

It's Dynamic! Laws of Motion and Speed

By Trista L. Pollard



¹ What do cars, airplanes, conveyor belts, and emails have in common? They all involve motion. Our daily lives are filled with objects and beings in **motion**. Each day we expect to see vehicles traveling on the streets and through the air; groceries moving toward cashiers in grocery stores; and emails making their journeys across the wires to their global destinations. As much as we may recognize that motion is an important part of our lives, do we really understand motion?



² Motion is the change of position of one body in relation to another body. **Dynamics** is the area of science that focuses on how objects move and the forces that change their motion. To fully understand the motion that is associated with vehicles and machines, you must also understand the scientific laws and principles of motion. It's easy to assume that bodies (beings and objects) are not always moving. However, when scientists analyze the motion of bodies, they do so in reference to other bodies. For example, if we talk about motion in relation to the earth, then all bodies on earth are only moving specific distances at specific points in time. However, if we analyze motion in relation to the sun, then all bodies on earth, including earth itself, are moving continuously. Therefore, our study of motion will focus on movement of bodies in relation to the earth.

³ When bodies move, they travel specific distances in a straight line in specific amounts of time. The rate at which they travel depends on different factors. Those factors are **velocity**, **force**, and **energy**. Let's look at the scientific laws of motion and the principle of velocity. Scientist Sir Isaac Newton (1642-1727) was one of the first scientists to discover the relationship between **force** and motion. His discoveries helped him to develop three scientific laws of motion. **Newton's First Law of Motion** states that bodies at rest tend to remain at rest, and that bodies in motion tend to remain in motion. These bodies that are in motion move at a constant **speed** in a straight line. This is called **inertia**. The factor that can affect inertia is force. Force, which is the push or pull on an object, can change the motion of an object. Newton's Second Law of Motion involves acceleration and mass. It states that the **acceleration** of a body is directly proportional to the force applied to that body; and that the mass (weight) of that body is inversely proportional to acceleration. When you increase the force on an object, the object's motion accelerates or increases. If the mass of an object is increased, the motion of the object will **decelerate** or slow down. Of course if you decrease the object's mass, its motion will accelerate.

⁴ **Newton's Third Law of Motion** is probably one of the most well known. It states that for every action there is an equal and opposite reaction. A good example of this law could occur during your first visit to an ice skating rink. As you hold on to the rink wall for

dear life, you try to balance on your new ice skates. You finally get up the nerve to push yourself away from the wall. You may not have noticed, but as you pushed towards the wall, your body on brand new ice skates moved in the opposite direction of the wall. The force you used to push against the wall is the same amount of force that is used to push you away from the wall to the middle of the ice. Now that we have the laws, let's talk about velocity.

⁵ **Velocity** is the **speed** of an object at a given duration. Speed is the change in the **displacement** or the distance of an object as it travels over a given time. Displacement, more specifically, refers to the length and direction of an object's path from its starting point to its ending point, hence its distance. We can look at velocity within an instant moment and over a span of time. **Instantaneous velocity** or **instantaneous speed** is the speed a body travels at a particular instant. Remember you on the ice skates? Well, the moment you pushed yourself away from the wall, your motion was instantaneous and could be measured in that short span of time. **Average velocity** or **average speed** is the total distance an object travels over the total time span it took to achieve that distance. Think about those long family vacations in the car during the summer. Let's say on this trip your parents drove 1,200 miles each way to Disney World in Orlando, Florida. If we know that it took them twenty hours to make the trip one way, we can figure out the average velocity for your car during this time. You would need to divide the total distance, one way (1,200 miles) by the total time span one way (twenty hours). The average velocity of your car during the first leg of this trip was sixty miles per hour. Velocity can also be measured metrically in kilometers per hour.

⁶ In Newton's second law we discussed acceleration and deceleration. Both are changes in the velocity of a body with respect to time. To accelerate the velocity of an object, force must be applied in the same direction as the velocity. This principle is demonstrated in cars. When your parent uses a foot to push on the accelerator, the force in addition to the car causes its velocity to increase. Likewise, when your parent decreases the amount of force on the accelerator, the car begins to decelerate, and therefore, its velocity decreases. Force can also be used to change the direction of an object's velocity if it is applied in right angles. You are playing kickball, and it is your turn at the plate. The pitcher rolls the ball straight towards you. When you kick the moving ball, it veers off to the right. You have just changed the direction of the ball's velocity.

⁷ As you can see, there is more to motion than just bodies and objects moving all over the place. In fact, there is a scientific field dedicated to it.

Name _____



Date _____

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<p>1. Dynamics is the science of ____.</p> <p><input type="radio"/> A How objects, motion, and force are unrelated</p> <p><input type="radio"/> B How objects remain stationary without force</p> <p><input type="radio"/> C How objects move and the forces that affect those objects</p> <p><input type="radio"/> D How objects disintegrate when force is applied</p>	<p>2. True or False? When you analyze the motion of objects and beings, you do so in relation to other objects and beings.</p> <p><input type="radio"/> A False</p> <p><input type="radio"/> B True</p>
<p>3. Velocity is ____.</p> <p><input type="radio"/> A The electrical measurement of an object over time</p> <p><input type="radio"/> B The floating of an object in water over time</p> <p><input type="radio"/> C The lack of speed of an object over time</p> <p><input type="radio"/> D The speed of an object during a given span of time</p>	<p>4. How is instantaneous velocity different from average velocity?</p> <p>_____</p> <p>_____</p>
<p>5. Define acceleration and deceleration.</p> <p>_____</p> <p>_____</p>	<p>6. Your older sister drove 500 miles to college one way in ten hours. What was her average velocity?</p> <p>_____</p> <p>_____</p>

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7. Your family decided to take a different route when they returned from Disney World in Orlando, Florida. This time they drove 1,500 miles. If they traveled sixty miles per hour, how long was the return trip?

8. Sir Isaac Newton's Third Law of Motion explains the scientific principle of inertia.

A False

B True

It's Dynamic! Laws of Motion and Speed - Answer Key

- 1 C How objects move and the forces that affect those objects
- 2 B True
- 3 D The speed of an object during a given span of time
- 4 Instantaneous velocity is the speed of an object at a particular instant. Average velocity is the total distance an object travels over the total time span it takes for that object to travel that distance.
- 5 Acceleration is when force is applied to a moving object, and as a result, the velocity of that object is increased. The force must be applied in the same direction as the velocity. Deceleration is the decrease in a moving object's velocity when force is applied in the opposite direction of the velocity.
- 6 $500 \text{ miles (displacement)} / 10 \text{ hours} = 50 \text{ miles/hour (average velocity)}$
- 7 $1,500 \text{ miles (displacement)} / 60 \text{ miles per hour (average velocity)} = 25 \text{ hours (time)}$
- 8 A False



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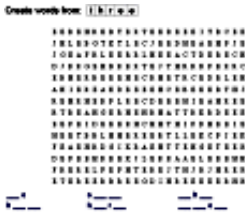
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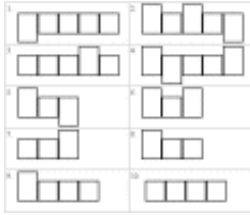
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