ENERGY - CONSERVATION, TRANSFER, STORAGE, and MEASURING...

(1) First - as always, make a cloud (google) document with an appropriate title, copy/paste all this into it.

Second - remember, all resubmissions need a comment explaining what you fixed, and you also need to make any edits/changes to the document PAINFULLY OBVIOUS (highlight, different color, text, etc.)

Let's get down to business!

IN AP PHYSICS, there are 7 BIG IDEAS - Six are addressed in the first year, and then a seventh is added as all are explored again during the second year (AP PHYSICS 2)

See if you can figure out which one(s) are the most important for studying energy!

- Big Idea 1: Objects and systems have properties such as mass and charge. Systems may have internal structure.
- Big Idea 2: Fields existing in space can be used to explain interactions.
- Big Idea 3: The interactions of an object with other objects can be described by forces.
- Big Idea 4: Interactions between systems can result in changes in those systems.
- Big Idea 5: Changes that occur as a result of interactions are constrained by conservation laws.
- Big Idea 6: Waves can transfer energy and momentum from one location to another without the permanent transfer of mass and serve as a mathematical model for the description of other phenomena.
- Big Idea 7: The mathematics of probability can be used to describe the behavior of complex systems and to interpret the behavior of quantum mechanical systems.

If you indicated that all 7 could have to do with energy, then you're well on your way to understanding how ALL PHYSICS is inter-related! (But if you focused on 4 & 5 you have good points)

You will need to demonstrate understanding of energy conservation principles, and how energy can be transferred and stored in different ways. Keep reading, and show your answers to the questions below!

GENERAL ENERGY CONCEPTS:

2. How many kinds of energy are there? And what is it called?

3. How many things are there that can be done to energy? What are they called?

4. How many ways are there to transfer energy between systems? Give an example of each.

5. Energy can be stored in fields (by arrangement or position), or in terms of motion. Name and describe each of the Storage modes listed below: (each is preceded by a delta ∆ , implying that energy is all about change)

- ∆Ek How fast?
- ∆Eth How hot?
- ∆Eg How high?
- ∆Eem How shocking?
- ∆Eel How stretched?
- ∆Ech How many Calories?
- ∆Ein Solid/Liquid/Gas?
- ∆Em How massive?

6. When learning about Energy Transfer Calculations, one usually starts with WORKING...look over sections 7.0 and 7.1 in the online book, then...

6a. How is the amount of Work related to Force and displacement? Show the relationship (equation) using W, F, and Δx.

6b. What are the units for Work and Energy? How is this unit abbreviated? How is a Joule related to other units we use (N, m, kg, and or sec?)

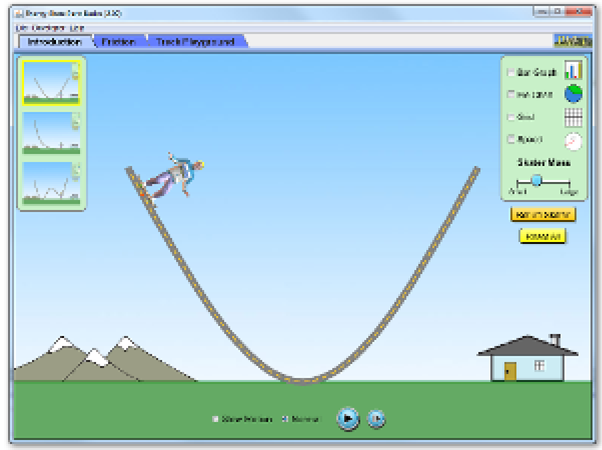
6c. Now calculate the amount of work done by using a force of 1000N to displace an object 5.2m

6d. (AP) show how to calculate Work done by a Force that is not completely parallel to the displacement.

7. Now let's look into this idea of gravitational energy storage. Energy stored in fields is often called POTENTIAL energy, but it's still just energy, so if we lift an object in a gravitational field, it has more POTENTIAL to cause changes... Calculating this Eg is really easy, it's just work done vertically --> $W = F\Delta x$ just becomes $Eg = F\Delta h$, where h is the height. Remember that F is the force due to gravity, the weight, which is just m*g (mass x gravity), so Eg = mgh. Calculate how much Work(Energy) needs to be added to a bowling ball to lift it 2.0m high! (Yeah, you'll need to measure the mass of the Bowling Ball)

Or, you can calculate how much energy was added to the steel sphere used on the rollercoaster (h = 0.5m, g = 9.8N/kg, m = ???)

