**CosmoVerse Adventures:**

**Geometric Gravity**

**Lesson Plan**

| **Grade/ Grade Band**: | **Topic:** Geometric Gravity | **Lesson # _____ in a series of _____ lessons** |
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**Brief Lesson Description**: This lesson allows students to embark on an interactive journey through the concepts of gravity, exploring Newton's and Einstein's theories. Experience hands-on activities and cosmic adventures to understand how gravity shapes our universe

**Specific Learning Outcomes**: By the end of the lesson, students will be able to:

(1) Understand the fundamental differences between Newtonian and Einsteinian gravity
(2) Grasp the concept of spacetime curvature as explained by Einstein's theory of General Relativity

**Narrative / Background Information**

**Prior Student Knowledge:** Students should have a basic understanding of:

- Familiarity with the concept of gravity as a force that attracts objects with mass.
- A grasp of fundamental physics concepts like force, motion, and the behavior of light.

**Materials needed:**

- A plastic bottle with a tight-fitting cap
- A pin or small nail to make holes in the bottle
- Water to fill the bottle
- Plastic sheet to contain the dripping water
- Access to a printer
- Projector
- A large, stretchable rubber sheet or spandex fabric
- A frame or stand to stretch and secure the sheet (optional)
- A heavy ball (e.g., a metal or rubber ball)
- Smaller balls (e.g., marbles or ping pong balls)

**LESSON PLAN – 5-E Model**

**ENGAGE:** To capture students' interest and connect their prior knowledge to the concept of gravity.
Activity: Start with a video of a falling bowling ball and feather in a vacuum chamber.
Discussion:

(1) What do you imagine the sensation of weightlessness would be like, as Einstein described?
(2) Considering the video of the bowling ball and feather, why do you think removing air resistance results in both objects falling at the same rate?
(3) If gravity acts over vast distances like between the Earth and the Sun, why don't we feel the Sun's gravity as strongly as we feel the Earth's?

**EXPLORE:** Dive into the main content with the students through the story with Albert Einstein.
Activity: Share/Read out the conversation with Einstein.
Discussion:

(1) Why do you think Mercury's peculiar orbit was such a crucial piece of evidence for Einstein's theory?
(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) How do these demonstrations change your understanding of gravity compared to before?

**ELABORATE:** Extend and apply gravitational concepts to broader contexts.
Activity: Interactive simulations or thought experiments to visualize the curvature of spacetime and its effects on light and matter.

**EVALUATE:** Assess students' understanding and application of gravity concepts.
Activity: A quiz or project where students explain gravity's effects in various scenarios, using both Newton's and Einstein's perspectives.
Discussion:

(1) How would you use Newton's and Einstein's theories to explain the orbit of a satellite around Earth?
(2) In what scenarios might one theory be more applicable than the other?

**Homework/Extension:** For students interested in further exploring the intriguing world of gravity and spacetime, the "Cosmic Library" (as referenced in our CosmoVerse adventures) offers a treasure trove of resources for extended learning:

- Interactive Simulations: Encourage students to engage with online simulations that allow them to visualize and manipulate the effects of gravity in a spacetime context.
- Assign a research project where students explore a topic related to Einstein's theories of relativity, such as the role of gravity in the formation of galaxies, gravitational waves, or time dilation effects in space travel.