AP Physics 1: Lab Review

- Labs are an important part of the AP Physics curriculum
- Most of the principles that we learned about were experienced through at least one laboratory assignment
- The experimental design problem included on the AP test is one of 5 free response questions that comprise 50% of the grade on the test.
  - It will test not only the physics principles you have learned, but also your understanding of the general science principles that underlie all experimental science.

Lab Question

Example:

You are given a metal block, about the size of a brick. You are also give a 2.0m long wooden plank with a pulley attached to one end. Your goal is to determine experimentally the coefficient of friction, μ, between the metal block and the wooden plank.

(a) From the list below, select the additional equipment you will need to do your experiment by checking the line to left of each item. Indicate if you intend to use more than one of an item

(b) Draw a labeled diagram showing how the plank, the metal block and the additional equipment you selected will be used to measure μ (mu).

(c) Briefly outline the procedure you will use, being explicit about what measurements you need to make and how these measurements will be used to determine μ (mu).

Lab Question Process – Evaluation of the ?

Read the Question Carefully and evaluate the following:

- **What** is it that you are trying to show or determine?
  - Jot down the obvious things you know about this concept
- If there is a list provided… **What** equipment is allowed?
- **What** measurements do you need to make in order to find the variables you need, but do not yet have?
  - Do you have the equipment? Which is the most accurate? Which way do you understand the best? Choose **ONE** way to do it.
- If you can define your own equipment… **What** do you need to make the measurements you have decided on?

Lab Question Process – Response to the ?

Construct your response:

- Clearly describe the **procedure** for a single trial and remember to specifically state when multiple trials are appropriate.
- Clearly describe the **calculations** you need to do with the measured data in order to find the requested value(s)
  - Remember graphing as a way to find accurate values!
- Clearly state any **assumptions** or **conditions** that are critical to your procedure
  - ie. horizontal launch, no air resistance, frictionless massless pulley…

General Lab Question Strategies

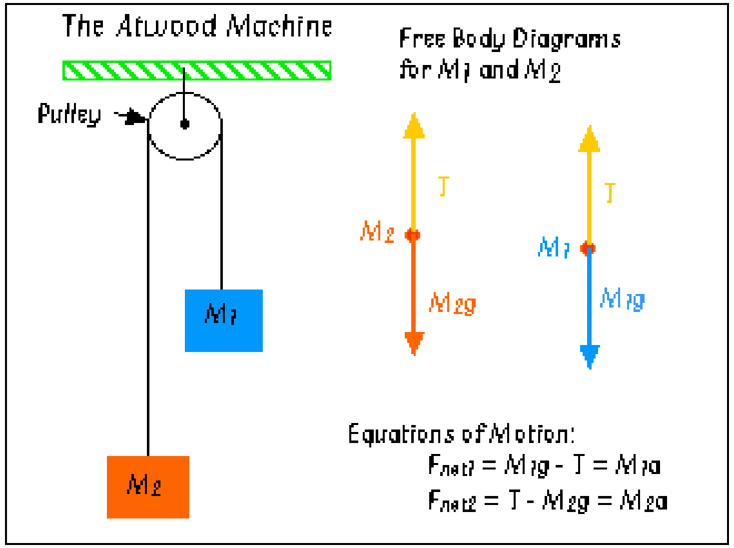
- The equipment list will contain items you don’t need. Be certain each item has a role in the procedure.
- Follow the directions – Draw a diagram if it says draw a diagram. Label it if it says label. Just like in class, you can earn credit for just this part.
- Use as few as words as possible. Answer the question using physics vocabulary correctly, and then stop. You will lose points if you add extra information and your answer does not make any sense.
- There are multiple ways to approach a lab, don’t do all of them. Choose the one that you understand the most about and can get the most points.

General Lab Question Strategies

- Don’t overthink the question. Recall, this is supposed to be a real world lab, just like in class.
- Write as if you were explaining this to a classmate with the same level of experience as you have.
- Use the words “multiple trials”, but only when there is a reasonable assumption that the measurement is reliably repeatable.
- Vary only one thing at a time in your experiment: remember independent, dependent and constant variables all play a part.

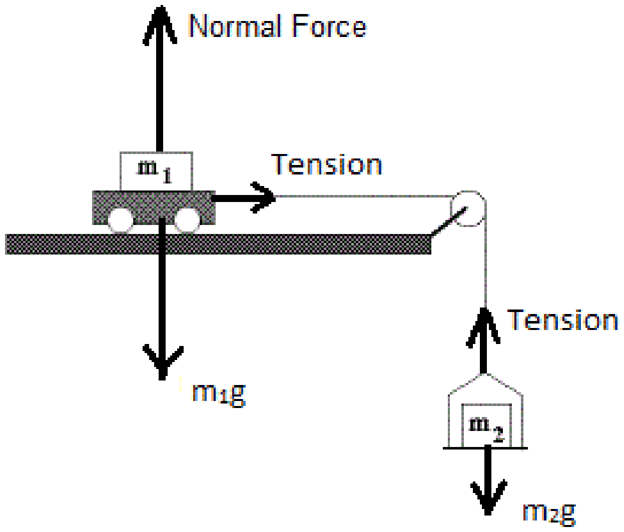
Potential Lab Question Material

- Atwood and Modified Atwood Machine questions
  - Often exploring F=ma concepts, but can include conservation of energy
  - Could include a pulley wheel with mass, introducing a third moving object and the concepts of rotational dynamics (rotational inertia,rotational kinetic energy
  - Could include rolling carts for which friction is negligible
  - Could include sliding blocks for which kinetic friction is a consideration



