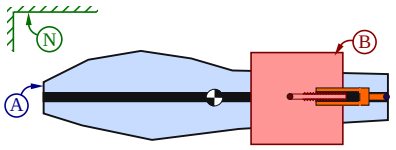
$\vec{\mathbf{F}} = m\,\vec{\mathbf{a}}$ **FBD, MG road-maps, and concepts for translating mechanical systems.**

14.1 Concept: Translational motion? (free-body diagrams)

A rigid body B is connected to a rigid body A with a force actuator (pushes B apart from A). Initially, A and B are **at rest** (stationary) in deep empty space in a Newtonian (inertial) reference frame N.

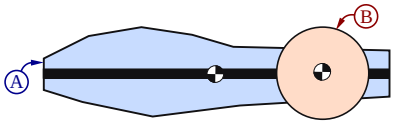
Using physical intuition, guess if the force actuator can move:

• A's mass center in N?	**Yes/No**
• B's mass center in N?	**Yes/No**
• System mass center in N?	**Yes/No**

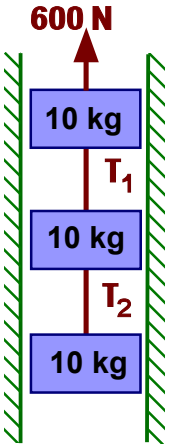


Verify each guess with an equation of motion (3^{rd}-column above).

The previous 3 answers are the **same/different** if B is connected to A with a torque/rotational motor (instead of a force actuator).



14.2 FE/EIT Review – Tension in vertical ropes (free-body diagrams). $\vec{\mathbf{F}} = m\,\vec{\mathbf{a}}$



$T_1 = T_2$

True/False

The figure to the left shows three 10 kg rigid blocks that are in a smooth (**frictionless**) vertical slot. The set of interconnected blocks is pulled vertically-upward with a 600 N force.

Under the figure to the left, circle **True** if the tensions T_i ($i = 1, 2$) in the light (massless) inextensible ropes are equal. Otherwise, circle **False** and report numerical values for T_1 and T_2 below. Approximate Earth's gravitational acceleration as $g = 10\ \frac{\text{m}}{\text{s}^2}$.

Repeat this analysis when the same set blocks has its bottom-most block fastened to a rigid floor (shown to the right).

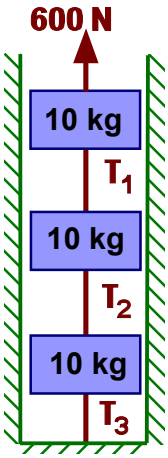
Result:

If **False** for left system:

$T_1 =$ _____ N $\quad T_2 =$ _____ N

If **False** for right system:

$T_1 =$ _____ N $\quad T_2 =$ _____ N

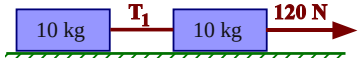


$T_1 = T_2 = T_3$

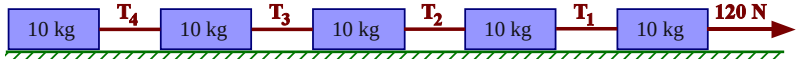
True/False

14.3 FE/EIT Review – Tension in horizontal ropes (free-body diagrams). $\vec{\mathbf{F}} = m\,\vec{\mathbf{a}}$

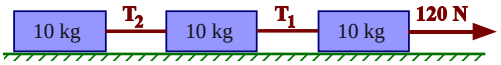
The following figures show rigid blocks, each of mass 10 kg, that are in contact with a smooth (**frictionless**) flat horizontal Newtonian reference frame. Each set of interconnected blocks is pulled horizontally-right with 120 Newtons. Using ***free-body diagrams***, determine the tension T_i (i = 1, 2, ...) in each light inextensible ropes connecting the blocks.



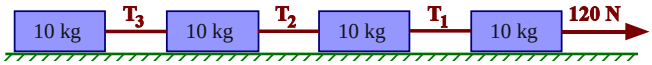
$T_1 =$ _____ Newtons



$T_4 =$ _____ N $\quad T_3 =$ _____ N $\quad T_2 =$ _____ N $\quad T_1 =$ _____ N



$T_2 =$ _____ N $\quad T_1 =$ _____ N



$T_3 =$ _____ N $\quad T_2 =$ _____ N $\quad T_1 =$ _____ N

Hint: Consider ***MG road-maps*** and first calculate system center of mass acceleration, then T_1, then T_2, etc.