8. If you drop the bowling ball, what happens before it hits the ground? Right, it goes faster! This is an example of energy being transferred between gravitational storage and kinetic storage. Let's look into this some more. Open the phet sim about the ENERGY SKATE PARK: BASICS, and answer these questions:



https://phet.colorado.edu/en/simulation/energy-skate-park-basics

8a. First, set up a nice "u" shaped track, and let the skater go - what do you notice about the pie charts and bar charts? For now, turn off friction. Add in three pictures below with pies and/or bars that show energy storage at the highest starting point, the lowest point, and the highest point on the other side of the track.

8b. Looking at your graphs above, does the total amount of energy change? Or just get stored differently? Would you say that the energy is conserved or not?

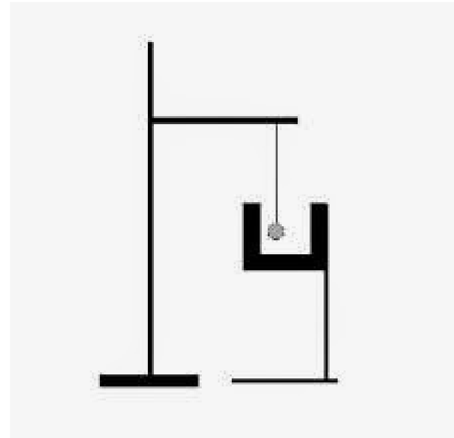
8c. How does changing the skater affect the amount of energy in the system?

8d. How does changing the starting height affect the amount of energy in the system?

8e. Make a cool track, and add three screen shots with pies/bars showing energy at a starting, lowest, and a medium height. Explain how these pictures demonstrate if energy is being conserved.

8f. Now add in some friction, and explain how friction affects the energy in the system (is it still conserved?)

9. Calculating Energy Stored Kinetically and/Gravitationally. Set up a pendulum with a photogate so you can measure velocity at the bottom of the swing. Create an experiment that answers this question: **How much higher do I need to raise the pendulum mass (bob) in order to get it to swing with twice the velocity?**



(Logger Pro has a photogate timer...Logger Pro/Experiment/SetUpSensors/LabPro/DigSonic1/PhotoGate/GateTiming/SetDistanceOrLength...)

9a. Explain what you did (and include a picture of your setup)

(Fizziks Selphie!)

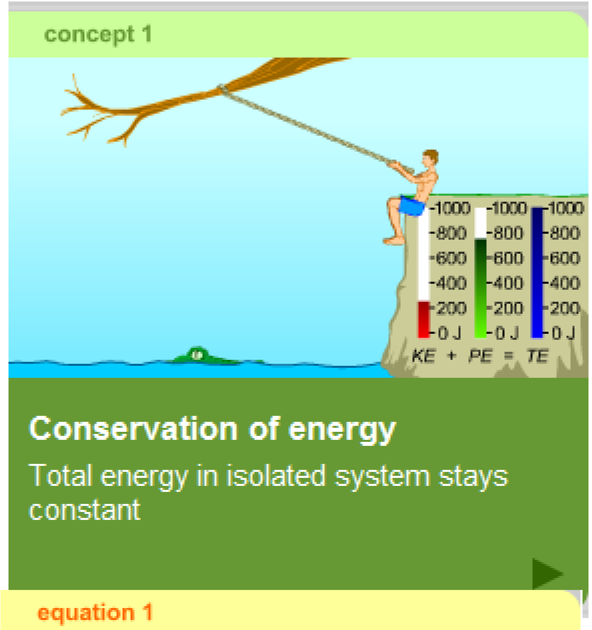
9b. What data did you collect?***(Fizziks Selphie!)***

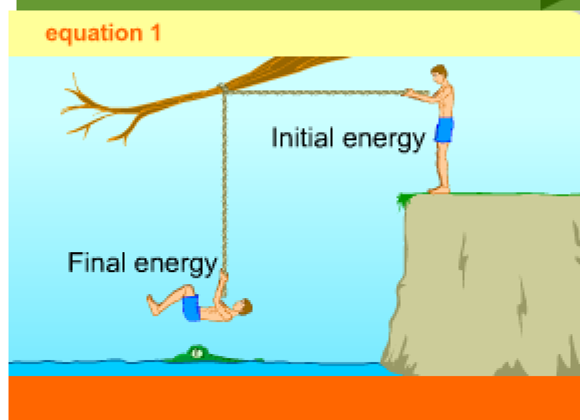
9c. What can you claim the answer to the question is, based on your DATA? (Evidence?)

