Subject Code	PHY 1	**Physics 1**
Module Code	1.0	**Kinematic Quantities**
Lesson Code	1.1	**Position, Displacement, and Distance Traveled**
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 position, displacement, and distance traveled.	1	
Hook 	Can you imagine a world without motion? That would be a very boring world, right? A lot of interesting and fun things in this world involve motion, and physics allows us to describe motion (and even stationary objects) under its branch called **mechanics**. Under mechanics, we have **kinematics,** which is the main topic for the first quarter and **dynamics**, which will be discussed during the second quarter. Both describe motion, but dynamics deals with the forces that cause the motion while kinematics focuses on the description of motion by its position, velocity, and acceleration. The topics we are about to discuss are the foundation of kinematics. These are position, displacement, and distance traveled. Be sure to take note of their interconnectedness, similarities, and differences.	2	
Ignite 	In describing the motion of an object, it is necessary to specify its location or **position** . We will first consider one-dimensional motion, that is, motion along a single axis: the x-axis in our case. The letter x is used to signify the position because the motion we are analyzing is along the x-axis (and you can think of it as the x-coordinate of the object). One-dimensional motion is illustrated in Figure 1, wherein the **initial position** of a car is shown by an arrow (which is a vector) labeled as $\vec{x}_0$ (read as "x-naught" or "x-sub-zero").	13	

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

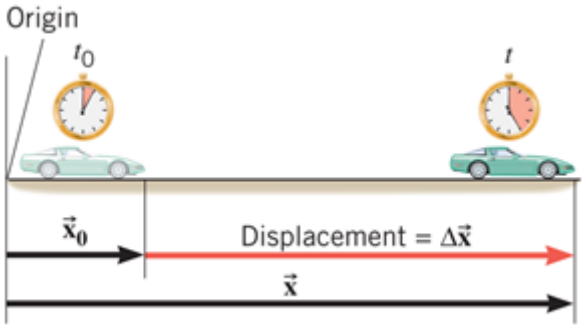

Figure 1. The displacement is a vector that points from the initial position to the final position. (Cutnell and Johnson, 2012)

The size of this arrow reflects the distance of the car from chosen origin. This quantity is a vector since it has both magnitude and direction. In most examples that we will discuss, the initial position is chosen to be zero, coinciding with the origin. Moreover, the time at which the object is in its initial position will be denoted by t_0. After some time (t) has passed, the car has moved to a new position, indicated by an arrow denoted by vector $\vec{x}$. We can now define the **displacement** $\triangle\vec{x}$ of any object as $\triangle\vec{x}$ (read as "delta x" or "the change in x") which is a vector originating from the initial position that is pointing towards and ending at the final position. This statement can be written in equation form as:

$$\Delta\vec{x} = \vec{x} - \vec{x}_0 \qquad \text{[eqn. 1]}$$

In other words, the displacement is the difference between the final and initial positions. The Greek letter delta (Δ) signifies this change or difference and whenever we use this symbol in our future equations, it always means the final value minus the initial value.

The SI unit for displacement is the meter (m), though we will also be using other units such as centimeters (cm), inches (in), kilometers (km), miles (mi), etc., so it is necessary that we know how to convert from one unit to another.

The magnitude of the displacement vector is the shortest distance between the initial and final positions and its direction points from the initial position towards the final position.

When analyzing motion along a straight line, we assign + and – signs to indicate the direction of the displacement.

Considering the car in Figure 1 as an example, if we assume that the car is moving along an east/west direction and we choose the positive sign to indicate the direction due east, then the car shown has a positive displacement. Conversely, if the same car travels to the west instead, it will have a negative displacement. For example, the car is traveling with a displacement of +700 m; this means the displacement points to the east and has a magnitude (straight-line distance) of 700 m.

As previously mentioned, the magnitude of the displacement vector is the shortest distance between the two positions. As you can see in Figure 2, displacement and distance traveled are not the same since the distance traveled is a scalar and considers the actual path taken – every step counts, while displacement only considers the starting and ending points.

