Measuring Motion

Try to stand perfectly still. Is there anything moving around you? Hopefully, if you have been listening in science class, there is always something moving even if we can’t see it. Gas molecules are moving even when we don’t see them. Liquid and solid molecules are vibrating in place even though we can’t see them. The bottom line there is always something moving.

Reference Points

So how do we see that something is moving? If the world is a white background, it would be difficult to see something moving. But our world isn’t blank (luckily); it has trees, houses, swing sets, cars, buildings, and all kinds of other things in the background that we can compare to see something moving.

When we compare two objects, the one that appears to not be moving is what we refer to as a reference point. So for example, if I run across the science classroom, the white board, my desk, the sink, my computer, these would all be reference points. In many cases, something on the earth’s surface is the most common reference point (trees, buildings, houses, playgrounds).

In our example of me running through the classroom, although I’m not very safe, I am in motion. Motion is when an object (me) changes position when compared to a reference point (my computer, desk or white board for example).

1. What is a reference point?

2. What is motion?

Speed

Whenever we measure how much motion an object has, we refer to it as the speed of an object. Speed is defined as the distance an object travels divided by the time it took the object to travel that distance. If this sounds like a math formula, you are correct. To calculate the speed of an object, you use the following formula.

\[
\text{Average speed} = \frac{\text{total distance covered}}{\text{time}}
\]

If you noticed, I put the word average in front of the word speed. Scientists do this because when you are measuring the speed of an object it rarely stays the same. You speed up and slow down, but over a long time you are moving at an average speed.

Let’s do an example to show you why we call it an average speed.

In PE class, you are timed to run around the track. The track is 400 meters in distance. If you take 2 minutes to run around the track, we can calculate your speed.

\[
\text{Average speed} = \frac{\text{total distance covered}}{\text{time}} = \frac{400 \text{ m}}{2 \text{ min}} = 200 \text{ m/min}
\]
So, we would say your average speed is 200 meters per minutes (m/min). Think about your race though. In the beginning, you are full of energy and probably moving very fast, but as you make your way around the track, your legs get tired and you slow down. Your speed at the beginning of the race and end of the race are different. Your speed for the entire race though would be your average speed which means it takes into account the points you are moving fast and slow.

3. Define average speed.

**Velocity**

Sometimes, you will hear people use velocity to describe speed. Velocity and speed are very similar. Scientists define velocity as speed with direction. For example, if I’m running 10 meter/second heading north, my velocity would be 10 meters/second heading north. My speed would just be 10 meters/second. This seems like a small difference, but direction plays a big role in science especially when you start talking about physics.

To calculate the velocity of something, you would simply divide the distance by the time.

$$\text{Average velocity} = \frac{\text{total distance covered}}{\text{time}}$$

Hopefully, the formula looks very familiar. It should because it is the same as the speed formula. The only difference would be how we report the answer. For example, if I’m running on a path heading north and cover 400 meters in 50 seconds, I can calculate my average velocity:

$$\text{Average velocity} = \frac{\text{total distance covered}}{\text{time}} = \frac{400 \text{ m}}{50 \text{ seconds}} = 8 \text{ m/second}$$

I would say that my average velocity is 8 m/sec heading north. The only difference between speed and velocity is that last piece “heading north.” That is the direction part which makes this velocity.

4. Define average velocity.

5. How are speed and velocity different?

**Directions:** Solve the following problems. Make sure you show all the work involved in solving the problems. Remember to label!

6. What is the average speed of a car that travels 150 km in 3.00 hrs?

7. A vehicle travels 2345 m in 315 s west toward the evening sun. What is its average velocity?

8. What is the average speed of a bus that travels 250.0 km in 2.00 hours?

9. How could you turn the average speed in problem 8 into an average velocity?