AP Chemistry Problem Set #1 - ANSWERS

1. Perform the following mathematical operations, and express the result to the correct number of significant figures.
   a. \((6.022 \times 10^{23}) \times (2.33 \times 10^{3}) = 1.40 \times 10^{27}\)
   b. \(1.00876 + 0.87206 – 0.0996 = 1.7812\)
   c. \((7.915 – 7.908) ÷ 7.915 \times 100. = 0.09\)
   d. \((3.000 \times 10^{5}) ÷ (4.00 \times 10^{-6}) = 7.50 \times 10^{10}\)
   e. \(2.38 ÷ 55.8 \times (6.022 \times 10^{23}) = 2.57 \times 10^{22}\)

2. Convert each of the following.
   a. \(8.57 \text{ micrograms to centigrams} = 8.57 \times 10^{-4} \text{ centigrams}\)
   b. \(2.11 \times 10^{-4} \text{ dekaliters to milliliters} = 2.11 \text{ milliliters}\)
   c. \(1.95 \times 10^{11} \text{ nanometers to meters} = 1.95 \times 10^{2} \text{ meters}\)
   d. \(2.27 \text{ kilograms to decigrams} = 2.27 \times 10^{4} \text{ decigrams}\)
   e. \(6.19 \times 10^{-8} \text{ megagrams to micrograms} = 6.19 \times 10^{4} \text{ micrograms}\)

3. Perform the following unit conversions. The unit conversions are on the last page of your text book and on the tools menu at http://www.sartep.com/chem.
   a. \(809 \text{ oz to kilograms} = 22.9 \text{ kilograms}\)
   b. \(22.4 \text{ L to gallons} = 5.92 \text{ gallons}\)
   c. \(375 \text{ mL to quarts} = 0.396 \text{ quarts}\)
   d. \(221 \text{ pounds to grams} = 1.00 \times 10^{5} \text{ grams}\)
   e. \(74^\circ \text{ C to Kelvin} = 347 \text{ Kelvin}\)

4. Solve the following using dimensional analysis. The unit conversions are on the last page of your text book and on the tools menu at http://www.sartep.com/chem. Show all of your work.
   a. A parsec is an astronomical unit of distance. 1 parsec = 3.26 light years (or the distance traveled by light in one year. Light speed = 186,282.397 miles per second. An object travels 9.6 parsecs. Calculate this distance in cm.
      \[
      9.6 \text{ parsecs} \times 3.26 \text{ yr} \times 365.25 \text{ days} \times 24 \text{ hr} \times 60 \text{ min} \times 60 \text{ sec} \times 186282.397 \text{ miles} \times 5280 \text{ ft} \times 12 \text{ inches} \times 2.54 \text{ cm} \\
      = 3.0 \times 10^{19} \text{ cm}
      \]
   b. The front edge of the pitcher’s mound is 60’6” from the rear point of home plate. If a power pitcher like Roger Clemens throws a fast ball at 95 miles/hour, how many seconds will it take for the ball to reach the catcher’s mitt?
      \[
      60.5 \text{ ft} \times 1 \text{ mile} \times 1 \text{ hour} \times 60 \text{ min} \times 60 \text{ sec} = 0.43 \text{ seconds}
      \]
   c. The current cost of gasoline is $3.87/gallon. If my car gets 12.0 kilometers/liter, how many miles will I be able to travel if I put $18.35 of gasoline in my car? If my house is 10.85 miles away from school, how many complete round trips can I make on $18.35? At the above cost of gas, how much will I pay to make 194 round trips between home and work this year?
      \[
      12.0 \text{ km} \times 0.62137 \text{ mi} \times 3.7854 \text{ L} \times 1 \text{ gallon} \times 18.35 \text{ dollars} = 134 \text{ miles}
      \]
      \[
      134 \text{ miles} \times 1 \text{ way trip} \times 1 \text{ round trip} = 6.16 = 6 \text{ complete round trips}
      \]
      \[
      194 \text{ trips} \times 21.70 \text{ miles} \times 1 \text{ gallon} \times 3.87 \text{ dollars} = 577 \text{ dollars}
      \]
5. The density of pure platinum is 21.45 g/mL at 20°C. If 5.50 grams of pure platinum is added to 14.45 mL of water, to what volume will the level in the cylinder rise?

\[
\frac{21.45 \text{ g}}{1 \text{ mL}} = \frac{5.50 \text{ g}}{x \text{ mL}}
\]

\[x = 0.256 \text{ mL}\]

\[0.256 \text{ mL} + 14.45 \text{ mL} = 14.706 \text{ mL} \quad \text{(rounded to)} \quad 14.71 \text{ mL}\]

6. The amount of mercury in a polluted lake is 0.35 μg Hg/mL, what is the total mass in kilograms of mercury in the lake? The lake has a surface area of 50. mi² and an average depth of 30. ft.

\[
50 \text{ mi}^2 \times (5280 \text{ ft})^2 \times 30 \text{ ft} = 4.18176 \times 10^{10} \text{ ft}^3 \times (12 \text{ in})^2 \times (2.54 \text{ cm})^2 = 1.184142564 \times 10^{15} \text{ cm}^3
\]

\[
1.184142564 \times 10^{15} \text{ cm}^3 = 1.184142564 \times 10^{15} \text{ mL} \times 0.35 \mu\text{g} \times 1 \text{ kg} = 4.1 \times 10^{5} \text{ kg Hg}
\]

7. A 20.00 gram sample of a solid is placed in a graduated cylinder and then filled to the 50.00 mL mark with benzene. The mass of the benzene and the solid together is 58.80 g. Assuming that the solid is insoluble in benzene and the density of benzene is 0.880 grams/cm³, calculate the density of the solid.

Benzene mass = 58.80 g – 20.00 grams = 38.80 grams
Benzene density = 0.880 g/mL (given)
Benzene volume = 44.1 mL

Solid volume = 50.00 – 44.1 = 5.9 mL
Solid mass = 20.00 grams (given)
Solid density = 3.4 g/mL

8. Cesium atoms are the largest naturally occurring atoms. The radius of a cesium atom is 2.62 Å (angstroms). How many cesium atoms would have to be laid side by side to give a row of cesium atoms 3.00 inches long? Assume that the atoms are spherical.

\[
2.62 \text{ Å} = \text{radius of 1.0 atom}
\]

\[
5.24 \text{ Å} = \text{diameter of 1.0 atom}
\]

\[
\frac{3.00 \text{ in} \times 2.54 \text{ cm} \times 1.00 \text{ m} \times 1.00 \text{ Å}}{1 \times 10^{-10} \text{ m} \times 5.24 \text{ Å}} = 1.45 \times 10^8 \text{ atoms}
\]