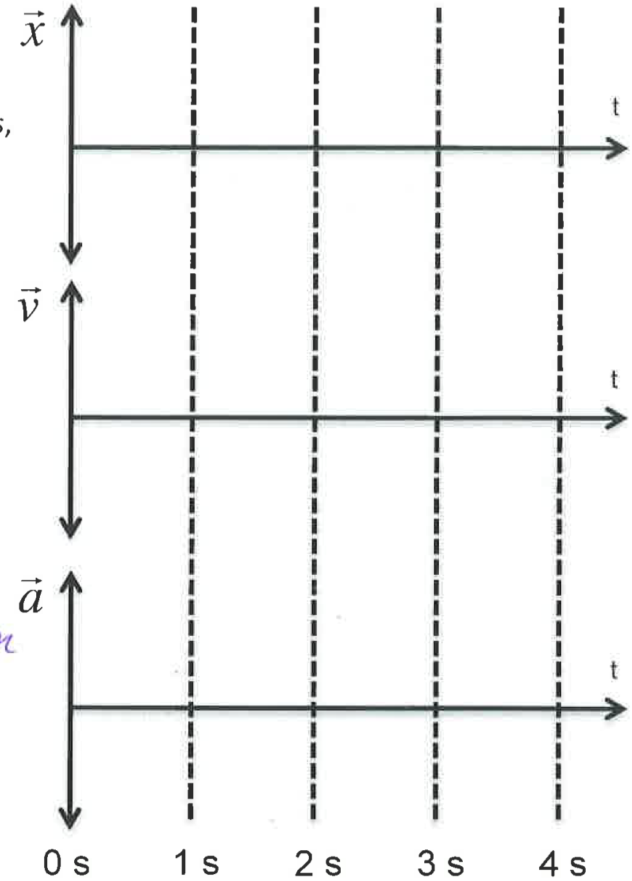
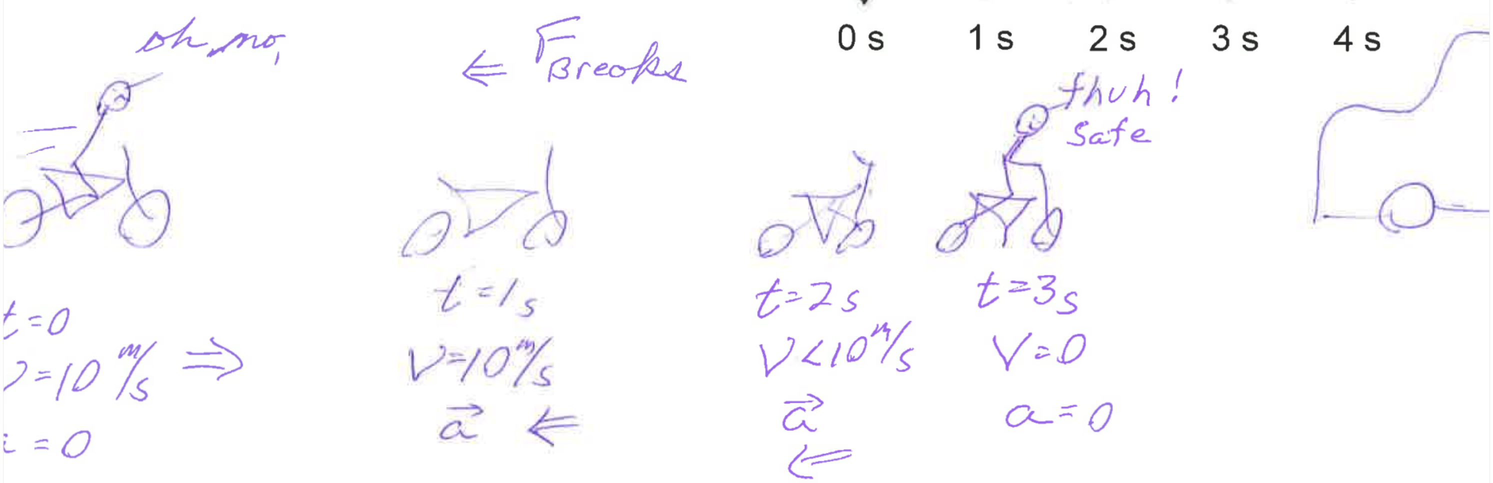
Big Exam #1 Use both sides. Put your name at the end

