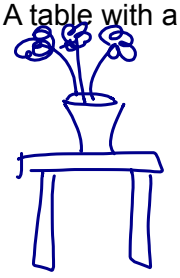
mass is in kg

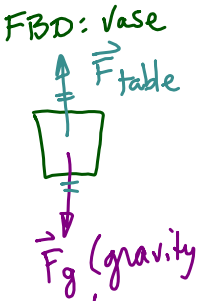
3.2 Free-Body Diagrams

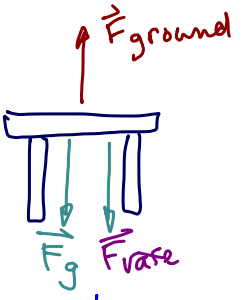
NOTE weight is a Force (N)

A Free-Body Diagram (FBD) is a representation of the body in question and the forces acting on it. The forces on the diagram are always drawn pointing away from the object.

ex. A table with a vase on it.



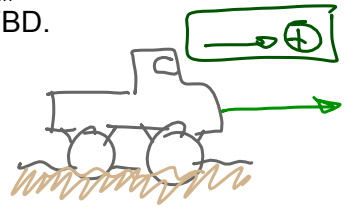


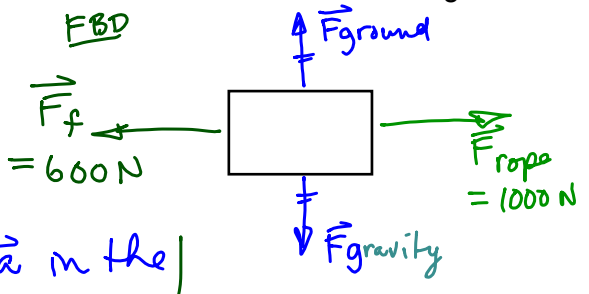


Note: Since neither object is accelerating, the 2nd law states that $\vec{F}_{net} = 0$ for both objects. Therefore,

$\vec{F}_g = \vec{F}_{table}$ $\qquad$ $\vec{F}_g + \vec{F}_{vase} = \vec{F}_{ground}$

ex. A truck is being pulled out of the mud. If tension on the rope is 1000 N and $F_{friction}$ is 600 N, what is the acceleration if the truck's mass is 2000 kg? Draw an FBD.





since there is no $\vec{a}$ in the vertical, $\vec{F}_g = \vec{F}_{ground}$

in the horizontal $\vec{F}_{net} = \vec{F}_{rope} - \vec{F}_{friction}$

$= 1000\text{ N} - 600\text{ N}$

$= 400\text{ N}$ [forward]

but $\vec{F}_{net} = m\vec{a}$

$\frac{400\text{ N}}{2000\text{ kg}} = \frac{2000\text{ kg}\,\vec{a}}{2000\text{ kg}}$

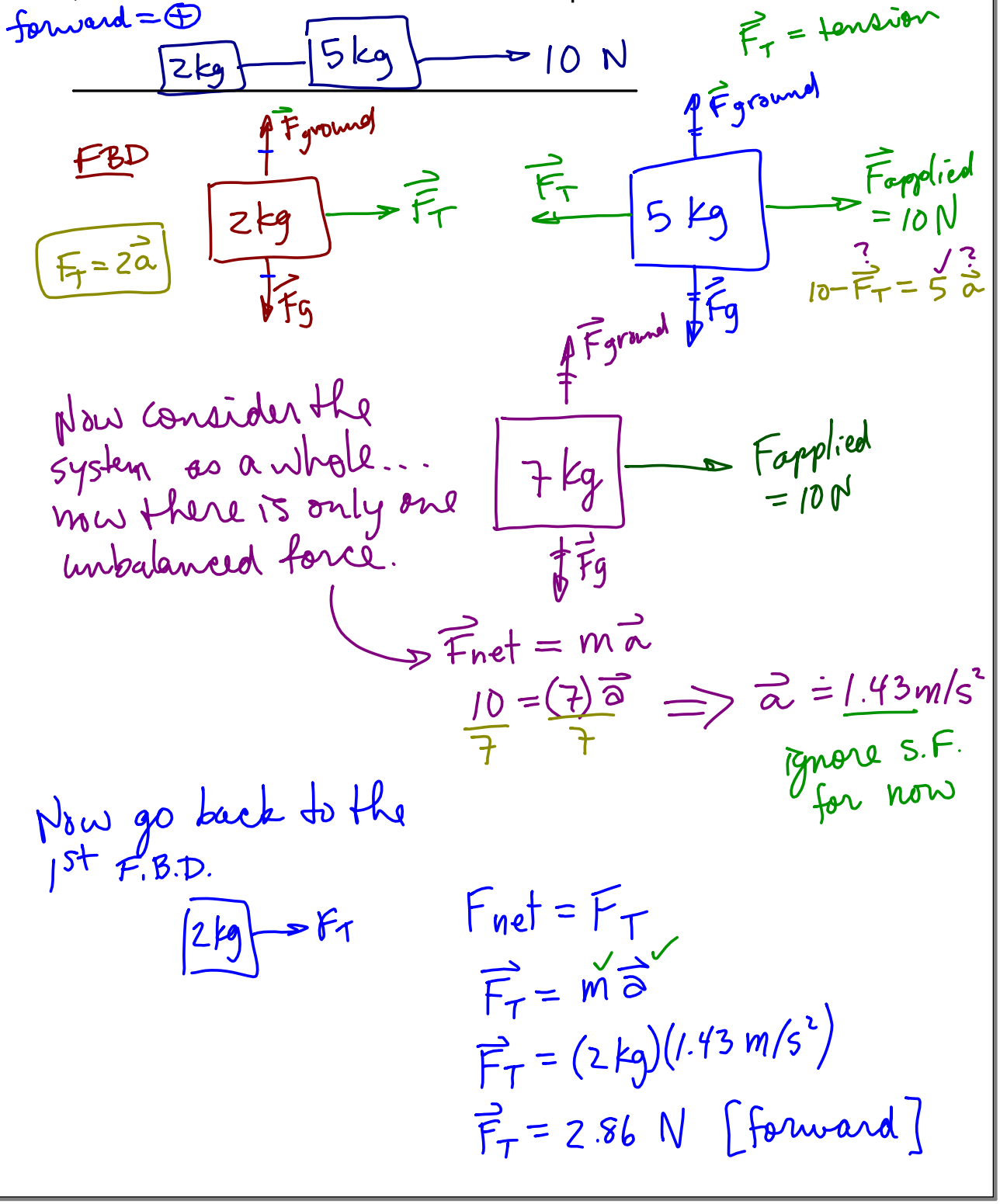
$0.2\ \frac{\text{kg m/s}^2}{\text{kg}} = \vec{a}$

