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) $NiSO_4 \cdot 7H_2O$
   b) $Co_3(PO_4)_2 \cdot 8H_2O$
   c) $Cr(NO_3)_3 \cdot 9H_2O$
   d) $Cu(NO_3)_2 \cdot 6H_2O$

4. Calculate the mass of the following.

   a) 4.50 mol of PCl_3
   b) 0.0215 mol of $Pb(OH)_4$
   c) 5.64×10^{-5} mol of $AuCl_3$
   d) 6.82×10^{-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 3.44×10^{-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_3CO_2H

b) 15 molecules of NH_4Cl

c) 2.56 mol of $(NH_4)_3PO_4$

d) 0.0871 mol of $CuSO_4 \cdot 5H_2O$

11. Find the mass, in grams, of each of the following.

a) 1 Pb atom

b) 235 Ag atoms

c) 4.51×10^{22} H_2O molecules

d) 5.62×10^{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) 2.87×10^{-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) 8.27×10^{20} molecules of $O_{2(g)}$

b) 5.67×10^{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) $CuSO_4 \cdot 5H_2O$

d) $Fe_2(SO_4)_3 \cdot 9H_2O$

15. Calculate the percentage composition of the bold species in each of the following.

a) $Cr\mathbf{(NO_3)_6}Cl_3 \cdot H_2O$

b) $Fe_2(SO_4)_3 \cdot \mathbf{9H_2O}$

c) $Al_2\mathbf{(SO_4)_3} \cdot 18H_2O$

d) $Ce_2\mathbf{(C_2O_4)_3} \cdot 9H_2O$

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 CH_2. If 0.550 L of the gas at STP has a mass of 3.44 g, what is the molecular formula? *$C_{10}H_{20}$*

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? *Si_2F_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 H_2O and 1.023 g of CO_2. If the molecular mass of caproic acid is 116.2, what is the molecular formula? *$C_6H_{12}O_2$*

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 $NaHCO_3$ in 12.8 L of solution *(0.444 M)*

    c) 50.0 g of $Fe(NO_3)_3$ in 150.0 mL of solution *(1.38 M)*

    d) 27.8 g of Na_3PO_4 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 $FeCl_3$, from solid $FeCl_3 \cdot 6H_2O$ *(16.2 g)*

    c) 650.0 mL of 0.350 M $Pb(NO_3)_2$, from solid $Pb(NO_3)_2$ *(75.3g)*

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 $FeCl_3$ is mixed with 150.0 mL of 0.250 M $FeCl_3$. *(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 M)*

30. Calculate the molarity of pure water if density = 1.000 g/mL. *(55.6 M)*

(2) 120.5 g/mol, 151.9 g/mol, 605.2 g/mol, 342.3 g/mol, 294.7 g/mol, 233.7 g/mol; (3) 280.8 g/mol, 510.7 g/mol, 400.0 g/mol, 295.5 g/mol; (4) 618.8 g, 5.92 g, 0.0171 g, 1.10 g; (5) 1.53 mol, 3.43×10^{-6} mol, 41.0 mol, 0.753 mol; (6) 381.9 g/mol, 2.17×10^{6} g/mol; (7) standard temperature and pressure, 101.3 kPa and 0˚C; (8) 555.5 L, 1.93 L; (9) 2.89 mol, 0.0288 mol; (10) 8, 90, 3.08×10^{25}, 1.10×10^{24}; (11) 3.44×10^{-22} g, 4.21×10^{-20}g, 1.35 g, 9.97×10^{-4} g, 15.9 g, 0.12 g; (12) 1.09×10^{24}, 1.13×10^{24}, 6.82×10^{17}, 4.55×10^{21}, 1.54×10^{23}, 9.33×10^{22}; (13) 0.0308 L, 21.1 L, 39.4 L, 0.369 L; (14) 27.4%Na, 1.2%H, 14.3%C, 57.1%O; 27.9%Fe, 24.1%S, 48.0%O; 25.4%Cu, 12.9%S, 57.7%O, 4.0%H; 19.9%Fe, 17.1%S, 59.8%O, 3.2%H; (15) 67.8%, 28.8%, 43.3%, 37.4%; (16) Li_2SO_4, $NaHCO_3$, FeC_2O_4, $KMnO_4$;