Names Date

University of Alabama
Department of Physics and Astronomy

PH 102-2 / LeClair Spring 2008

In-class exercise: Special Relativity

Instructions:

1. Answer all questions below.
2. Show your work for full credit, attach sheets as necessary.
3. You are encouraged to work in groups, turn in one paper per group
4. *List all group members names.*

1. An interstellar space probe is moving at a constant speed relative to earth of $0.76c$ toward a distant planet. Its radioisotope generators have enough energy to keep its data transmitter active continuously for 15 years, as measured in their own reference frame.

a) How long do the generators last as measured from earth?

b) How far is the probe from earth when the generators fail, as measured from earth?

c) How far is the probe from earth when the generators fail, *as measured by its built-in trip odometer*?

2. A proton moves with a speed of $0.95c$.

a) Calculate its rest energy *in MeV*.

b) Calculate its total energy *in MeV*

c) Calculate its kinetic energy *in MeV*

3. A Klingon space ship moves away from Earth at a speed of $0.700c$. The starship Enterprise pursues at a speed of $0.900c$ relative to Earth. Observers on Earth see the Enterprise overtaking the Klingon ship at a relative speed of $0.200c$. With what speed is the Enterprise overtaking the Klingon ship as seen by the crew of the Enterprise?

4. What is the speed of a particle whose kinetic energy is equal to $\frac{2}{3}$ its own rest energy?

5. A rectangular billboard in space has the dimensions $10\,\mathrm{m} \times 20\,\mathrm{m}$. How fast, and in what direction with respect to the billboard would a space traveler have to pass for the billboard to appear square?

6. A hangar for housing spaceships is 100 m long. How fast must a 200 m long spaceship be traveling to (briefly) fit in the hangar?