2015

Friction iPad Lab (Prelab)

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Recommended Citation

Friction iPad Lab

Prelab Sheet

In this lab, you will take and analyze video of block as it slides along an aluminum track. The goal is to indirectly measure the coefficient of kinetic friction between the block and the track.

Example 1: Block on horizontal surface In the first part of the lab, you give a block a quick shove on a horizontal surface and watch it slow down as it travels.

1. Draw a diagram that shows all the forces that are acting on the block once it loses contact with your hand (but before the block comes to a stop). Label all the forces.

2. In the lab, you will use the video to determine the acceleration of the block. Suppose you find that the block slows down at a rate of $2 \ m/s^2$. What is the value of μ_k for this situation?

3. Suppose mass of the block were doubled (but no other change was made) and the experiment repeated. What would be acceleration of the block be now? Explain briefly.

Example 2: Block sliding up an incline In the second part of this lab, you will give a block a quick shove up an incline and watch it slow down as it goes up.

4. Is the normal force numerically equal to the gravity force for the block sliding up the incline? Explain briefly.

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Instructions

Block on Horizontal Surface

In this part of the lab, you will make and analyze a video of a block traveling along a horizontal surface.

1. Make the video of the motion using Vernier's Video Physics app on the iPad. Some suggestions for making video that's easy to analyze follow. Make sure that

    - the cart shows up well against the background
    - the iPad camera is stationary
    - the iPad is held parallel to the track
    - the cart's motion fills a majority of the screen (use landscape orientation for the iPad).
    - there is a meter stick in the picture just in front of the motion (this will be your reference object)

2. Use Video Physics to your video. Check to make sure it's good enough for analysis. Is the object clear (not blurry)? Is there a spot on the object that's easy to mark? Does the motion fill most of the screen? Is the action all in a plane that's parallel to the iPad? If your video isn't good, now's the time to reshoot it.

3. Once you think your video is good enough, track/mark the motion of the object using Video Physics. Adjust the axes so that the motion of the object is along the x-axis. Use the software to mark the length of your reference object (the meter stick). Check your graphs in Video Physics to make sure that y-velocity and y-acceleration are both zero throughout the motion. (If not, adjust your axes slightly and recheck).

4. Analyze the motion using Vernier's Graphical Analysis app on the iPad. Only consider the part of the motion where the block is moving freely- that is, from just after the block is released until just before it stops. In the space below, record the block's acceleration and briefly describe how you found it:

    > Acceleration = _____
    >
    > Describe how you found the value:

5. Analyze this data to find the coefficient of kinetic friction between the block and the surface. Record your work and answer in the space below:

Show your work here:

$\mu_k =$

Block on horizontal surface with much more mass

In this part of the lab, you will analyze what happens if you repeat the experiment above, but with more mass.

6. Record the mass of the block and the additional mass you will you in the space below:

Record the mass of the block here:

Record the additional mass you will use here:

7. Make a ***numerical prediction***. How quickly will the block slow down with the additional mass? Show your work and your prediction in the space below:

Show your work here:

$a =$

8. Make a video to test your prediction. Based on your measurements, does the mass significantly affect the acceleration of the block?
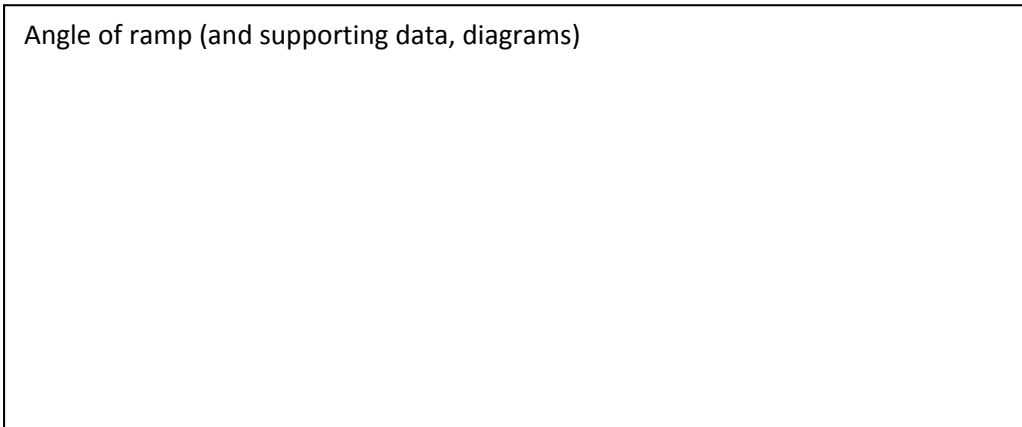
Block sliding up an incline

