Diff. Chemistry: Conversions review Name

I. Setting up conversions: Convert the following and show ALL your work.

1. 3770 mL to L

$3770\,mL \times \frac{1\,L}{1000\,mL} = 3.77\,L$

2. 37 g to kg

$37\,g \times \frac{1\,kg}{1000\,g} = 0.037\,g$

3. 3240 mg to kg

$3240\,mg \times \frac{1\,kg}{1\times10^{6}\,mg} = 3.24\times10^{-3}\,kg$

4. 6300 nm to m

$6300\,nm \times \frac{1\,m}{1\times10^{9}\,nm} = 6.3\times10^{-6}\,m$

5. 24900 cg to Mg

$24900\,cg \times \frac{1\,Mg}{1\times10^{8}\,cg} = 2.49\times10^{-4}\,Mg$

6. 2.30 x 10^{-3} mL to µL

$2.30\times10^{-3}\,mL \times \frac{1000\,\mu L}{1\,mL} = 2.30\,\mu L$

II. Put the following measurements in order of <u>increasing magnitude</u>. Show all your work.

1. 5 km, 52,000 mm, 52 m

5000 m 52 m

52,000 mm = 52 m < 5 km

2. 6 L, 900 mL, 400 cL

0.9 L 4 L

900 mL < 400 cL < 6 L

3. 300 mg, 1,500 g, 1 kg

0.3 g 1000 g

300 mg < 1 kg < 1500 g

4. 2320 cm, 2.2 x 10^{2} in, 11.8 yds

913 in 220 in 424 in

2.2×10^{2} in < 11.8 yds < 2320 cm

5. 32,000 nm, 42.0 µm, 6.540 x 10^{-5} m

3.2×10^{-5} m 4.2×10^{-5} m

32000 nm < 42.0 µm < 6.540×10^{-5} m

6. 6,300 mL, 3.55 gal, 1.69 x 10^{-4} m^3

6.3 L 13.4 L 0.169 L

$1.69\times10^{-4}\,m^3$ < 6300 mL < 3.55 gal

7. 387.1 K, 111.4 °F, 63.8 °C

114.0 °C 44.1 °C

111.4 °F < 63.8 °C < 387.1 K

8. 3.76 x 10^{3} cal, 4.19 x 10^{-2} kJ, 3.22 x 10^{24} eV

1.57×10^{4} J 41.9 J 5.16×10^{5} J

4.19×10^{-2} kJ < 3.76×10^{3} cal < 3.22×10^{24} eV

III. Solve the following questions. Show ALL your work.

1. Batrachotoxin, the active component of South American arrow poison obtained from the golden frog (*Phyllobates terribilis*), is so toxic that a single frog contains enough poison (1100 µg) to kill 2200 people. How many micrograms would it take to kill one person?

$1100\,\mu g \div 2200\,people = 0.50\,\mu g/person$

2. The white blood cell concentration (w.b.c.) in normal blood is approximately 5000 cells/mm^3. How many white blood cells does a normal adult have? Assume that the total blood volume in a normal adult is 5 liters.

$5\,L \times \frac{1000\,mL}{1\,L} \times \frac{1\,cm^3}{1\,mL} \times \frac{10^3\,mm^3}{1\,cm^3} \times \frac{5000\,cells}{1\,mm^3} = 2.5\times10^{10}\,cells = 3\times10^{10}\,cells$

3. The density of liquid bromine is 3.12 g/mL. What is the mass of 0.500 L of bromine?

$0.500\,L\,Br_2 \times \frac{1000\,mL}{1\,L} \times \frac{3.12\,g}{1\,mL} = 1560\,g\,Br_2$

4. Mercury is traded by the "flask," a unit that has a mass of 34.5 kg. What is the volume, in liters, of a flask of mercury, if the density of mercury is 13.6 g/mL?

$$34.5\text{ kg} \left|\frac{1000\text{ g}}{1\text{ kg}}\right|\frac{1\text{ mL}}{13.6\text{ g}}\left|\frac{1\text{ L}}{1000\text{ mL}}\right| = 2.54\text{ L Hg}$$

