CosmoVerse Adventures:

Dark Matter

Lesson Plan

Grade/ Grade Band:	Topic: Dark Matter	Lesson # _____ in a series of _____ lessons

Brief Lesson Description: This lesson allows students to embark on an intriguing journey through the mysterious realm of dark matter, exploring its fundamental role in shaping the universe. Engage with interactive demonstrations and discussions to uncover the secrets of this unseen but influential force.

Specific Learning Outcomes: By the end of the lesson, students will be able to:
  (1) Grasp the fundamental idea of dark matter and its distinction from ordinary (baryonic) matter.
  (2) escribe the key astronomical observations, like the rotation curves of galaxies and gravitational lensing, that provide evidence for dark matter's existence.
  (3) Understand how dark matter contributes to the formation and structure of galaxies and clusters in the universe.

Narrative / Background Information

Prior Student Knowledge: Students should have a basic understanding of:
  • Familiarity with fundamental concepts such as gravity, the solar system, and the structure of galaxies.
  • Some knowledge of atomic structure, including electrons, protons, and neutrons.

Materials needed:
  • Lens or the base of a wine glass (Figure 9).
  • Canvas print of the Hubble Ultra Deep Field image (Figure 10)
  • Graph paper
  • Access to a printer
  • Projector

LESSON PLAN – 5-E Model

ENGAGE: To capture students' interest and provoke curiosity about dark matter.
Activity: Start with turning on a projector displaying a map of the world at night.
Discussion:
  (1) Why do you think we use the term 'dark matter' to describe this substance? What does the 'dark' part signify?
  (2) Considering that dark matter makes up a significant portion of the universe, how might its presence affect the formation and evolution of galaxies?
  (3) Can you think of other examples in science where we have to infer the existence of something from its effects, rather than observing it directly?

EXPLORE: Dive into the main content with the students through the story with Vera Rubin.
Activity: Share/Read out the conversation with Vera Rubin.
Discussion:
  (1) How do Vera Rubin's observations of galaxy rotation challenge our traditional understanding of gravity and mass distribution in galaxies?
  (2) How does the concept of time dilation in strong gravitational fields challenge our everyday understanding of time?
  (3) Why do you think it's important to understand both Newton's and Einstein's theories of gravity? How do they complement each other?

EXPLAIN: Introduce hands-on learning with the Action Lab.
Activity: Conduct the " Free Fall Water Bottle" and '' Space-time Rubber Sheet Gravity '' demonstrations.
Discussion:
  (1) Why does the water stop spraying out of the bottle when it's in free fall? How does this relate to Einstein's theory of gravity?
  (2) Why do you think the rotation curves of galaxies being flat, rather than decreasing at greater distances from the center, suggests the presence of dark matter?

ELABORATE: Extend students' understanding of dark matter and its cosmic implications.
Discuss:
  (1) How do experiments like the Large Hadron Collider contribute to our understanding of dark matter?
  (2) What might be the implications for physics and cosmology if we were to fully understand dark matter?

EVALUATE: Assess students' understanding and ability to apply the concept of dark matter.
Activity: A quiz or project where students explain dark matter's effects in various cosmic scenarios, using both observational evidence and theoretical models.

Homework/Extension: For students keen on further exploring the enigmatic concept of dark matter, the "Cosmic Library" section offers a variety of resources for deeper investigation and learning:
  • Online Simulations: Encourage students to explore online simulations and interactive tools that demonstrate the effects of dark matter on galactic rotation and the formation of cosmic structures.
  • Assign a project where students research and present on various aspects of dark matter. Topics could include its discovery, theories about its composition (like WIMPs or MACHOs), or current research and detection methods.