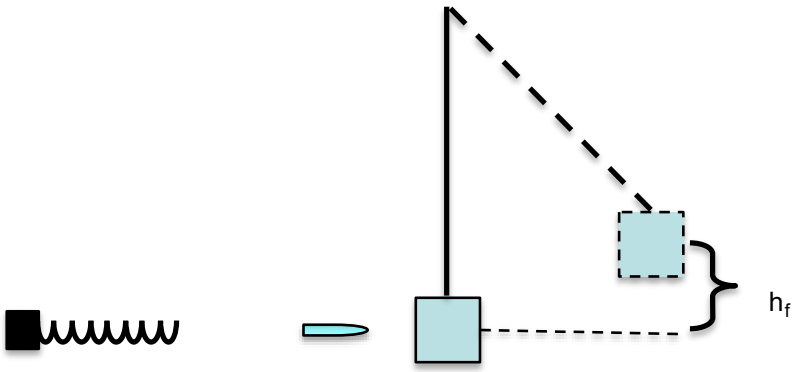
Problem Set #4 due beginning of class, Monday Oct. 14. Please state the lens you are using and why. Remember that you are graded on your ***communication*** of physics understanding.

1. Exercise 5 in 2.7, potential energy graph.

2. An object starts at 10 m with a speed of 5 m/s and has an acceleration of $-4\ m/s^2 + 2\ m/s^3(t)$. Find the velocity and position after 3 seconds.

3. A loaded gun is cocked by compressing a spring of $k = 10^4$ N/m. and then releasing it behind a 20 g bullet. The bullet strikes and sticks inside of a 0.5 kg ballistics pendulum and swings upward to a final height of 50 cm. Presume the spring is massless and there is no friction in the system. Please find:



a) The bullet's speed.
b) how far the spring was compressed.
c) Does the bullet have constant acceleration in the gun, or does the acceleration change over time? Please explain your answer… identify a lens.
d) Please find the maximum acceleration of the bullet in the gun.
e) Did you identify the lenses at the very beginning, or one at a time for each question? Which do you think would be a better approach?

4. Using an energy lens, please show that if you drop a 5 kg box from 60 m, it hits the ground at ~35 m/s. But then, you *throw* the box *downward* from 60 meters height with an initial speed of 35 m/s.
a) Find the speed that it has when it hits the ground.
b) What if I throw it *upwards* at 35 m/s, what is the speed when it hits the ground?
c) What if I throw it straight off the cliff at 35 m/s horizontally, what speed does it have when it hits the ground now?
d) *Can* I throw a 5 kg box at 35 m/s? Please back up your answer.

5. Exercise 1 in 3.0, changing reference frames

6. Exercise 2, in 3.1, What are the final velocities in this elastic collision?

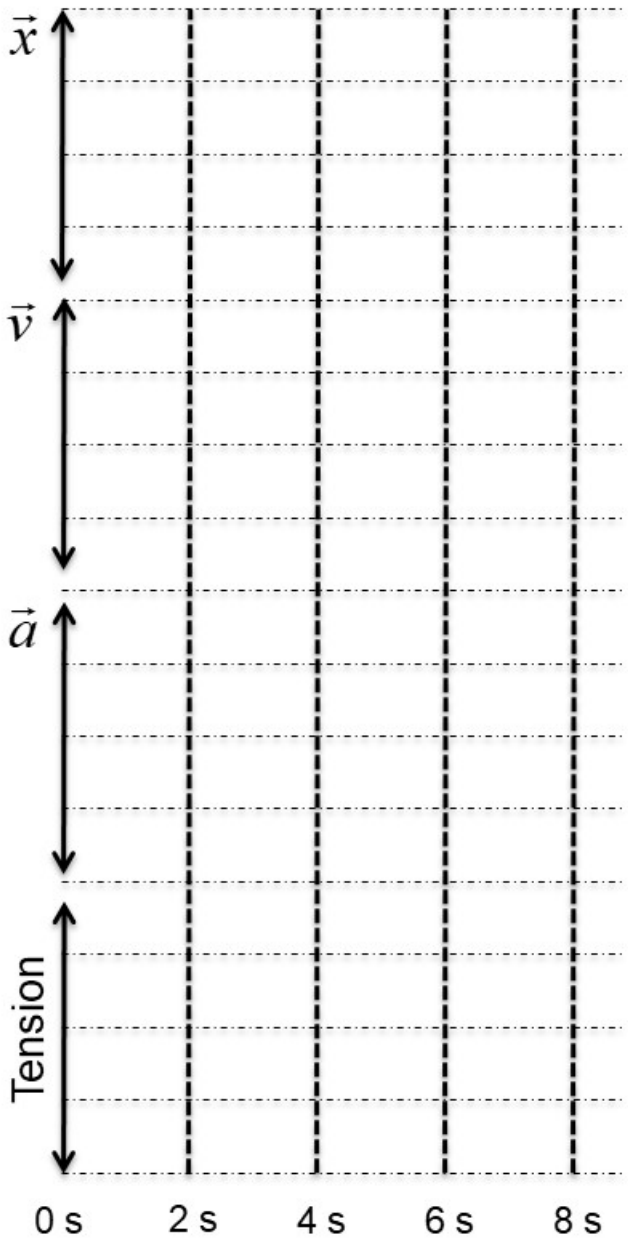
7. Dragsters have a mass of about 1000 kg and the best dragsters get to 44 m/s in about 0.8 s.
a) What's the acceleration?
b) Estimate the coefficient of friction necessary to make this happen if you were in a regular car on flat ground.
c) What's the average power output during this 0.8 s?
d) Dragsters have their exhaust pipes pointed *upwards*, which ejects a huge amount of exhaust straight up into the air at very high velocity. What effect does this thrust have on the ability of the car to accelerate? *Why? Please start with clarification of reasons, drawings, lenses.*
According to my calculations, the engines kick out about 18 kg of exhaust every second at about 230 m/s.
e) What is the momentum of this amount of gas?
f) How much force should this put on the vehicle? In which direction?
g) With this extra "downforce", what coefficient of friction is necessary in order to accelerate the dragster?

8. From Assessment #3

Imagine that you are traveling upward in an elevator at a constant rate of 10 m/s. after two seconds, you are slowing down at a rate of 2 m/s every second until you stop. The mass of the elevator is 1000 kg (with you in it).

a) Please graph the motion at right. Show work below

b) Please graph the tension on the cable over time. Please use the other side of this page to elaborate the beautiful work behind your answer.



#9, From Wednesday's Class Activity, the Ballistics Pendulum. At Pete's 4:00 class, Phil threw a 41g bean bag causing the 2.0 kg cooler hanging on a 67 cm string to swing back 7 cm. Please see the video https://www.youtube.com/watch?v=1feir-_KhEQ&feature=youtu.be

a) Please estimate the speed that Phil is able to throw the bean bag. Please outline your work nicely as if this were an assessment… the way you should approach all physics problems… and maybe all challenges in general.

b) Use kinematics to find the speed of the bean bag (from the video)

….Just so you know, my calculations for a) and b) didn't match too well… Maybe I just made a mistake, or maybe physics is just wrong… but maybe there's some way to explain why this should be the case. We can talk a little about it Monday in class.