In this part of the lab, you will make and analyze a movie of the block as it slides to a stop while going up an incline.

9. Set up your incline. Record measurements for finding the angle the track makes with the horizontal.

> Angle of ramp (and supporting data, diagrams)

10. Make a video of the block slowing down as it travels up the incline. Give it a quick shove and allow it to come to a stop (just like you did for the other parts of the lab). Use Video Physics and Graphical Analysis to find out the acceleration of the block. Remember to check the quality of your video as you go. Record the acceleration value below:

> Acceleration = _____
>
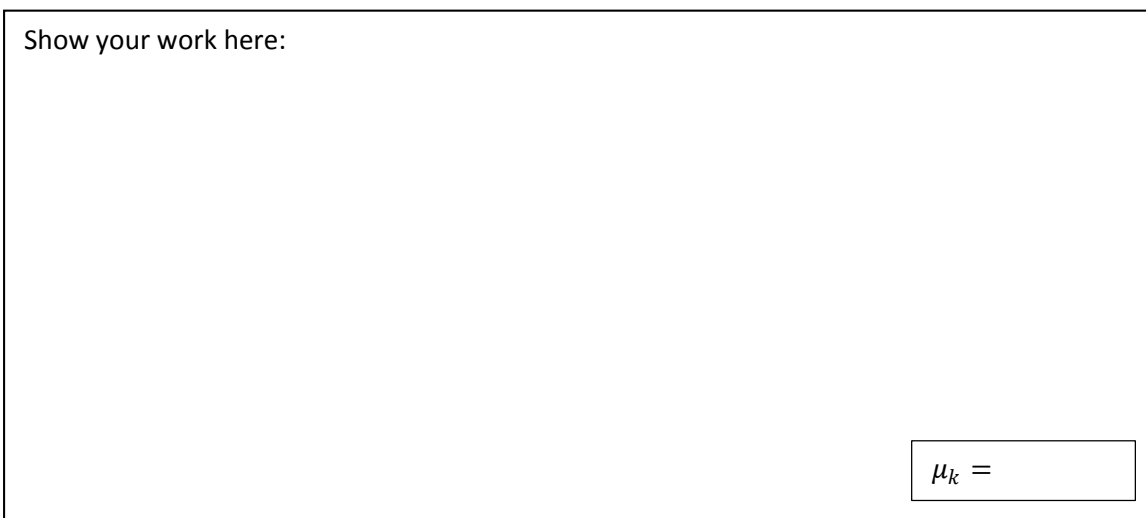> Describe how you found the value:

11. Use the value of acceleration above to calculate the coefficient of kinetic friction.

> Show your work here:
>
> $\mu_k =$

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12. Compare the coefficient of friction you just found with the μ_k value you found in part 1 (Block on Horizontal Surface). How similar are they?

13. Based on theory alone, should the two values be similar? Explain.

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Homework Sheet

A cardboard box containing books is given a quick shove along a horizontal floor. After it is released, the box slows to a stop at rate of 3.4 m/s^2.

1. Find the coefficient of kinetic friction between the floor and cardboard. Show your work.

2. In the same hallway, there is a ramp that makes a 10° angle with the horizontal. A different load of books in the same cardboard box is given a quick shove **down** the ramp.
   a. Find the acceleration of this box as it travels down the ramp.
   b. Is this box speeding up or slowing down? Explain how you can tell from your calculations.

3. In this hallway there is a second, steeper ramp. When the box filled with some books is given a quick shove down this ramp, the box maintains constant speed after it is released. What is the slope of the steeper ramp?