

# Physics Glossary

## **acceleration**

Objects that are changing their speed or their direction are said to be accelerating. The rate at which the speed or direction changes is referred to as acceleration. Some amusement park rides (such as roller coasters) are characterized by rapid changes in speed and or direction. These rides have large accelerations. Rides such as the carousel result in small accelerations; the speed and direction of the riders change gradually.

## **balanced and unbalanced forces**

A balanced force results whenever two or more forces act upon an object in such a way as to exactly counteract each other. As you sit in your seat at this moment, the seat pushes upward with a force equal in strength and opposite in direction to the force of gravity. These two forces are said to balance each other, causing you to remain at rest. If the seat is suddenly pulled out from under you, then you experience an unbalanced force. There is no longer an upward seat force to balance the downward pull of gravity, so you accelerate to the ground.

## **centripetal force**

Motion along a curve or through a circle is always caused by a centripetal force. This is a force that pushes an object in an inward direction. The moon orbits the earth in a circular motion because a force of gravity pulls on the moon in an inward direction toward the center of its orbit. In a roller coaster loop, riders are pushed inwards toward the center of the loop by forces resulting from the car seat (at the loop's bottom) and by gravity (at the loop's top).

## **energy**

Energy comes in many forms. The two most important forms for amusement park rides are kinetic energy and potential energy. In the absence of external forces such as air resistance and friction (two of many), the total amount of an object's energy remains constant. On a coaster ride, energy is rapidly transformed from potential energy to kinetic energy when falling and from kinetic energy to potential energy when rising. Yet the total amount of energy remains constant.

## **force**

A force is a push or a pull acting upon an object. Forces result from interactions between two objects. Most interactions involve contact. If you hit the wall, the wall hits you back. The contact interaction between your hand and the wall results in a mutual push upon both objects. The wall becomes nicked (if hit hard enough) and your hand hurts. Bumper cars experience mutual forces acting between them due to contact during a collision. Some forces can act from a distance without actual contact between the two interacting objects. Gravity is one such force. On a free fall ride, there is a force of gravitational attraction between the Earth and your body even though the Earth and your body are not in contact.

**friction**

Friction is a force that resists the motion of an object. Friction results from the close interaction between two surfaces that are sliding across each other. When you slam on your brakes and your car skids to a stop with locked wheels, it is the force of friction that brings it to a stop. Friction resists the car's motion.

**g**

A g is a unit of acceleration equal to the acceleration caused by gravity. Gravity causes free-falling objects on the Earth to change their speeds at rates of about 9.8 m/s each second. That would be equivalent to a change in speed of 32.2 ft/s in each consecutive second. If an object is said to experience 3 g's of acceleration, then the object is changing its speed at a rate of about 29.4 m/s every second.

**gravitational force**

Any two objects with mass attract each other with a type of force known as a gravitational force. The strength of this force depends upon the mass of the two objects and the distance between them. For objects with masses as large as the earth and the sun, these forces are sizeable and have tremendous influence upon the subsequent motion. For objects such as two persons sitting in a theater, the force of gravitational attraction is so small that it is insignificant. In order for such persons to increase the force of attraction between them, they must add to their mass (maybe by eating more popcorn). Objects on the earth experience noticeable attractions with the earth due to the earth's large mass.

**inertia**

Inertia is a tendency of an object to resist change in its state of motion. More massive objects have more inertia; that is, they have more tendency to resist changes in the way they are moving. An elephant has a lot of inertia, for example. If it is at rest, it offers a large resistance to changes in its state of rest, and so it's difficult to move an elephant. On the other hand, a pencil has a small amount of inertia. It's easy to move a pencil from its state of rest. More massive objects have more inertia and thus require more force in order to change their state of motion.

**kinetic energy**

Kinetic energy is the energy possessed by an object because of its motion. All moving objects have kinetic energy. The amount of kinetic energy depends upon the mass and speed of the object. A roller coaster car has a lot of kinetic energy if it is moving fast and has a lot of mass. In general, the kinetic energy of a roller coaster rider is at a maximum when the rider reaches a minimum height.

**mass**

The mass of an object is a measurement of the amount of material in a substance. Mass refers to how much "stuff" is there. Elephants are very massive, since they contain a lot of "stuff."

**momentum**

Momentum pertains to the quantity of motion that an object possesses. Any mass that is in motion has momentum. In fact, momentum depends upon mass and velocity, or in other words, the amount of "stuff" that is moving and how fast the "stuff" is moving. A train of roller coaster cars moving at a high speed has a lot of momentum. A tennis ball moving at a high speed has less momentum. And the building you are in, despite its large mass, has no momentum since it is at rest.

**Newton's First Law of Motion**

An object at rest or in uniform motion in a straight line will remain at rest or in the same uniform motion unless acted upon by an unbalanced force. This is also known as the law of inertia.

**Newton's Second Law of Motion**

The acceleration of an object is directly proportional to the total unbalanced force exerted on the object, and is inversely proportional to the mass of the object (in other words, as mass increases, the acceleration has to decrease). The acceleration of an object moves in the same direction as the total force. This is also known as the law of acceleration.

**Newton's Third Law of Motion**

If one object exerts a force on a second object, the second object exerts a force equal in magnitude and opposite in direction on the object body. This is also known as the law of interaction.

**period**

A motion that repeats itself in cyclic fashion is said to be periodic. The time for one complete cycle is known as the period of the motion. The motion of a second hand has a period of 60 seconds. The periodic rotation of the earth about its axis is 24 hours. The periodic motion of an amusement park pendulum ride may have a period as high as 10 or 15 seconds.

**potential energy**

Potential energy is the energy possessed by an object because of its height above the ground. The amount of potential energy possessed by an object depends on its mass and its height. A roller coaster car is initially hauled by a motor and chain system to the top of a tall hill, giving it a large quantity of potential energy.

**speed**

Speed is a measurement of how fast an object is moving. Fast-moving objects can cover large distances in a small amount of time. They are said to have a high speed. A roller coaster car moving at 60 miles per hour would be able to cover a distance of 60 miles in one hour if it could maintain this pace.

**velocity**

The velocity of an object refers to the speed and direction in which it moves. If you drive north to your work place and your speedometer reads 35 miles per hour, then your velocity is 35 miles per hour in a northward direction. Velocity is speed with a direction and is important in understanding bumper car collisions.

**weight**

Weight is a measurement of the gravitational force acting on an object. The weight of an object is expressed in pounds in the U.S. A 180-pound person is experiencing a force of gravitational attraction to the earth equal to 180 pounds.

**weightlessness**

Amusement park rides often produce sensations of weightlessness. These sensations result when riders no longer feel an external force acting upon their bodies. At the top of the tower of a free-fall ride, a 100-pound rider would feel 100 pounds of force from the seat pushing as an external force upon her body. The rider feels her normal weight. Yet, as she falls from the tower, the seat has fallen out from under her. She no longer feels the external force of the seat and subsequently has a brief sensation of weightlessness. She has not lost any weight, but feels as though she has because of the absence of the seat force. In this context, weightlessness is a sensation and not an actual change in weight.