$\vec{a} = 0.2\text{ m/s}^2$

$\vec{F} = m\vec{a}$

$[\text{N}] = [\text{kg}][\text{m/s}^2]$

ex. 2 boxes are tied together and are being pulled by a rope. If there is no friction, find $\vec{a}$ for both and the tension in the rope between the boxes.



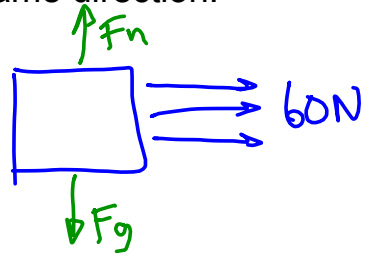
ex. For a person on a toboggan being pulled by three friends, find the acceleration for the following situations. The mass of the person on the toboggan is 60 kg and each friend can pull 20 N. Draw an FBD for each case.

a) they all pull in the same direction

b) two pull forward, one pulls backwards

c) There is a 30 N force of friction acting on the toboggan and all the friends pull in the same direction.

a)



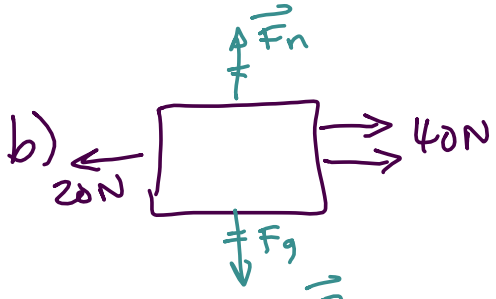
$F_{net} = 60N$

$F_{net} = m\vec{a}$

$\frac{60N}{60} = \frac{60kg \cdot \vec{a}}{60}$

$\vec{a} = 1\ m/s^2$

b)

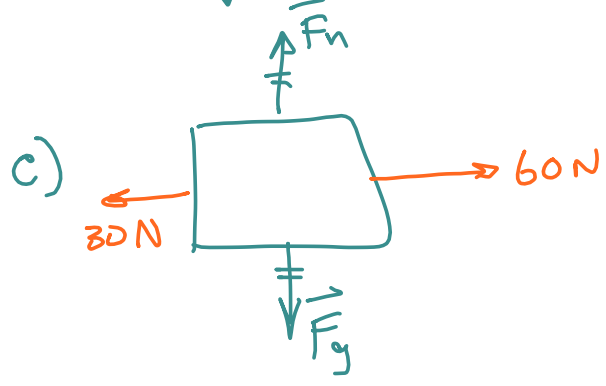


$F_{net} = 20N$

$\frac{20N}{60} = \frac{60kg \cdot \vec{a}}{60}$

$\vec{a} = 0.3\ m/s^2$

c)



$F_{net} = 60N - 30N$

$= 30N$

$\frac{30N}{60} = \frac{60kg \cdot \vec{a}}{60}$

$\vec{a} = 0.5\ m/s^2$

practice: photocopy #36acegi, 37, 38, 40 - 43