Course and Section_____ Names _____

Date_____ _____

NEWTON LAWS SIMULATION

Introduction

In this simulation you will study the notion of inertia, how a force effects the acceleration of an object and the action reaction pairs of forces.

Newton's 2nd law of motion states that if a net force *F* acts on an object, then the object accelerates. Its acceleration is linearly proportional to the net force applied.

$$\vec{a} = \frac{1}{m}\vec{F} \qquad \text{or} \qquad \vec{F} = m\vec{a}$$

The proportionality constant *m* is the inertia of the object and its numerical value is called the mass.

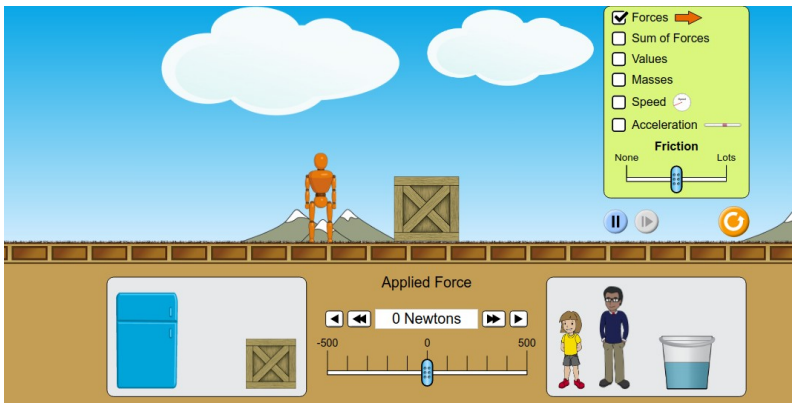
Submit your answers using Blackboard.

1 – Preliminary Questions

1. What does a force 1 N corresponds to?
2. Which Newton's laws of motion gives a quantitative definition of force?
3. What is Newton's 2nd law?

2 – Force, Mass, Acceleration

Open the simulation (https://phet.colorado.edu/en/simulation/forces-and-motion-basics) and select *Acceleration.*



Select *Acceleration.* Set the *Friction* to None (and make sure re-set it to zero for each run). Click and drag the person toward the wooden box to apply a force on it. You can select to display a physical quantity using the table on the top right corner. Answer the following questions

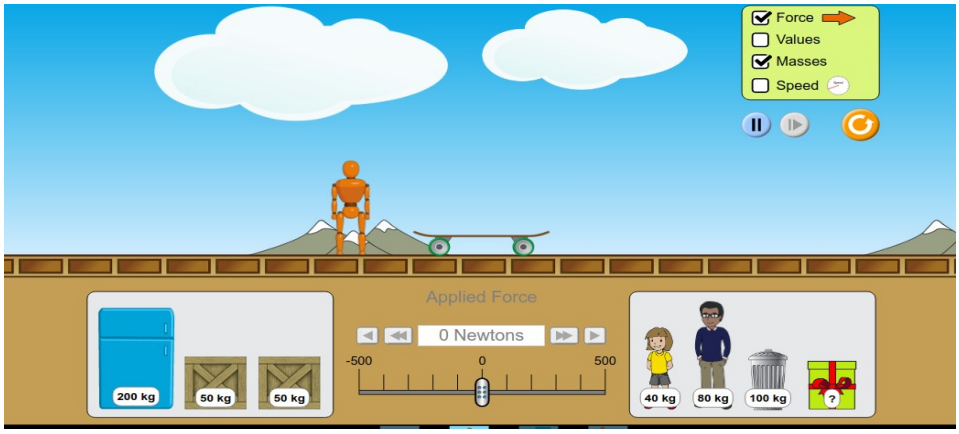
4. As you apply a constant force, what happens to the speed?
5. Now to maintain a constant speed what should you do?
6. When you decrease the applied force what happens to acceleration?

Set the applied force to a fix value.

7. Take 50 kg mass and note the value of acceleration. Now, double the mass by adding a second wooden box on top, what happens to acceleration?
8. Take 200 kg mass and note the acceleration. Now decrease the mass by factor of two, what happens to acceleration.
9. From the above-mentioned simulation state the relationship between mass and acceleration for constant applied force.
10. With the friction set to zero, does the object need a force for it to move at constant speed?

