

1. Calculate the following.
- a. How many **minutes** will it take to travel from Los Angeles to Chicago if the distance is 3306 kilometers and you are travelling at 70 miles per hour?

$$? \text{ min} = 3306 \text{ km} \times \frac{1 \text{ mi}}{1.609 \text{ km}} \times \frac{1 \text{ h}}{70 \text{ mi}} \times \frac{60 \text{ min}}{1 \text{ h}} = 1.8 \times 10^3 \text{ min}$$

- b. What is the **volume of a room in mL** if the room measures 3.5 yards by 4.2 yards by 1.0 yards?

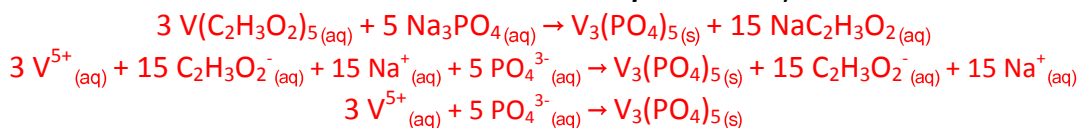
$$? \text{ mL} = (3.5 \text{ yd} \times 4.2 \text{ yd} \times 1.0 \text{ yd}) \times \left(\frac{3 \text{ ft}}{1 \text{ yd}}\right)^3 \times \left(\frac{12 \text{ in}}{1 \text{ ft}}\right)^3 \times \left(\frac{2.540 \text{ cm}}{1 \text{ in}}\right)^3 \times \frac{1 \text{ mL}}{1 \text{ cm}^3} = 1.1 \times 10^7 \text{ mL}$$

- c. How many **cents** will it require to purchase 64.5 L of gasoline at \$3.07 per gallon?

$$? \text{ cents} = 64.5 \text{ L} \times \frac{1 \text{ qt}}{0.9463 \text{ L}} \times \frac{1 \text{ gal}}{4 \text{ qt}} \times \frac{3.07 \text{ dollars}}{1 \text{ gal}} \times \frac{100 \text{ cents}}{1 \text{ dollar}} = 5.23 \times 10^3 \text{ cents}$$

2. 2.86 mL of 0.1698 M Vanadium Acetate is mixed with 3.49 mL of .06893 M Sodium Phosphate. A double replacement reaction occurs.

- a. Write the **balanced chemical and net ionic equations** any reaction that occurs.



- b. Calculate the number **grams of solid product**.

$$? \text{ g V}_3(\text{PO}_4)_5 = 2.86 \text{ mL V}(\text{C}_2\text{H}_3\text{O}_2)_5 \times \frac{0.1698 \text{ mol V}(\text{C}_2\text{H}_3\text{O}_2)_5}{1000 \text{ mL V}(\text{C}_2\text{H}_3\text{O}_2)_5}$$

$$\times \frac{1 \text{ mol V}_3(\text{PO}_4)_5}{3 \text{ mol V}(\text{C}_2\text{H}_3\text{O}_2)_5} \times \frac{627.6813 \text{ g V}_3(\text{PO}_4)_5}{1 \text{ mol V}_3(\text{PO}_4)_5} = 0.102 \text{ g V}_3(\text{PO}_4)_5$$

$$? \text{ g V}_3(\text{PO}_4)_5 = 3.49 \text{ mL Na}_3\text{PO}_4 \times \frac{0.06893 \text{ mol Na}_3\text{PO}_4}{1000 \text{ mL Na}_3\text{PO}_4}$$

$$\times \frac{1 \text{ mol V}_3(\text{PO}_4)_5}{5 \text{ mol Na}_3\text{PO}_4} \times \frac{627.6813 \text{ g V}_3(\text{PO}_4)_5}{1 \text{ mol V}_3(\text{PO}_4)_5} = 0.0302 \text{ g V}_3(\text{PO}_4)_5$$

The number of grams of solid product is 0.0302 g V₃(PO₄)₅.

- c. Calculate the **actual yield** if the percent yield is 89.5%.

$$\text{actual yield} = 0.0302 \text{ g V}_3(\text{PO}_4)_5 \text{ theor.} \times \frac{89.5 \text{ g V}_3(\text{PO}_4)_5 \text{ actual}}{100.0 \text{ g V}_3(\text{PO}_4)_5 \text{ theor.}} = 0.0270 \text{ g V}_3(\text{PO}_4)_5$$

3. A moth repellent, *para*-dichlorobenzene, has the composition 49.1% C, 2.7% H, and 48.2% Cl. Its molecular weight is 147 amu. What is its **molecular formula**?

