NS101 LEARNING OBJECTIVES

Fall 2019

Intro Week

By the end of this week, you should be able to:

Relate the wide range of scales involved in Nature to familiar objects, and explain in his/her own words how we can investigate the module questions using the Scientific method

1. Compare the **scales** (sizes in order of magnitude) of various objects (entities), such as atoms, bacteria, humans, planets, stars, galaxies, and the Universe, expressed in scientific notation
2. Describe the procedure of **Scientific method** (hypothesis, prediction, test, observation, modify/confirm hypothesis) and distinguish science from non-science
3. Identify **International System of Units (SI) units** and convert units to and from SI units correctly
4. **Estimate** physical quantities by making **reasonable assumptions** and state the reasons for the assumptions

MODULE 1: Are We Alone in the Universe?

UNV 1: What is life? Where do we come from? Our planet and the solar system

By the end of this week, you should be able to:

Recognize Earth as a biosphere, and describe its position and motion in a larger structure such as the Solar system, an environment that hosts a habitable planet

1. Distinguish **"living"** from "non-living" by evaluating their essential characteristics
2. Identify and differentiate the major constituents (Sun, planets) of our **solar system** and describe their motions within.
3. Distinguish **vector** quantities from **scalar** quantities
4. Analyze a simple motion of an object by calculating its **position, velocity** and **acceleration** as a function of time, given any one of the functions
5. Given the **graph** of position, velocity or acceleration as a function of time, sketch the graph of other parameters as a function of time

UNV 2: What makes planets go around the Sun? What holds the Solar system together?

By the end of this week, you should be able to:

Apply the concept of force and momentum to explain what causes the motions of the planets and what holds the Solar system together, showing all the force vectors correctly

1. Use **Newton's laws** to explain the relationships among the fundamental classical mechanical concepts of **force**, mass, acceleration and **momentum**
2. Draw a **free body diagram** of a given object showing all the physical forces exerted on it, label them correctly, and find the **net force** on the object
3. Given Newton's 2nd law, recognize in what situation the momentum is **conserved**
4. **Analyze** a simplified real-life situation by applying the concepts of Newton's laws and momentum.

UNV 3: How did the Solar system form? Is it unique?

By the end of this week, you should be able to:

Explain how the solar system may have formed and evaluate whether our solar system is unique or not

1. Explain why an object (planet) in a **uniform circular motion** is 'accelerating' and show that the net force is directed towards the center of the circle
2. Demonstrate applications of the conservation of **angular momentum** in a planetary system
3. Apply the concepts of circular motion and angular momentum to describe the main events in the theory for **solar system formation**

UNV 4: How did life on Earth begin? Building blocks of life, first form of life on Earth.

By the end of this week, you should be able to:

By providing supporting evidence, describe how molecules of life can be synthesized under conditions similar to those on early Earth

1. Distinguish various types of **energy** (potential, kinetic, thermal) and give daily-life examples of energy conversion.
2. Analyze the motion of an object using the concept of energy **conservation**
3. Describe the conditions on **early Earth** leading to formation of organic molecules and outline the probable sequence of events in **chemical evolution**.
4. Discuss the significance of events leading to **DNA replication** and **protein formation**.
5. Explain the significance of **RNA** in the origin of life within the context of the **RNA world hypothesis**.

UNV 5: How can we look for ET life? Atom and EM spectrum.

By the end of this week, you should be able to:

Relate various types of electromagnetic (EM) waves by giving daily-life examples and discuss how we can use the EM waves to search for extraterrestrial life

1. Describe the concept of "**field**" (gravitational, electric, or magnetic), and compare/contrast electric and gravitational fields and forces
2. Give daily life examples of the use of various wavelengths of **electromagnetic waves**
3. Given the frequency or wavelength of an electromagnetic wave, relate it to the corresponding photon **energy**
4. Describe what a **spectrum** of an object is and relate it to the **blackbody radiation**
5. Apply the concepts of **absorption spectra** to discuss how we can use the EM waves to search for extraterrestrial life

UNV 6: Possibility of life on other planets

By the end of this week, you should be able to:

1. Evaluate **chances of finding life** elsewhere in the solar system using the Drake equation
2. Estimate the time it takes for **two way communication** with an advanced civilization in our Galaxy, and discuss the implication of the estimated time with respect to the timescales involved in human history