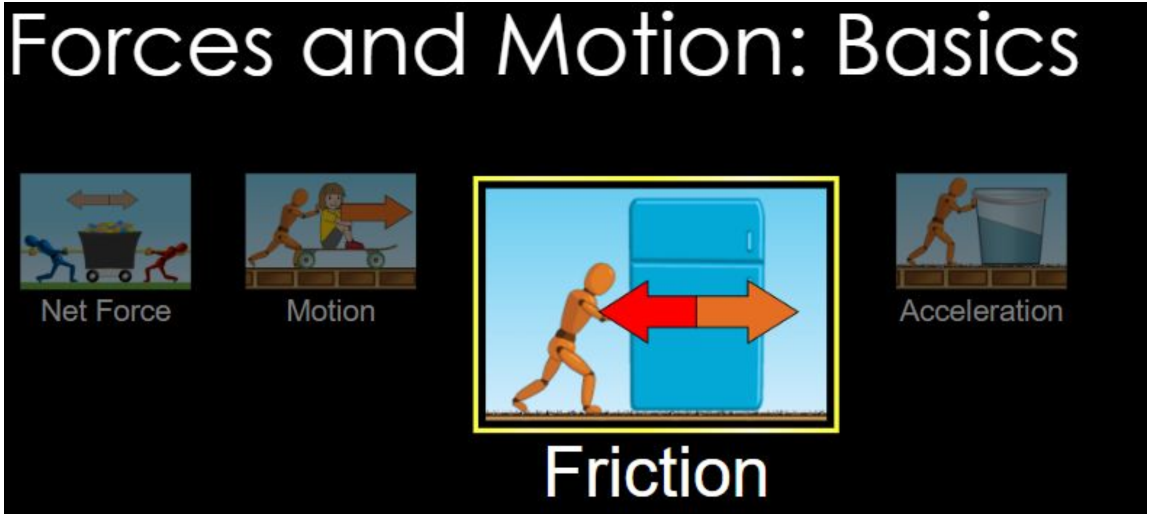
You will use a computer simulation today to reinforce your ideas of Newton's Laws of Motion. Since this is "inquiry based", you're not supposed to know everything going in, but learn as we walk through the lesson. **You must read the following slides carefully.** Let's get started!

Newton's Laws of Motion with Friction II

Website:[Force and Motion Computer Simulation]

Make sure to use the HTML5 version.

Select the Friction icon and double click to start.



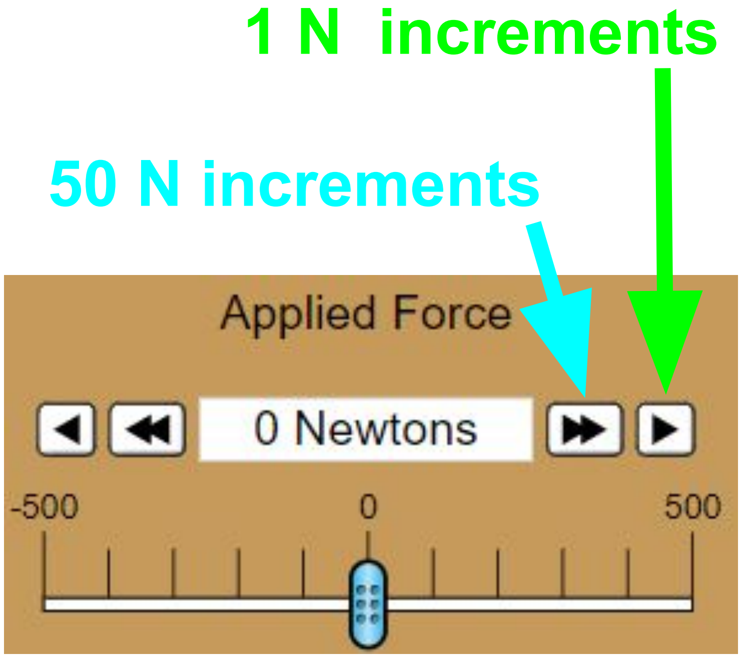
Newton’s Laws of Motion with Friction II

Remember to press Pause before setting your parameters!

