Questions 1-20 count for 4 points each; Questions 21 and 22 are 10 points each and have partial credit.

1. You dissolve some sugar in very pure water. All the sugar dissolves. The result is a: **homogeneous mixture**

2. The atomic number of K is **19**

3. The mass number of the only stable isotope of arsenic, As is: **75**

4. The species $^{35}\text{Cl}^-$ has: **17 protons, 18 neutrons, and 18 electrons.**

5. An atom becomes a cation by: **losing electrons**

6. Which ionic compound listed below does not have a correct formula?

   - CaPO$_4$ because Ca$^{2+}$ and PO$_4^{3-}$ charges do not cancel; should be Ca$_3$(PO$_4$)$_2$

7. The elements Be and Mg are in the same periodic **group** and the elements C and N are in the same periodic **period**.

8. An element has the following isotopic abundances:

   - 20% mass 45.00 g/mol
   - 78% mass 47.00 g/mol
   - 2% mass 49.00 g/mol

   Which of the following the average molar mass of this element? **46.64 g/mol**

9. The relationship between O$_2$ and O$_3$ is that they are... **allotropes**

10. The molar mass of Mg(NO$_3$)$_2$ is **148.3 g/mol**

11. What kind of compound will be formed between the elements Fe and Br? **ionic**

12. How many F atoms are there in a 68.9-g sample of F$_2$?

   \[
   68.9 \text{ mol } F_2 \times \frac{2 \text{ mol } F \text{ atoms}}{1 \text{ mol } F_2} \times \frac{6.022 \times 10^{23} \text{ F atoms}}{1 \text{ mol } F \text{ atoms}} = 2.18 \times 10^{24} \text{ atoms}
   \]
13. What is the percent mass of carbon (to two significant figures) in $\text{C}_2\text{H}_6\text{O}_2$?

$$\frac{2 \text{ mol C} \times \frac{12.01 \text{ g C}}{\text{mol C}}}{62.07 \text{ g } \text{C}_2\text{H}_6\text{O}_2} \times 100\% = 39\%$$

14. A compound is composed of 25.93% N and 74.06% O by mass. What is its empirical formula? $\text{N}_2\text{O}_5$

Assume 100 g of compound, so there are 25.93 g N and 74.06 g O.

$$\frac{25.93 \text{ g N}}{14.01 \text{ g N}} = 1.85 \text{ mol N}$$

$$\frac{74.06 \text{ g O}}{16.00 \text{ g O}} = 4.63 \text{ mol O}$$

$$\frac{\text{mol O}}{\text{mol N}} = \frac{4.63}{1.85} = 2.50 = \frac{5}{2}$$

Therefore, empirical formula = $\text{N}_2\text{O}_5$

15. Consider the reaction, $\text{P}_4 + 6 \text{Cl}_2 \rightarrow 4 \text{PCl}_3$

If 3.5 mol of $\text{P}_4$ react, how many moles of $\text{PCl}_3$ can be formed?

$$3.5 \text{ mol } \text{P}_4 \times \frac{4 \text{ mol PCl}_3}{1 \text{ mol P}_4} = 14 \text{ mol PCl}_3$$

16. An experiment is performed where NaOH is slowly added to 50.0 g FeCl₃. The reaction that occurs produces Fe(OH)₃. The plot below shows the mass of Fe(OH)₃ produced as a function of the mass of NaOH added. Choose TWO correct statements. Circle both on the answer sheet.

- at point B, FeCl₃ is the limiting reactant
- at point A, NaOH is the limiting reactant
- adding more FeCl₃ will move the deflection point to the right
17. How many moles of NO₂ are in 9.7 g of NO₂? \[ 9.7 \text{ g NO}_2 \times \frac{1 \text{ mol NO}_2}{46.01 \text{ g}} = 0.21 \text{ mol NO}_2 \]

17. How many moles of OF₂ are in 29.7 g of OF₂? \[ 29.7 \text{ g NO}_2 \times \frac{1 \text{ mol OF}_2}{54.00 \text{ g}} = 0.55 \text{ mol OF}_2 \]

18a. The formula of ammonium sulfate is: \((\text{NH}_4)_2\text{SO}_4\) The formula of ammonium carbonate is: \((\text{NH}_4)_2\text{CO}_3\)

