Newton's Third Law

Every force occurs as one member of an *action/reaction* pair of forces.
- The two members of an action/reaction pair act on two *different* objects.
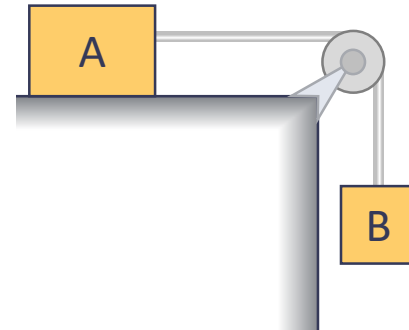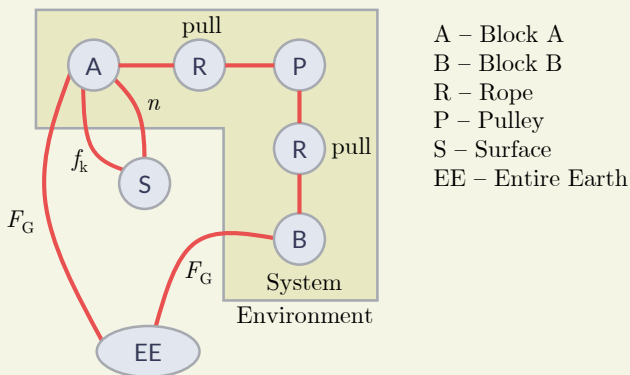- The two members of an action/reaction pair are equal in magnitude and opposite in direction:

$$\vec{F}_{\text{A on B}} = -\vec{F}_{\text{B on A}}$$

Interaction Diagrams

To help understand the interaction between objects you can make an *interaction diagram*. Each object is represented abstractly and forces between objects are shown as lines.
- The *system* consists of the objects you want to analyze.
- The *environment* is all objects that are external to the system.

For the two-block example system shown to the right, the interaction diagram would look like:

A – Block A
B – Block B
R – Rope
P – Pulley
S – Surface
EE – Entire Earth

Tension and Massless Strings

If a string is massless (or at least much lighter than the other objects), we can approximate the tension as being equal along the length of the string:

$$\vec{T}_{\text{S on A}} = -\vec{T}_{\text{S on B}}$$

If that's the case, we can ignore the string and treat tension forces $\vec{T}_{\text{A on B}}$ and $\vec{T}_{\text{B on A}}$ as though they are an action/reaction pair.

Acceleration Constraints

If two objects move together, they must have the same *acceleration*:

$$\vec{a}_{\text{A}} = \vec{a}_{\text{B}}$$

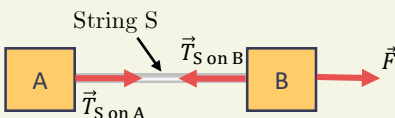The acceleration constraint for the two-block example system shown above would be

$$a_{\text{A}x} = -a_{\text{B}y}$$

with the negative sign appearing since the acceleration of block B is *downward*.

Pulleys

If we assume that both the string *and* the pulley are massless, and there's no friction in the axle of the pulley, then no net force is needed to turn the pulley. Therefore

Tension remains constant along the string as it passes over the pulley.

In the two-block example system shown above, the pulley doesn't affect the *magnitude* of the tension in the string, but does affect the *direction*:

$$T_{\text{B on A } x} = T_{\text{A on B } y}$$