#1: My mass is *70 kg*, and the mass of my bike is *10 kg*. I'm riding my bike at a speed of *10 m/s* on flat ground. At *t = 0s*, my position is *x = -15 m*, then I see a car. At *t = 1s*, I apply my breaks, and smoothly slow to a stop over a period of two seconds.

a) Please graph my acceleration, velocity, and displacement as a function of time. Label the axes correctly. *Then* please also find:
b) The force exerted by my breaks;
c) the work done by my breaks and the average power.
d) Was energy conserved in this process? How?
e) Was momentum conserved in this process? How?



a) I use the kinematics lens because these graphs + the story are explictly functions of position + motion.



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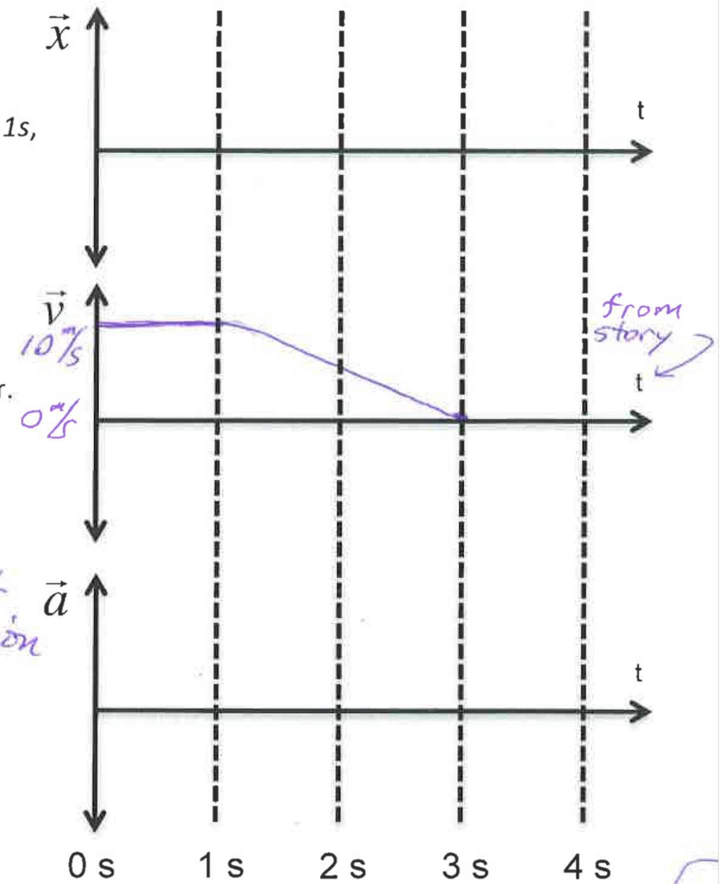

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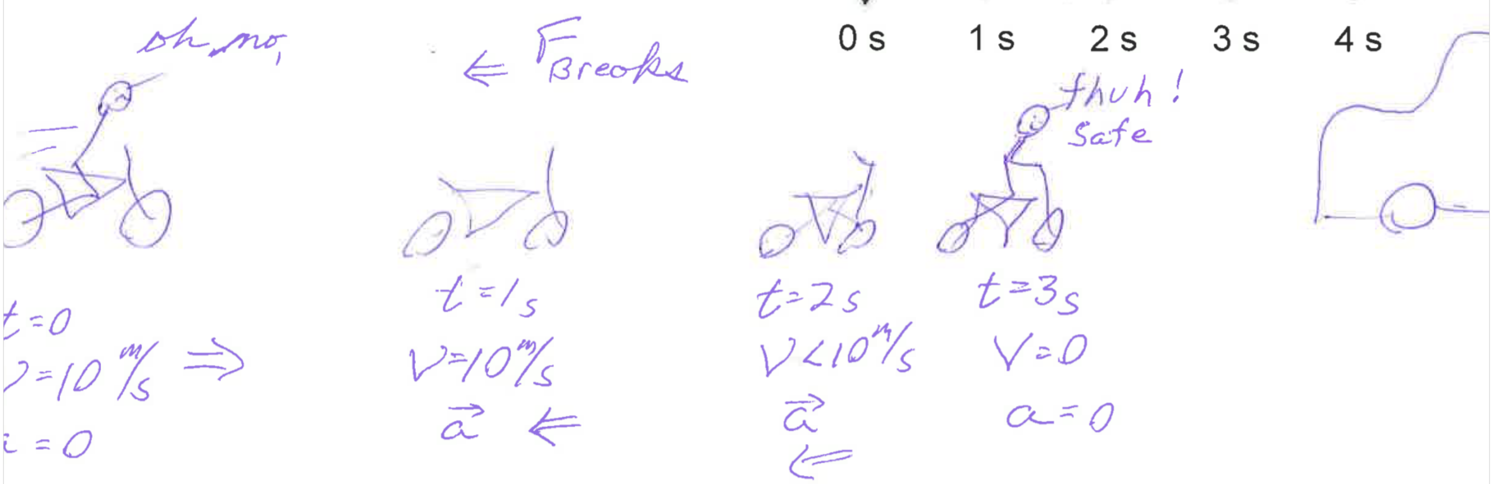

