Forces

Knowledge/Understanding Goals:

- what force is
- net force
- types of forces

Skills:

- identify the forces acting on an object

Notes: Definitions

force: (vector) the push or pull on an object.

weight: the force of gravity pulling an object downward.

opposing force: a force in the opposite direction of another force that reduces the effect of the original force.

net force: the overall force on an object after opposing forces cancel out.

contact force: a opposing force that exists only while another force is acting on an object. Examples include friction and the normal force.

normal force: a force exerted by a surface (such as the ground or a wall) that resists the force of gravity on an object.

Because force is a vector, two forces in opposite directions counteract each other; if the magnitudes are equal, the forces completely cancel.

Example: A Bird on the ground

In the picture a bird is standing on the ground. The forces acting on the bird are:

- gravity, which is pulling the bird down, and
- the force from the ground, which is pushing the bird up.

The force from the ground is called the normal force. (The term “normal” is borrowed from math and means “perpendicular”.)

The normal force is the force exerted by a surface (such as the ground, a table, or a wall) that counteracts another force on the object. This is a direct result of Newton’s Third Law: for every
action there is an equal but opposite reaction. The normal force is called a *contact force* (reaction force), because it is caused by another force, and it exists *only* while the objects are in contact. The normal force is also an *opposing force* because it acts in the opposite direction from the applied force, and acts to lessen or diminish the applied force. If the normal force was not present there would be nothing to stop the bird from falling to the center of the earth.

**Example:** if you push on a wall with a force of 10 N and the wall doesn’t move, that means the force you apply to the wall causes a normal force of 10 N pushing back from the wall. This normal force continues for as long as you continue pushing.

An object can have several forces acting on it at once as shown in the picture:

On the box in the diagram, the forces are:

- gravity ($F_g$),
- the normal force ($F_N$),
- the tension in the rope ($F_T$),
- friction ($F_f$).

**The net force** is the remaining force on an object after canceling opposing forces. Remember that Forces are vectors so they add to each other. The net force on the box (after canceling out gravity and the normal force, and subtracting friction from the tension) would be represented as:

You can think of forces as participants in a multi-direction tug-of-war as shown in the picture:
In the above situation, the net force is in the direction that the ropes will move.

**Forces cause acceleration.** If a net force acts on an object, it will speed up or slow down. Remember that *if the object’s velocity is not changing, there is no net force, which means all of the forces on the object cancel.* If the net force is zero it does not mean there are no forces present it just means that the forces that are there cancel each other out.

In the MKS system, the unit of force is the newton (N). The definition of the Newton is simply derived from:

\[
F = ma \\
\text{Force} = \text{mass} \times \text{acceleration} \\
\text{Newton} = \text{kilogram} \times \text{meter/second} \\
N = \text{kg m/s}^2
\]

One newton is defined as the amount of force that it would take to cause a 1 kg object to accelerate at a rate of 1 m/s\(^2\).

Because the acceleration due to gravity on Earth is 9.8 m/s\(^2\), \(F = mg\) indicates that a 1 kg mass has a weight on Earth of 9.8 N.

The Table below list and defines assorted forces that you could see or feel in our world as we understand it today. Of course science being science a discipline of exploring our world for understanding could change tomorrow if new knowledge is acquired as it should be. Science is a dynamic theory based on experiments, experiments and experiments.
<table>
<thead>
<tr>
<th>Force</th>
<th>Symbol</th>
<th>Definition</th>
<th>Direction</th>
</tr>
</thead>
<tbody>
<tr>
<td>gravity</td>
<td>$\vec{F}_g$</td>
<td>pull of gravity between two objects with mass, one of which is usually the Earth</td>
<td>between the centers of mass of the objects (usually toward the center of the Earth)</td>
</tr>
<tr>
<td>tension</td>
<td>$\vec{F}_T$</td>
<td>pull exerted by a rope/string/cable</td>
<td>away from the object in the direction of the string/rope/cable</td>
</tr>
<tr>
<td>normal</td>
<td>$\vec{F}_N$</td>
<td>contact force by a surface on an object</td>
<td>perpendicular to and away from surface</td>
</tr>
<tr>
<td>friction</td>
<td>$\vec{F}_f$</td>
<td>contact force that opposes sliding between surfaces</td>
<td>parallel to surface; opposite to direction of motion</td>
</tr>
<tr>
<td>thrust</td>
<td>$\vec{F}_t$</td>
<td>push that accelerates objects such as rockets, planes &amp; cars</td>
<td>in the same direction as acceleration</td>
</tr>
<tr>
<td>spring</td>
<td>$\vec{F}_s$</td>
<td>the push or pull exerted by a spring</td>
<td>opposite the displacement of the object</td>
</tr>
<tr>
<td>buoyancy</td>
<td>$\vec{F}_b$</td>
<td>the upward force by a fluid on objects less dense than the fluid</td>
<td>opposite to gravity</td>
</tr>
<tr>
<td>drag</td>
<td>$\vec{F}_D$</td>
<td>friction caused by the molecules of a fluid as an object moves through it</td>
<td>opposite to the direction of motion</td>
</tr>
<tr>
<td>lift</td>
<td>$\vec{F}_l$</td>
<td>the upward push (reaction force) by a fluid on an object (such as an airplane wing) moving through it at an angle</td>
<td>opposite to gravity.</td>
</tr>
<tr>
<td>electrostatic</td>
<td>$\vec{F}_e$</td>
<td>the attraction or repulsion between two objects with an electrical charge</td>
<td>like charges repel; opposite charges attract</td>
</tr>
<tr>
<td>magnetic</td>
<td>$\vec{F}_B$</td>
<td>the magnetic attraction or repulsion between two objects</td>
<td>like poles repel; opposite poles attract</td>
</tr>
</tbody>
</table>