Newton's Laws of Motion

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DEPARTMENT OF PHYSICS

MECHANICS 1 –FIRST SEMESTER

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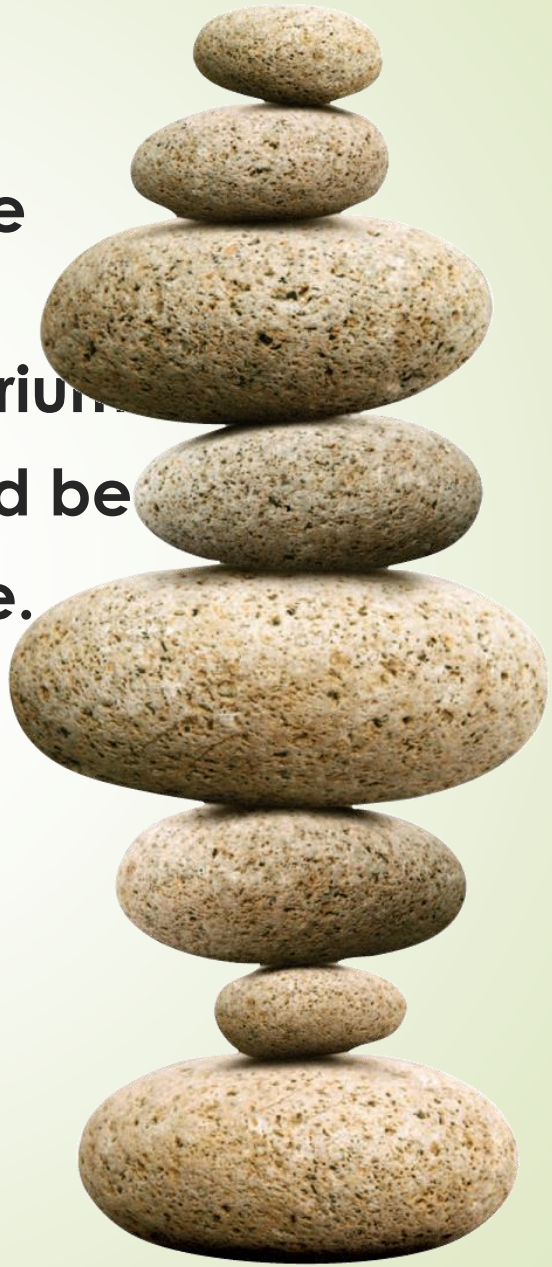
Things that are in balance with one another illustrate *equilibrium*.

Things in *mechanical equilibrium* are stable, without changes of motion.

The rocks are in mechanical equilibrium.

An unbalanced external force would be needed to change their resting state.



Mechanical Equilibrium

Mechanical equilibrium is a state wherein no physical changes occur.

Whenever the net force on an object is zero, the object is in mechanical equilibrium—this is known as the **equilibrium rule.**

Mechanical Equilibrium

$$\sum F = 0$$

The Σ symbol stands for “the sum of.”