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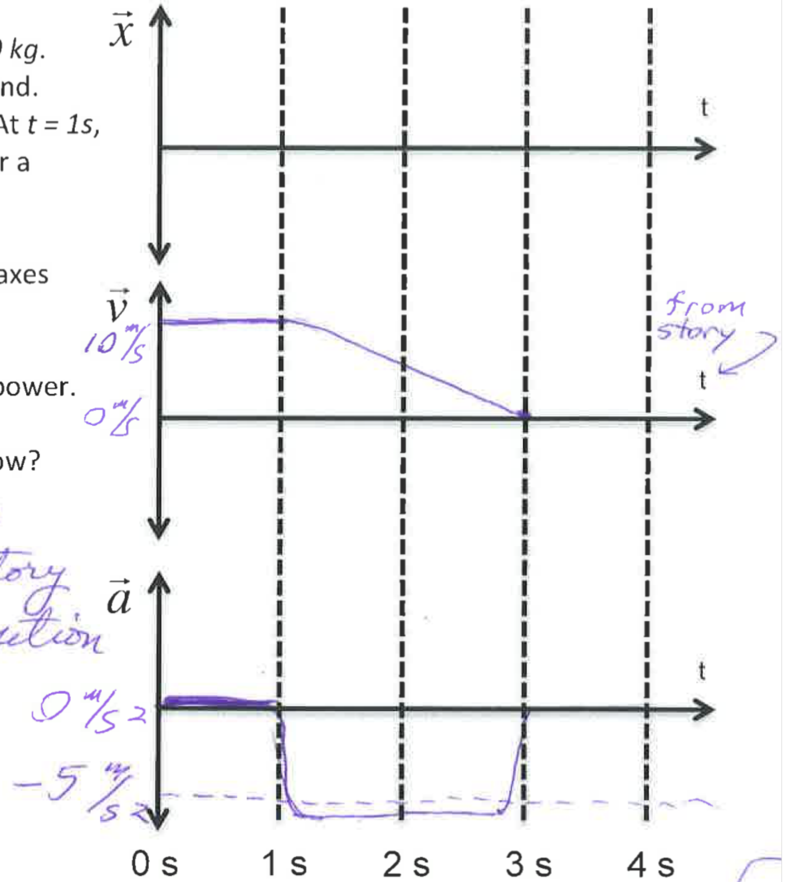

