$h = 6.63 \times 10^{-34}$ J-s; $m_e = 9.11 \times 10^{-31}$ kg; $m_p = 1.67 \times 10^{-27}$ kg; 1 eV = 1.6×10^{-19} J

1(a) The nearest star to us other than the Sun is Proxima Centauri, which is 4.22 light-year away. Suppose we had a spaceship that could travel at the speed of 0.90*c*. If you were in the spaceship, how long does it take for you to travel from the Sun to Prixima Centauri, from your point of view? (b) An electron and a α particle moving through a piece inside a particle accelerator. The particles are traveling in the same direction. The speed of the electron is 0.830*c* and the speed of the α particle is 0.750*c*, both measured by a stationary observer in the lab. What is the speed of the α particle as observed from the electron, in units of the speed of light? (15 分)

2. The rest energy of an electron is $E_0 = 0.511$ MeV. If an electron has a speed of 99.0% that of light, what are its kinetic energy and momentum? (10 分)

3. A 5.0-g particle has a de Broglie wavelength of 20.0 cm. (a) How fast is the particle moving? (b) What is the smallest speed uncertainty of the particle if its position uncertainty is 20.0 cm? (15 分)

4. X rays of wavelength λ = 22 pm (photon energy = 56 keV) are scattered from a carbon target, and the scattered rays are detected at 90° to the incident beam. What is the Compton shift (Δλ) of the scattered rays? (10 分)

5. An electron is confined to a one-dimensional, infinitely deep potential of width $L = 0.20$ nm. (a) What is the lowest energy the electron can have? (b) If we reduce the potential well to half its original value, what is the energy of the $n = 3$ wave function? (15 分)

6. A 25-eV electron is incident on a square barrier of height 35 eV. What is the probability that the electron will tunnel through if the barrier width is 0.10 nm? (10 分)

7. The radius of a nucleus can be expressed as $R(A) = R_0 A^{1/3}$, where A is its mass number and $R_0 = 1.12$ fm. What is the mass density inside an atomic nucleus? (10 分)

8. Matter-antimatter annihilation is a popular energy source in science fiction books and movies. (a) How much energy would be released if you could let a 1.25-liter bottle full of anti-water annihilate with regular water? (b) The largest nuclear power plants produce 1200 MW. How long would such a power plant have to operate in order to produce the same amount of energy (15 分)

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