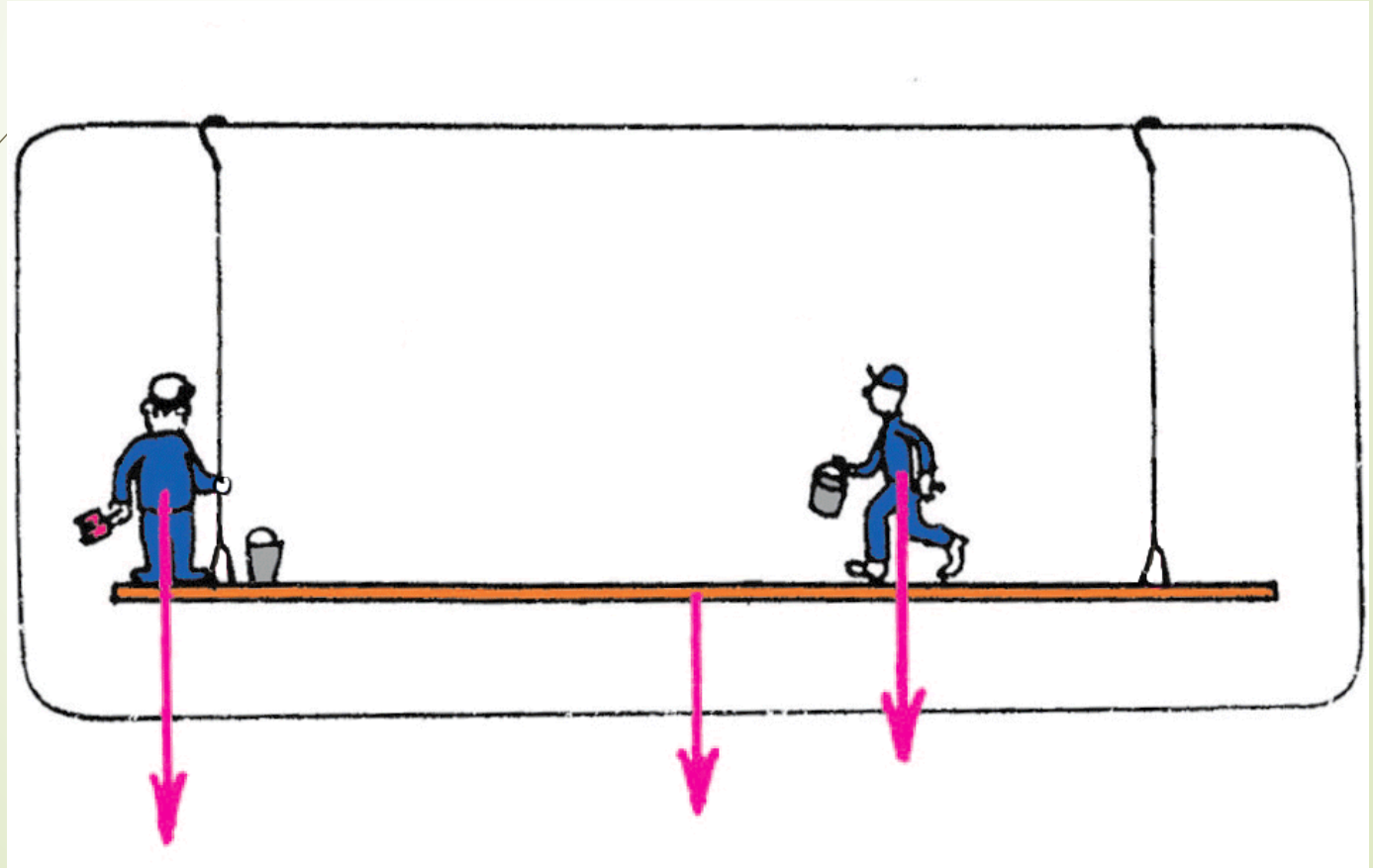
F stands for “forces.”

For a suspended object at rest, the forces acting upward on the object must be balanced by other forces acting downward.

The vector sum equals zero.

Mechanical Equilibrium

The sum of the upward vectors equals the sum of the downward vectors. $\Sigma F = 0$, and the scaffold is in equilibrium.



