1. . A train at rest has a length of 100 m. At what speed must it approach a tunnel of length 80 m so that an observer at rest with respect to the tunnel will see that the entire train is in the tunnel at one time? (A) 1.25c (B) 0.8c (C) 0.64c (D) 0.6c (E) 0.36c

2. . A photon has 6.6 x 10-18 J of energy. Planck’s constant, h, is 6.6 x 10-34 J Â· s. The frequency of the photon is most nearly: (A) 1.0 x 10-52 Hz (B) 1.0 x 10-16 Hz (C) 1.0 Hz (D) 1.0 x 1016 Hz (E) 1.0 x 1052 Hz

3. . What happens to a stream of alpha particles that is shot at a thin sheet of gold foil? (A) All of the particles pass straight through (B) A few of the particles bounce back at 180Âº (C) All of the particles bounce back at 180Âº (D) Most of the particles are absorbed by the foil (E) None of the particles are deflected by more than 45Âº

4. . According to Bohr’s model of the atom, why do atoms emit or absorb radiation only at certain wavelengths? (A) Because the protons and electrons are distributed evenly throughout the atom (B) Because electrons can orbit the nucleus at any radius (C) Because electrons orbit the nucleus only at certain discrete radii (D) Because protons orbit the nucleus only at certain discrete radii (E) Because photons can only have discrete wavelengths

5. . An electron is accelerated through a particle accelerator and then ejected through a diffraction grating. By means of the diffraction experiment, it is determined that the electron’s de Broglie wavelength is 6.6 x 10-10 m. What is the electron’s linear momentum? Use Planck’s constant, h = 6.6 x 10-34 J Â· s. (A) 1.0 x 10-44 kg Â· m/s (B) 1.0 x 10-24 kg Â· m/s (C) 1.0 x 10-24 kg Â· m/s (D) 2.0 x 10-24 kg Â· m/s (E) 1.0 x 1044 kg Â· m/s

6. . Which of the following is the best definition of the uncertainty principle? (A) We cannot know for certain when any given radioactive particle will undergo decay (B) We cannot know both the momentum and the position of a particle at the same time (C) The laws of physics are the same in all intertial reference frames (D) Light exhibits both wave and particle properties (E) An unobserved particle can be in two places at the same time

7. . Which of the following particles is most massive? (A) A proton (B) A neutron (C) An electron (D) A beta particle (E) An alpha particle

8. . In nuclear reaction, what particle is represented by X? (A) A proton (B) An electron (C) An alpha particle (D) A gamma ray (E) A beta particle

9. . Which graph plots the activity of a radioactive substance as a function of time? (A)  (B)  (C)  (D)  (E)

10. . Which graph shows the half-life of a radioactive substance as a function of time? (A)  (B)  (C)  (D)  (E) 