Physics 123 section 2 CID _____

Homework 40

Score _____ / 30

1. (5 pts) Explain why communication or travel faster than the speed of light violates causality.

2. (5 pts) At what speed is a particle's momentum twice that given by the classical momentum relation?

3. (5 Pts) A particle with a rest mass of m, traveling at a speed of 0.98 c has a head-on collision with a particle of mass $3m$ which is initially at rest. If the larger mass moves away with a velocity of 0.89 c, what is the final velocity of the smaller mass?

4. (5 pts) Two grams of hydrogen burn, combining with 15.9 grams of oxygen to produce water. In the process, 5.72×10^5 Joules of energy are released. How much mass is lost in this process (i.e. how much less mass does the water have compared to the sum of the mass of the hydrogen and the oxygen we started with)?

5. (5 pts) The largest power reactor in the world is the RBMK-1500 reactor at the Ignalina nuclear power plant in Italy. The nuclear reactions in the fuel rods generates 4.80 GW (4.80×10^9 Watts) of heat. This heat creates steam which drives turbines to generate 1.50 GW of electricity. If a new set of fuel rods is placed in the reactor, and then the reactor runs at full power for a year, how much less will the fuel rods weigh at the end of the year?

6. (5 pts) A 1 kg block of copper is heated from a temperature of 25°C to a temperature of 150°C. How much does the mass of the copper change?

Extra problems I recommend you work (not to be turned in)

- At what speed u does the classical momentum equation ($p = mu$) differ from the relativistic form ($p = \gamma mu$) by less than 0.1 percent?
- At what speed u does the classical kinetic energy equation differ from the relativistic form by less than 0.1 percent?
- If an object with a rest mass of 10 kg is accelerated with a constant force of 10 N, how long will it take before the object reaches (a) half the speed of light, (b) the speed of light?
- An electron has a mass of $9.1093897 \times 10^{-31}$ kg. A proton has a mass of $1.67262171 \times 10^{-27}$ kg. A hydrogen atom is made of an electron bound to a proton. It takes 2.1790×10^{-18} J of energy to separate the electron and the proton of a hydrogen atom. To 9 decimal places, how much does a hydrogen atom weigh?
- A photon has no rest mass. Can a photon have momentum? Why or why not?
- A 1 gram meteor strikes the moon and makes a huge crater. From the size of the crater you determine that the energy released in the collision was equivalent to detonating 1 million tons of TNT. How fast was the meteor going before it hit the moon?