9d. Can you find a relationship between the velocities you measured, the mass, and the height you dropped the pendulum from? (Hint - Make a data table and a graph)

9e. How can one calculate kinetic energy if one knows the speed of an object? (A phormula is phine)

10. Calculations for conservation of energy (Ek and Eg) also known as (KE and PE). As you continue working through chapter 7 in the online text, this is a good time to do interactive #7.21 - write your answer, and then explain WHY YOU ARE ABLE TO SOLVE PROBLEMS LIKE THIS EVEN IF YOU DON'T KNOW THE MASS?



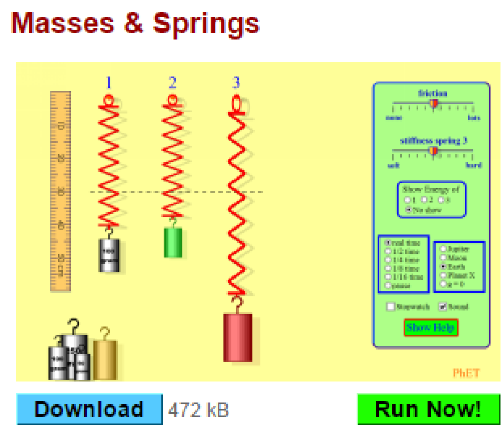


$$E_f = E_i$$

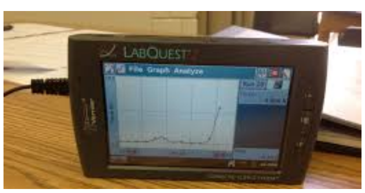
$$PE_f + KE_f = PE_i + KE_i$$

11. Spring ahead, fall behind (no, it's not daylight savings time, we're in Arizona). Let's look a little closer at springs: Play around with the phet sim for MASSES AND SPRINGS (click the phet icon on the class computers, or just load it up here: https://phet.colorado.edu/en/simulation/mass-spring-lab

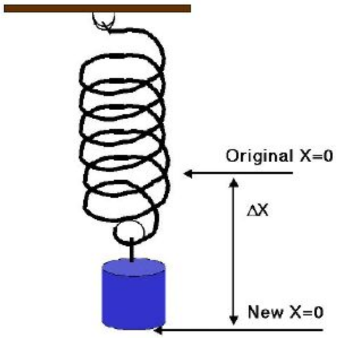
- What happens if you double the mass?
- What happens if you increase the gravitational field strength?
- What happens if you decrease the gravitational field strength?
- How much does the energy stored in the spring change if you stretch it twice as far?
- What can you say about the gravitational field strength on Planet X? (add in your whiteboard here)



Now let's do it in real life :-)



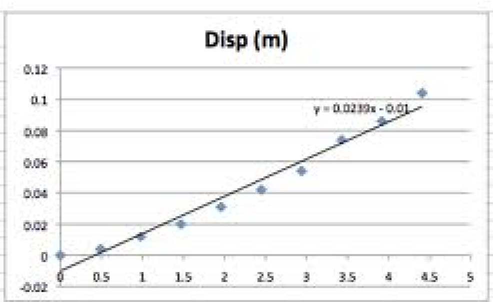
12a. Grab a spring, a force sensor, and be careful not to overstretch the spring (seriously). What is the relationship between the Force applied to a spring and the amount it stretches? What variables will you need to measure? (Use a Labquest 2 or the Lab Pro)



12b. Set up your data table (see part c) and show the values below, include a picture of your experimental setup

12c. Make a pictorial representation of your graph with a line of best fit (is it a line?)

Force (N)	Disp (m)
0	0
0.49	0.004
0.98	0.012
1.47	0.02
1.96	0.031
2.45	0.042
2.94	0.054
3.43	0.074
3.92	0.086
4.41	0.104



12d. What does the slope represent? What does the intercept represent? Who is Robert Hooke and what is Hooke's Law?

12e. Do it again with another spring and add the new data to the same graph. Which spring is "stiffer", and how can you tell from the graph? Does either spring have a Preload and how can you tell?

