11. The Sun is radiating heat and light at the rate of 3.9×10^{26} W. In 1 year, how much mass does the Sun lose because of this radiation?

17. The helium nucleus ^{4}He consists of two protons and two neutrons bound together. The mass of this nucleus is 3727.4 MeV/c^2.
(a) Calculate the binding energy of this nucleus.
(b) From Section 4.4, we know that the binding energy of the deuterium nucleus is 1.3 MeV. How much energy is released when two deuterium nuclei are allowed to fuse into a helium nucleus, according to the reaction D + D $\rightarrow$ ^{4}He ?

19. While moving at a speed of $0.90c$ relative to our laboratory, a $K^0{}_S$ meson decays into two pions, each of mass 140 MeV/c^2 and kinetic energy 110 MeV. In the rest frame of the K meson, one of these pion moves in the forward direction and the other in the backward direction. What are the kinetic energy and the momentum of each pion in the laboratory frame?

8. A photon of initial energy 20 MeV collides with a *proton* and is deflected by 30^0. What is the final energy of the photon?

14. In practice, magnetic fields are usually produced by means of currents on electrically neutral wires, so in the rest frame of the wire, there is a magnetic field but no electric field. Consider such a pure magnetic field $B = \mu_0 I / 2\pi r$, produced by a long straight wire carrying a current I. Suppose that a point charge q of mass m instantaneously moves parallel to this wire with velocity v at a distance r.
(a) What is the radial magnetic force that acts on the point charge and what is the acceleration?
(b) In the rest frame of the point charge there is no magnetic force, but there is a radial electric field that produces a radial force. What is the radial electric field in this reference frame, what is the force on the point charge, and what is the acceleration?
(c) Since there is a radial electric field in this reference frame, there must be a charge per unit length on the wire in this reference frame. Deduce the charge per unit length from the electric field.
(d) Show that this charge per unit length can be explained by examining the positive and negative charges (ions and conduction electrons) that exist within the wire. In the rest frame of the wire, the ions are at rest, but the conduction electrons are in motion. The charge of the ions is λ per unit length, and the charge of the conduction electrons is $-\lambda$ per unit length, giving a net charge of zero; but the motion of the conduction electrons produces a current $I = \lambda v$ (for the sake of simplicity, assume that the speed of the conduction electrons is the same as the speed of the point charge). Show that as a result of the length contraction of the ionic and electronic charge distributions, the wire will have a net electric charge per unit length in the rest frame of the point charge.