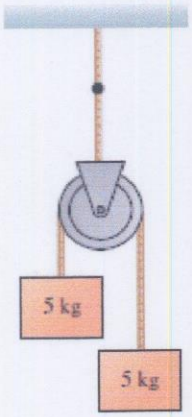
**Group Problems: connected objects**

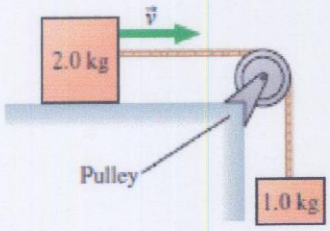
CQ 19 Both objects are at rest. The strings and pulley are massless, and the pulley is frictionless. Determine the tension at the point indicated by the dot.




prob. 40 A 220 kg truck has put its front bumper against the rear bumper of a 2400 kg SUV to give it a push. With the engine at full power and good tires on good pavement, the maximum forward force on the truck is 18,000 N.

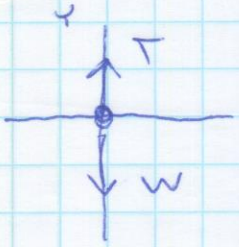
a. what is the maximum possible acceleration the truck can give the SUV?
b. at this acceleration, what is the force of the SUV's bumper on the truck's bumper?

prob 74 Two blocks are connected by a string as shown. What is the upper block's acceleration, if the coefficient of kinetic friction between the block and the table is 0.20?



Concept Q

5-17




$a = 0$

$\Sigma F_y = ma_y$

$T - W = 0$

$T = mg = 49\ N$

5-18

Look at right-hand side:

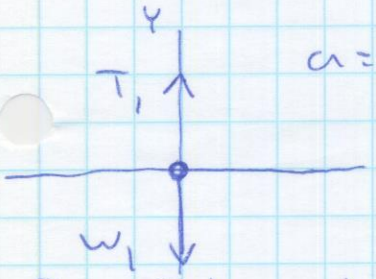
$\Sigma F = ma$

$T - W = 0$

$T = W = 49\ N$

Rope is motionless exactly as if it were tied to ceiling

5-19




$a = 0$

for 5 kg object either

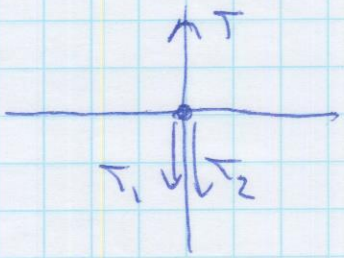
$\Sigma F_y = ma_y$

$T - W = 0$

$T = mg = 0$

$T = 49\ N$

so




for pulley

$\Sigma F_y = ma_y$

$T - T_1 - T_2 = 0$

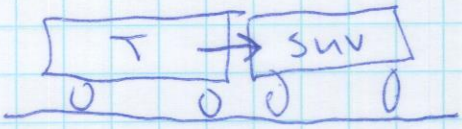
$T = T_1 + T_2$

$T_1 = 98\ N$

5-20

This is just like 5-18. Rope is motionless. Whether you look at left side or right, tension is 49 N

5-40




Both move together.

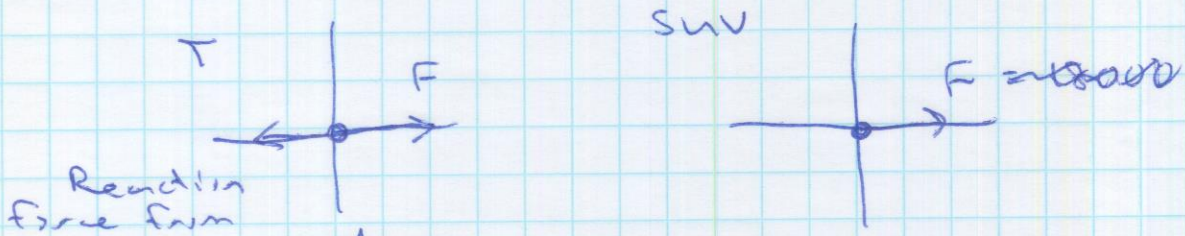
Max accel would be if no backwards forces, such as ONE BIG friction. (rolling friction)

$\therefore \Sigma F = ma$

$18000\ N = (2200 + 2400\ kg)\,a$

$a = 3.9\ m/s^2$

SEPARATE:




Reaction force from SUV: 3rd Law

$\therefore$ ~~$= 18000\ N$~~

$= 9400\ N$

$\Sigma F$ on SUV $= m_{SUV}\, a_{SUV}$

$= (2400\ kg)(3.9\ m/s^2)$

$= 9400\ N$

Check this: truck also accels at $3.9\ m/s^2$.

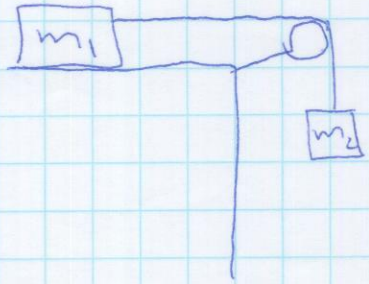
So $\Sigma F_{Truck} = m_T\, a_T$

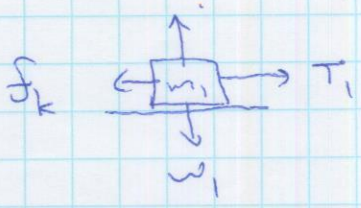
$= (2200\ kg)(3.9\ m/s^2)$

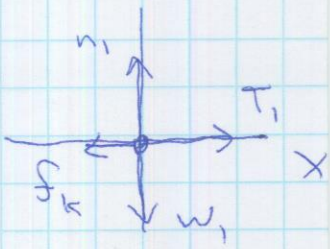
$F - Reaction = 8580$

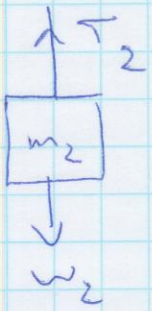
$18000 - Reaction = 8580$

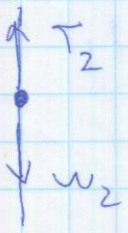
Reaction $F = 9400\ N$ ✓




My x-axis is this one! (positive down)

Block 2:

$\Sigma F_x = ma_x$

$w_2 - T_2 = m_2 a_{x2}$

$T_2 = w_2 - m_2 a_{x2}$

$T_2 = m_2 (g - a_{x2})$

Block 1:

$\Sigma F_x = ma_x$

$T_1 - f_k = m_1 a_x$

$T_1 = m_1 a_x + \mu_k n_1$

$= m_1 a_x + \mu_k (m_1 g)$

$\Sigma F_y = ma_y$

$n_1 - w_1 = 0$

$n_1 = m_1 g$

$T_1 = T_2$ in magnitude: 3rd law

$a_x$ of $m_1$ = $a_x$ of $m_2$: they must move together or string will break

So: $T_1 = T_2$

$m_1 (a + \mu_k g) = m_2 (g - a)$

$m_1 a + m_2 a = m_2 g - \mu_k m_1 g$

$(m_1 + m_2) a = g(m_2 - \mu_k m_1)$

$(3\,kg)\, a = 9.8\ m/s^2 [1.0\ kg - (.2)\, 2\,kg]$

$a = 2.0\ m/s^2$