MT1, 141, Schwartz Name Pete *provide lens for each part of each question*

4:23
4:51
$v = 400 \, m/s$

1. You fire a 5g bullet into a 1 kg mass which embeds itself into the block. The bullet is well known to have a speed of 400 m/s. The mass slides 2.0 meters on a frictionless surface, and then compresses a spring as shown. The spring constant is 1000 N/m. We want to find the speed of the block immediately after the collision with the bullet and the compression of the spring.

   a) Using the lens approach, explain how you will go about finding the compression of the spring.
   b) $\vec{v}_{Block} =$
   c) $\Delta x_{Spring} =$ ____________
   d) What if the bullet and the block instead had a perfectly elastic collision. Please estimate best you can how this would have changed your answers above.

a) $KE_{Bullet} \Rightarrow KE_{Block} \Rightarrow PE_s$

$\downarrow$ Heat (lots)

I need to first use the $\vec{p}$ lens to find V_{Block} because KE isn't conserved in an inelastic collision but $\vec{p}$ is always conserved.

b) $\vec{P}_{Bullet}$ Before $= \vec{P}_{Bull+Block}$ After

$m_{Bull} V_{Bull} = m_{Total} V_f$ $\quad V_f = \frac{m_{Bull} V_{Bull}}{m_T} = \frac{0.005 \, kg \; 400 \, m/s}{1.005 \, kg}$

$\sim \underline{\underline{2 \, m/s}}$

c) $KE_{Block + Bull} \Rightarrow PE_s$

$\frac{1}{2} m_T V_T^2 = \frac{1}{2} k x^2$

$x = \sqrt{\frac{m_T}{k} V_T^2} = \sqrt{\frac{m_T}{k}} V_T = \left(\frac{1.005 \, kg}{1000 \, \frac{kg \, m/s^2}{m}} \right)^{\frac{1}{2}} 2 \, m/s$

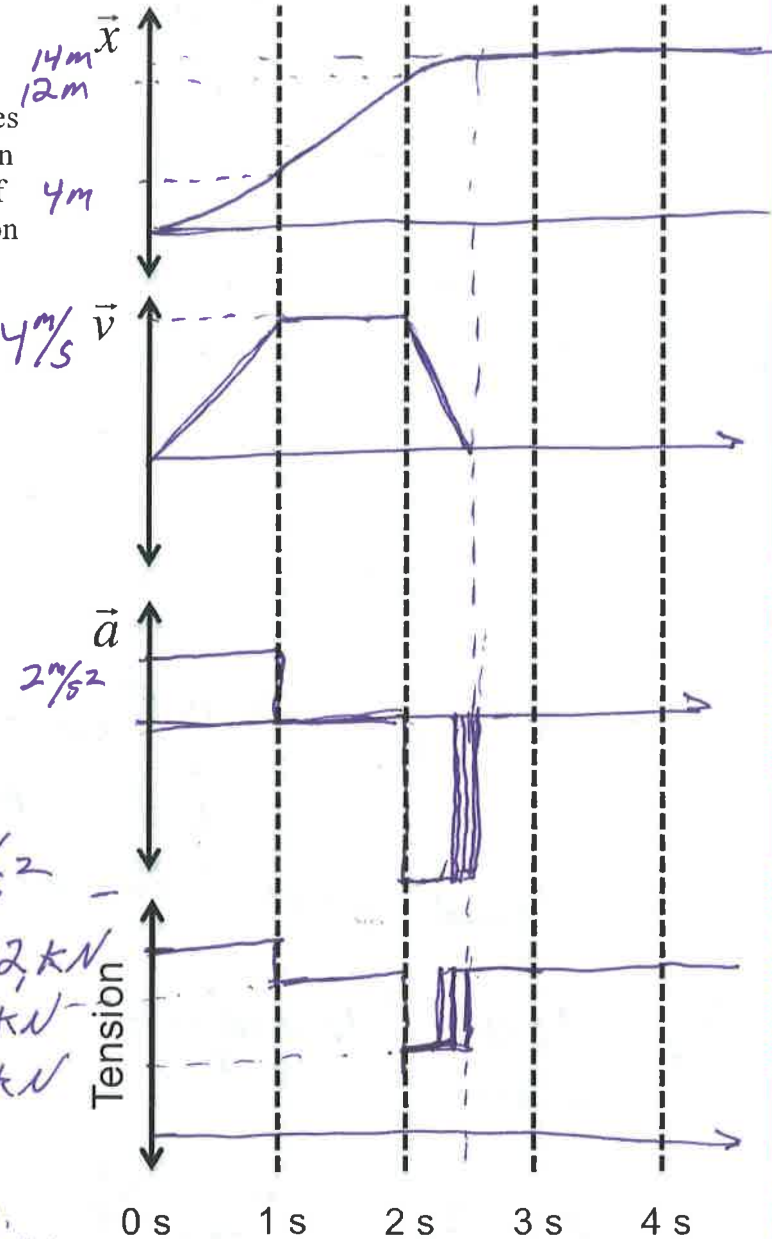
Using a $\vec{p}$ lens, I can see the rebounding bullet has much greater $\Delta \vec{p}$ than the inelastic bullet