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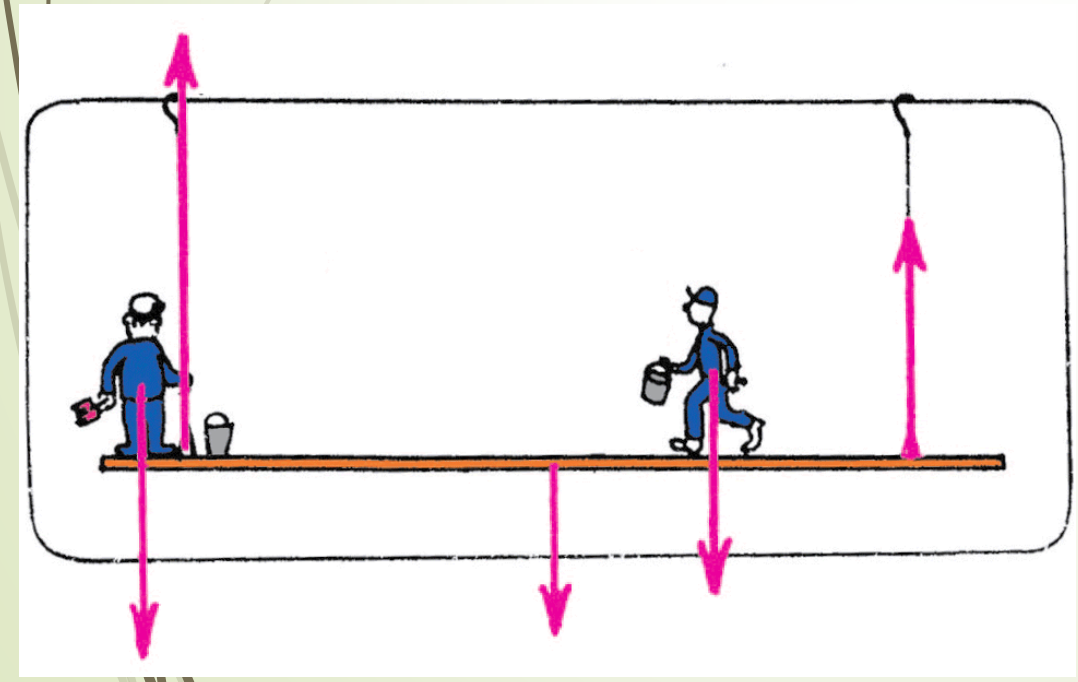

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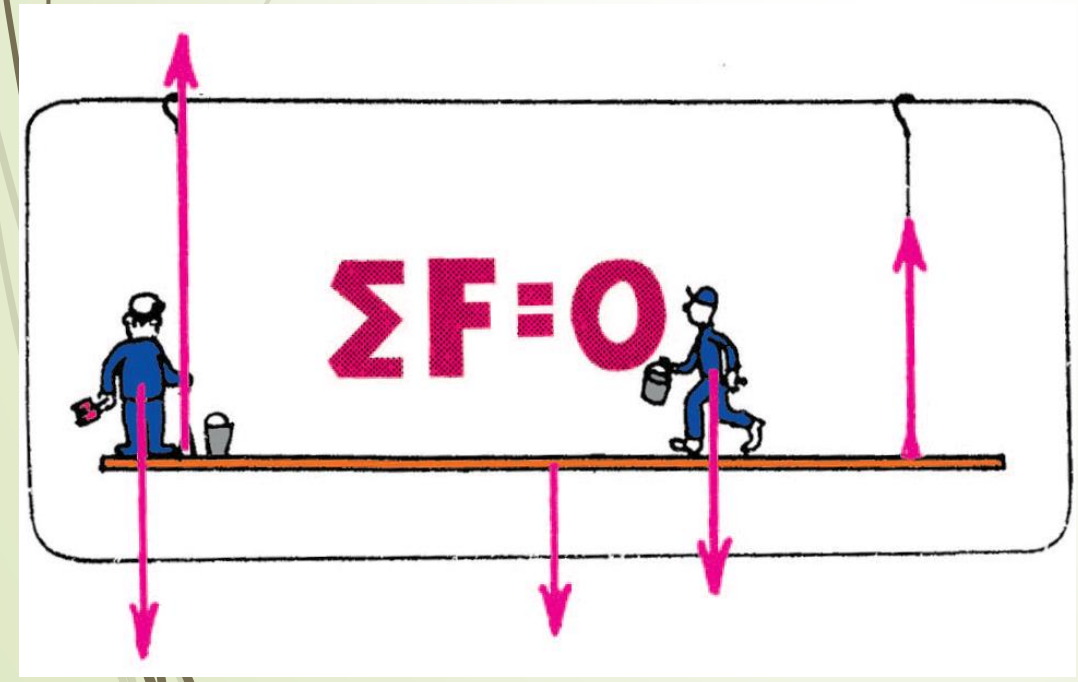


Equilibrium for stationary objects

- To find the force necessary to put something in equilibrium, first find the **resultant**.
- The force necessary to put something in equilibrium is called the **equilibrant force.**
- The equilibrant force is **equal but opposite** to the resultant.