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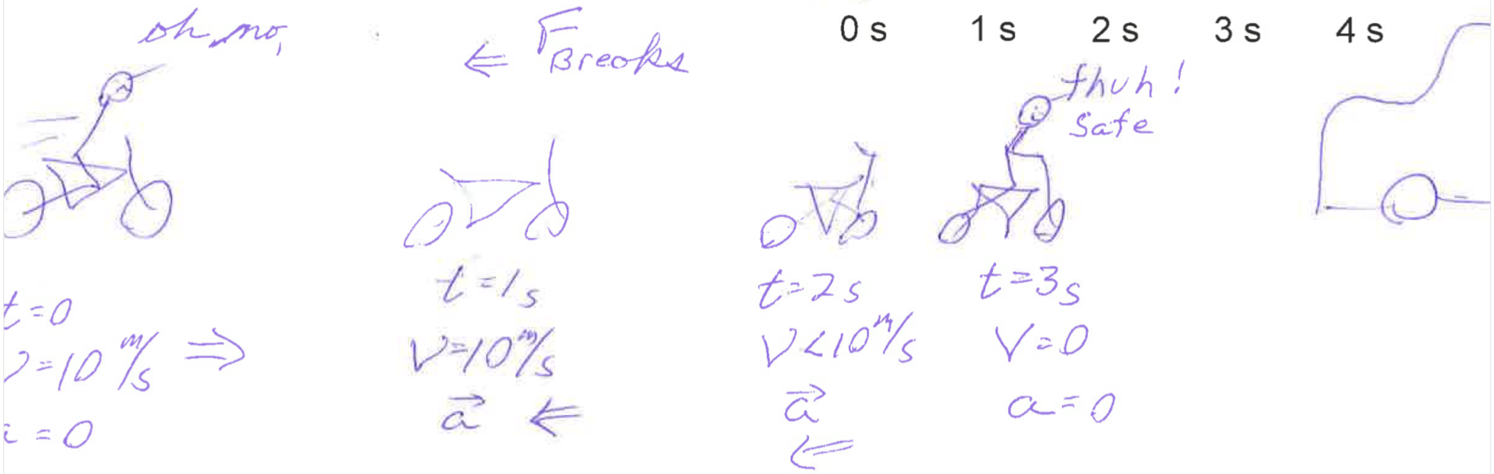

Graphs -

$a = \frac{dv}{dt}$ = slope of $v \leftrightarrow t$ graph,

$a = 0$ until $t = 1s$ then $a_{ave} = \frac{\Delta v}{\Delta t} = \frac{-10\ m/s}{2s} = -5\ m/s^2$

so, if I choose to ease my breaks in + out, then the a_{max} must be a little greater than $5\ m/s^2$ as I show

Position, x ... $V = \frac{dx}{dt}$, so $dx = V dt$ or area under the V-t curve or slope of x-t graph $= V$. so slope is +, const from $1 \to 2$ s and decreases but remains ~~const~~ + until $t = 2$s + is flat. The area under the $V \leftrightarrow t$ graph is 10^m @ $t = 1$s + 20m @ $t = 3$s, so

$X_{(0)} = -15$m , $X_{(1s)} = -5$m $X_{(3s)} = +5$m

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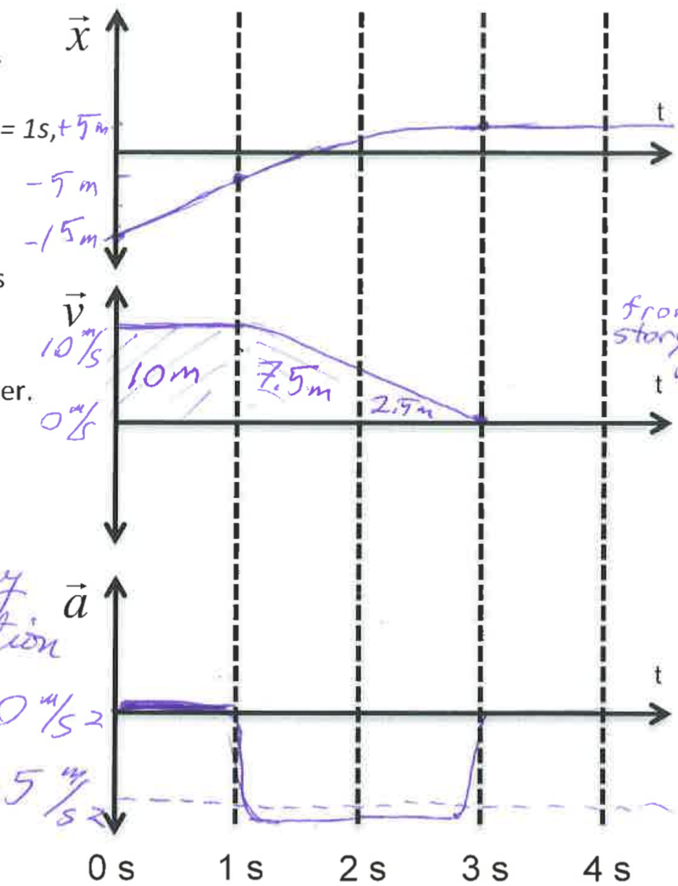

