Chapter 11 Review Questions

Solutions can be found in Chapter 12.

Section I: Multiple Choice

1. According to the theory put forth by Louis de Broglie, all matter has wave-like properties such as interference, but these properties are only seen at a microscopic scale. Why are these properties not typically observed at a macroscopic scale?

   (A) The wavelength of matter is typically too large to observe this interference.
   (B) Interference of matter only occurs when these waves interact with other objects comparable to their wavelength and those things are microscopic.
   (C) There are no energy level transitions available to allow for this interference to be observed.
   (D) At the macroscopic scale, the interference is always destructive so it cannot be observed.

2. A metal whose work function is 6.0 eV is struck with light of frequency 7.2×10^{15} Hz. What is the maximum kinetic energy of photoelectrons ejected from the metal's surface?

   (A) 7 eV
   (B) 13 eV
   (C) 19 eV
   (D) 24 eV

3. An atom with one electron has an ionization energy of 25 eV. How much energy will be released when the electron makes the transition from an excited energy level, where $E = -16$ eV, to the ground state?

   (A) 9 eV
   (B) 11 eV
   (C) 16 eV
   (D) 25 eV

4. The single electron in an atom has an energy of –40 eV when it's in the ground state, and the first excited state for the electron is at –10 eV. What will happen to this electron if the atom is struck by a stream of photons, each of energy 15 eV ?

   (A) The electron will absorb the energy of one photon and become excited halfway to the first excited state, then quickly return to the ground state, emitting a 15 eV photon in the process.
   (B) The electron will absorb the energy of one photon and become excited halfway to the first excited state, then quickly absorb the energy of another photon to reach the first excited state.
   (C) The electron will absorb two photons and be excited to the first excited state.
   (D) Nothing will happen.

5. The products of several radioactive decays are being studied. Each particle starts with the same speed and enters into a region with a uniform magnetic field directed perpendicular to the initial velocity of the particles. Which observation could be made?

   (A) A neutron and an electron are deflected in the same direction, but with the electron turning with a larger radius.
   (B) An alpha particle and an electron are deflected in the same direction, but with the alpha particle turning with a larger radius.
   (C) An alpha particle and a neutron are both undeflected.
   (D) An alpha particle is deflected and a neutron is undeflected.

6. A partial energy-level diagram for an atom is shown below. What photon energies could this atom emit if it begins in the $n = 3$ state?

–3 eV ____________ $n = 4$

–5 eV ____________ $n = 3$

–8 eV ____________ $n = 2$

–12 eV ____________ $n = 1$ ground state

(A) 5 eV only
(B) 3 eV or 7 eV only
(C) 2 eV, 3 eV, or 7 eV
(D) 3 eV, 4 eV, or 7 eV

7. Which of the following transitions between energy levels results in emission of the shortest wavelength photon?

(A) A large energy transition to a higher energy level
(B) A small energy transition to a higher energy level
(C) A large energy transition to a lower energy level
(D) A small energy transition to a lower energy level

8. What would happen to the energy of a photon if its wavelength were reduced by a factor of 2 ?

(A) It would decrease by a factor of 4.
(B) It would decrease by a factor of 2.
(C) It would increase by a factor of 2.
(D) It would increase by a factor of 4.

9. In an exothermic nuclear reaction, the difference in mass between the reactants and the products is m, and the energy released is Q. In a separate exothermic nuclear reaction in which the mass difference between reactants and products is $m/4$, how much energy will be released?

(A) $Q/4$
(B) $Q/2$
(C) $(Q/4)c^2$
(D) $(Q/2)c^2$

10. What's the missing particle in the following nuclear reaction?

$$^{2}_{1}\text{H} + {}^{63}_{29}\text{Cu} \longrightarrow {}^{64}_{30}\text{Zn} + (?)$$

(A) Proton
(B) Neutron
(C) Electron
(D) Positron

11. What's the missing particle in the following nuclear reaction?

$$^{196}_{78}\text{Pt} + {}^{1}_{0}\text{n} \longrightarrow {}^{197}_{78}\text{Pt} + (?)$$

(A) Proton
(B) Electron
(C) Positron
(D) Gamma

Section II: Free Response

1. The Bohr model of electron energy levels can be applied to any one-electron atom, such as doubly ionized lithium (Li^{2+}). The energy levels for the electron are given by the equation

$$E_n = \frac{Z^2}{n^2}(-13.6\text{ eV})$$

where Z is the atomic number. The emission spectrum for Li^{2+} contains four spectral lines corresponding to the following wavelengths:

11.4 nm, 13.5 nm, 54.0 nm, 72.9 nm

(a) What's the value of Z for Li^{2+}?

(b) Identify which energy-level transitions give rise to the four wavelengths cited.

(c) Can the emission spectrum for Li^{2+} contain a line corresponding to a wavelength between 54.0 nm and 72.9 nm? If so, calculate its wavelength. If not, briefly explain.

(d) What is the next shortest wavelength in the emission spectrum (closest to, but shorter than, 11.4 nm)?