Homework 2

Due: In class on Wednesday 10/14/09

0. Write a one-page summary of this week's reading and include three questions.

1. The speed of light is 3×10^5 km/s or 6.7×10^8 mph; 1 mph is 4.5×10^{-4} km/s.

   (1) You are driving at a speed of 80 mph; so is an incoming police car. How fast is your car traveling relative to the police car according to (a) Newton; (b) Einstein?

   (2) Your spaceship is traveling at 90% the speed of light (relative to distant stars); so is an incoming alien spaceship. How fast is the alien ship going relative to you according to (a) Newton; (b) Einstein? Express your answers in units of the speed of light. Comment on your answers.

2. **The algebra for this problem is so simple that you don't need a calculator.**

   The identical twins, Tweedledee and Tweedledum, have identical clocks. Tweedledee sets out on a long voyage to the Sirius star to attend the Queen of Hearts' party, while Tweedledum stays in Wonderland on Earth. The distance to Sirius is 8 light-years as measured from Earth, and Tweedledee's spacecraft travels at 0.8 the speed of light. How long does Tweedledum have to wait (according to his own clock) for his twin brother to return to Earth? (Assume Tweedledee spends a negligible amount of time at the party and in turning around his ship.) How much will Tweedledee have aged when he returns? How much will Tweedledum have aged?

3. **This problem is slightly more involved and requires a calculator. It gives you another chance at understanding space travel and special relativity.**

   It is the year 2165 A.D. Human life expectancy has reached 100 years, but as a result the population growth rate is now so high that experts are predicting that global famine and war are likely in the next decade. A group of scientific leaders, fearing that the end of the human race is near, decide that they must begin an urgent program to colonize the galaxy in the hope that humanity can survive elsewhere even if we destroy our home planet. A major effort in rocket technology produces ships that can travel at 0.96 times the speed of light. You and other 20 year olds are sent off in small groups to establish new homes wherever you can, knowing that your choice is between staying on a dying Earth and taking your chances among the stars. Your group heads in the direction of the sun-like star 51-Pegasi with a planetary system, which is 50 light-years away, with instructions to radio home when you arrive.

   (1) If humans survive on Earth, when can they expect to get your message? [*Hint: They must wait for you to arrive, then wait for your signal to travel back.*]

   (2) You depart on your 20th birthday. How old are you when you arrive? [*Hint: This involves clocks travelling with you and a distance measured from Earth*]

   (3) According to you, what was the distance you travelled?

   (4) Divide the distance you measure for the trip by the time you measure to get the velocity. It should be the same as the velocity measured by the Earth bound observers. If two observers are moving with respect to one another, each sees the other move at the same velocity.