18b. The name of SO₂ is: sulfur dioxide The name of SO₃ is: sulfur trioxide

19a. Name AlCl₃: aluminum chloride 19b. Name FeCl₂: iron(II)chloride

19a. Name MgCl₂: magnesium chloride 19b. Name FeCl₃: iron(III)chloride

20. Balance the following reaction:

\[ \text{1 C}_6\text{H}_{12} + 9 \text{ O}_2 \rightarrow 6 \text{ CO}_2 + 6 \text{ H}_2\text{O} \]

\[ \text{1 C}_8\text{H}_{18} + 12 \text{ O}_2 \rightarrow 8 \text{ CO}_2 + 8 \text{ H}_2\text{O} \]

21. Consider the reaction, \[ 4 \text{ Cr} + 3 \text{ O}_2 \rightarrow 2 \text{ Cr}_2\text{O}_3 \]

If 75.0 g of Cr are mixed with 25.0 g O₂, how many grams of Cr₂O₃ can be formed?

\[ 75.0 \text{ g Cr} \times \frac{1 \text{ mol Cr}}{52.00 \text{ g}} = 1.44 \text{ mol Cr} \]

\[ 25.0 \text{ g O}_2 \times \frac{1 \text{ mol O}_2}{32.00 \text{ g}} = 0.781 \text{ mol O}_2 \]

\[ \frac{1.44 \text{ mol Cr}}{4} > \frac{0.781 \text{ mol O}_2}{3} \text{ so O}_2 \text{ is the limiting reactant} \]

\[ 0.781 \text{ mol O}_2 \times \frac{2 \text{ mol Cr}_2\text{O}_3}{3 \text{ mol O}_2} = 0.521 \text{ mol Cr}_2\text{O}_3 \]

\[ 0.521 \text{ mol Cr}_2\text{O}_3 \times \frac{151.99 \text{ g Cr}_2\text{O}_3}{1 \text{ mol}} = 79.1 \text{ g Cr}_2\text{O}_3 \]
22. Chemical Analysis: You have a 10.56-gram sample that is a mixture of \( \text{Cr}_2(\text{CO}_3)_3 \) and \( \text{Fe}_2\text{O}_3 \). You heat it and the following reaction takes place.

\[
\text{Cr}_2(\text{CO}_3)_3 (s) \rightarrow \text{Cr}_2\text{O}_3(s) + 3 \text{CO}_2(g)
\]

No reaction occurs to the \( \text{Fe}_2\text{O}_3 \). After heating, the mass is found to be 8.46 g. What is the mass percent of \( \text{Cr}_2(\text{CO}_3)_3 \) in the original mixture?

The mass lost is all due to \( \text{CO}_2 \) lost, which comes from \( \text{Cr}_2(\text{CO}_3)_3 \).

Map: \( g \text{ CO}_2 \rightarrow \text{mol} \text{ CO}_2 \rightarrow \text{mol} \text{ Cr}_2(\text{CO}_3)_3 \rightarrow g \text{ Cr}_2(\text{CO}_3)_3 \rightarrow \text{percent} \text{ Cr}_2(\text{CO}_3)_3 \).

\[ g \text{ CO}_2 \text{ lost } = 10.56 \text{ g } - 8.46 \text{ g } = 2.10 \text{ g CO}_2 \]

\[ 75.0 \text{ g Cr } \times \frac{1 \text{ mol Cr}}{52.00 \text{ g Cr}} = 1.44 \text{ mol Cr} \]

\[ 2.10 \text{ g CO}_2 \times \frac{1 \text{ mol CO}_2}{44.01 \text{ g CO}_2} = 0.0477 \text{ mol CO}_2 \]

\[ 0.0477 \text{ mol CO}_2 \times \frac{1 \text{ mol Cr}_2(\text{CO}_3)_3}{3 \text{ mol CO}_2} = 0.0159 \text{ mol Cr}_2(\text{CO}_3)_3 \]

\[ 0.0159 \text{ mol Cr}_2(\text{CO}_3)_3 \times \frac{284.01 \text{ g Cr}_2(\text{CO}_3)_3}{1 \text{ mol}} = 4.51 \text{ g Cr}_2(\text{CO}_3)_3 \]

\[ \% \text{Cr}_2(\text{CO}_3)_3 = \frac{4.51 \text{ g Cr}_2(\text{CO}_3)_3}{10.56 \text{ g sample}} \times 100 = 42.8\% \]