Title: Mass on an Inclined Plane

Purpose:

- to practice using an online Physics simulation
- to investigate factors associated with mass, velocity, and friction

Procedure:

- open Physics Exploration
- go to Motion, Mass on an Inclined Plane
- explore how the simulation works for about 10 minutes
- develop a hypothesis
- LIST/DESCRIBE YOUR SETTINGS
- PRINT OUT SAMPLE RESULTS/GRAPHS

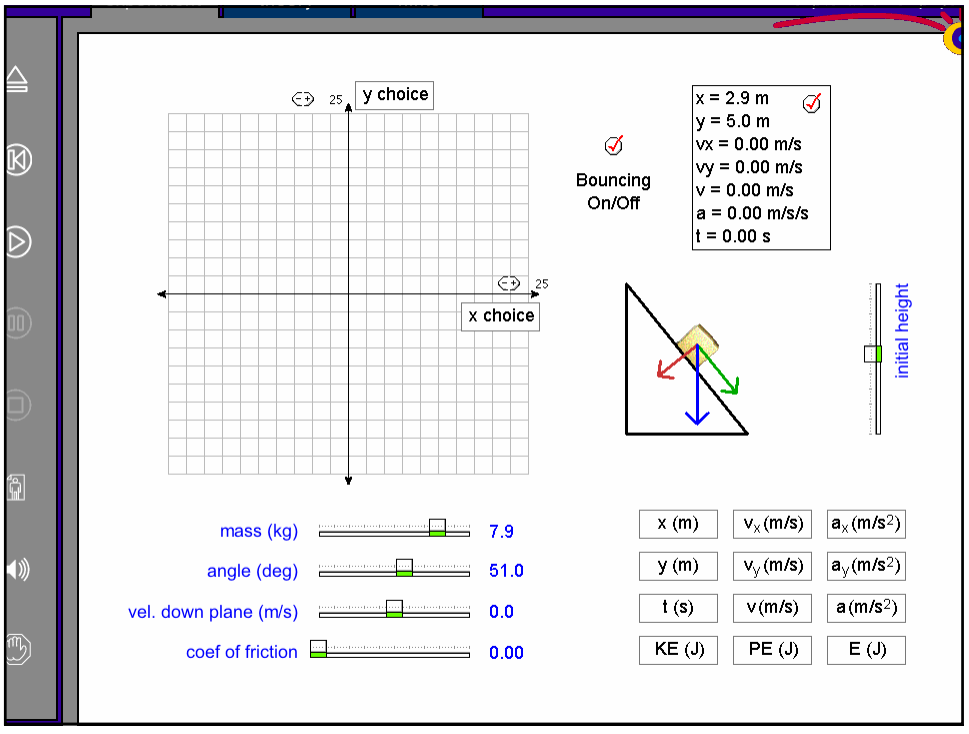
Discussion:

- Follow lab write-up guidelines

Conclusion:

- testable statement

Reflection: (personal statement)



The motion along an inclined plane will obey Newton's laws. The diagram shows the normal force, the gravitational force.

The block will not move off the plane, so for analysis the axes are often chosen as shown[1]. The x and y components of the forces are determined from trigonometry which leads to

$$N = mg\cos\theta$$
$$a_x = g\sin\theta$$

where m is the mass of the object, and g is the gravitational acceleration, a_x is the acceleration along the surface of the plane, and N is the normal force.

If a frictional force is present, it will always try to oppose the direction of motion. The magnitude of the frictional force is given by $F_f = \mu N$, where μ is the coefficient of friction. The acceleration of the object then becomes

$$a_x = g\sin\theta - \mu g\cos\theta$$

when the object is sliding down the plane, and

$$a_x = g\sin\theta + \mu g\cos\theta$$

as the block slides up the plane.

[1] In this simulation, the a_x and a_y values are from the classical x and y axes as shown below.

User Interface and Simulation Features.

The graph can be customized to plot the quantities of your choice. From the collection of variables at the lower right corner of the screen, click and drag the variable you wish to plot and drop it on the axis of the graph. Do this for both the x-axis and y-axis. The scale for the x-axis and y-axis can be adjusted using the controls near each axis.

The vectors shown on the block consist of the weight (shown in blue), the component of weight which is normal to the surface (dark red), and the component of weight acting along the surface of the plane (green). If the coefficient of friction is greater than zero a frictional vector is shown (bright red).

An inclined plane with a block.

Although the inclined plane looks like a simple device, an extremely large amount of physics can be studied with a plane and a block. This simulation allows you to plot a wide array of variables on a graph while exploring many concepts including friction, potential energy, kinetic energy, velocity, acceleration, etc.

Sliding down a plane.

With no friction, measure the time required for the block to reach the bottom of the plane. Increase the mass of the block. Does that change the time required to reach the bottom of the plane? Try this at several different angles. Can you predict what the plot of Kinetic Energy vs. Time will look like? What about V_x vs. Potential Energy?

Frictional forces.

Select a large coefficient of friction, with an initial velocity of zero. Vary the angle of the plane. Is there a certain angle required for the object to slide down the plane? Does the angle depend on the mass of the object, or the coefficient of friction? Can you choose an initial velocity for the block such that it will stop at a certain height?