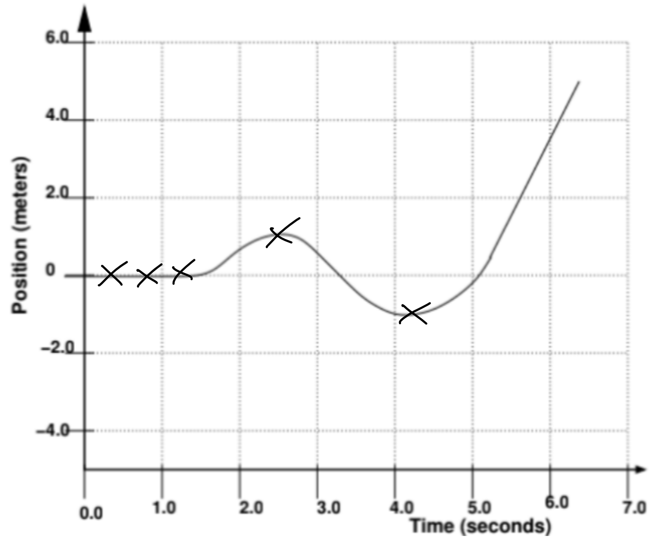
SI Summary Session 1

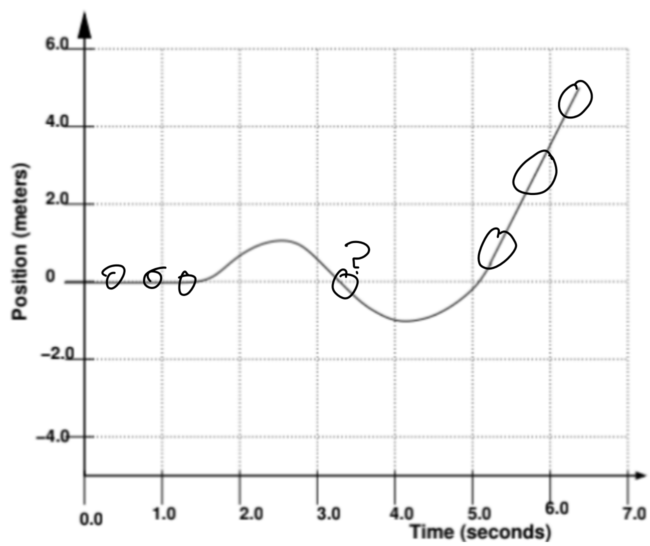
Problem 2)

1 a)



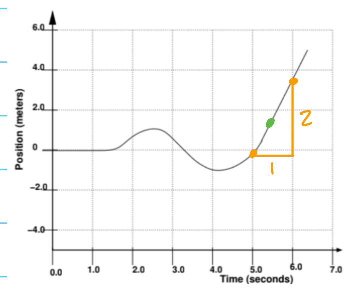
The particle is instantaneously at rest when the velocity = 0. Def of velocity says velocity is derivative of position. At rest at any instant when the slope = 0.

1b)



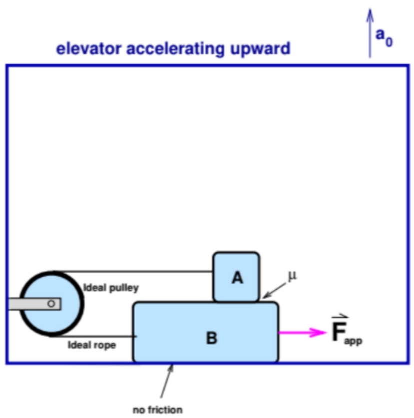
Again the definition of velocity states that the time derivative of position is velocity. velocity, therefore, must be constant if position is linearly changing, as the derivative of a linear equation is a constant.

1c) The maximum speed can be found at the point where the velocity, or slope by definition, of the particle is at its greatest. This is around the circled region, and the slope calculation is below.



About 2 m/s

Problem 1)



Given: Block A mass: m_A

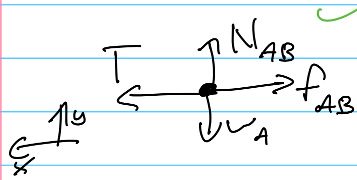
Block B mass: m_B

Kinetic Friction: μ_K

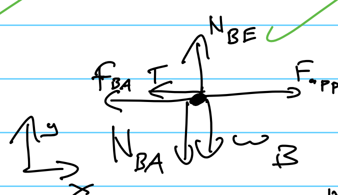
F_{app} on B

Accel up at a_0

a) FBD A



FBD B



b) N2L $F_{A_y}=m_A a_{A_y}$

$N_{AB}-w_A=m_A a_0$

$N_{AB}=m_A a_0+m_A g$

$$\boxed{N_{AB}=m_A(a_0+g)}$$

c) $F_{B_y}=m_B a_{B_y}$ N2L

$N_{BE}-w_B-N_{BA}=m_B a_{B_y}$

$N_{BA}=N_{AB}$ N3L

$N_{BE}=m_B a_0+w_B+N_{AB}$

$N_{BE}=m_B a_0+m_B g+m_A(a_0+g)$

$\Rightarrow N_{BE}=m_B(a_0+g)+m_A(a_0+g)$

$$\boxed{N_{BE}=(m_A+m_B)(a_0+g)}$$

d) N2L $F_{A_x}=m_A a_{A_x}$

$T-f_{AB}=m_A a_{A_x}$

Kinetic Friction $f_{AB}=\mu_K N_{AB}$

$f_{AB}=\mu_K(m_A(a_0+g))$

$T-\mu_K(m_A(a_0+g))=m_A a_{A_x}$

Stop!

