Problem Set #1, PHYS 141, Schwartz, Due the beginning of class, Monday, Sept. 18

Please read textbook sections 1.0 – 1.4. While you are reading, please address the exercises. In particular, please do and hand in the following:

1. Exercise 1 in section 1.0, Describing your Problem-Solving Experience

2. Exercise 1 in section 1.1, fly and window collision

3. Exercise 3 in section 1.2, Solar Panels

4. Exercise 4 in section 1.2, Energy Bar Bicycling

5. Exercise 1 in section 1.3, Pushing off a boat

6. Exercise 2 in section 1.4, Rocket taking off

7. Exercise 3 in section 1.4, Car Collision

8. Exercise 1 in chapter 1.5, rocket acceleration.

9. Taken from Exercise 3 in chapter 1.5. *Please be mindful <u>to identify</u> a lens for each step*:
   You push a 1000 kg car from rest on smooth level ground. It takes you 5 s to get the car to a speed of 1 m/s.
   a) What is the car's acceleration?
   b) What is the force you are exerting on the car?
   c) How does this force compare with the force of gravity on your body?
   d) Please imagine doing this in your mind. Does this sound reasonable?
   e) Estimate the power you put out accelerating the car.

   This is the first problem that requires the use of force units, the Newton, *N*. I haven't defined this unit, but we have defined and spoken about force already. Can you describe a Newton in terms of other more basic units to do this problem?

   **Please let me know if you find some mistake in the text (or a video), or if there is something that is confusing the way it is written. I appreciate any feedback that will improve the material for everyone.

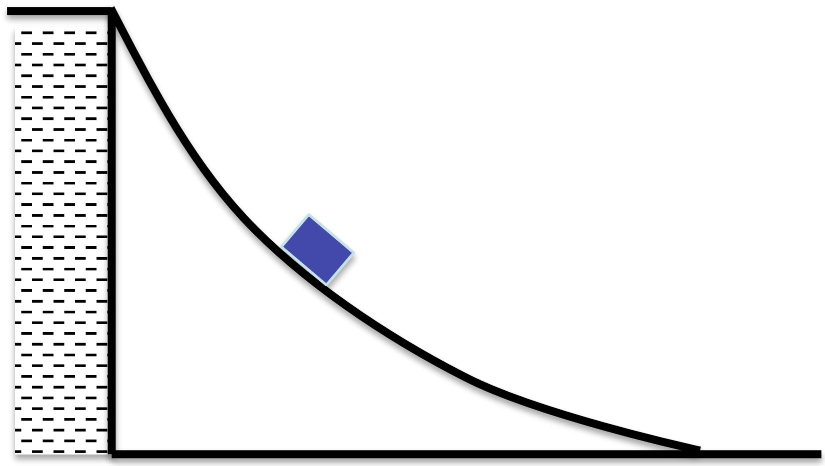
10. Please read through exercise 8 in 1.6. What does this tell you about conservation of energy versus conservation of *<u>kinetic</u>* energy in a collision?

11. Exercise 1 in 1.9, scaling energy of a cart..

12. If I double the height from which I drop a rock, by what factor will this change the final velocity of the rock immediately before impact? That is if $\Delta H_B = \Delta H_A$, v_{fB} =_?__ v_{fA}. Please draw a picture of this, provide a lens and carefully consider.

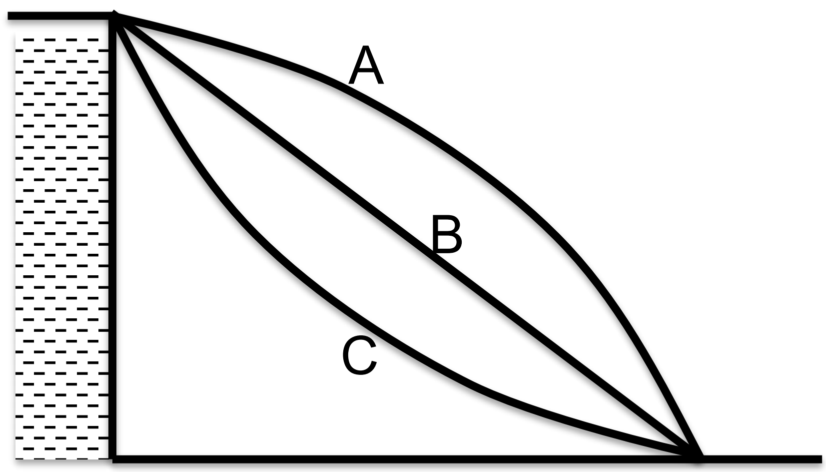
13. I inadvertently walk off a cliff. The process comes to a grim result 3 seconds later when I meet the ground. Please look at this process closely through all 4 lenses.
<u>NOTE</u>: These questions may not be in the best order for answering them. My advice is to look through all of them quickly and start thinking about what's happening… did you make a drawing? That's usually the most important step in problem analysis.
    a) Momentum:
        i) How does my momentum change during the three seconds and thereafter?
        ii) Why should this be the case?
        iii) Can you make a rough graph of my momentum as a function of time from 0 seconds to 4 seconds?
        iv) Is momentum conserved during this process? Did I break the law of conservation of momentum?
        v) If it's true that momentum inside of a closed system must be conserved, please describe the full system we're talking about here.
    b) Energy:
        i) Please identify energy transitions or state why there are none.
        ii) What is the energy at the very beginning? What is the form of energy at the very end?
        iii) Was energy conserved? Please describe.
    c) Forces:
        i) Is there a force or forces acting on me? Please identify.
        ii) I've defined a force as an interaction between two bodies whereby momentum is transferred. Can you identify two bodies? What do we mean by momentum is transferred? What is happening?
    d) Kinematics:
        i) Can you describe my motion? What might my speed look like as a function of time. Can you make a speed vs time graph?
        ii) Can you describe my height as a function of time? Can you make a height vs time graph?

14. Imagine a 5 kg box sliding down a frictionless curved track at the edge of a 60 m high cliff as shown at right. We would like to know how fast it's going at the bottom. Neglect air friction.



a) Describe using each of the four lenses, what is happening in this process.
b) Which lens is the most helpful to find the final speed of the block at the end?
c) 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.



d) Which track should we use for the fastest final speed, or would all three tracks yield the same final speed? Which lens do you look at this problem through? Please explain your answer.
e) How about if we wanted to know which was going the fastest *half way* down the total length of its path?
f) 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 of them? Please explain your answer in terms of which lens you used.