**Mole Concept Review**

1. Review the following terms: *arbitrary mass, Avogadro’s hypothesis, mole, atomic mass, molar mass, molar volume, STP, density, empirical formula, molecular formula, empirical mass, concentration, dilution, molarity.*

2. Calculate the molar mass of each of the following.
   
   a) NCl_3  
   b) FeSO_4  
   c) Pb(ClO_4)_4  
   d) Al_2(SO_4)_3  
   e) Sn(C_2O_4)_2  
   f) Ni(H_2O)_2(NH_3)_4Cl_2

3. Calculate the molar mass of each of the following.
   
   a) NiSO_4•7H_2O  
   b) Co_3(PO_4)_2•8H_2O  
   c) Cr(NO_3)_3•9H_2O  
   d) Cu(NO_3)_2•6H_2O

4. Calculate the mass of the following.
   
   a) 4.50 mol of PCl_3  
   b) 0.0215 mol of Pb(OH)_4  
   c) 5.64 x 10^{-5} mol of AuCl_3  
   d) 6.82 x 10^{-3} mol of ZnSO_4

5. Calculate the number of moles in the following.
   
   a) 85.6 g of CaO  
   b) 0.547 mg of CuSO_4  
   c) 6.48 kg of KMnO_4  
   d) 12.8 g of NH_3

6. Calculate the molar mass of each of the substances mentioned in the following.
   
   a) A 0.00496 mol sample of cholesterol has a mass of 1.894 g.
   b) The mass of a 3.44 x 10^{-5} mol sample of a particular protein has a mass of 74.8 g.

7. What is STP and what are the experimental conditions of STP?

8. Calculate the volume at STP occupied by the following.
   
   a) 24.8 mol of NH_3  
   b) 0.0861 mol of HCl

9. Calculate the number of moles in the following gases at STP.
   
   a) 64.8 L of Xe(g)  
   b) 645 mL of SO_2(g)
10. How many atoms are contained in the following.
   a) 1 molecule of CH$_3$CO$_2$H
   b) 15 molecules of NH$_4$Cl
   c) 2.56 mol of (NH$_4$)$_3$PO$_4$
   d) 0.0871 mol of CuSO$_4$·5H$_2$O

11. Find the mass, in grams, of each of the following.
   a) 1 Pb atom
   b) 235 Ag atoms
   c) 4.51 x 10$^{22}$ H$_2$O molecules
   d) 5.62 x 10$^{18}$ Fe(OH)$_3$ molecules
   e) 17.8 L of HF$_{(g)}$ at STP
   f) 85.4 mL of O$_2(g)$ at STP

12. How many atoms are contained in each of the following?
   a) 60.5 g of AlCl$_3$
   b) 125.0 g of CaBr$_2$
   c) 2.87 x 10$^{-5}$ g of FeSO$_4$
   d) 84.6 mL of HCl$_{(g)}$ at STP
   e) 2.87 L of H$_2(g)$ at STP
   f) 867.5 mL of NH$_3(g)$ at STP

13. What volume at STP is occupied by each of the following?
   a) 8.27 x 10$^{20}$ molecules of O$_2(g)$
   b) 5.67 x 10$^{23}$ molecules of NH$_3(g)$
   c) 125.0 g of Cl$_2(g)$
   d) 0.725 g of CO$_2(g)$

14. Calculate the percentage composition of the following.
   a) NaHCO$_3$
   b) Fe$_2$(SO$_4$)$_3$
   c) CuSO$_4$·5H$_2$O
   d) Fe$_2$(SO$_4$)$_3$·9H$_2$O

15. Calculate the percentage composition of the bold species in each of the following.
   a) Cr(NO$_3$)$_6$Cl$_3$·H$_2$O
   b) Fe$_2$(SO$_4$)$_3$·9H$_2$O
   c) Al$_2$(SO$_4$)$_3$·18H$_2$O
   d) Ce$_2$(C$_2$O$_4$)$_3$·9H$_2$O

16. Find the empirical formula for the following compounds.
   a) 12.6% Li, 29.2% S, 58.2% O
   b) 27.4% Na, 1.2% H, 14.3% C, 57.1% O
   c) 38.8% Fe, 16.7% C, 44.5% O
   d) 24.7% K, 34.7% Mn, 40.5% O
17. A gas has the empirical formula CH₂. If 0.550 L of the gas at STP has a mass of 3.44 g, what is the molecular formula? \( \text{C}_4\text{H}_2\text{O} \)

18. A sample of gas is analyzed and found to contain 33.0% Si and 67.0% F. If the gas has a density of 7.60 g/L at STP, what is the molecular formula? \( \text{Si}_2\text{F}_6 \)

19. Caproic acid, the substance responsible for the aroma of dirty gym socks and running shoes, contains carbon, hydrogen and oxygen. On combustion analysis, a 0.450 g sample of caproic acid gives off 0.418 g of H₂O and 1.023 g of CO₂. If the molecular mass of caproic acid is 116.2, what is the molecular formula? \( \text{C}_6\text{H}_{12}\text{O}_2 \)

20. Calculate the molar concentration of the following solutions.
   a) 0.578 mol of NaCl in 52.0 mL of solution (11.1 M)
   b) 5.68 mol of NaHCO₃ in 12.8 L of solution (0.444 M)
   c) 50.0 g of Fe(NO₃)₃ in 150.0 mL of solution (1.38 M)
   d) 27.8 g of Na₃PO₄ in 200.0 mL of solution (0.848 M)

21. Calculate the mass of solute needed to make the following solutions.
   a) 125.0 mL of 0.0750 M KOH, from solid KOH (0.526 g)
   b) 500.0 mL of 0.120 M FeCl₃, from solid FeCl₃•6H₂O (16.2 g)
   c) 650.0 mL of 0.350 M Pb(NO₃)₂, from solid Pb(NO₃)₂ (75.3 g)

22. What is the concentration of the solution that results when 250.0 mL of water is added to 550.0 mL of 3.50 M NaOH? (2.41 M)

23. What is the concentration of the solution that results when 50.0 mL of water is added to 250.0 mL of 0.850 M HCl? (0.708 M)

24. If 500.0 mL of 0.100 M LiOH is boiled down to 200.0 mL, what is the concentration? (0.250 M)

25. If 1.50 L of 0.0850 M NaCl is boiled down to 450.0 mL, what is the concentration? (0.283 M)

26. Calculate the concentration of the solution that results when 250.0 mL of 0.750 M NaCl is mixed with 100.0 mL of 0.250 M NaCl. (0.607 M)

27. Calculate the concentration of the solution that results when 350.0 mL of 1.25 M FeCl₃ is mixed with 150.0 mL of 0.250 M FeCl₃. (0.950 M)

28. What is the resulting concentration when 500.0 mL of 0.250 M NaCl is mixed with 250.0 mL of 0.450 M NaCl and the mixture is boiled down to 400.0 mL? (0.594 M)
29. If 250.0 mL of solution A containing 28.0 g of LiOH is mixed with 500.0 mL of solution B containing 56.0 g of LiOH and the resulting solution is boiled down to 600.0 mL, what is the concentration? \((5.86 \text{ M})\)

30. Calculate the molarity of pure water if density = 1.000 g/mL. \((55.6 \text{ M})\)