LEARNING AS ONE NATION

Expanded Project

SHS LEARNING ACTIVITY

Name: _____ **Score/Mark:** _____

Grade and Section: _____ **Date:** _____

Strand: ☐ STEM ☐ ABM ☐ HUMSS ☐ ICT (*TVL Track*)

Subject: _____

Type of Activity: ☑ Concept Notes ☑ Skills: Exercise/Drill ☐ Illustration ☐ Performance Task ☐ Essay/Report ☐ Others: _____

Activity Title: **LA03: Kepler's Three Laws of Planetary Motion**

Learning Targets:
1) To explain how Brahe's astronomical observations led to the formulation of Kepler's laws of planetary motion.
2) To state and illustrate Kepler's laws.

References: *(Author, Title, Pages)*
1) Bernido, C. and Bernido, M. V. (2008). *Physics Essentials Portfolio*. pp. 98–100;
2) NASA Earth Observatory. *The Science: Orbital Mechanics*. https://earthobservatory.nasa.gov.

Tycho Brahe (1546–1601), a Danish astronomer, had significant and important astronomical observations and records, which initially led him to consider a geocentric (Earth-centered) model of the solar system. Brahe then asked his assistant, Johannes Kepler (1571–1630), a German astronomer, to describe Mars' orbits using Brahe's records. Kepler ended up proving the heliocentric (sun-centered) model of the solar system and proving three planetary laws bearing his name.

Kepler's First Law of Planetary Motion:

The orbit of a planet in the solar system is an ellipse with the sun at one of the two foci of the ellipse. (**Fig. 1**)

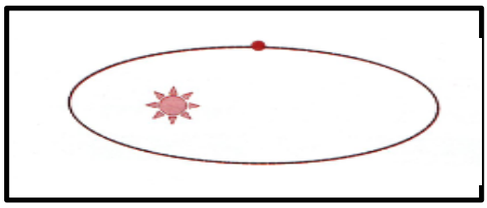

Figure 1. Illustration of Kepler's First Law

Kepler's Second Law of Planetary Motion:

The position vector of a planet from the sun sweeps out *equal areas in equal times*. The area A_1 is equal to the area A_2. (**Fig. 2**)

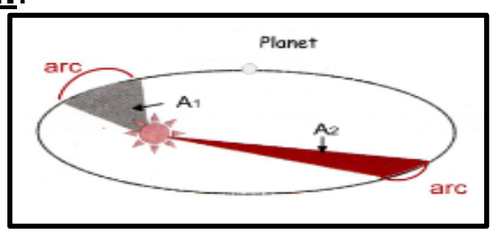

Figure 2. Illustration of Kepler's Second Law

Kepler's Third Law of Planetary Motion:

The square of the period of a planet (***T***, time it takes to make one complete revolution around the sun) is proportional to the cube of its mean distance (***d***, average of farthest and nearest distances) from the sun.

$$T^2 = kd^3 \qquad \text{where } k = \text{constant.}$$

Exercises:

Apply Kepler's third law to Venus, Earth, and Mars. See if the value of the ratio (***k***) is indeed similar for these planets. Show your solutions.

Planet	Period (in Earth years)	Mean distance from the Sun (in astronomical units, AU)	*k*
Venus	0.615	0.723	
Earth	1.000	1.000	
Mars	1.88	1.524	