Subject Code	PHY 1	**Physics 1**
Module Code	1.0	**Kinematic Quantities**
Lesson Code	1.2	**Velocity**
Time Frame		30 minutes

Components	Tasks	TA[1] (min)	ATA[2] (min)
Target 	By the end of this learning guide, the student should be able to: • define and differentiate speed and velocity • compute for average velocity	1	
Hook 	Are you aware of the nickname "The fastest man alive"? Depending on who you ask, it can either be Usain Bolt or the fictional Barry Allen (The Flash). Usain Bolt holds the world record for the 100-meter sprint at 9.58 s and it is said that he reached a top speed of 44.6 kph during this achievement in 2009. Barry Allen, being the fictional hero that he is, can run faster than the speed of sound (approx. 1235 kph). It is not hard to imagine the concept of speed or how fast an object is, but can you believe that in some instances and in some interpretations, you can actually be "faster" than these two men? By learning about the concepts of speed and velocity, particularly the average velocity, you will understand how.	1	
Ignite 	Both speed and velocity describe how fast an object is moving. Common units include kilometers per hour (km/h or kph), miles per hour (mi/h or mph), and the SI base unit: meters per second (m/s). The **average speed** tells us how much ground an object can cover (or is covered) per unit time. $$Average\ speed\ = distance/elapsed\ time$$ [eqn. 1] Using equation 1, we can calculate the average speed of a car that traveled 30 km in one hour to be 30 kph, for example. As you can imagine, this car did not travel 30 kph for the whole entire trip – it had to slow down and could speed up at certain points. Those different speeds (that can be seen on the car's speedometer) are called **instantaneous speeds**. Speed, however, does not reveal the direction of the motion since speed (both instantaneous and average speed) is a scalar. To describe both	10	

[1] Time allocation suggested by the teacher.
[2] Actual time allocation spent by the student (for information purposes only).

how fast the motion is and the direction of this motion, we introduce the concept of velocity, which is a vector.

Average velocity uses displacement rather than distance traveled, so the difference between the two must be clear from lesson 1.1. The equation for average velocity is seen in equation 2. The horizontal bar above the $\vec{v}$ symbol means the quantity is an average, and the arrow above the v is there to denote that it is a vector. We represent the difference in time to get from initial to final position as Δt (read as "delta t"), which is given by the final time t minus the initial time t_0. The average velocity's direction is the same as the displacement's direction and can therefore be indicated by + and – as well as north-east-west-south directions. There is also a concept called **instantaneous velocity**, which denotes the specific velocity (thus it includes direction) at a certain instant of time.

$$Average\ velocity\ = displacement/elapsed\ time$$

$$\bar{\vec{v}} = \frac{\vec{x}-\vec{x}_0}{t-t_0} = \frac{\Delta\vec{x}}{\Delta t} \qquad \text{[eqn. 2]}$$

Example: A dog ran in a straight line that is 50.0 m to the right for 10.0 seconds. What is the dog's average velocity for the run?
Solution: According to equation 2, the average velocity is

$$\bar{\vec{v}} = \frac{\vec{x}-\vec{x}_0}{t-t_0} = \frac{+50.0\ m-0\ m}{10.0\ s-0\ s} = +5.00\ \frac{m}{s}$$

The final answer follows the rules on significant figures and includes the positive sign indicating the direction of the dog's average velocity. It is also likely that this dog did not maintain the velocity of +5.00 m/s all throughout the 10.0 s, so it may have had instantaneous velocities higher or lower than this value. Since the dog ran in a straight line, its distance traveled is also the displacement of 50.0 m, making the average speed to be 5.00 m/s (note the lack of + sign).

If this dog reversed its motion and returned to a spot to the left of the 50.0 m mark for a total of 10.0 s, its distance traveled would be greater than its displacement so the magnitude of its average speed would also be greater than the magnitude of its average velocity.

	Now suppose you participate in a race against two of the fastest men alive in an athletic oval where your finish line is at the 200 m mark (halfway around the track), while theirs is at the 400 m mark – which is exactly at the starting line. Now when the race begins, they will likely blow past you and will therefore have higher instantaneous speeds and instantaneous velocities compared to you. But by the time the race is over, and you all stay in your respective finish lines, you will have a nonzero average velocity while they will both have zero, which can be interpreted as being "*faster"* than them. They will still have a higher average speed compared to you, though, so they are still *generally faster* than you.		
Navigate 	Write your answers on a clean sheet of paper. Follow your teacher's instructions regarding submission. This activity is non-graded. 1. For each of the following statements, defend if true, and debunk if false using brief justifications. For a certain object moving during a certain time interval, (a) average speed can be equal to average velocity. (b) average speed can be greater than average velocity. (c) average speed can be lesser than average velocity. (d) average speed can be nonzero even while the average velocity is zero. 2. A person ran back and forth along a straight 100 m track for 10 minutes. With the definitions in mind, compare the person's (a) average speed and instantaneous speed, (b) average velocity and instantaneous velocity, and (c) average speed and average velocity.	10	
Knot 	In summary , ● The average speed of an object is the distance traveled by the object over the time required to cover that distance. ● The average velocity of an object is the object's displacement divided by the elapsed time. ● Average velocity is a vector that has the same direction as the displacement. Write your answers (with complete solutions for word problems) on a clean sheet of paper. Follow your teacher's instructions regarding submission. This activity is graded (scoring system is the subject teacher's discretion.)	8	

	1. A jogger runs along a straight and level road for 8.0 km and then runs back to her starting point. The time for this round-trip is 2.0 h. Which one of the following statements is true? (a) Her average speed is 8.0 km/h, but there is not enough information to determine her average velocity. (b) Her average speed is 8.0 km/h, and her average velocity is 8.0 km/h. (c) Her average speed is 8.0 km/h, and her average velocity is 0 km/h. (Cutnell and Johnson, 2012) Explain your answer using the definitions. 2. According to the GPS watch of Sir Q, he completed a 10.0 km fun-run in 51.12 minutes. (a) What was the average speed of Sir Q (in meters per second)? (b) Considering that the fun-run Sir Q participated in was a loop where the starting and finish lines coincide, what was Sir Q's average velocity?		

References:

1. Cutnell, John D. and Johnson, Kenneth W. (2012). *Physics 9th ed*. United States of America: John Wiley & Sons, Inc.
2. Henderson, Tom (2020, July 13). *The Physics Classroom*. Retrieved from https://www.physicsclassroom.com/class/1DKin/Lesson-1/Speed-and-Velocity

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