12f. You may have noticed that it got harder to pull each spring as you stretched it more (duh). This tells us that the Force needed to stretch the spring changes - or that the Work (Energy) in the spring is not simple like $F\Delta x$ or mgh - it's still the area under the F vs X graph though...which is a triangle...which is $E = ½*\Delta x*k\Delta x$ or more commonly written as:

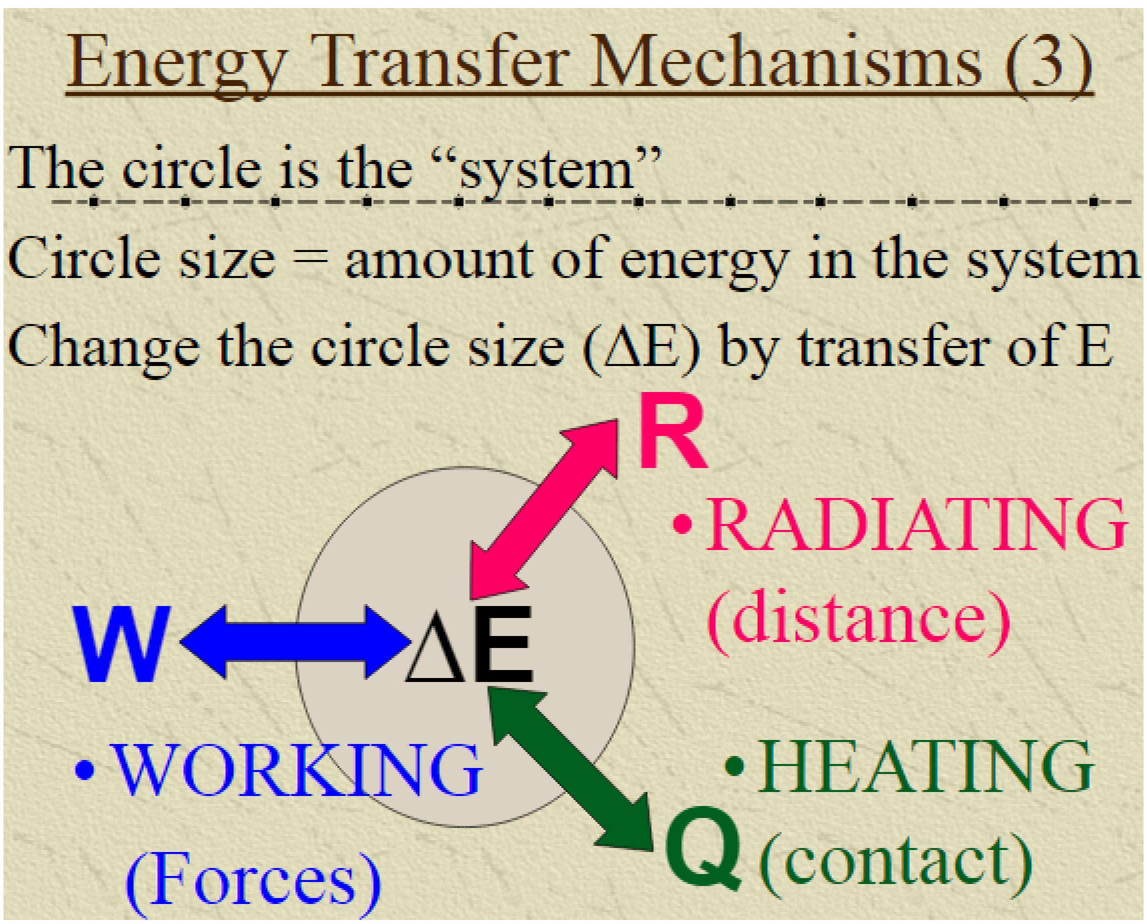
E_{sp} =

These slides might be helpful too…

https://docs.google.com/presentation/d/1MtAOdSA1Pb2NTz9gD2YGRaW-TnSQ_xaurkCG6gEmXRA/edit?usp=sharing

(some of the above slides go with our next investigation on Power, so keep that link handy!)

13. Just for phantastic review, what are the 123s of ENERGY again?



Cool, now you have relationships between work and energy stored gravitationally, kinetically, and elastically.

$$W = F\Delta x = \Delta E = mg\Delta h = \frac{1}{2} mv^2 = \frac{1}{2} k\Delta x^2$$

14 please add a picture demonstrating that you can qualitatively describe the energy flow and storage in a system (One of your whiteboards from worksheet 3a is just fine) Please demonstrate that you know what you're doing by explaining your solution!

15. Same as #14, except this is for a quantitative analysis (One of your whiteboards from worksheet 3b is just phine) - Please demonstrate that you know what you're doing by explaining your solution!