Name _____ HONORS CHEM ____/____/____

Dimensional Analysis

- Used to convert a number from one system of units to another.
- **Understanding dimensional analysis is crucial. This process will help you when performing difficult calculations later in the year.**
- When using dimensional analysis you should set up your problem so that any unit you wish to cancel appears as both a numerator and a denominator.

Example 1: Calculate how many kilometers there are in 5.00 miles.
Solution: (Needed Equivalents: 1 mile = 1760 yards, 1 meter = 1.094 yards)

$$\frac{5.00 \text{ miles}}{} \times \frac{1760 \text{ yards}}{1 \text{ mile}} \times \frac{1 \text{ meter}}{1.094 \text{ yards}} \times \frac{1 \text{ kilometer}}{1000 \text{ meters}} = 8.04 \text{ kilometers}$$

You try: A certain blue whale weighs 147.82 ton. How much does the whale weigh in ounces?

- Sometimes you will need to convert both parts of a derived unit. Do one unit at a time.

Example 2: Convert 55.0 miles/hour to meters/second
Solution: (Needed Equivalents: 1 mile = 1760 yards, 1 meter = 1.094 yards, 1 hour = 60.0 minutes, 1 minute = 60.0 seconds)

$$\frac{55.0 \text{ miles}}{\text{hour}} \times \frac{1760 \text{ yards}}{1 \text{ mile}} \times \frac{1 \text{ meter}}{1.094 \text{ yards}} \times \frac{1 \text{ hour}}{60.0 \text{ minutes}} \times \frac{1 \text{ minute}}{60.0 \text{ seconds}} = 24.5785 \text{ (rounded to) } \mathbf{24.6\ m/s}$$

You try: At room temperature oxygen gas travels at 393.5 meters per second. Calculate how fast oxygen gas travels in miles per hour.

Homework: Convert all of the following. You must show all work to receive credit. All answers should have exactly three significant figures. Place your final answer on the line in front of each problem. You must include units. This is a graded assignment (3 points each).

_____ 1. 5.50 miles to centimeters

$$\frac{5.50 \text{ miles}}{} \times \frac{5280 \text{ foot}}{1 \text{mile}} \times \frac{12 \text{ inches}}{1 \text{foot}} \times \frac{2.54 \text{ cm}}{1 \text{ inch}} = 885139.2 \text{ rounded to } \mathbf{885000\ cm}$$

_____ 2. 20.4 kilograms to pounds

$$\frac{20.4 \text{ kg}}{} \times \frac{1 \text{ pound}}{0.45359 \text{ kg}} = \mathbf{45.0\ lbs}$$

_____ 3. 7.00 kilopascals to torr

$$\frac{7.00 \text{ kilopascals}}{} \times \frac{760 \text{ torr}}{101.325 \text{ kilopascals}} = \mathbf{52.5\ torr}$$

_____ 4. 0.0397 ton to ounces

$$\frac{0.0397 \text{ ton}}{} \times \frac{2000 \text{ pounds}}{1 \text{ ton}} \times \frac{16 \text{ ounces}}{1 \text{ pound}} = \mathbf{1270\ ounces}$$

_____ 5. 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 Å x 2 = 5.24 Å

3.00 inches x $\frac{2.54\text{ cm}}{1\text{ inch}}$ x $\frac{1\text{ meter}}{100\text{ cm}}$ x $\frac{1 \times 10^{10}\text{ Å}}{1\text{ meter}}$ x $\frac{1\text{ atom}}{5.24\text{ Å}}$ = **1.45×10^{8} atoms**

_____ 6. 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 9.60 parsecs. Calculate this distance in cm.

$\frac{9.60\text{ parsecs}}{}$ x $\frac{3.26\text{ yr}}{1.0\text{ parsec}}$ x $\frac{365\text{ days}}{1\text{ year}}$ x $\frac{24\text{ hr}}{1\text{ day}}$ x $\frac{60\text{ min}}{1\text{ hr}}$ x $\frac{60\text{ sec}}{1\text{ min}}$ x $\frac{186282.397\text{ miles}}{1\text{ sec}}$ x $\frac{5280\text{ ft}}{1\text{ mile}}$ x $\frac{12\text{ inches}}{1\text{ foot}}$ x $\frac{2.54\text{ cm}}{1\text{ inch}}$

2.96×10^{19} cm

_____ 7. The amount of mercury(Hg) in a polluted lake is 0.250 μg/mL, what is the total mass in kilograms of mercury in the lake? (The lake has a surface area of 50.0 mi^2 and an average depth of 20.0 ft.)

$\frac{20\text{ feet}}{}$ x $\frac{1\text{ miles}}{5280\text{ feet}}$ = 0.00379 miles

0.00379 miles x 50.0 mi^2 = 0.189 mi^3

$\frac{0.189\text{ mi}^3}{}$ x $\frac{(5280\text{ feet})^3}{(1\text{ mile})^3}$ x $\frac{(12\text{ inches})^3}{(1\text{ foot})^3}$ x $\frac{(2.54\text{ cm})^3}{(1\text{ inch})^3}$ x $\frac{0.250\text{ μg}}{\text{mL}}$ x $\frac{1\text{ gram}}{1 \times 10^{6}\text{ μg}}$ x $\frac{1\text{ kilogram}}{1000\text{ grams}}$ = **197000 kilograms**

Note: The information for the following three questions continues from 8a through 8c.

_____ 8a. 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?

$\frac{12.0\text{ km}}{1\text{ L}}$ x $\frac{0.62137\text{ mi}}{1\text{ km}}$ x $\frac{3.7854\text{ L}}{1\text{ gallon}}$ x $\frac{1\text{ gallon}}{3.87\text{ dollars}}$ x $\frac{18.35\text{ dollars}}{1}$ = **134 miles**

$\frac{12.0\text{ km}}{1\text{ L}}$ x $\frac{0.62137\text{ mi}}{1\text{ km}}$ x $\frac{3.7854\text{ L}}{1\text{ gallon}}$ = **28.2 miles/gallon**

_____ 8b. If my house is 10.9 miles away from school, how many **complete round trips** can I make on $18.35?

$\frac{134\text{ miles}}{1}$ x $\frac{1\text{ way trip}}{10.9\text{ miles}}$ x $\frac{1\text{ round trip}}{2\text{ way trip}}$ = 6.15 = **6 complete round trips**

_____ 8c. At the above cost of gas, how much will I pay to make 194 **round trips** between home and work this year?

$\frac{194\text{ round trips}}{1}$ x $\frac{21.80\text{ miles}}{1\text{ round trip}}$ x $\frac{1\text{ gallon}}{28.2\text{ miles}}$ x $\frac{3.87\text{ dollars}}{1\text{ gallon}}$ = **$577**