$T=m_A a_{A_x}+\mu_K(m_A(a_0+g))$

N2L $F_{B_x}=m_B a_{B_x}$

$F_{app}-T-f_{BA}=m_B a_{B_x}$

$f_{AB}=f_{BA}$ N3L

$F_{app}-T-\mu_K(m_A(a_0+g))=m_B a_{B_x}$

$T=m_B a_{B_x}-\mu_K(m_A(a_0+g))-F_{app}$

$m_A a_{A_x}+\mu m_A(a_0+g)=-m_B a_{B_x}-\mu m_A(a_0+g)+F_{app}$

$a_{A_x}=a_{B_x}=a_x$ Kinematic constraint

$m_A a_x+2\mu m_A(a_0+g)=-m_B a_x+F_{app}$

$m_A a_x+m_B a_x=F_{app}-2\mu m_A(a_0+g)$

$a_x(m_A+m_B)+2\mu m_A(a_0+g)=F_{app}$

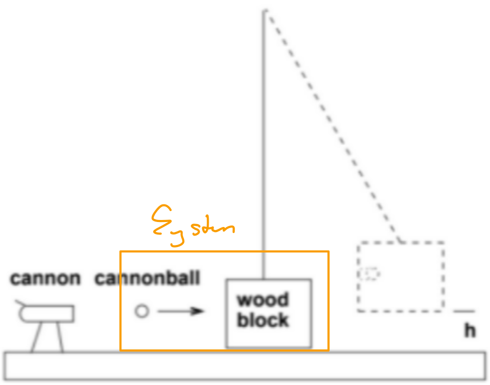
$$a_x=\frac{F_{app}-2\mu m_A(a_0+g)}{m_A+m_B}$$

This is correct just not fully simplified

$$T=\frac{m_A(F_{app}-2\mu_K m_A(a_0+g))}{m_A+m_B}+\mu_K m_A(a_0+g)$$

$$\boxed{T=\frac{F_{app}-2\mu_K m_A(a_0+g)}{1+\frac{m_B}{m_A}}+\mu_K m_A(a_0+g)}$$

Problem 3)



Given: Cannonball Mass $= m_c$

Velocity of CB $= V_0$

Wooden Block mass $= m_b$

height h

a) C of LM Totally Inelastic

Ball and Block System, Isolated ✓

Before = After

$P_{Tot} = P'_{Tot}$

$m_A v_A + m_B v_B = m_A v_A' + m_B v_B'$

$v_A' = v_B' = v'$ bc totally inelastic

$m_c V_0 + m_b 0 = m_c v' + m_b v'$

$$\boxed{v' = \frac{m_c V_0}{m_c + m_b}}$$

b) C of ME

All does 0 work on Ball/Block System. Tension and Normal are perp.

Before = After

$E_{Tot} = E'_{Tot}$

System

Mass $= m_c + m_b$, $V_0 = \frac{m_c V_0}{m_c + m_b}$

$\frac{1}{2}\cancel{m}v^2 + \cancel{m}gh = \frac{1}{2}\cancel{m}v'^2 + \cancel{m}gh'$

$h' = \frac{\frac{1}{2}v^2 + gh - \frac{1}{2}v'^2}{g}$ $\Rightarrow$ $\frac{\frac{1}{2}v^2}{g} = \boxed{\frac{(m_c V_0)^2}{2g(m_c + m_b)^2}}$

$h_0 = 0$, $v_f = 0$

c) Work Energy Relation

$W_{Tot} = \Delta K$

$W_{Tot} = \frac{1}{2}mv'^2 - \frac{1}{2}mv^2$

$v_0 = 0 \rightarrow v' = V_0$

$$\boxed{W_{Tot} = \frac{1}{2}m_c V_0^2}$$

d) Work done by Tension is 0. Assuming Block is moving with the rope and not fighting it then the tension is perp. to direction of motion $\Rightarrow$ 0 work done

e) $W_w = -\Delta U$

$W_w = -mgy' + mgy$

$y = 0 \Rightarrow W_{\vec{\omega}} = m_c g h' \rightarrow W_{\vec{\omega}} = \frac{-(m_c V_0)^2 m_c g}{2g(m_c + m_b)^2}$

$$W_{\vec{\omega}} = \frac{-(m_c V_0)^2 m_c}{2(m_c + m_b)^2}$$

f) No, the Cannonball does work on the Block during collision. For inelastic $\rightarrow$ energy lost !!