5. A pound of coffee beans yields 50 cups of coffee. How many mL of coffee can be obtained from 1 g of coffee beans?

$$1\text{ g}\left|\frac{1\text{ kg}}{1000\text{ g}}\right|\frac{2.2046\text{ lbs}}{1\text{ kg}}\left|\frac{50\text{ cups}}{1\text{ lb}}\right|\frac{1\text{ gal}}{16\text{ cups}}\left|\frac{3.7854\text{ L}}{1\text{ gal}}\right|\frac{1000\text{ mL}}{1\text{ L}} = 26.1\text{ mL} = 30\text{ mL}$$

6. What is the area of a baseball diamond in acres? (A baseball diamond is a square whose side is 90 feet in length.) 1 acre = 43, 560 square feet

$$90^2\text{ ft}^2\left|\frac{1\text{ acre}}{43560\text{ ft}^2}\right| = 0.186\text{ acre} = 0.2\text{ acre}$$

7. Analysis of an air sample reveals that it contains 3.5×10^{-6} g/Lof carbon monoxide. Express the concentration of carbon monoxide in lb/ft^3.

$$\frac{3.5\times10^{-6}\text{ g}}{\text{L}}\left|\frac{1\text{ kg}}{1000\text{ g}}\right|\frac{2.2046\text{ lbs}}{1\text{ kg}}\left|\frac{28.32\text{ L}}{1\text{ ft}^3}\right| = 2.2\times10^{-7}\text{ lbs/ft}^3$$

8. The pressure reading from a barometer is 742 mm Hg. Express this reading in ~~kilo~~pascals, kPa.

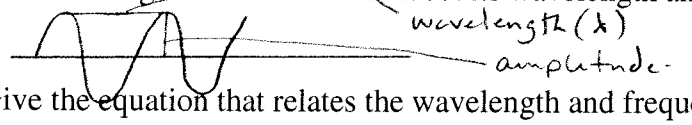
$$742\text{ mm Hg}\left|\frac{1\text{ atm}}{760\text{ mm Hg}}\right|\frac{101.325\text{ kPa}}{1\text{ atm}} = 98.9\text{ kPa}$$

IV. Answer the following questions about waves. Be sure to show ALL your work.

1. What is meant by the "frequency of light"? What symbol is used for it, and what is the SI unit for frequency?

frequency is the oscillations (cycles) of wave energy per time. ν (nu) is the symbol and hertz is the unit

2. Sketch a diagram ~~of a wave~~ and label its wavelength and its amplitude.



3. Give the equation that relates the wavelength and frequency of a light wave to the speed of light.

$\lambda \cdot \nu = c$ (wavelength · frequency = speed of light) for e.m.r

4. What is the frequency in hertz of blue light having a wavelength of 425 nm?

$$\frac{2.998\times10^{8}\text{ m}}{\text{s}}\left|\frac{1\times10^{9}\text{ nm}}{1\text{ m}}\right|\frac{}{425\text{ nm}} = 7.05\times10^{14}\text{ Hz}$$

5. Ozone protects the earth's inhabitants from the harmful effects of ultraviolet light arriving from the sun. This shielding is a maximum for UV light having a wavelength of 295 nm. What is the frequency in hertz of this particular wavelength of UV light?

$$\frac{2.998\times10^{8}\text{ m}}{\text{s}}\left|\frac{1\times10^{9}\text{ nm}}{1\text{ m}}\right|\frac{}{295\text{ nm}} = 1.02\times10^{15}\text{ Hz}$$

6. Radar signals are also part of the electromagnetic spectrum in the microwave region. A typical radar signal has a wavelength of 3.19 cm. What is the frequency in hertz?

$$\frac{2.998\times10^{8}\text{ m}}{\text{s}}\left|\frac{100\text{ cm}}{1\text{ m}}\right|\frac{}{3.19\text{ cm}} = 9.40\times10^{6}\text{ Hz}$$

1 mHz = 1×10^6 Hz

7. FM radio dials are calibrated in frequency. In Ottawa, the radio station MAGIC 100 broadcasts its FM signal at a frequency of 101.1 megahertz (MHz). What is the wavelength of this signal in meters?

$$\frac{2.998 \times 10^8 \text{ m}}{\text{s}} \left| \frac{\text{s}}{101.1 \times 10^6} \right. = \boxed{2.965 \text{ m}}$$

8. Sodium vapour lamps are often used in residential street lighting. They give off a yellow light having a frequency of 5.09 X 10^{14} Hz. What is the wavelength of this signal in nanometers?

