AT3: Einstein for Everyone: Take-home Exam (or Exam Review):

Hurricane evacuation: If we are evacuated because of a hurricane in the Gulf of Mexico, this will serve as your final exam. You MUST pledge this assignment. You will be pledging that you did NOT work with anyone else on this take-home exam (you may e-mail me with questions and I will respond) and you ONLY used your textbook and notes from class (and correspondence with me). Due: Friday, August 31, 2006 (via e-mail: coxaj@eckerd.edu or snail mail with August 31, 2006 post-mark).

Short-answer (6 pts each):

1. Describe one experiment that Einstein explained during his “miraculous year” (1905). Briefly describe the implications of his explanation.

2. Give an example of an observation made of the celestial realm (observations made not on Earth) that helped humans to refine scientific theories. Describe the observation (briefly) and the corresponding idea it supported or refuted.

3. What is the connection between electricity and magnetism and special relativity?

4. Length contraction: One way that people describe one outcome of special relativity is to say that moving objects get shorter (contract). This can be misleading, however, because if I am carrying a meter stick in my very fast rocket (going 0.6c relative to you), I find that it is still one meter long. What is meant, then, by “moving objects get shorter”? (and how should it be stated to be more precise?)

5. An alien space-station in a faraway galaxy is at rest with respect to the Earth. The Earth and the alien space-station fire rockets simultaneously at each other, starting Universal War I. At the headquarters of the United Galaxies (instead of the United Nations), the Earth is charged with starting the War because Earth fired first. How is this possible? On what grounds can the residents of Earth (if anyone survives) make the case that they did not begin the War?

6. Which of the points, if any, on the diagram below are in “elsewhere” for the event at the origin (point A)? What does it mean for an event to be in “elsewhere” from another event?

   ![Diagram](image)

7. Professor Cox, in her very fast rocket (going 0.6c relative to you sitting at your desk on Earth), measures the time it takes for her to travel to a distance planet. You, sitting on Earth, also measure the time it takes for this same trip. How do the values compare?
8. Some reports claim that Einstein got to the problem of relativity by trying to imagine what things would look like if you traveled at the speed of light. Using special relativity, then, what do things look like if you travel close to the speed of light? What about at the speed of light? Explain.

**Physlet Problems (6 pts each):**

9. The Physlet at [http://www.bqlearning.org/ospdb/osp_display.php?phys_text_id=736](http://www.bqlearning.org/ospdb/osp_display.php?phys_text_id=736) shows the ticking of two clocks: one is in your reference frame and the other is on the rocket with Professor Cox. You can change the speed of Prof Cox’s rocket relative to you. In the animation, which clock is which (in other words, just by how they tick relative to each other, which clock is which)? Explain.

\[ \beta = \frac{v}{c} = 0.8 \]

10. Determine the properties of the wave (amplitude, wavelength, period and speed) given in the animation at [http://www.bqlearning.org/ospdb/osp_display.php?phys_text_id=926](http://www.bqlearning.org/ospdb/osp_display.php?phys_text_id=926). Give one example of a property of a wave that clearly differentiates it from a particle (and explain the difference). What evidence do we have that light is a wave?

Note: If you cannot run the Physlets on your computer (you must have Java installed on the computer), answer how you would determine the values for each given the animation (and use the screen shots shown above in your explanation).

**Essay questions (20 pts each):**

1. **A letter to Grandma.** Write a letter to Grandma or some other relative who has not had a class in special relativity explaining to her or him special relativity. Focus, in particular, on one example where you can show that time or space is not absolute. Explain the implications of the example to our understanding of time or space.  
   **-OR-**
   **A science fiction-like scenario.** Set up a situation that might seem like science fiction to someone who has not had this class. Explain why it is not science fiction and how it follows from the ideas of special relativity (using language that someone who has not been in this class would understand).

2. **Einstein and pop culture.** Why do you think Einstein has become a pop culture icon? Specifically reference an explanation suggested by one of the presentations by your classmates (besides the one you gave). What do you think Lightman’s answer would be to “why is Einstein a pop culture icon”? Cite specific examples from *Einstein’s Dreams* to support your answer.