Equilibrium for Moving Objects

The state of rest is only one form of equilibrium.
An object moving at constant speed in a straight-line path is also in a state of equilibrium. Once in motion, if there is no net force to change the state of motion, it is in equilibrium.

Equilibrium for Moving Objects

An object under the influence of only one force cannot be in equilibrium.
Only when there is no force at all, or when two or more forces combine to zero, can an object be in equilibrium.

Equilibrium for Moving Objects

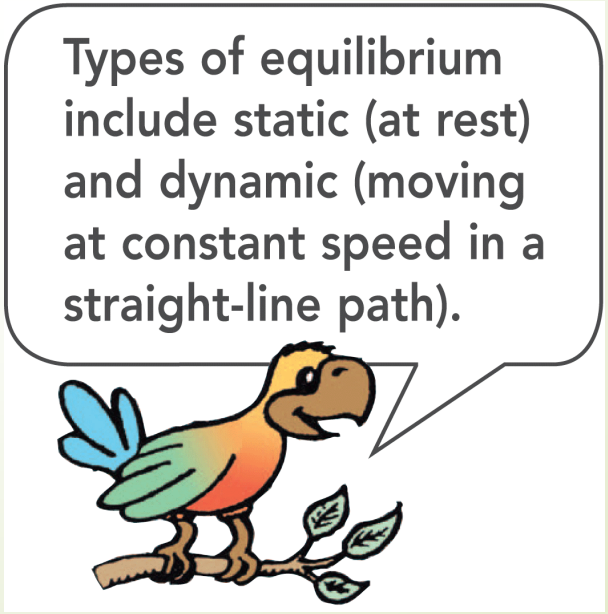
When the push on the desk is the same as the force of friction between the desk and the floor, the net force is zero and the desk slides at an unchanging speed.

Equilibrium for Moving Objects

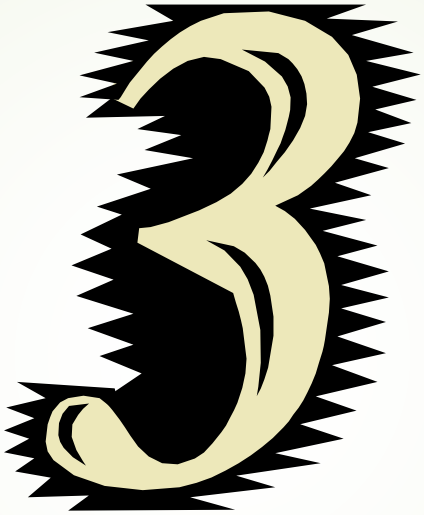
If the desk moves steadily at constant speed, without change in its motion, it is in equilibrium.

Friction is a contact force between objects that slide or tend to slide against each other.

In this case, $\Sigma F = 0$ means that the force of friction is equal in magnitude and opposite in direction to the pushing force.



Newton's Third Law



For every action there is an equal and opposite reaction.

What does this mean?

For every force acting on an object, there is an equal force acting in the opposite direction. Right now, gravity is pulling you *down* in your seat, but Newton's Third Law says your seat is pushing *up* against you with *equal force*. This is why you are not moving. There is a *balanced force* acting on you– gravity pulling down, your seat pushing up.

Newton’s Third Law

Newton’s third law describes the relationship between two forces in an interaction.

- One force is called the **action force.**
- The other force is called the **reaction force.**
- Neither force exists without the other.
- They are equal in strength and opposite in direction.
- They occur at the same time (simultaneously).

Newton's Third Law

When the girl jumps to shore, the boat moves backward.

Review

Newton's First Law:

Objects in motion tend to stay in motion and objects at rest tend to stay at rest unless acted upon by an unbalanced force.

Newton's Second Law:

Force equals mass times acceleration ($F = ma$).

Newton's Third Law:

For every action there is an equal and opposite reaction.

THANK YOU