General Relativity II Lesson Plan

Time: 40 minutes

Goals: To gain an understanding of what curved space-time does to light, time, and planetary orbits.

Objectives: Students will:

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

Materials:

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

Directions:

- Introduce the 'General Relativity II' segment as the video that explains the effects of the intrinsically curved space-time covered in part one.
- Show the video.
- Review what they saw:
    - How the space is curved around the Sun and that curvatures impact on the orbit of Mercury.
    - How gravity bends light – including how it lenses light that passes through massive galaxy clusters.
    - How matter tips light cones, slows down time and moves space.
    - And what a black hole might look like up close – but not too close.

Assessment:

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

- How does Earth's gravity effect our Global Positioning System satellite clocks?
  Answer: c) They run faster than clocks on the Earth's surface [because they are further away from the mass that is slowing the clocks on the surface]
- What is Frame Dragging?
  Answer: a) The moving of space around a rotating mass
- What happens to an object's light cone as it reaches the event horizon?
  Answer: b) It tilts 90 degrees towards the center of the black hole

General Relativity II quiz

- How does Earth's gravity effect our Global Positioning System satellite clocks?

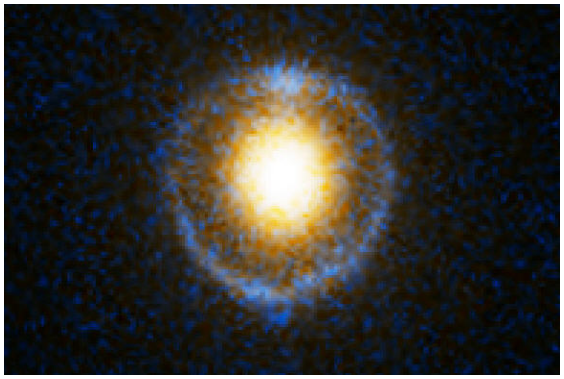
  a) It doesn't
  b) They run slower than clocks on the Earth's surface
  c) They run faster than clocks on the Earth's surface
  d) It cancels out the time dilation due to the satellite's speed

- What is Frame Dragging?

  a) The moving of space around a rotating mass
  b) The dragging of time in an intense gravitational field
  c) The compression of space inside a black hole
  d) The pulling of space away from orbiting planets

- What happens to an object's light cone as it reaches the event horizon?

  a) It collapses into a singularity
  b) It tilts 90 degrees towards the center of the black hole
  c) It inverts and you can't get out
  d) It converts space into time



Einstein Ring