**Chapter 05: Relativity and Nuclear Physics**

**1 Einstein's Postulates**

**2 Relativity of Time Intervals**

1. A muon decays with a mean lifetime of 2.20×10-6 s as measured in a frame of reference in which it is at rest. If a muon is moving at 0.990c (about 2.97×108 m/s) relative to the earth, what will you (an observer on earth) measure its mean lifetime to be?
2. An airplane flies from San Francisco to New York (about 4800 km) at a steady speed of 300 m/s.

How much time does the trip take, as measured by an observer on the ground? By an observer in the plane?

**3 Relativity of Length**

1. A spaceship flies past earth at a speed of 0.990c. A crew member on board the spaceship measures its length, obtaining the value 400 m. What length do observers measure on earth?

**4. Relativistic Dynamics**

1. A proton (rest mass 1.67 ×10-27 kg) has total energy that is 4.00 times its rest energy. What are (a) the kinetic energy of the proton; (b) the magnitude of the momentum of the proton; (c) the speed of the proton?

**5. General theory of relativity**

**B. NUCLEAR PHYSICS**

**1 Properties of Nuclei **

**2 Nuclear Binding and Nuclear Structure**

1. Because it has the highest binding energy per nucleon of all nuclides, Ni (Z=28; A=62) may be described as the most strongly bound. Its neutral atomic mass is 61.928349 u. Find its mass defect. its total binding energy, and its binding energy per nucleon.
2. When lithium  is bombarded by a proton, two alpha particles  
   () are produced. Find the reaction energy.

**3.1 Fission Reactions**

1. Calculate the energy released in the fission reaction:



You can ignore the initial kinetic energy of the absorbed neutron. The atomic masses are , 235.043923 u; , 139.921636 u; and , 93.915360 u.

**3.2 Nuclear Fusion**

1. Two deuterons fuse to form a triton (a nucleus of tritium, or  ) and a proton. How much energy is liberated?

**4. Radioactivity**

1. The radioactive isotope 57Co decays by electron capture with a half-life of 272 days. (a) Find the decay constant and the lifetime. (b) If you have a radiation source containing 57Co, with activity 2.00 μCi, how many radioactive nuclei does it contain? (c) What will be the activity of your source after one year?
2. The isotope 226Ra undergoes a decay with a half-life of 1620 years. What is the activity of 1.00 g of 226Ra? Express your answer in Bq and in Ci.