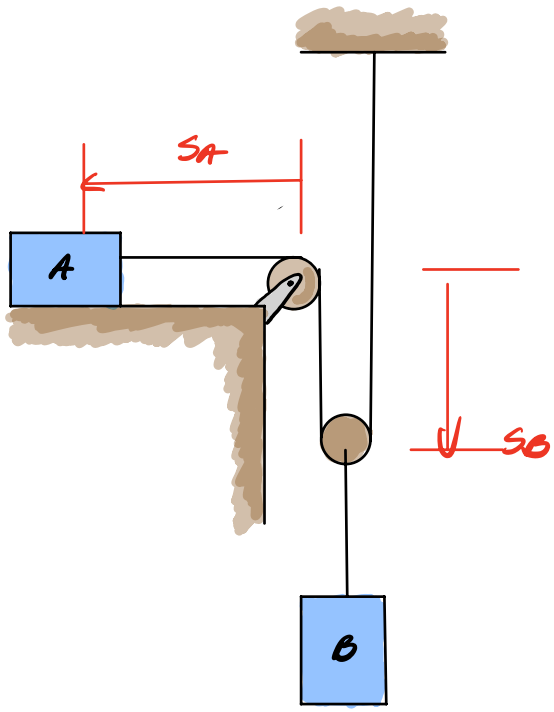
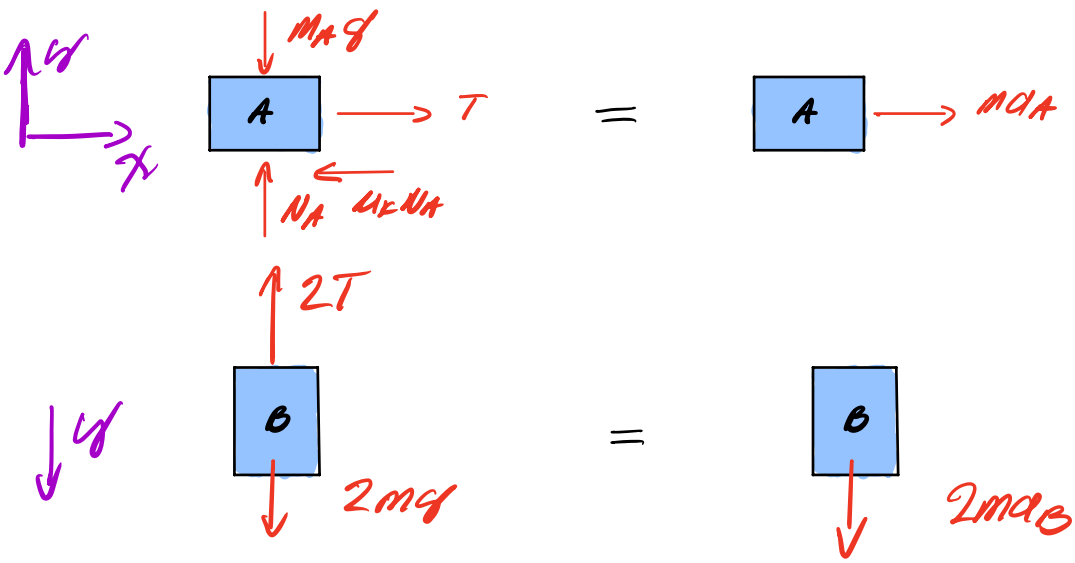
Block A of mass $m = 10\,kg$ is traveling to the right at $v_A = 2\,ft/s$ at the instant shown. If the coefficient of kinetic friction is $\mu_k = 0.2$ between the surface and A, determine the acceleration of A and B. Block B has a mass of $2m$.



Step ① FBD



Step ② Kinetic Equations

Block A

$\xrightarrow{+} \Sigma F_x : \quad T - \mu_k N_A = m a_A$

$+\uparrow \quad \Sigma F_y : -mg + N_A = 0$

Block B

$+\downarrow \quad \Sigma F_y : -2T + 2mg = 2m a_B$

$N_A = mg$

$$\left.\begin{aligned} T - \mu_k m g &= m a_A \\ -2T + 2mg &= 2m a_B \end{aligned}\right\}$$

2 eqns
3 unknowns
a_A, a_B, T

Step ③ Kinematics

$L = s_A + 2s_B = 0$

$\frac{dL}{dt} = \dot{s}_A + 2\dot{s}_B = 0$

$\frac{d^2L}{dt^2} = \ddot{s}_A + 2\ddot{s}_B = 0$

$\ddot{s}_A = -2\ddot{s}_B$ in cable coordinate system

This a source of confusion. We need to convert from local to global

$a_A = -\ddot{s}_A$

$a_B = +\ddot{s}_B \longrightarrow \ddot{a}_A = +2a_B$

Think of it this way

$a_A \leftarrow \quad a_B = 2a_A \uparrow$

$a_A \rightarrow \quad a_B = 2a_A \downarrow$

} What we need

Now we defined in our summation of forces a_A is positive to right and a_B is positive downward and equal to $2a_A$

$$T - \mu_k m g = m a_A$$

$$-2T + 2mg = 2m a_B$$

$2a_B$ ~ I assumed $a_A \rightarrow$ and $a_B \downarrow$

I just need the relationship and to know what the cable equation means

$$T - \mu_k m g = 2m a_B$$

$$-2T + 2mg = 2m a_A$$

solving

$$T = \frac{mg(\mu + 2)}{3} = \frac{10 \cdot 9{,}81\,(0{,}2 + 2)}{3} = 71{,}94\,N$$

$$a_B = \frac{g(1 - \mu)}{3} = \frac{9{,}81\,(1 - 0{,}2)}{3} = 2{,}62\,m/s^2$$