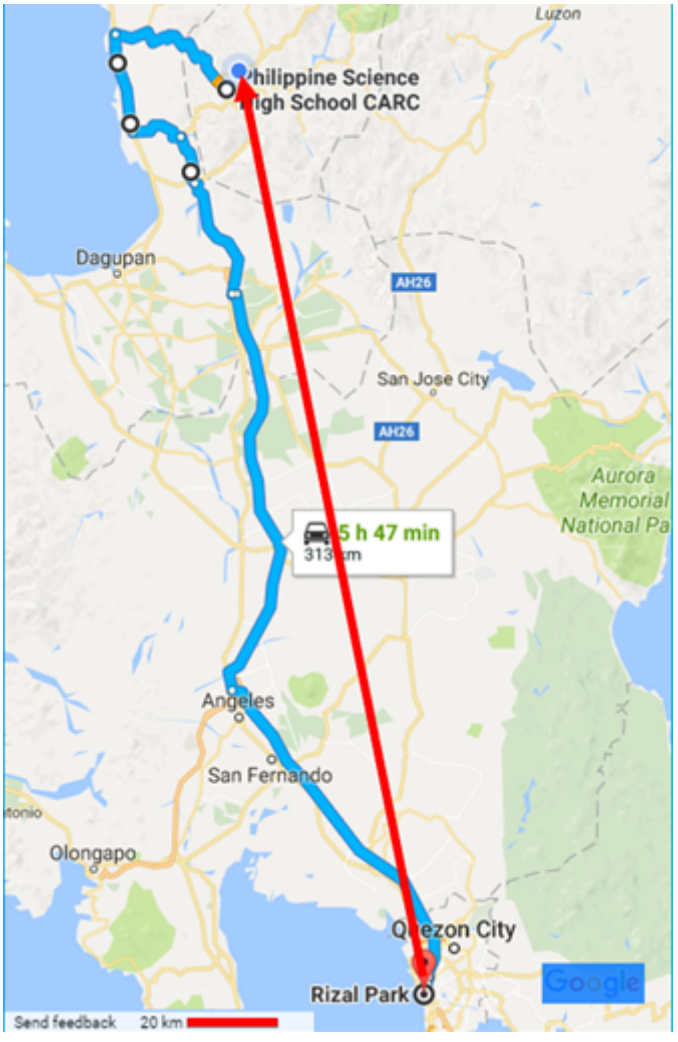

Figure 2. The distance traveled from Rizal Park to PSHS-CARC is 313 km along the route shown in blue. Using the scale, the displacement is

	approximately 205 km north-west, indicated by the red straight arrow. (Figure courtesy of Google Maps).		
Navigate 	Now it is time for you to apply what you have learned. 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 it is true, and debunk if it is false using brief justifications. For a certain object moving during a certain time, (a) displacement can be equal to the distance traveled. (b) displacement can be greater than the distance traveled. (c) displacement can be less than the distance traveled. (d) displacement can be zero even when the distance traveled is not. 2. Summarize the similarities and difference of displacement and distance traveled using a Venn diagram.	8	
Knot 	In summary, ● Kinematics is a branch of mechanics that describes the motion of objects without considering the cause (forces) of the motion. ● Position refers to the location of an object and is denoted by x (for horizontal motion). ● Displacement is a vector that points from the initial position to the final position of the object and has a magnitude that is equal to the shortest distance between the final and initial positions. ● Distance traveled considers all the "ground covered" as the object moves from its initial to its final point and the path taken is not always along a straight line connecting these two points. 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). 1. What is the displacement of a runner who joins a marathon if the race begins at a certain park, runs 42	6	

	km, and finishes the race at the same location in the said park? Explain briefly. 2. One afternoon, a couple walks three-fourths of the way around a circular lake, the radius of which is 1.5 km. They start at the west side of the lake and head due south to begin with. (a) What is the distance they traveled? (Cutnell and Johnson, 2012) (b) describe the couple's displacement as compared to the distance traveled.		

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 11). The Physics Classroom. Retrieved from https://www.physicsclassroom.com/class/1DKin/Lesson-1/Distance-and-Displacement.
3. Google (n.d.). [Google Maps direction for driving from Rizal Park, Manila to Philippine Science High CARC, Baguio City]. Retrieved July 11, 2020, from https://www.google.com/maps/dir/

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