

1. Dimensional Analysis problems:

$$1 \text{ lb} = 453.59 \text{ g} \quad 1 \text{ qt} = 0.9464 \text{ L} \quad 1 \text{ in} = 2.540 \text{ cm} \quad 1 \text{ ft} = 12 \text{ in} \\ 1 \text{ mi} = 5280 \text{ ft}$$

a. An object has a mass of 1.068 lb and a volume of 6.59 qt. What is the *density of the object in kg m<sup>-3</sup>*?

$$? \frac{\text{kg}}{\text{m}^3} = \frac{1.068 \text{ lb}}{6.59 \text{ qt}} \times \frac{453.59 \text{ g}}{1 \text{ lb}} \times \frac{1 \text{ kg}}{10^3 \text{ g}} \times \frac{1 \text{ qt}}{0.9464 \text{ L}} \times \frac{10^{-3} \text{ L}}{1 \text{ mL}} \times \frac{1 \text{ mL}}{1 \text{ cm}^3} \times \left( \frac{1 \text{ cm}}{10^{-2} \text{ m}} \right)^3 = 77.7 \frac{\text{kg}}{\text{m}^3}$$

b. If a room measures 12.5 ft by 10.7 ft by 9.2 ft and a gallon of paint covers  $3.00 \times 10^2 \text{ ft}^2$  and a gallon of paint costs \$35.46, what is the *cost* of painting the room?

$$\text{Area of walls} = 2(12.5 \text{ ft} \times 9.2 \text{ ft}) + 2(10.7 \text{ ft} \times 9.2 \text{ ft}) = 426.88 \text{ ft}^2$$

$$? \$ = 426.88 \text{ ft}^2 \times \frac{1 \text{ gal}}{3.00 \times 10^2 \text{ ft}^2} \times \frac{\$35.46}{1 \text{ gal}} = \$50.5$$

or alternatively, buying whole cans of paint, the cost would be \$70.92.

c. The Voyager 1 spacecraft was launched on 5 September 1977. It is currently the farthest man-made object from Earth at a distance of about 98 Astronomical Units (AU,  $1 \text{ AU} = 9.3 \times 10^7 \text{ mi}$ ). What is the approximate *speed of Voyager 1 in km/yr* (at least 2 significant figures)?

$$? \frac{\text{km}}{\text{yr}} = \frac{98 \text{ AU}}{(1 \text{ Mar } 2006 - 5 \text{ Sep } 1977)} \times \frac{9.3 \times 10^7 \text{ mi}}{1 \text{ AU}} \times \frac{5280 \text{ ft}}{1 \text{ mi}} \times \frac{12 \text{ in}}{1 \text{ ft}} \times \frac{2.540 \text{ cm}}{1 \text{ in}} \times \frac{10^{-2} \text{ m}}{1 \text{ cm}} \times \frac{1 \text{ km}}{10^3 \text{ m}} = 5.1 \times 10^8 \frac{\text{km}}{\text{yr}}$$

this is 28.485 years

2. Chlorine has two naturally occurring isotopes. Chlorine-35 has a mass of 34.96885 amu and Chlorine-37 has a mass of 36.96950 amu. If the relative average atomic mass of chlorine is 35.453 amu, what are the ***fractional abundances*** of the two isotopes?

$A_1$  = fractional abundance of Cl-35;  $A_2$  = fractional abundance of Cl-37

We have two unknowns so we need two equations:

$$A_1 + A_2 = 1.000$$

$$M_1 A_1 + M_2 A_2 = M_{avg}$$

We can then solve the equations together to get the abundances:

$$A_1 + A_2 = 1.00000 \Rightarrow A_1 = 1.00000 - A_2$$

$$(34.96885 \text{ amu}) A_1 + (36.96950 \text{ amu}) A_2 = 35.453 \text{ amu}$$

$$(34.96885 \text{ amu})(1.00000 - A_2) + (36.96950 \text{ amu}) A_2 = 35.453 \text{ amu}$$

$$34.96885 \text{ amu} - (34.96885 \text{ amu}) A_2 + (36.96950 \text{ amu}) A_2 = 35.453 \text{ amu}$$

$$(36.96950 \text{ amu} - 34.96885 \text{ amu}) A_2 = 35.453 \text{ amu} - 34.96885 \text{ amu} = 0.48415 \text{ amu}$$

$$(2.00065 \text{ amu}) A_2 = 0.48415 \text{ amu}$$

$$A_2 = \frac{0.48415 \text{ amu}}{2.00065 \text{ amu}} = 0.2420014 = 0.242$$

$$A_1 = 1.00000 - 0.2420014 = 0.7579985 = 0.758$$

3. An alloy of iron (54.7%), nickel (45.0%), and manganese (0.3%) has a density of 8.17 g/cm<sup>3</sup>. ***How many iron atoms*** are in a block of alloy measuring 10.0 cm × 20.0 cm × 15.0 cm?

