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

From the timeline for week 4, day 3, I have:

5) Jane (50 kg) standing on a tree limb spots Tarzan (100 kg) down below, and it's not going well for him, standing motionless among a group of hyenas. She rescues him by grabbing a frictionless vine and swinging down 10 m from the limb she is on in a circular arc like on a swing. At the bottom of her swing, she is moving horizontally and runs into Tarzan with a *THUD* and proceeds to hold him with one arm while holding the vine with the other arm.

   a) How fast are the two of them going after she grabs him?
   Consider the different lenses, and explain why you need two lenses, and which they are. You may decide to do this problem in two steps. ~ 5 m/s

   b) Is mechanical energy (KE+PE) conserved in this process? If so, how do you know? If not, what portion of the energy is lost?
   Where might energy go? Can you calculate the initial energy and the final energy? You could also consider the equation for kinetic energy (in terms of speed or in terms of momentum) 2/3

6) A 2000 kg truck has an engine that accelerates it from 20 m/s to 35 m/s in 5 seconds.
   a) Find the average force that the wheels must provide. I needed two lenses to get 6000 N. Please explain each two lenses.

   b) Find the average power the engine provides during this 5 seconds. Which lens do I need? Power is the rate of change of what?
   I get 165 kW.

3. At right, you see a potential energy diagram for a 3 kg mass, as a function of its displacement. (positive x is to the right). The mass is released at x = 0 m moving at 2 m/s to the right. What's the lens for all of this stuff?

U (J)

x (m)
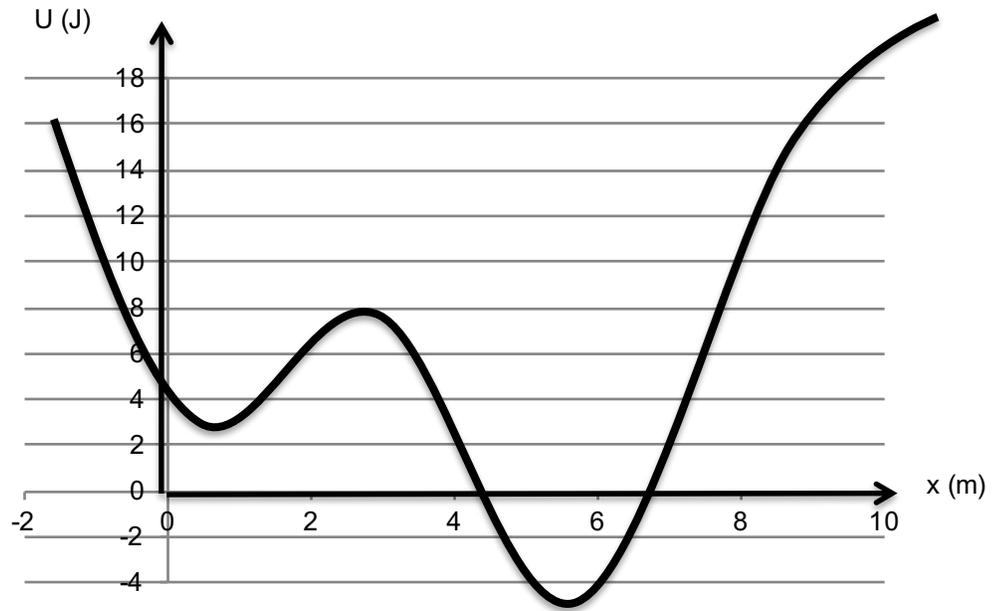
a) Is the mass accelerating at this point (x = 0) immediately after release? If not how do you know? If so, estimate the acceleration. Which lens? How can you express force as a gradient? I get ~ 1.3 m/s² in the positive x direction.

b) Are there any turning points, if not, how do you know? If so, please indicate where they are by placing a "T" at those points.
Can you find the total energy? I estimate the turning points at x ~ -0.8 m and + 8.1 m

c) Is the mass in equilibrium at any point(s) in time? If not, how do you know? If so, please indicate where are the stable equilibrium points, and where are the unstable equilibrium points by placing a "S" or a "U" at those points. x ~ 0.6 m (S), 2.8 m (U) and + 5.5 m

d) Where does the 3 kg mass achieve its maximum speed? x ~ 5.7 m

e) Calculate the maximum speed that the 3 kg mass achieves. v ~ 3.3 m/s

4) I throw an object directly upward at 15 m/s, it leaves my hand at an elevation of 10m above the ground (I'm in a tree). Please graph the velocity, displacement, and acceleration at right. You might start with forces, because the ball is subject to what force? However, please indicate why you pick kinematics as the lens. Many students changed acceleration from positive to negative during the time interval. Can you explain why this isn't correct? Maximum height is x = 21.25 m, speed = zero after 1.5 s. It's hard to calculate when the rock hits the ground, but you can use energy to find the final speed, and then find the average speed the rock has while falling from 21.25 m, and from this finding the amount of time it takes to fall... I get about a little more than 3.5 s

$\vec{x}$

$\vec{v}$

$\vec{a}$

0 s   1 s   2 s   3 s   4 s
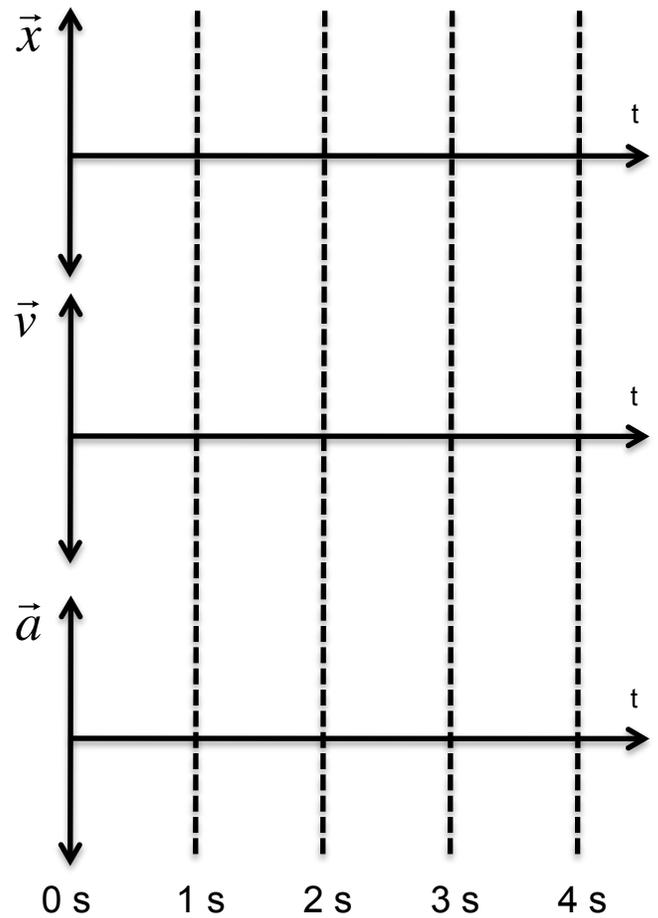
5) If an object starts at a displacement of -20 m, and has a velocity of $v(t) = 5$ m/s $- 2$ m/s^2(t) $+ 1$m/s^3(t^2), please find the displacement and acceleration at t = 4 s. Which lens do you use?

$a_{(5s)} = 6$ m/s^2

$x_{(5s)} = 5.3$ m