

SECTION 1 (PP. 381-388): GRAVITY IS A FORCE EXERTED BY MASSES.

Georgia Standards: S8P3b – Demonstrate the effect of balanced and unbalanced forces on an object in terms of gravity, inertia, and friction; S8P5a – Recognize that every object exerts gravitational force on every other object and that the force exerted depends on how much mass the objects have and how far apart they are.

1. Masses attract each other

Gravity is the force objects exert on each other because of their mass. It attracts any two masses anywhere in the universe. The strength of the gravitational force is proportional to the product of the masses divided by the distance between them squared.



Greater mass results in greater force.



Greater distance results in smaller force.



- **Gravitational acceleration** is symbolized by g and equals 9.8 m/s^2 at Earth's surface. Any object falling in a vacuum, no matter how massive, has this acceleration. The force of gravity (F) equals mass (m) times gravity (g) at Earth's surface. So, $F = mg$.
- **Mass** and **weight** are not synonymous (the same). **Mass** is the amount of matter something contains. **Weight** is the effect of gravity on the object.

2. Gravity keeps objects in orbit.

An **orbit** is an elliptical path that one object takes around another object. An orbital path is the result of the speed of the orbiting body and the gravitational pull between the two objects.

The speed an object must have to escape the gravitational pull of another body, such as a spacecraft leaving a planet, is called **escape velocity**. Speeds lower than the escape velocity will result in an orbit.

A spacecraft and its contents in orbit are in **free fall**. The environment is such that an astronaut cannot feel gravity.

SECTION 2 (PP. 389-394): FRICTION IS A FORCE THAT OPPOSES MOTION.

Georgia Standards: S8P3b - Demonstrate the effect of balanced and unbalanced forces on an object in terms of gravity, inertia, and friction; S8CS6a – Write clear, step-by-step instructions for conducting scientific investigations, operating a piece of equipment, or following a procedure.

1. Friction occurs when surfaces slide against each other.

Friction is a force that resists the movement of two surfaces that are in contact with each other. Several factors determine the amount of friction between two surfaces:



- The type of surface determines the amount of friction. Generally, smooth surfaces have less friction than rough surfaces.
- The motion of the surfaces affects friction. It takes more force to start an object moving (**static friction**) than it does to keep an object moving (**sliding friction**).
- As the force pressing the surfaces together increases, friction increases. This force is often called the normal force because it is perpendicular, or normal, to the surface.

Friction between surfaces produces heat.

2. Motion through fluids produces friction.

A **fluid** is a substance that flows easily, such as liquids and gases. As an object moves through a fluid, its surface moves against particles in the fluid, causing friction.

When the fluid is air, the friction caused by the moving object is called **air resistance**.

- The amount of air resistance is based on the surface area of the object and the speed at which it moves.
- When an object falls through air at a speed at which air resistance balances gravity, the object reaches its maximum speed. This is called **terminal velocity**.

SECTION 3 (PP. 395-401): PRESSURE DEPENDS ON FORCE AND AREA.

Georgia Standards: S8P3b – Demonstrate the effect of balanced and unbalanced forces on an object in terms of gravity, inertia, and friction.

1. Pressure describes how a force is spread out over an area.

Pressure measures how much force is acting on a certain area.

- It increases when force stays the same but acts on a smaller area.
- It increases when area stays the same but the force increases.
- The equation $P = F/A$, where force is in *Newtons (N)* and area is in *square meters (m²)*, can be used to find pressure. The units for pressure are *Pascals (Pa)*.
1 Pascal (Pa) = 1 N/m².

$$\text{Pressure} = \text{Force} / \text{Area}$$

2. Pressure acts in all directions in fluids.

The particles in a fluid move constantly and rapidly. They collide with objects that come in contact with the fluid, applying pressure to the surface of the object. The amount of pressure exerted depends on the density and the depth of the fluid. Air exerts pressure on all objects in air. It is denser at lower elevations and less dense at higher elevations. The denser the air, the more pressure it exerts.

Because water is denser than air, it exerts more pressure on objects in it.



3. Pressure in fluids depends on depth.

The pressure that a fluid exerts depends on depth and density of the fluid. At sea level, air exerts a pressure called *atmospheric pressure*. Air has weight.

- The more air above you, the greater the weight of that air.
- Air at higher elevations weighs less.
- Air at lower elevations is more compressed, therefore denser, and weighs more.

Water has a greater density than air, and therefore exerts more pressure on objects than air.

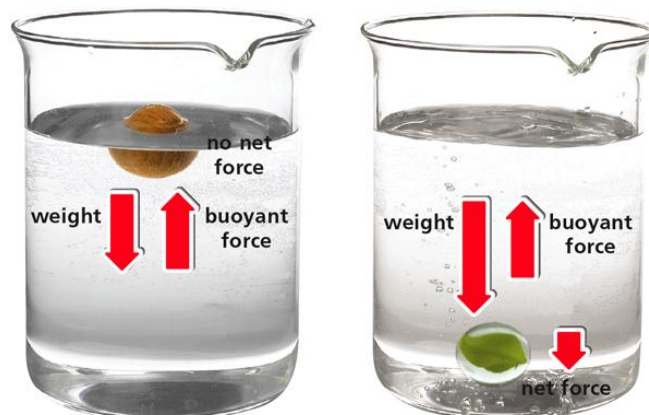


SECTION 4 (PP. 402-407): FLUIDS CAN EXERT A FORCE ON OBJECTS.

Georgia Standards: S8P3 – *Students will investigate the relationship between force, mass, and the motion of objects.*

1. Fluids can exert an upward force on objects.

On Earth, objects are subject to forces from all directions, but these forces might not be balanced. The difference in water pressure at different depths produces an upward force, called *buoyant force*.



For a particular object, this force directly relates to the amount of fluid the object replaces.

Density is the amount of matter per unit of volume ($D = m / v$), where mass is commonly in grams (g) and volume is commonly in cubic centimeters (cm^3).

$$\text{Density} = \text{Mass} \div \text{Volume}$$

Because of buoyancy, a less dense material will float on another denser material.

2. The motion of a fluid affects its pressure.

Bernoulli's principle states that, as the speed of a fluid increases, the pressure inside the fluid decreases.

3. Forces can be transmitted through fluids.

Pascal's principle states that, when outside pressure is applied to a fluid in a container, that pressure is transmitted equally throughout the entire fluid.

Hydraulic machines use liquids to transmit forces. Gases would be less effective because they change volume when force is applied.