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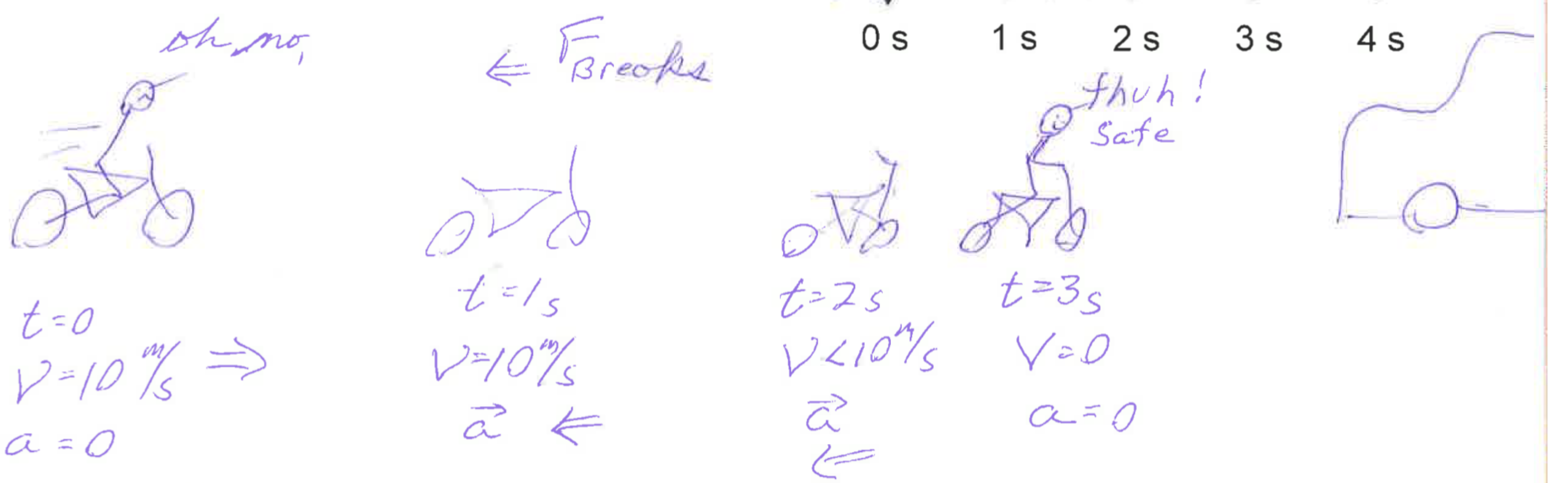

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$X_{(0)} = -15 m$, $X_{(1s)} = -5 m$ $X_{(3s)} = +5 m$

b) I want $\vec{F}_{Breaks}$, + I could use an Energy lens because F is the gradient of Energy + this $(F = \frac{dE}{dt})$ is beautiful, but I'll use dynamics (or $\vec{p}$ because $F = \frac{dp}{dt}$) because I already know $m, a_{(t=3s)}$

$F = ma \approx 80 kg(-5 m/s^2) = -400 kg\, m/s^2 = -400 N$ ←

c) I use work/Energy lens because $W = F dx$ $= -400N \cdot 10 m$ $= -4000 J$

or $\underline{\Delta E} = \frac{1}{2} m V_f^2 - \frac{1}{2} m V_0^2 = -4000 \frac{kg\, m^2}{s^2}$

(V_f ↑ 0 m/s, V_0 ↑ 10 m/s)

t = 2s, so $P = \frac{dE}{dt} = \frac{dW}{dt} = \frac{-4000J}{2s} = -2000W$

d) Energy lens because we explicitly ask about energy. Energy is conserved + transformed from $E_k \Rightarrow E_{therm}$ (breaks)

e) momentum lens because we discuss p explicitly. momentum is conserved + transmitted from the bike to the earth through the force of friction on tires.

Name ⇒ Pete Schwartz