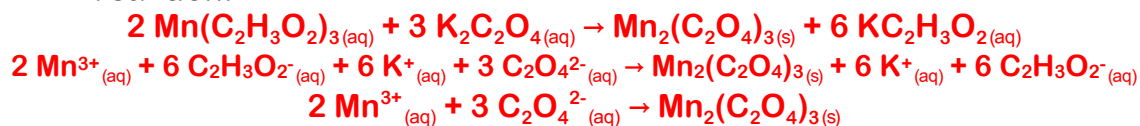
$$\begin{aligned} ? \text{ at Fe} &= (10.0 \text{ cm} \times 20.0 \text{ cm} \times 15.0 \text{ cm}) \times \frac{8.17 \text{ g}}{\text{cm}^3} \times \frac{54.7 \text{ g Fe}}{100.0 \text{ g alloy}} \times \frac{1 \text{ mol Fe}}{55.845 \text{ g Fe}} \\ &\quad \times \frac{6.0221 \times 10^{23} \text{ at Fe}}{1 \text{ mol Fe}} = 1.45 \times 10^{26} \text{ at Fe} \end{aligned}$$

4. Complete the following table.

Name of Compound	Formula of Compound
Iron(II) Phosphate	$\text{Fe}_3(\text{PO}_4)_2$
Disulfur Dichloride	$\text{S}_2\text{Cl}_2$
Chromium(III) Sulfite	$\text{Cr}_2(\text{SO}_3)_3$
Nitrous acid	$\text{HNO}_{2(\text{aq})}$
Diphosphorus Pentoxide	$\text{P}_2\text{O}_5$
Lithium Phosphide	$\text{Li}_3\text{P}$

5. A double replacement reaction occurs in solution between manganese(III) acetate and potassium oxalate. A solid is formed. 36.32 mL of 0.2972 M manganese(III) acetate solution is mixed with 53.99 mL of 0.1599 M potassium oxalate solution.

a. Write the **chemical**, **total ionic** and **net ionic equations** for this reaction.



b. How many **grams of the solid** can form?

$$? \text{ g Mn}_2(\text{C}_2\text{O}_4)_3 = 36.32 \text{ mL Mn}(\text{C}_2\text{H}_3\text{O}_2)_3 \times \frac{0.2972 \text{ mol Mn}(\text{C}_2\text{H}_3\text{O}_2)_3}{1000 \text{ mL}} \times \frac{1 \text{ mol Mn}_2(\text{C}_2\text{O}_4)_3}{2 \text{ mol Mn}(\text{C}_2\text{H}_3\text{O}_2)_3}$$

$$\times \frac{373.9330 \text{ g Mn}_2(\text{C}_2\text{O}_4)_3}{1 \text{ mol Mn}_2(\text{C}_2\text{O}_4)_3} = 2.018 \text{ g Mn}_2(\text{C}_2\text{O}_4)_3$$

$$? \text{ g Mn}_2(\text{C}_2\text{O}_4)_3 = 53.99 \text{ mL K}_2\text{C}_2\text{O}_4 \times \frac{0.1599 \text{ mol K}_2\text{C}_2\text{O}_4}{1000 \text{ mL}} \times \frac{1 \text{ mol Mn}_2(\text{C}_2\text{O}_4)_3}{3 \text{ mol K}_2\text{C}_2\text{O}_4}$$

$$\times \frac{373.9330 \text{ g Mn}_2(\text{C}_2\text{O}_4)_3}{1 \text{ mol Mn}_2(\text{C}_2\text{O}_4)_3} = 1.076 \text{ g Mn}_2(\text{C}_2\text{O}_4)_3$$

**1.076 g of  $\text{Mn}_2(\text{C}_2\text{O}_4)_3$  can form.**

c. If the percent yield is 86.33%, how many **grams of the solid** actually did form?

$$? \text{ g actual} = 1.076 \text{ g Mn}_2(\text{C}_2\text{O}_4)_3 \text{ theoretical} \times \frac{86.33 \text{ g actual}}{100.00 \text{ g theoretical}} = 0.9290 \text{ g Mn}_2(\text{C}_2\text{O}_4)_3 \text{ actual}$$

6. Balance the following oxidation-reduction reactions.

