Solutions to the Extra Problems for Chapter 3

1. The answer is 6.49×10^{-23} g. Potassium is abbreviated as K. You need to have that one and the other 20 elements in the table on page 70 memorized. On the Periodic Table, potassium is found in box #19. The mass is the bottom number of the box, which is 39.10. However, that's in amu, so we have to convert:

$$\frac{39.10\ \cancel{\text{amu}}}{1} \times \frac{1.66 \times 10^{-24}\ \text{g}}{1\ \cancel{\text{amu}}} = 6.49 \times 10^{-23}\ \text{g}$$

The three significant figures in 1.66×10^{-24} limit the answer to three significant figures.

2. The mass is 29.0 amu, and it is not the most abundant isotope. This is just another conversion, but this time going from grams to amu:

$$\frac{4.814 \times 10^{-23}\ \cancel{\text{g}}}{1} \times \frac{1\ \text{amu}}{1.66 \times 10^{-24}\ \cancel{\text{g}}} = 29.0\ \text{amu}$$

If this were the most abundant isotope of silicon, its mass would be close to the average mass that is on the periodic table. Silicon is abbreviated "Si" (which you are supposed to have memorized), and it is found in box #14. The average mass is below the symbol, and it is 28.09 amu. Thus, the most abundant isotope is ^{28}Si.

3. Argon is another element for which you must know the symbol (Ar). It's number 18 on the Periodic Table, so it has 18 protons and 18 electrons. The mass number tells you the total number of protons and neutrons, so the number of neutrons is 40 – 18 = 22 neutrons.

4. If it has 35 protons, its atomic number is 35. That means we are dealing with bromine (Br). If it has 35 protons and 45 neutrons, its mass number is the total, 80. So the symbol is ^{80}Br.

5. The wavelength is 3.44×10^{-8} m, and the frequency is 8.72×10^{15} Hz. This requires us to convert from nm to m. You must have that conversion relationship memorized: 1 nm = 10^{-9} m.

$$\frac{34.4\ \cancel{\text{nm}}}{1} \times \frac{10^{-9}\ \text{m}}{1\ \cancel{\text{nm}}} = 3.44 \times 10^{-8}\ \text{m}$$

To get frequency, we need to use Equation (3.1):

$$f = \frac{c}{\lambda} = \frac{3.00 \times 10^{8}\ \frac{\cancel{\text{m}}}{\text{sec}}}{3.44 \times 10^{-8}\ \cancel{\text{m}}} = 8.72 \times 10^{15}\ \frac{1}{\text{sec}}$$

6. The wavelength is 5.9×10^{-7} m. This also uses Equation (3.1), but you need to rearrange it with algebra to get the wavelength:

$$f = \frac{c}{\lambda}$$

$$5.1 \times 10^{14}\ \frac{1}{\text{sec}} = \frac{3.00 \times 10^{8}\ \frac{\text{m}}{\text{sec}}}{\lambda}$$

$$\lambda = \frac{3.00 \times 10^{8}\ \frac{\text{m}}{\cancel{\text{sec}}}}{5.1 \times 10^{14}\ \frac{1}{\cancel{\text{sec}}}} = 5.9 \times 10^{-7}\ \text{m}$$

7. The energy is $\underline{3.94 \times 10^{-14}\ \text{J}}$. This uses Equation (3.2):

$$E = h \cdot f = (6.63 \times 10^{-34}\ \text{J} \cdot \cancel{\text{sec}})(5.94 \times 10^{19}\ \frac{1}{\cancel{\text{sec}}}) = 3.94 \times 10^{-14}\ \text{J}$$

8. The frequency is $\underline{7.4 \times 10^{18}\ \text{Hz}}$. This uses Equation (3.2), but we have to use algebra to solve for frequency:

$$E = h \cdot f$$

$$4.9 \times 10^{-15}\ \text{J} = (6.63 \times 10^{-34}\ \text{J} \cdot \text{sec})(f)$$

$$f = \frac{4.9 \times 10^{-15}\ \cancel{\text{J}}}{6.63 \times 10^{-34}\ \cancel{\text{J}} \cdot \text{sec}} = 7.4 \times 10^{18}\ \frac{1}{\text{sec}}$$

9. The energy is $\underline{2.1 \times 10^{-18}\ \text{J}}$. We can't relate wavelength directly to energy, but we can get the frequency from the wavelength, and then we can get the energy from the frequency. However, to get the frequency, we need to use the speed of light, which is in m/sec. Thus, we first have to convert nanometers to meters to get our units consistent:

$$\frac{94\ \cancel{\text{nm}}}{1} \times \frac{10^{-9}\ \text{m}}{1\ \cancel{\text{nm}}} = 9.4 \times 10^{-8}\ \text{m}$$

$$f = \frac{c}{\lambda} = \frac{3.00 \times 10^{8}\ \frac{\cancel{\text{m}}}{\text{sec}}}{9.4 \times 10^{-8}\ \cancel{\text{m}}} = 3.2 \times 10^{15}\ \frac{1}{\text{sec}}$$

$$E = h \cdot f = (6.63 \times 10^{-34}\ \text{J} \cdot \cancel{\text{sec}})(3.2 \times 10^{15}\ \frac{1}{\cancel{\text{sec}}}) = 2.1 \times 10^{-18}\ \text{J}$$

10. Since the first electron had to absorb a photon of wavelength 103 nm, that wavelength corresponds to the energy difference between the two orbits. The other electron is making the same

jump, just in reverse. Thus, it must release the same energy. So it must emit a photon of energy 103 nm.

11. The n = 6 orbit is higher in energy than the n = 4 orbit. Thus, the difference in energy between n = 6 and n = 1 is greater. As a result, more energy must be released to jump from the n = 6 orbit. More energy means a higher frequency, because energy and frequency are directly proportional. However, it means a smaller wavelength, since frequency and wavelength are inversely proportional. Thus, the electron jumping from the n = 4 orbit emits the photon with the longer wavelength. The electron jumping from the n = 6 orbit emits the photon with the higher frequency.

12. There aren't many lines in this spectrum, which eliminates all but lithium, sodium, and potassium. There is no violet line, so that eliminates potassium. The yellow line corresponds to what we see in sodium, and the other two correspond to what we see in lithium. Thus, this mixture contains sodium and lithium.