Zhejiang University

Department of Physics

General Physics (H) Problem Set #10

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1. Calculate the momentum of an electron moving with a speed of (a) 0.0100*c*, (b) 0.500*c*, (c) 0.900*c*. For what speed does the use of the nonrelativistic expression for the momentum of a particle yield an error in the momentum of 1.00 percent?

2. Electrons are accelerated to an energy of 20.0 GeV in the 3.00-km-long Stanford Linear Accelerator. (a) What is the γ factor for the electrons? (b) What is their speed? (c) How long does the accelerator appear to them?

3. When 1.00 g of hydrogen combines with 8.00 g of oxygen, 9.00 g of water is formed. During this chemical reaction, 2.86×10^5 J of energy is released. How much mass do the constituents of this reaction lose? Is the loss of mass likely to be detectable?

4. In a nuclear power plant the fuel rods last 3 yr before they are replaced. If a plant with rated thermal power 1.00 GW operates at 80.0% capacity for the 3 yr, what is the loss of mass of the fuel?

5. In class, we showed that the classical definition of the linear momentum cannot be right in the relativistic case. We illustrated by the example of the collision of two particles with equal mass. In the rest frame (for the center of mass) *K*, the two particles have velocities with the same amplitude *v* but opposite directions along *x* axis before the collision, as illustrated in Fig. (a). After the collision, they move away along *y* axis with the same speed *v*, as illustrated in Fig. (b). Now, in a frame *K′* that moves with speed *v* along the positive x direction with

respect to the rest frame K [Fig. (c)], one particle is at rest before the collision. (i) What is the velocity of the other particle before the collision? (ii) After the collision [Fig. (d)], what are the velocities of the two particles? Specify the components of the velocities along x and y axes. (iii) Show that if you use the definition of the relativistic momentum, you will maintain the conservation of linear momentum in the moving frame K'.