Physics Internal Assessment Notes:

11/20/15

NOTE: YOUR REPORT MUST BE SUBMITTED THROUGH TURNITIN.COM

PLAGIARISM WILL BE DETECTED! AND SEVERE CONSEQUENCES WILL RESULT!!

What is the coefficient of friction, µ, between a block and the lab floor?

**Personal Engagement :**

* Sports footwear
* Bicycle and car tires
* Reducing the coefficient of friction in machinery (car engines)

**Exploration (Physics background and analysis)**

* State clear question – What is the coefficient of friction, µ, between a block and the lab floor?

The mass of the block will be varied , and the force required to pull the object at a fixed, constant velocity will be measured. Graph the mass versus the applied force. The slope will be µg (see physics analysis below). Therefore, the slope can be used to determine µ.

* Include chart with
  + dependent variable – (this is the variable that you change in your experiment – this will be one of the axes on your graph which you will end up analyzing – there must be ONLY ONE!! – in this case it is mass of the block)
  + Independent variable – you will measure this
  + control variables (which is everything that will be constant in your experiment). State clearly how you will **be sure** that these variables do not change during your experiment . For example, if you say that the velocity will remain constant during the experiment, be very clear on exactly how you will be sure that the velocity stays constant. Realize that saying speed must remain constant is not sufficient unless you also say that the direction the object moves must stay constant also. There are several options you have for ensuring that the speed stays constant.
* Example of chart:

|  |  |
| --- | --- |
| Dependent Variable | Mass of the object being pulled (not just ‘mass’)- this will be varied by putting masses on top of the block. This plan will keep the two surfaces which are in contact with each other unchanged |
| Independent Variable | The applied force necessary for pulling at a constant velocity |
| Control variables | The surface the block is being pulled on – this will be kept constant by using the same surface  The block itself on – this will be kept constant by using the same block  The pull angle – the object will be pulled with a force horizontal to the surface – this will be controlled by taking a video of the experiment while it is being performed, and verifying that the pull angle remains horizontal  The velocity of the block – this will be constant, and will be verified by …….  Etc. (fill in all the others) |

* Discuss some background research on friction and on µ (from the internet or text– you MUST place your experiment into a larger context for all experiments – you must properly reference)
* Summarize/ Do the physics if possible –(this is not possible in all cases) What you know, what you are looking for, a diagram, equations. In this case, show a free body diagram and analyze according to Newton’s laws. For example

Fg

F applied

F friction

FNormal

Mass m

If the object moves at a constant velocity, then a = 0. Therefore

UP/Down Analysis: Fnet = ma; FNormal –Fg=0, So FNormal = mg

Right/Left Analysis: Fnet = ma; Fapplied–Ffriction=0, So Ffriction = Fapplied

But Ffriction = µ FNormal = µmg so Fapplied = µmg

So, if I graph Fapplied versus mass, I should get a straight line with a slope of µg

* Data to be collected is clearly outlined :
  + (1) vary the mass of the block by putting masses on top of the block
  + (2) pull the block at a velocity of 1 m/second
  + (3) collect velocity data, and Force data, with the Vernier labpro and video recording
  + verify that the velocity is constant to +/- x meter/second (determine this value while you are doing the experiment and you see what a reasonable number would be )by doing what?
  + (5) graph mass versus the Applied Force
  + (6) measure 5 different values for the dependent variable, 5 trials for each dependent variable.

**Analysis: (Analyze the data paying attention to the errors) – CLARITY IS CRUCIAL \_ EXPLAINING WHAT YOU DID AND WHY IS IMPERATIVE**

* Data chart: Clear data chart is included with well labeled data columns, errors included for each of the measurements.
* If the data needs to be processed, you need to show a sample calculation for each calculation required. For example, if you measure mass and need to graph Weight, you need to give the physics formula relating Weight to mass, plug in a value with units, and get the answer with units. You must also give sample calculations for averages, or for any conversions (for example, cm to meters)
* You need a final data chart with the x,y values which are being graphed
* Justify each error. Your stated error must include two effects
  + the variation within the repeated 5 trials of the same value of the dependent variable (if the data was perfect, these should all be identical).
  + The error associated with the instrument itself. This will often be less than the variation between trials.
  + In general, the total error is the sum of these two errors
* Error bars should be shown on the graph for all data points. If the error bar is not visible, you need to state and explain this explicitly. You cannot just say it is too small. You may say the it is 1/20 of a box, for example, which is too small to see.
* Graph : Clear graph is included with axes, appropriate scale, data points clearly indicated
* Graph: Draw best fit line with pts used for slope clearly indicated with their coordinates and units, slope calculation with equation, substitution with units, and answer with units. From the slope determine the µ value
* Graph: Draw max and min fit line with pts used for slope clearly indicated with their coordinates and units, slope calculation with equation, substitution with units, and answer with units. From the max and min slope results determine the max and min µ value
* State the results – For example: My best estimate for the µ value between the block and the ground is .32, with a possible range from .29 to .36. This corresponds to a µ value of +/- 10%

**Evaluation: (Improvements/Reflection)**

**Discuss the results**. Discuss the limitations of the results, under what circumstances your results have validity.

**Discuss the errors** which, although you tried to minimize them, could not be eliminated completely. For example

* + Difficult to keep the block moving at a constant velocity – what you did to try to maintain a constant velocity, and the struggles you encountered with this. Be as specific as possible. (i.e. I couldn’t control the velocity to better the 0.2 m/sec)
  + Ground was not a uniform surface – Due to waxing by the janitorial staff, some areas of the floor had a slightly different surface - I observed this by seeing the required applied force vary by about 2 Newtons. I could reduce the distance that I pulled the block which would minimize this problem, but this made it difficult to get a good value for the applied Force.

**Discuss reasonable improvements**. These improvements must relate to the graph drawn. In other words, if there was no mass errorbar visible on the graph, then increasing the precision of the mass measurement will not make a difference! (So, is the mass error what is limiting your result, or is the F applied, or both? Be specific in this discussion.)

Note: While doing the experiment jot down difficulties you encountered in performing the experiment . You can possibly use these in this discussion. (example – if the meter reading moved around more than the error of the instrument, it may be reasonable to write down the max and min readings)

**Communication: (presentation of the experiment and the results)**

Well Structured report

Clearly presented

Neat graphs

**Possible extensions:**

µ vs pressure in a bike tire

µ of a shoe as a function of mass in the shoe

Suggested time allocation

Day 1 (one period)

* state the research question (determine the coefficient of friction between a block and the ground in a classroom)
* show the equipment
* give the students 7 minutes in a group to decide how to conduct an experiment
* discuss the groups ideas
* homework: do the personal engagement and Exploration part of the rubric (bullets is fine- paragraphs not necessary)

Day 2 (one period)

* discuss the homework
* groups will take 1-2 data points
* Students will be given data
* homework: they will be given two nights to graph the data and do the analysis section of the report

Day 3 (one period)

* Discuss homework
* Assign evaluation

Day 4 (one period)

* Discuss homework