$\approx \frac{1}{31} s \, (2 \, m/s)$

$\approx 0.06 \, m = 6 \, cm$

d) The bullet would have rebounded with near its original speed, almost doubling $\Delta \vec{p}$, $\vec{V}_{Block}$, and new Δx

2. A crane lifts a 1000 kg mass off the ground directly upward with a cable. The mass accelerates 2 m/s^2 upward for 2 s, then continues at constant velocity for 2 s, then comes to rest in 1 s and stays there. Please draw as a function of time, the displacement, velocity and acceleration of the box. Also graph the tension in the cable.



This is straight up kinematics - all about motion + time.

Dynamics because T is one of $\Longrightarrow$ the $\vec{F}$, and $\Sigma\vec{F} = m\vec{a}$

1) oh no! I don't know anything

2) wait $\Sigma\vec{F} = m\vec{a}$

a

3)

4) $T - F_g = ma$

$T = \underset{1{,}000(a)}{ma} + \underset{10{,}000\,N}{F_g}$

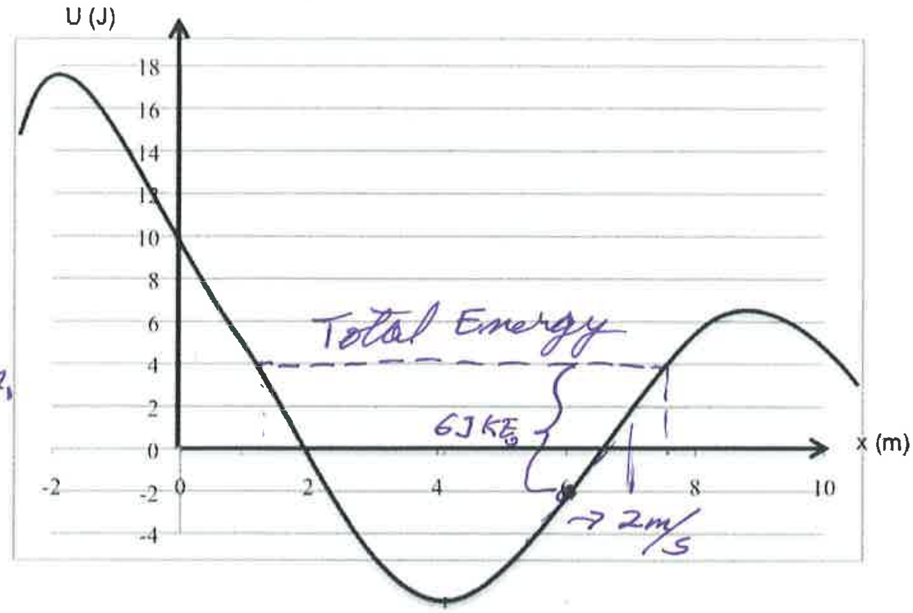
3. You see below a potential energy diagram for a **3 kg mass**, as a function of displacement. (positive x is to the right). The mass **starts out at $x = 6$ m moving at 2 m/s** to the right. *There may be more than one correct answer. In this case, list all correct answers.*

   a) WIs the mass accelerating at this point? If so, estimate the acceleration.

   b) Are there any turning points, or does the mass go on forever? If there are turning points, please state their location(s)

   c) Is the mass in equilibrium at any point(s) in time? If so where?

(x = 6)



I will use Energy lens,

$m = 3k$

$KE_0 = \frac{1}{2} m v^2$

$= \frac{1}{2} \cdot 3kg \cdot 4 \frac{m^2}{s^2}$

$= 6\ J$

a) is Energy + dynamics

$J/m \equiv N$

a) $= \frac{F}{m} = \frac{-\frac{dE}{dx}}{m} = \frac{-\frac{4J}{m}}{3kg} = -\frac{4}{3} \frac{m}{s^2}$

b) $x \approx 7.4m$, $1.4m$

c) around $x = 4m$, the gradient $= F = a(m) = 0$