3 – Mystery Mass

Use the same simulation but now select *Motion*.



There is no friction and your goal is to find mass of the yellow present with the red ribbon. The value of the acceleration is not given so you'll have to find another way to estimate the acceleration. Hint: you can use the kinematic equations and take measurements of time intervals with a stopwatch (your phone for example).

11. What is the mass of the present?

4 – Data Analysis

An experiment is conducted by using a force sensor and cart system. Different forces are applied on a cart and the accelerations are measured as shown in table below.

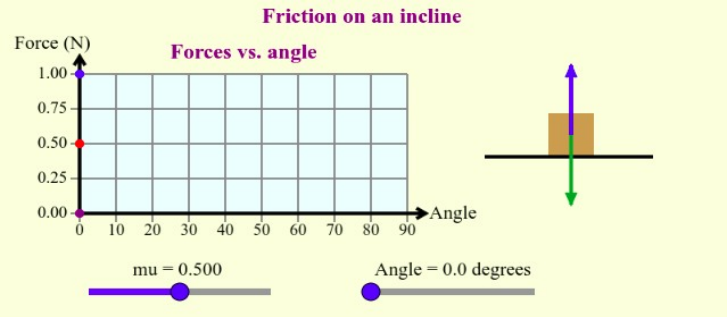
Force (N)	9.6	14.8	20.0	24.5	33.6	35.6	43.0	49.7
Acceleration (m/s^2)	2	3	4	5	6	7	8	9

Make a plot of force vs acceleration (do not set the 0 intercept).

12. Is the graph quadratic?
13. What physical quantity does the slope represent?
14. What is the value of slope?

5 – Free body diagram on inclined plane

Open the simulation (http://physics.bu.edu/~duffy/HTML5/friction_on_ramp.html)



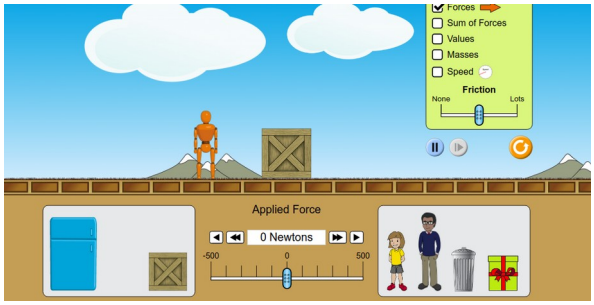
Set *mu* = 0.00 (there is no friction.) and Angle of the incline = 0.0 degrees.
15. In the free body diagram, the normal force is represented by which arrow?
16. In the free body diagram, the weight force is represented by which arrow?
The magnitude of the normal force is 1N (blue dot on the Force y-axis).
17. What is the weight of the block?
18. What is the mass of the block?

Set the Angle = 25 degrees and assume a coordinate system for the free body diagram such that the red line is the x-axis.
19. In the free body diagram, the normal force is represented by which arrow?
20. In the free body diagram, the component of the weight along the y-axis is represented by which arrow?
21. In the free body diagram, the component of the weight along the x-axis is represented by which arrow?
22. Calculate the magnitude of the normal force. (N) Use the Force diagram to check
23. Calculate the sum of the forces in x-direction. (N)
24. Will the block move in the x-direction? If so what is its acceleration?

25. What happens to the magnitude of normal as you decrease the angle of inclination?
26. What happens to the magnitude of violet force as you increase the angle of inclination?
27. For which angle are the normal and the violet force equal?

6 – Action/Reaction pairs

Open the simulation (https://phet.colorado.edu/en/simulation/forces-and-motion-basics) and select *Friction.*



You will study the force of friction more in details in the next online simulation, right now we are not interested on its quantitative aspects, just how the friction relates to the other forces.
Apply a force of 50 N

28. Does the box move?
29. Which force corresponds to the reaction of the horizontal normal force acting on the person?
30. Which force corresponds to the reaction of the vertical normal force acting on the ground?
31. Which force corresponds to the reaction of the friction acting on the ground from the box?