Problem Set #1 due beginning of class, Monday, Sept 29. – worth 75 pts – 5 pts per each part.
Remember to carry units throughout the equations, remember to draw a good picture.

#1 Tracker Assignment

Due Monday, September 29th at the beginning of class

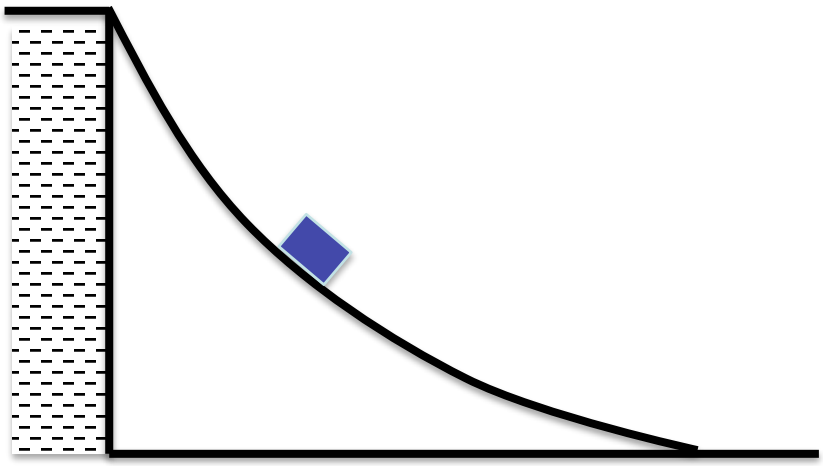
Purpose: In this assignment you will familiarize yourself with the Tracker software.

Parts:

1. Watch Smarter Every Day (https://www.youtube.com/watch?v=O-JVepPdZbY). Download the "Raw Grasshopper Jump Video" file located adjacent to this PS #1 document. (The link at the end of the Smarter Every Day video is unreliable).
2. Read the Instructions also located adjacent to this document on the Wikispaces website.
3. Repeat the Grasshopper experiment as described in the Smarter Every Day Video using the Tracker Software.
4. On Monday, bring in the value you found for the acceleration of the grasshopper.

Note: For the "Raw Grasshopper Jump Video" file, you should change the frame rate in the Tracker program from 30 frames/second to 3000 frames/second. To do this, click on the Film icon in the toolbar and make the necessary change in the pop-up window.

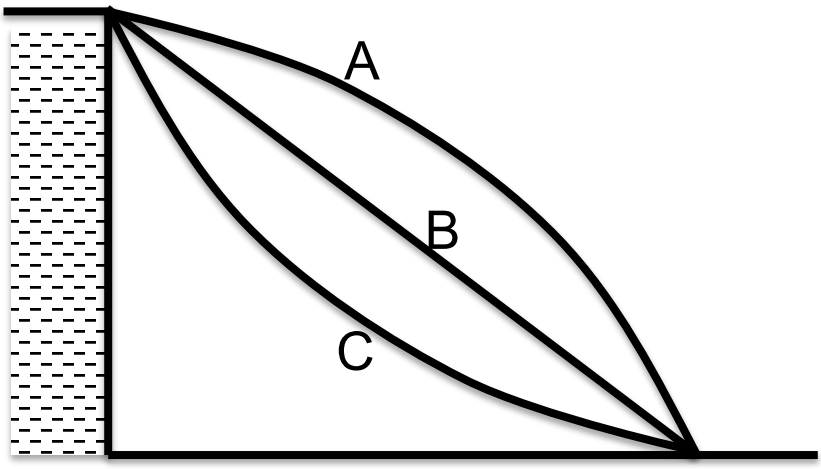
#2 Sliding down a frictionless track. Imagine a 10 kg box sliding down a frictionless curved track at the edge of a 50 m high cliff as shown at right. We would like to know how fast it's going at the bottom.



a) Of the 4 kinds of physics problems, which kind is this? Please explain your reasoning carefully. ** We symbolize this question with two asterisks. Whenever you see **, first answer this question.

b) Please find out the speed at the bottom of the track.

Now imagine that there are two other tracks that the box could use as shown at right, bottom.



c) Which track should we use for the fastest final speed, or would all three tracks yield the same final speed? Please explain your answer.

d) How would the speeds on the different tracks relate for a box half way down each track? **

e) If three identical frictionless boxes were released at the top of each track, which would get to the bottom first, or would it be the same for all? Please explain your answer. **

#3 In the above problem, what if someone just dropped the 10 kg box off the edge of the cliff and it fell vertically downward?!

a) What's the speed at the bottom of the cliff? Did the momentum of the box change during the fall? If so, have we violated a conservation law? Are we in trouble?
b) If everything was at rest before we let the box go at the top of the cliff, what must be the speed of the earth immediately before the box hits the ground? Include direction **
c) What is the kinetic energy of the earth immediately before the box hits the ground? Would this be something important that we should consider when solving problems in the future? Why?

#4 Cars. Let's say I bought a 1000 kg (with me in it) car that has 100 hp!

a) what is this power in Watts?
b) If there are no friction forces acting on the car (impossible), and the car could put out 100 hp at all speeds (also impossible, but getting better with a continuously variable transmission, no?) how long would it take me to reach a speed of 100 mph? **
c) At 100 mph, with what force are the wheels pushing the car forward? **Hint: first estimate how far the car goes in one second.**
d) Make an energy flow diagram that shows the conversion of energy all the way from the most fundamental energy source (radiant solar energy) to the most final energy form (dissipated IR radiation from the earth).