Physics 2220 (Schroeder)

Relativity Study Guide

You should understand all the terms and definitions on the relativity handout distributed earlier, including the metric equation, $(\Delta s)^2 = (\Delta t)^2 - (\Delta x/c)^2$. From the metric equation you should be able to work essentially any quantitative problem involving the three kinds of time. You should be able to draw accurate spacetime diagrams and interpret them correctly.

You should be able to work simple problems involving length contraction. The apparent length of a moving object (as measured along the direction of motion) is *less* than its true length, by a factor of $\sqrt{1-(v/c)^2}$.

You should understand how the invariance of the speed of light implies that simultaneous events in one reference frame are generally not simultaneous in another. You should be able to represent this fact on a spacetime diagram, showing the t and x axes for both reference frames.

You should know the Einstein velocity combination formula, $u_x = \dfrac{u'_x + v_x}{1 + (u'_x/c)(v_x/c)}$, where u_x and u'_x are the velocities of an object as measured in two different inertial reference frames, and v_x is the velocity of the primed frame with respect to the unprimed frame.

You should understand why momentum and energy are redefined in relativity theory (because they couldn't be conserved in all inertial reference frames otherwise). The relativistic definition of energy is $E = mc^2/\sqrt{1-(v/c)^2}$. For an object at rest this reduces to the "rest energy", mc^2. The difference $E - mc^2$ is called the "kinetic energy", and is approximately $\frac{1}{2}mv^2$ when $v \ll c$. The thing that's conserved for any isolated system is the *total* energy, E, summed over all objects in the system.

Nuclear Physics Study Guide

You should understand the following terminology and notation: proton, neutron, nucleon, atomic number (Z), mass number (A), isotope, atomic mass unit (u), binding energy, radioactivity, decay constant, half-life, alpha particle, beta particle, gamma ray, positron, neutrino. You should have a rough idea of the sizes and masses of nuclei and subnuclear particles, and of how much energy is typically involved in nuclear reactions. You should be able to balance nuclear reaction equations and determine what is missing in an incomplete equation. (You need not memorize the names of elements.)

Given the mass of a nucleus, you should be able to compute its binding energy. Given the masses of all the particles that participate in a nuclear reaction (such as a radioactive decay), you should be able to compute the amount of "energy released" in the reaction.

Unstable (radioactive) nuclei decay in a random fashion, with a certain fixed probability λ of decaying per unit time. For a large sample of radioactive material, this implies that the number of nuclei remaining after time t is

$$N(t) = N(0) \cdot e^{-\lambda t}.$$

You should be able to determine from this equation how λ is related to the half-life. By taking the derivative of this equation, you should also be able to derive the equation for the decay rate as a function of time.