1. The lifetime of a high speed elementary particle relative to a stationary observer appears to a stationary observer to be

   (a) Shorter than the particle's lifetime at rest;

   (b) The same as the particle's lifetime at rest;

   (c) Longer than the particle's lifetime at rest;

   (d) Any of the above depending on whether the particle is approaching or receding from the stationary observer.

2. Two spaceships leave a space station with identical speeds in opposite directions. After each captain records that one year has passed he turns the space ships around and comes back at the same speed to meet the other spaceship. When the captains discuss their journey they

   (a) agree that the other turned around at the same time as they did and that it was two years ago that they first passed each other;

   (b) each think that the journey took more than two years for the other captain;

   (c) each think that the journey took less than two years for the other captain.

   (d) disagree about who turned around first, but agree that it was two years ago that they first passed each other.

3. An observer in a closed laboratory wishes to determine if she is at rest or in motion with constant velocity. She can find out by

   (a) making a careful measurement of the speed of light in the lab.

   (b) by making a careful measurement of the length of meter sticks in the lab.

   (c) by making a careful measurement of the lifetime of known radioactive elements in the lab.

   (d) she cannot find out.

4. Two identical space ships pass each other at high speed. The captains on both ships will always agree

   (a) that the other ship is the same length as theirs.

   (b) on the speed of a passing comet.

   (c) that they have the same speed relative to each other.

   (d) on none of the above.

Part II

1. Suppose you are standing beside a railway track watching a high speed train go by without stopping.

   (a) You and a passenger on the train observe the movement of the second hand of a clock on the train. Who measures the proper time?

   (b) Who measures the proper length of the train car?

   (c) Who measures the proper length between sign posts on the station?

2. (a) A hypernaut from the year 2218 travels in space at $0.9c$ for 45 days according to a clock on earth. How much time has passed for him?

   (b) A cosmonaut from 2011 travels in space at 7900 m/s aboard the international space station for 45 days according to a clock on earth. Determine the difference between the time he measures and the time measured on earth (in seconds). (Hint: when u/c is very small, as in this case, it is helpful to use the approximate result $1/\gamma = \sqrt{1 - u^2/c^2} \approx 1 - \frac{1}{2}\, u^2/c^2$.)

3. Johanna jumps from a bridge attached to a bungee cord. Due to conservation of energy she returns a short time later to the position from which she jumped. Her friend John observes this motion from the top of the bridge and times how long it takes her to go down and back up. A passing motorist also observes this motion and times how long it takes. Of the three observers who measures the longest time for the jump? Who measures the shortest time? Explain.

4. A space shuttle with proper length 20 m enters a docking port which has a proper length of 24 m while traveling at at 0.8c relative to the docking port.

   (a) The crew of the space shuttle claim the space shuttle is too long to fit entirely within the space port. What is the length of space shuttle and the docking port as seen by the crew of the space shuttle?

   (b) The crew at the docking port observe that the space shuttle fits easily into the port. What is the length of the space shuttle and the docking port as seen from the docking port?

   (c) If the space shuttle passes right through the space dock without slowing down whose assessment is correct? Explain your answer.

   (d) If instead the space shuttle comes to a complete stop inside the space dock whose assessment is correct?

5. The Milkyway has a diameter of 1.2×10^5 light years. Suppose a space traveler crosses the galaxy in one year according to her watch.

   (a) How fast was she going?

   (b) How wide would the galaxy appear to her (give your answer in light years)?

   (c) If it were possible for her to travel at the speed of light how large would the galaxy appear to her? How large would the universe appear?

6. Your boss is traveling from Earth to Pluto traveling at 0.6c on board the Pluto Express. Pluto is 5 light hours away from Earth. One hour into the journey (as measured by your boss) she sends you a message (at the speed of light) telling you she is going to take a nap and asks you to wake her up after she has slept for an hour. You immediately send her a note (at the speed of light) apologizing for not waking her up on time because the laws of physics prevented you from doing so. How long did your boss sleep according to her and according to you? (Hint: you may find a space time diagram useful.)