IB Physics
Energy-Force Design Lab

You will gather data in groups of 2-6, and write the lab up in groups of 2. You will choose as a group an independent (manipulated) and dependent (measured) variable, gather data, average it, and graph it, and write a conclusion.

Directions

1. Pick an independent (manipulated) and dependent (measured) variable, and gather data for 6-12 variations of your independent variable, and at least 3 trials of each variation.
2. Average your trials, and make a graph where the dependent is the y axis, and the independent the x
3. Write an appropriate method:

   Stating the problem and listing the variables

   State the problem concisely, and list the independent, dependent and controlled variables. Independent variables (IV) are the ones you manipulate, dependent (DV) are the variables you measure, and controls are the things that stay constant. Controlled variables are not objects, they need to be quantities only, just like the IV and DV.

   Method for control of variables

   Explain how you will manipulate the independent variable, measure the dependent, and make sure that the controlled variables don't change. Draw a **diagram**, include measurements of anything that matters, tell what equipment and materials you used, and give a step by step description of what you did to actually gather the data.

   Method for collecting sufficient data

   State which variations of the independent variable you chose, and explain why you chose the variations and number of trials that you did. (Variations are like 5^o, 10^o, 15^o, 20^o, 25^o, etc, and trials are repetitions of the same thing) You need to do a sufficient number of variations (6?, 12?) of the independent variable, do an adequate number of trials (3?) of each variation, and the variations should be if possible well distributed throughout the possible range of variations.
4. Write a conclusion for your lab:
   a. Summarize the trend you see in the data and try to explain it if you can using your by now vast knowledge of Physics.
   b. List the sources of error, and describe what effect they would have on the data
   c. Describe how you could eliminate or mitigate these sources of error

Ideas Energy Force Design lab (Including but not limited to)

Independent (Manipulated)	**Dependent** (Measured)
Height of ramp	Time to roll down the ramp from rest
Length of ramp	Time to roll down the ramp from rest
Amount of water in water bottle	Time to roll down the ramp from rest
Number of coffee filters	Time to fall a certain distance Terminal velocity measured by rangefinder
Deflection of ruler	Speed of marble launched from table
Mass	Period of a mass on a spring
Mass	Force of friction
Mass	Length of elongation of a spring Distance of deflection of a cantilevered ruler
Position of pivot	Period of a physical pendulum. Period of a simulated physical pendulum
Drop height of a ping pong ball	Time it takes to bounce 5 times
Length of cantilevered ruler	Period of vibration
Amplitude of swing	Period of a simple pendulum
Length of string	Period of a simple pendulum
Amount of draw	Force exerted by compound bow
Height of ramp	How far a car rolls on the level ground
Height of ramp (Motion encoder cart) Pulling mass	Speed of car at the bottom of the ramp
Height of ramp	Terminal speed of cart with magnetic brakes
Pulling mass	Terminal speed of cart with magnetic brakes

Example:

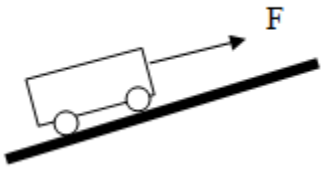
Suppose I am doing an experiment to see how the parallel force depends on the angle of an incline.

Stating the problem and listing the variables (After a bit of introductory information)

The purpose of this investigation, then, is to determine the relationship between the force necessary to keep a wheeled cart from rolling down an incline, and the degree of that incline. The independent variable is the degree of incline, the angle it makes with the horizontal, the dependent variable is the force needed parallel to the plane to hold the cart stationary on the plane, and the controlled variables include, but are not limited to the mass of the cart, the position on the plane, the type of surface used, and the angle of the force scale used to measure the force.

Method for control of variables

Our setup consists of a 2.0 m long inclined plane that we propped up using a pile of books. We kept the mass of the cart constant at 1.85 kg, and always positioned the cart in the middle of the plane. The angle we measured using a protractor placed on the table surface, and we measured the force using a 20 N force scale for all trials.



We took special care to keep the force scale parallel to the surface when we measured the force. To gather a data point, our procedure was this: First, we propped up the plane to the angle we desired, and measured this carefully keeping the protractor level with the table surface. Second, we tipped the force scale parallel to the plane, and made sure the scale read zero. If not, we adjusted the zero. Then we carefully attached the cart in the middle of the plane, and very slowly let it exert a force on the scale. We then read the force on the scale.

Method for collecting sufficient data

We chose to try the following angles: 10, 20, 30, 40, 50, 60, and 70 degrees. We could not get the plane to remain stationary for 80 degrees or above. For each variation, we did four trials of each angle to make sure that the measurements were repeatable.