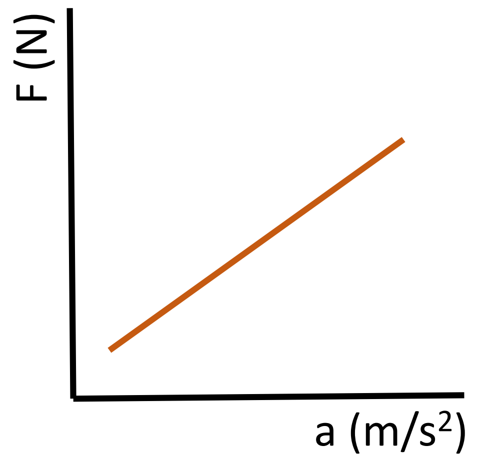
Hints:

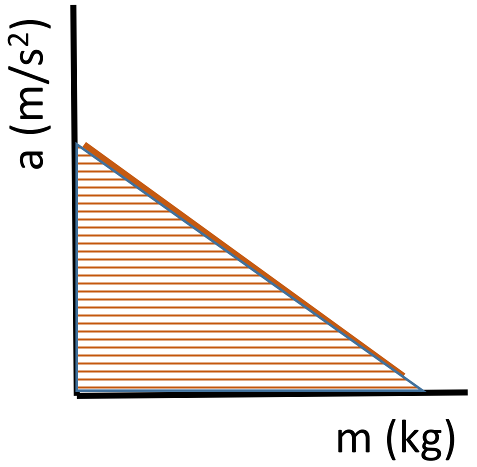
- Define your coordinate system for all moving parts in the same direction
- Mind your signs



Potential Lab Question Material

- Our Lab Experience: Modified Atwood with 2 changing masses
  - First, varied the hanging mass while keeping the total system mass constant and measured the acceleration of the system.
    - Graphed Force vs acceleration and found that the slope = the total system mass
  - Second, varied the system mass while keeping the hanging mass constant and measuring the acceleration of the system.
    - Graphed acceleration vs system mass and found area = Force on the system (hanging mass)





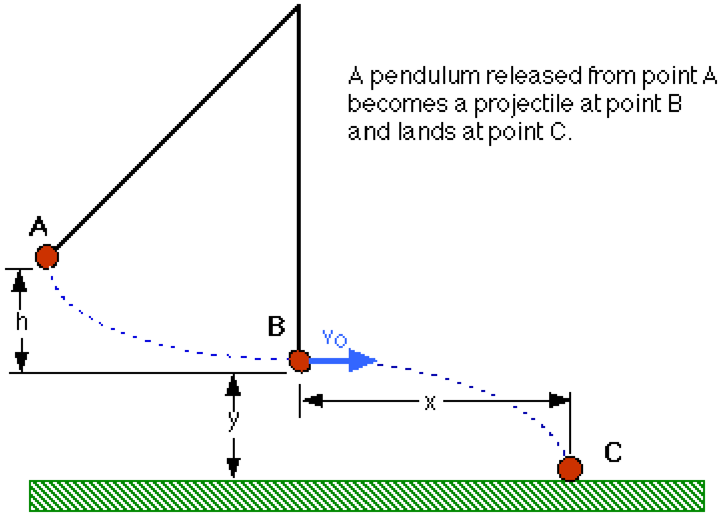
Independent variable
Dependent variable
Constant variable

Potential Lab Question Material

- Energy and Momentum Conservation
  - Often explores the ideas of conservation and conversion of one type of energy to another.
    - Gravitational Potential Energy ↔ Kinetic Energy
    - Gravitational Potential Energy ↔ Spring Potential Energy
    - Spring potential Energy ↔ Kinetic Energy
  - Could include energy loss/gain due to work done on the system
    - Friction causes loss, applied force from outside causes gain
  - With the addition of a collision, momentum conservation should also be considered
    - Elastic conserves, Inelastic does not

Potential Lab Question Material

- Our Lab Experiences: CPO carts and track AND pendulum projectile
- The cart, ramp and photo-gate lab demonstrated that PE_{grav} is converted to KE with a minor loss to Thermal Energy due to friction
  - Friction does negative W that equals the energy lost to the system
  - Use that W and the distance over which it acts to find F_F (average) and coefficient of friction
- The pendulum projectile lab demonstrated both energy conversion and energy loss as well as momentum conservation.
  - Even the elastic collisions lose a small amount of energy.



Potential Lab Question Material

- Impulse and Work
  - Situations involving Work often revolve around the work done by friction or the force due to gravity because the forces involved in both can be considered to be constant
    - Recall that $\Delta KE = W = Fd$
    - Friction does negative work, Force to gravity can do either (depending on the direction)
    - Graph ΔKE vs. distance; slope = force applied
  - Situations involving Impulse often involve the idea of a constant change in momentum (Impulse) over a variable time resulting in different forces
    - Recall that $\Delta p = J = Ft$
    - Egg drop designs, for example
    - Graph Δp vs. time; slope = force applied

Potential Lab Question Material

- Our Lab Experiences: Impulse on a Spit Ball and Blocks on an Inclined Plane
- Impulse: Materials included a straw, a bean (known mass) and a meter stick
  - Best procedures minimized variables required (horizontal launch)
  - Multiple trials not really relevant because launch is not reproducible
- Blocks on a plane demonstrated that vertical and slanted work are the same, even though applied force is different.
  - Simple machine concept of trading more distance for less force.