**Motion**

Take a moment to think of all the things that move. People run, walk, ride bicycles and ride in all sorts of vehicles. Earth rotates on its axis once a day, and revolves around the sun. Our solar system is moving with the Milky Way, and our galaxy is hurtling through space right now!

Because motion is common to everything in the universe, physics usually begins with the study of motion.

**Motion** is a change in position over time.

**Position** is the separation between an object and a reference point.

To determine motion and position, you have to determine a **reference point**.

So motion is always relative to a reference point and sometimes called **relative motion**. We will only explore motion in a straight line in the eighth grade.

For instance, a passenger in a car may be motionless relative to the inside of the car, but moving at tremendous speed relative to the ground outside the moving car. A book at rest on the table is actually moving at about 30 kilometers per second relative to the sun. Unless stated otherwise, when discussing the speed of objects, we mean speed with respect to the earth. Motion is relative.

**Speed** is a measure of how fast something is moving; the distance covered per unit of time.

Speed is the rate at which distance is covered. Remember, the word *rate* is a clue that something is being *divided by time*. Speed is almost always measured in terms of a unit of distance divided by a unit of time. In the metric system, it is usually measured in kilometers per hour, or meters per second. The word *per* means “divided by.”

**Average speed** is defined as follows: total distance covered / time interval

**Velocity** is speed in a given direction. For example, 60km/h to the north.

In everyday use, speed and velocity are often used interchangeably, but in physics we make a distinction between the two.

Motion at constant velocity is motion in a straight line at a constant speed. If *either the speed or direction* changes, or both, the velocity changes. A ball circling on a string may be moving at a constant *speed*, but its *velocity* is constantly changing because its direction of motion is changing.

**Acceleration** is the rate at which velocity changes. It is defined this way:

Acceleration = change in velocity / time interval or a=Vf-Vi/t where Vf is the ending velocity and Vi is the initial, or beginning velocity.

Acceleration can be a positive number (Getting faster) or a negative number. (Getting slower, or *deceleration*.)

Since velocity is already expressed in distance per unit of time, acceleration is expressed as distance per unit of time per unit of time. In the instance of acceleration due to gravity (g) acceleration is expressed as 9.8 meters per second per second. So a falling object is moving 9.8 meters per second faster *each second* that it falls.

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| --- |
| Elapsed Time Speed m/s  0s 0 m/s  1s 9.8 m/s  2s 19.6 m/s  3s 29.4 m/s  4s 39.2 m/s  . .  t 9.8t |

Data Set Questions:

If a cheetah can maintain a constant speed of 25 m/s it will cover 25 meters every second. At this rate, how far will it travel in 10 seconds? In 1 minute?

The speedometer of a car moving southward reads 60 km/h. It passes another car that travels southward at 60 km/h. do both cars have the same speed? Do they have the same velocity?

In 5 seconds a car moving in a straight line increases its speed from 50 km/h to 65 km/h while a truck goes from rest to 15 km/h in a straight line. Which undergoes greater acceleration? What is the acceleration of each vehicle?

**Answers to data set questions:**

In 10s the cheetah will cover 250 m and in 1 minute (60 seconds) it will cover 1500 m, more than 15 football fields!

Distance = (25 m/s) x (10 s) = 250 m

Distance = (25 m/s) x (60 s) = 1500 m

Both cars have the same speed, but they have opposite velocities because they are moving in opposite directions.

The car and truck both increase their speed by 15 lm/h during the same time interval so their acceleration is the same.

Acceleration = change in speed/ time interval = 15 km/h / 5s = 3 km/h/s