$$\frac{2.998 \times 10^8 \text{ m}}{\text{s}} \left| \frac{\text{s}}{5.09 \times 10^{14}} \right| \frac{1 \times 10^9 \text{ nm}}{1 \text{ m}} = \boxed{589 \text{ nm}}$$

9. AM radio dials are calibrated in frequency. A certain AM Brockville radio station broadcasts at a frequency of 830 kHz. What is the wavelength of these radiowaves expressed in meters?

$$\frac{2.998 \times 10^8 \text{ m}}{\text{s}} \left| \frac{\text{s}}{830 \times 10^3} \right. = \boxed{360 \text{ m}}$$

10. Some earthquake waves travel at 5 km/sec. What is the wavelength of these waves if the earth tremors are 10 per second?

$$\frac{5 \text{ km}}{\text{s}} \left| \frac{\text{s}}{10 \text{ tremors}} \right. = \boxed{0.5 \text{ km}}$$

11. Calculate the energy in joules/photon for green light having a wavelength of 550 nm.

$E = \frac{h \cdot c}{\lambda}$

$$\frac{6.626 \times 10^{-34} \text{ J} \cdot \text{s}}{} \left| \frac{2.998 \times 10^8 \text{ m}}{\text{s}} \right| \frac{}{550 \text{ nm}} \left| \frac{1 \times 10^9 \text{ nm}}{1 \text{ m}} \right. = \boxed{3.6 \times 10^{-19} \text{ J}}$$

12. Microwaves are used to heat food in microwave ovens. The microwave radiation is absorbed by moisture in the food. This heats the water, and as water becomes hot, so does the food. How many photons having a wavelength of 3.00 mm would have to be absorbed by 1.00 g of water to raise its temperature by 1°C? It takes 4.184 J of energy to heat this much water.

$E = \frac{h \cdot c}{\lambda}$

$E_T = E_p$

$$\frac{4.184 \text{ J}}{} \left| \frac{\text{photon}}{6.626 \times 10^{-34} \text{ J} \cdot \text{s}} \right| \frac{\text{s}}{2.998 \times 10^8 \text{ m}} \left| \frac{3.00 \text{ mm}}{} \right| \frac{1 \text{ m}}{1000 \text{ mm}} = 6.32 \times 10^{22} \text{ photons}$$

13. The wavelengths of X-rays are much shorter than those of ultraviolet or visible light. Show quantitatively why continued exposure to X-rays is more damaging than exposure to sunlight.

$$\frac{6.626 \times 10^{-34} \text{ J} \cdot \text{s}}{} \left| \frac{2.998 \times 10^8 \text{ m}}{\text{s}} \right| \frac{}{1 \times 10^{-10} \text{ m}} = 1.99 \times 10^{-15} \text{ J/photon}$$

$$(5.5 \times 10^{-7} \text{ m}) \quad = 3.61 \times 10^{-19} \text{ J/photon}$$

$\approx 10{,}000 \times$ energy per photon

14. Rubidium has two common isotopes, ^{85}Rb and ^{87}Rb. If the abundance of ^{85}Rb is 72.2% and the abundance of ^{87}Rb is 27.8%, what is the average atomic mass of rubidium?

$$A.m = (85 \cdot 0.722) + (87 \cdot 0.278) = \boxed{85.6}$$

15. Titanium has five common isotopes: ^{46}Ti (8.0%), ^{47}Ti (7.8%), ^{48}Ti (73.4%), ^{49}Ti (5.5%), ^{50}Ti (5.3%). What is the average atomic mass of titanium?

$$A.m = (46 \cdot 0.08) + (47 \cdot 0.078) + (48 \cdot 0.734) + (49 \cdot 0.055) + (50 \cdot 0.053)$$

$$= \boxed{47.9}$$

16. Silver consists of 2 naturally occurring isotopes: silver-107, which has a mass of 106.90509 g/mol, and silver-109, which has a mass of 108.9047 g/mol. The atomic weight of silver is 107.8682. Determine the isotopic abundance of each isotope in naturally occurring silver.

$$107.8682 = (106.90509 \cdot q_1) + (108.9047 \cdot q_2) \qquad q_1 + q_2 = 1$$

$$q_2 = 1 - q_1$$

$$107.8682 = (106.905090 \cdot x) + (108.9047 \cdot (1 - x)) \qquad x = q_1 = 0.51836 \qquad q_2 = 0.48164$$