WKS
Dimensional Analysis 3

NAME Answer Key
Period _______ **Date** _______________

IX. Double Units

A. Double Unit Conversions

Remember to put the number and the first unit in the numerator and put the second unit, with value "1," into the denominator; i.e. 75.8 mi/hr = $\frac{75.8 \text{ mi}}{1 \text{ hr}}$. **Show all steps** needed to convert from starting units to ending units. Every number must have units and you must round to the proper number of sig figs in your answer. Remember, conversion factors do not limit your sig figs. When performing metric conversions, you may use either dimensional analysis or the new method, but you must show the conversion.

1) In the US, milk is sold by the gallon, while in Denmark it is sold by the liter. Milk in the US costs \$3.29/gal. What is the equivalent cost in Danish Krone per liter (the exchange rate is 6.599 DKK/\$1.00 as of Sept. 19, 2015)?

$$? \text{ DKK/L} = \frac{\$3.29}{1 \text{ gal}} \times \frac{1 \text{ gal}}{4 \text{ qts}} \times \frac{1.057 \text{ qts}}{1 \text{ L}} \times \frac{6.599 \text{ DKK}}{\$1.00} = \frac{5.74 \text{ DKK}}{1 \text{ L}} = \boxed{5.74 \text{ DKK/L}}$$

2) The speed of sound in dry air at sea level and 20°C is 343.2 m/s. What would this be in km/day?

$$? \text{ km/day} = \frac{343.2 \text{ m}}{1 \text{ s}} \times \frac{1 \text{ km}}{1\times10^{3} \text{ m}} \times \frac{60 \text{ s}}{1 \text{ min}} \times \frac{60 \text{ min}}{1 \text{ hr}} \times \frac{24 \text{ hr}}{1 \text{ day}} = \boxed{2.965\times10^{4} \text{ km/day or } 29{,}650 \text{ km/day}}$$

3) The energy released when propane (C_3H_8) burns is 2,044 kJ/mol (kilojoules/mole). What is this amount in picojoules/molecule (pJ/mlcl)? (Use the conversion factor 1 mol = 6.022×10^{23} mlcl)

$$? \text{ pJ/mlcl} = \frac{2{,}044 \text{ kJ}}{1 \text{ mol}} \times \frac{1\times10^{3} \text{ J}}{1 \text{ kJ}} \times \frac{1 \text{ pJ}}{1\times10^{-12} \text{ J}} \times \frac{1 \text{ mol}}{6.02\times10^{23} \text{ mlcl}} = \boxed{3.394\times10^{-6} \text{ pJ/mlcl}}$$

4) *At an altitude of 10,000 m, the density of air is 4.20×10^{-4} g/cm^3. Convert this to µg/mm^3 (note: to convert a cubed unit, put the *entire* conversion factor into parentheses and cube it).

$$? \ \mu\text{g/mm}^3 = \frac{4.20\times10^{-4} \text{ g}}{\text{cm}^3} \times \frac{1 \ \mu\text{g}}{1\times10^{-6} \text{ g}} \times \left(\frac{1 \text{ cm}}{1\times10^{-2} \text{ m}} \times \frac{1\times10^{-3} \text{ m}}{1 \text{ mm}}\right)^3 = \boxed{0.42 \ \mu\text{g/mm}^3}$$

*Challenge Problem

B. Double Units as Conversion Factors

Remember to put the number and the first unit in the numerator and put the second unit, with value "1," into the denominator, as above. **Show all steps** needed to convert from starting unit to ending unit. Be sure to use the reciprocal of the conversion factor when needed. Every number must have units and you must use the proper number of sig figs in your answer. Remember, conversion factors do not limit your sig figs.

5) In problem #1 you found that milk in Denmark costs 5.74 DKK/L. If the average Danish family uses 208 L of milk each year, how much do they spend, in DKK, on milk in one year?

$$\frac{5.74\text{ DKK}}{1\text{ L}} \Rightarrow ?\text{ DKK} = 208\ \cancel{\text{L}} \times \frac{5.74\text{ DKK}}{1\ \cancel{\text{L}}} = \boxed{1190\text{ DKK}}$$

6) The speed of light in a vacuum is 2.998×10^8 m/s. The average distance from the sun to the earth is 1.496×10^8 km. How much time, in minutes, does light take to travel this distance? (Hint: you must convert km to m first.)

$\frac{2.998\times10^8\text{ m}}{1\text{ s}}$ so use the inverse to convert from meters to seconds:

$$?\text{ min} = 1.496\times10^8\ \cancel{\text{km}} \times \frac{1\times10^3\ \cancel{\text{m}}}{1\ \cancel{\text{km}}} \times \frac{1\ \cancel{\text{s}}}{2.998\times10^8\ \cancel{\text{m}}} \times \frac{1\text{ min}}{60\ \cancel{\text{s}}} = \boxed{8.317\text{ min}}$$

7) Gold has a density of 19.31 g/cm^3. An explorer finds a large, pure gold statue and determines its mass to be 11.6 kg (convert kg to g first). What is the volume, in cm^3, of this statue? *`What is its volume in m^3? (Remember to cube the conversion factor from cm → m to get the conversion from cm^3 → m^3.)

$\frac{19.31\text{ g}}{1\text{ cm}^3}$ so use the inverse as the conversion from g to cm^3:

$$?\text{ cm}^3 = 11.6\text{ kg} \times \frac{1\times10^3\text{ g}}{1\text{ kg}} \times \frac{1\text{ cm}^3}{19.31\text{ g}} = \boxed{601\text{ cm}^3};\ ?\text{ m}^3 = 601\text{ cm}^3 \times \left(\frac{1\times10^{-2}\text{ m}}{1\text{ cm}}\right)^3 = \boxed{6.01\times10^{-4}\text{ m}^3}$$

8) *The average neon (Ne) atom has a mass of 20.18 atomic mass units/atom (atomic mass unit = amu). There are 1.661×10^{-24} g/amu. If the typical Ne light holds 1.00×10^{15} Ne atoms, what mass of neon, in kg, is in the Ne light? (Note: there are 2 double units in this problem.)

$$\frac{20.18\text{ amu}}{1\text{ atom}}, \frac{1.661\times10^{-24}\text{ g}}{1\text{ amu}} \Rightarrow$$

$$?\text{ kg} = 1.00\times10^{15}\ \cancel{\text{atoms}} \times \frac{20.18\ \cancel{\text{amu}}}{1\ \cancel{\text{atom}}} \times \frac{1.661\times10^{-24}\ \cancel{\text{g}}}{1\ \cancel{\text{amu}}} \times \frac{1\text{ kg}}{1\times10^3\ \cancel{\text{g}}} = \boxed{3.35\times10^{-11}\text{ kg}}$$