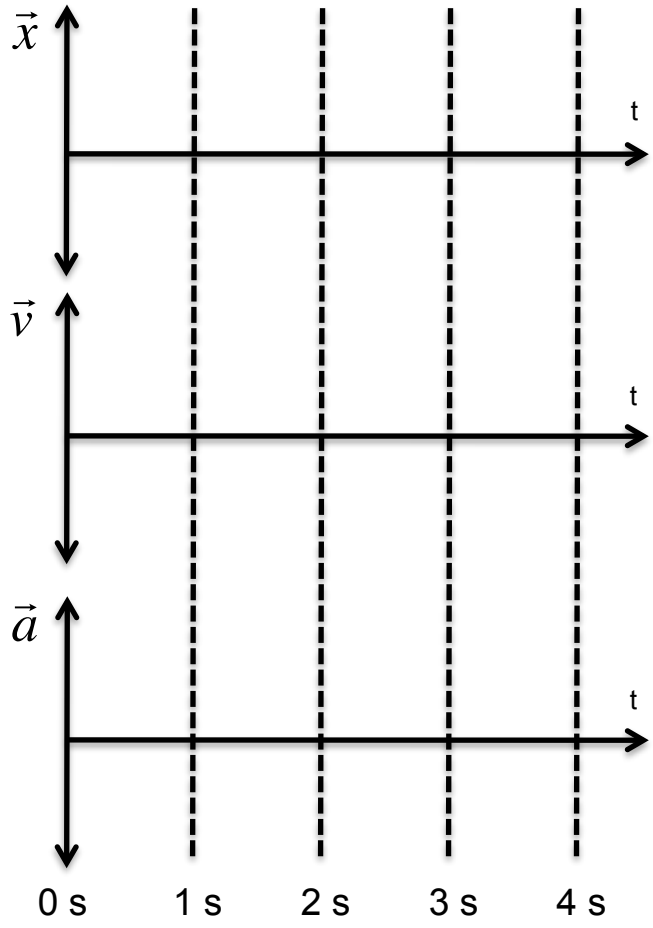
Midterm #1, 141, Schwartz Name_____Graded on ***COMMUNICATION*** of physics

1) Fusion is the process that powers the sun and hydrogen bombs: small nuclei are fused into larger nuclei. One fusion process involves a triton (two neutrons and a proton) and a deuteron (one neutron and a proton) fusing to form a supercharged 5-nucleon nucleus, which gives off its energy by breaking up into a single neutron and a helium nucleus (or alpha particle) at high speeds. I want to know which of the particles gets more of the energy. Let's simplify the problem to just the explosive breakup: Protons and neutrons have the same mass, so we can think of this process as **a 5-ball cluster (in space, at rest) breaking up into one ball and a 4-ball cluster. Do the two pieces equally share the kinetic energy or does one get all or more kinetic energy?** You will be graded not on your answer, but on your reasons, drawings, and lens descriptions.

2) Dragsters have a mass of about 1000 kg and the best 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.

3) My friend at mass 50 kg is on a scale in an elevator headed upwards at a constant speed of 8 m/s for two seconds, and then in two more seconds, smoothly comes to a stop at a height of 20 m.
   a) Please make the displacement, velocity, acceleration graphs at right. Show your work below, including lens explanation.

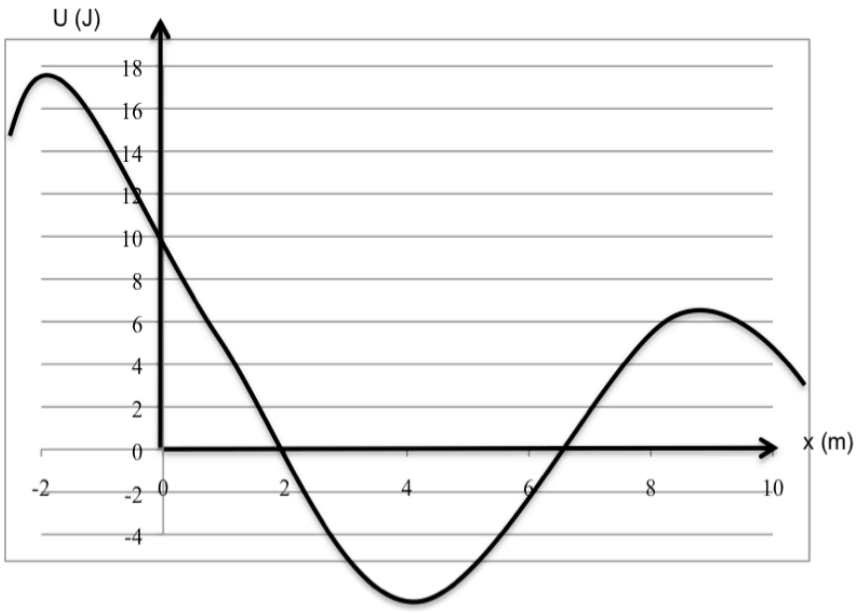


   b) Please calculate what the scale reads under my friend at t = 1 s, and at t = 3 s. Include discussion of lens and drawing

4) 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.

5) You see below a potential energy diagram for a **2 kg mass**, as a function of displacement. (positive *x* is to the right). The mass **<u>starts out at *x* = 0 moving at 2 m/s</u>** to the left. *There may be more than one correct answer. In this case, list all correct answers.*

a) Label stable equilibria with "S"
b) Label unstable equilibria with "U"
c) Label any turning points with "T"
d) what is its speed at $x = 6$m?
e) What is the approximate acceleration of the mass at $x = 6$m? (What two concepts are necessary for this?)
Include direction in your answer, with a unit vector or an arrow.



Recognize that the cart is not *moving* up and down on the y axis. The movement is in the x direction only. The *y* component on the graph is the energy, which could be the result of some electric field, magnets, springs, rubber bands, etc.

6) 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) <u>*Can*</u> I throw a 5 kg box at 35 m/s? Please back up your answer.