Newton's Laws of Motion with Friction II

1. **Reset the app. Check the force and speed box. Apply 50 N of force to the crate. Slowly click (in 50 N increments) to increase the amount of applied force until the crate starts to move/accelerate. Note the range of force values when the crate first started to move.**

   Record this range. (e.g. starts moving somewhere between 0 and 50 N).



Newton’s Laws of Motion with Friction II

2. **Reset the app. Repeat the steps in “a”. Once you have just made the crate move do not adjust the force any higher. Allow the block to move with this constant force for 2.0 seconds. Now reduce the force by 50 N.**

   a. **How does the crate behave immediately after reducing the force by 50 N?**

   b. **Did it keep accelerating? Move at a constant speed or decelerate?**

   c. **Does this behaviour surprise you based on your knowledge of Newton’s 1st and 2nd Law.**

   d. **Why do you think the crate behaves this way?**

Newton’s Laws of Motion with Friction II

3. **Reset the app. Check the speed, force, sum of forces and values boxes. Adjust the value of the applied force using single Newton increments to determine the exact force required to make the crate move.**

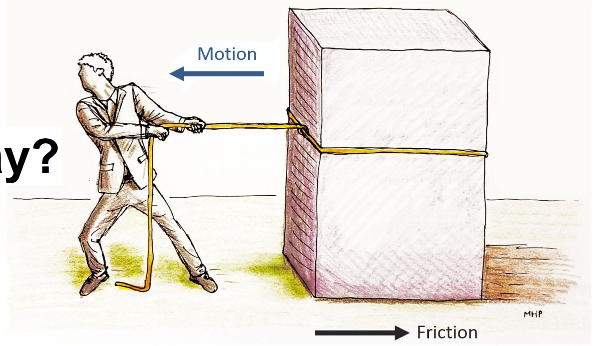
    a. **What is the value of this force?**

    b. **What happened to the friction force at this point?**

Now keep increasing the value of the applied force in small single Newton increments.

    c. **What happens to the value of the friction?**

    d. **Why does the friction force behave this way?**



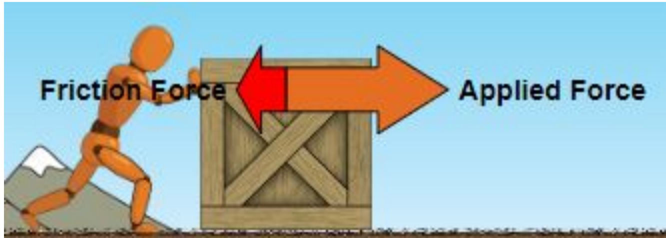
Newton's Laws of Motion with Friction II

4. Repeat step 3 and after the block has accelerated for 3.0 seconds reduce the applied force by 1 N increments until the applied force equals the friction force.

   a. What amount of force is needed to exactly balance the friction force?
   b. What is happening to the motion of the crate when these forces are balanced?

   Adjust the applied force to 0 N.

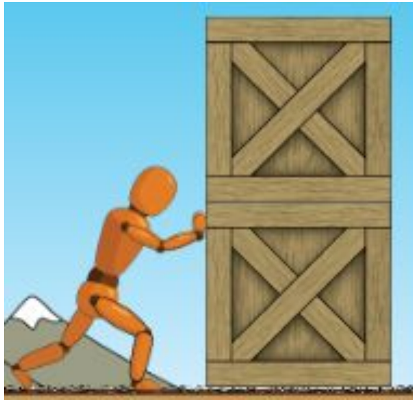
   c. What happens to the size of the friction force?
   d. How does the crate behave?