$$49.1 \text{ g C} \times \frac{1 \text{ mol C}}{12.0107 \text{ g C}} = 4.0880 \text{ mol} / 1.3595 = 3.007 = 3$$

$$2.7 \text{ g H} \times \frac{1 \text{ mol H}}{1.00794 \text{ g H}} = 2.6787 \text{ mol} / 1.3595 = 1.9704 = 2$$

The empirical formula is $\text{C}_3\text{H}_2\text{Cl}$ and the empirical mass is 73.501 amu.

$$48.2 \text{ g Cl} \times \frac{1 \text{ mol Cl}}{35.453 \text{ g Cl}} = 1.3595 \text{ mol} / 1.3595 = 1$$

$$\frac{147 \text{ amu}}{73.501 \text{ amu}} = 2.00 \text{ Therefore the molecular formula is } \text{C}_6\text{H}_4\text{Cl}_2.$$

4. A new element is discovered in a supernova explosion. There are three naturally occurring isotopes of the element. Given that the relative average atomic mass is 300.89 amu **complete the following table**.

| Isotope mass | Percent abundance |
|---------------|-------------------|
| 299.90563 amu | 16.83% |
| 300.90638 amu | -- |
| 301.90665 amu | -- |

$$0.1683 + A_2 + A_3 = 1.0000 \Rightarrow A_2 = 0.8317 - A_3$$

$$(0.1683)(299.90563 \text{ amu}) + (A_2)(300.90638 \text{ amu}) + (A_3)(301.90665 \text{ amu}) = 300.89 \text{ amu}$$

$$(0.1683)(299.90563 \text{ amu}) + (0.8317 - A_3)(300.90638 \text{ amu}) + (A_3)(301.90665 \text{ amu}) = 300.89 \text{ amu}$$

$$50.47411753 \text{ amu} + 250.2638362 \text{ amu} - A_3 \times 300.90638 \text{ amu} + (A_3)(301.90665 \text{ amu}) = 300.89 \text{ amu}$$

$$(1.00027 \text{ amu})A_3 = 0.15204627 \text{ amu}$$

$$A_3 = 0.15 \therefore A_2 = 0.68$$

The abundance of the second isotope is 68% and the abundance of the third isotope is 15%.

5. A student worker's supervisor in a chemistry laboratory assigns them to determine the amount of Iron(III) ion in the laboratory water. The student remembers from their Chemistry 101 class that Carbonate ion will precipitate with Iron(III) ion. The student measures out 50.00 mL of the water and adds enough Sodium Carbonate to it to ensure that all of the Iron has been precipitated. After she dries this precipitate she determines its mass to be 0.0159 g. What is the **molar concentration of the Iron(III) ion** in the water?

$$\begin{aligned}
 & 2 \text{Fe}^{3+}_{(\text{aq})} + 3 \text{Na}_2\text{CO}_{3(\text{aq})} \rightarrow \text{Fe}_2(\text{CO}_3)_3(\text{s}) + 6 \text{Na}^{+}_{(\text{aq})} \\
 ? \frac{\text{mol Fe}^{3+}}{\text{L}} &= \frac{0.0159 \text{ g Fe}_2(\text{CO}_3)_3}{50.00 \text{ mL}} \times \frac{1 \text{ mol Fe}_2(\text{CO}_3)_3}{291.717 \text{ g Fe}_2(\text{CO}_3)_3} \times \frac{2 \text{ mol Fe}^{3+}}{1 \text{ mol Fe}_2(\text{CO}_3)_3} \times \frac{1 \text{ mL}}{10^{-3} \text{ L}} \\
 &= 2.18 \times 10^{-3} \text{ M Fe}^{3+}
 \end{aligned}$$

6. Another student worker wants to determine how acidic the laboratory water is. He also remembers from his Chemistry 101 class that acids and bases neutralize one another. Because one mole of Hydroxide ion will neutralize one mole of Hydrogen ion it's not terribly important which base is used to titrate the water. The student chooses a solution with a Hydroxide ion concentration of $1.593 \times 10^{-4} \text{ M}$. He titrates a 10.00 mL sample of the laboratory water and finds that he needs 16.82 mL of the Hydroxide solution to reach an end point. What is the **molar concentration of the Hydrogen ion** in the laboratory water?

$$\begin{aligned}
 & \text{H}^{+}_{(\text{aq})} + \text{OH}^{-}_{(\text{aq})} \rightarrow \text{H}_2\text{O} \\
 ? \frac{\text{mol H}^{+}}{\text{L}} &= \frac{16.82 \text{ mL OH}^{-}}{10.00 \text{ mL H}^{+}} \times \frac{1.593 \times 10^{-4} \text{ mol OH}^{-}}{1 \text{ L OH}^{-}} \times \frac{1 \text{ mol H}^{+}}{1 \text{ mol OH}^{-}} = 2.679 \times 10^{-4} \text{ M}
 \end{aligned}$$

7. Balance the following reactions:

