General Relativity I Lesson Plan

Time: 40 minutes

Goals: To gain an understanding of what the presence of matter does to space-time and how this understanding gives us a new way to view gravity.

Objectives: Students will:

- Watch the "General Relativity I" segment of the "How fast is it" video book
- Take a short quiz

Materials:

- Internet connection with a computer for viewing "General Relativity I" segment on YouTube

Directions:

- Introduce the 'General Relativity I' segment as an introduction to how matter effects the geometry of space and time.
- Show the video.
- Review what they saw:
    - How acceleration equals gravity – The Equivalence Principle.
    - That the shortest distance between two points in curved space is called a geodesic.
    - How particles move along geodesics unless they are acted on by a force.
    - That the Einstein tensor describes how the volume of a group of particles will change due to the curvature of the space they are in.
    - That this is proportional to the Energy-Momentum tensor.

Assessment:

Take a simple quiz. Print and distribute the quiz on page 2. Here are the answers:

- What is the essential difference between a gravitational field in an elevator accelerating at 9.9 m/s^2 and the gravitational field at the surface of the Earth?
  Answer: d) There is no difference
- Is there a fourth space dimension that our familiar 3D space bends into?
  Answer: b) No
- What do the 4 coordinates of an event in space-time represent?
  Answer: c) The time and place an event occurred

General Relativity I quiz

- What is the essential difference between a gravitational field in an elevator accelerating at 9.9 m/s^2 and the gravitational field at the surface of the Earth?

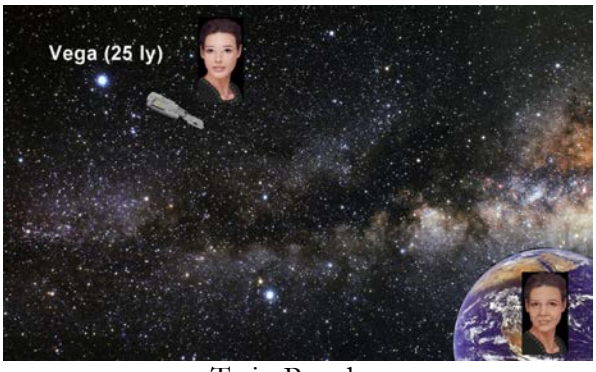
  a) The elevator has walls
  b) The Earth is bigger
  c) The elevator can stop
  d) There is no difference

- Is there a fourth space dimension that our familiar 3D space bends into?

  a) Yes – you always need an extra dimension to get a bending effect
  b) No – in General Relativity we are only talking about intrinsic curvature. There is no need for and no evidence for a fourth space dimension

- The constant of proportionality between the curvature as represented by the Einstein Tensor and the matter energy that created the curvature as represented by the Matter-Energy tensor is very small. This indicates that?

  a) A small amount of mass can create a great deal of energy.
  b) It takes a large amount of matter-energy just to create a small amount of curvature.
  c) Curvature and mass are inversely proportional
  d) Negative curvature represents dark matter



Twin Paradox