Newton's Laws of Motion with Friction II

5. Reset the app. Check the forces, values and speed boxes. Place another crate on top of the first.

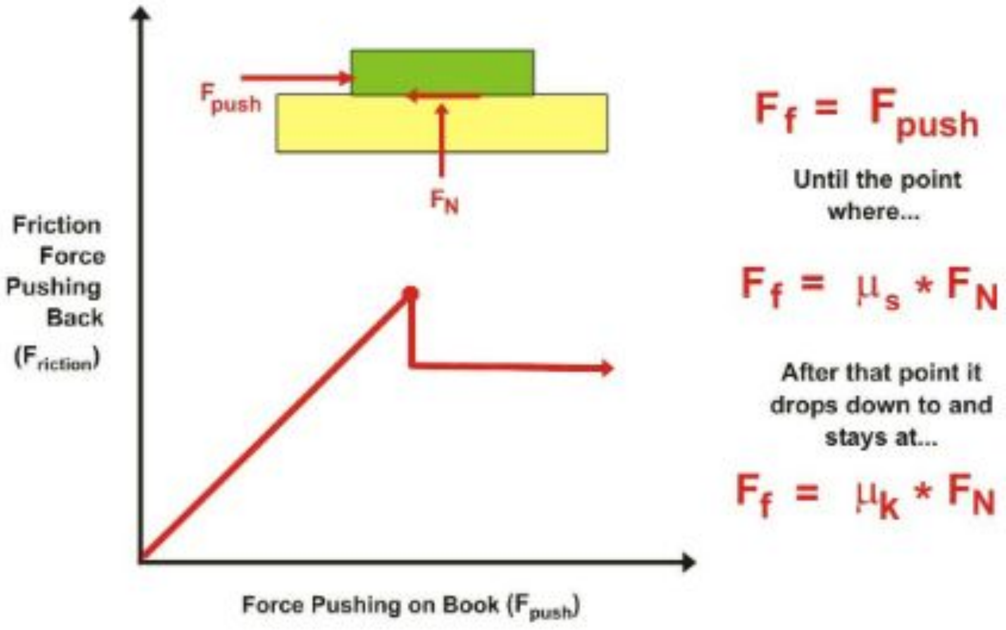
- **a. What is the minimum amount of force required to move the crates.**
- **b. What is the minimum amount of force required to keep the crates moving at a constant speed.**
- **c. How do these values compare to the values found for one crate?**
- **d. What does this tell you about the affect of mass on friction?**



Newton's Laws of Motion with Friction II

6

Discuss 4 things about friction that were observed in this investigation.



Newton’s Laws of Motion with Friction II Answers

1. Started to move between 100-150N
2.
   a. The crate keeps moving.
   b. The crate moves with a much slower acceleration.
   c. Although the force was reduced there was still an unbalanced force in the direction of motion. The smaller net force accelerates the crate in the same direction as before but with a lot less magnitude..
   d. The crate is following the Laws of Physics as stated in 2c.
3.
   a. 126N
   b. The friction force changed from 126N to 94N.
   c. The force of friction remains 94 N as long as the crate is moving.
   d. The crate and ground had a certain amount of static friction which was larger than the sliding friction. Once the crate was moving the friction was the same regardless of the velocity of the crate.

Newton's Laws of Motion with Friction II Answers

4.

a. It takes 94 N of applied force to balance the friction force exactly.
b. When the forces are balanced the crate is in equilibrium and continues at a constant velocity as per Newton's 1st Law of Motion.
c. The friction force remains unchanged at 94 N.
d. The crate now having a net force in the opposite direction begins to slow and eventually stops

5.

a. It took 251 N to get the crates to move.
b. 188 N would balance the friction of the sliding crates.
c. These forces are twice what it was for just one crate
d. So friction is directly proportional to the mass of the objects.

6. 1-friction always acts in the opposite direction of the applied force.
2-When friction is equal to the applied force the object is in equilibrium and travels at a constant velocity.
3- Friction will cause things to slow to a stop if there is not enough applied force.
4- Static friction is larger than sliding friction

Additional Practice

Follow the link below for additional interactive opportunities to further your experiences.

[Force Interactives]