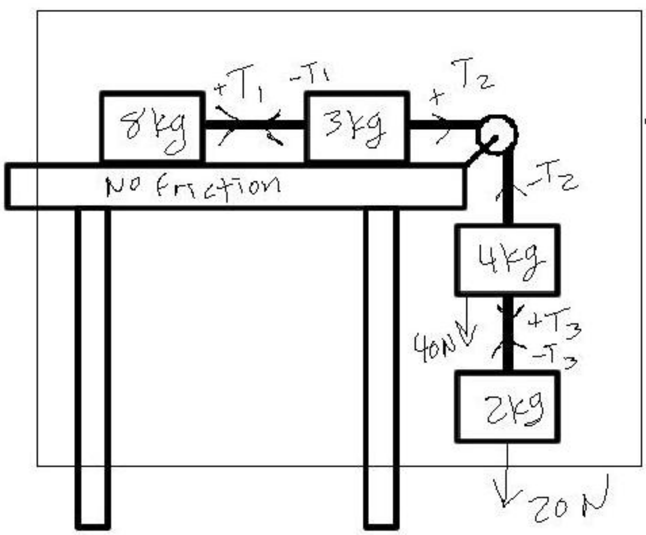
Finding the acceleration of a connected system using the system model.

It is assumed that you already know about common directions and which direction is positive. (See notes "Connected Objects and Ramps").




Our system includes all of the masses, if we want to find the acceleration of the whole system.

We use the "T" or "tension" direction: x-direction on the table and y-direction for the hanging objects, since the tensions are what unify the system.

On the left side of F = ma we put all of the T-direction forces acting on each object. The "T's" will show up twice: once for each mass they are attached to.

$$\Sigma F_T = m a_T$$

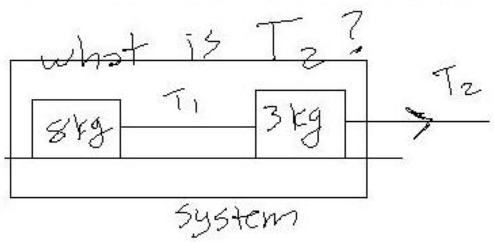
$$\underbrace{+T_1 - T_1 + T_2 - T_2 + T_3 - T_3}_{\text{cancel}} + 40 + 20 = 17a$$

Just as we saw with the substitution method, the T's cancel each other out.

$$60 = 17a$$

$$a = 3.53\ m/s^2$$

But what if we want to find the tension in one of the ropes? We simply reduce our system so that only one of the ropes pulls outside the system.

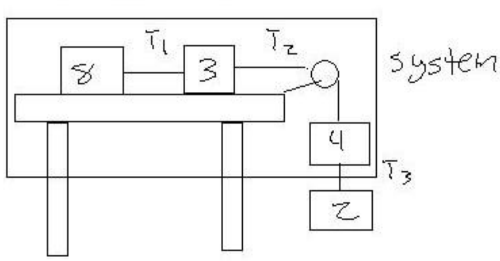



$$\Sigma F_T = m a_T$$

$$T_2 = 11(3.53)$$

Use the system acceleration we just found.

There are 2 methods to find T3, since you can define your system in 2 ways.




We can have the three upper masses as our system

$$\Sigma F_T = ma \quad \text{(the Ts will cancel)}$$

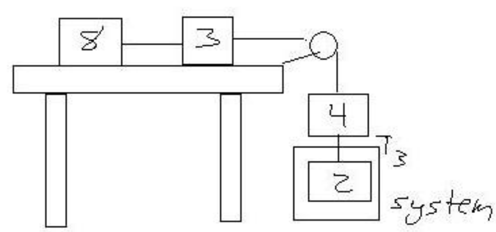
$$40 + T_3 = 15a$$

weight of 4kg mass

mass of 8kg, 3kg + 4kg

$$T_3 = 15(3.53) - 40$$

$$T_3 = 12.95N$$




OR just the 2 kg mass as our system. Either way T3 is external.

$$\Sigma F_T = m a_T$$

$$20 - T = 2(3.53)$$

$$20 - 2(3.53) = T$$

$$12.94\ N = T$$

The small difference is because we rounded when solving for acceleration.