PRACTICE PROBLEMS - CHEMISTRY

1. How many tons of an ore containing 2.50% magnetite, Fe_3O_4 (MW=232) must be processed to yield 1.00 ton Fe (ATWT=55.85) if the process is 100% efficient? Ans. 55.3 tons.

2. a. Assuming 100% efficiency, calculate the tons of an ore 15.0% by weight FeS_2 (MW=119.97) which must be processed to produce 1.00 ton of 98.0 wt% H_2SO_4 solution (MW= 98.1). Ans. 4.00 tons.
   $FeS_2 + O_2(air) = SO_2 + Fe_2O_3$ $SO_2 + O_2 = SO_3$ $SO_3 + H_2O = H_2SO_4$
   b. Calculate the liters of air (21.0 mole $\%O_2$) at 620.0 mm Hg and 25.0°C required in the process of part a. Ans. 1.78×10^6 liter.

3. An ore contains 12.0 wt% Cu_2S. Cu is to be recovered by the process:
   $Cu_2S + H_3O^+ + NO_3^- = Cu^{++} + SO_4^{=} + NO(g) + H_2O$ $Cu^{++} + Fe = Cu + Fe^{+++}$
   a. Calculate the tons Fe needed in processing 1.00 ton of ore. Ans. 0561.
   b. Calculate the liters NO gas at 620.0 mm Hg and 27.0°C generated in processing 1.00 ton of ore. Ans. 6.8×10^4 liter.

4. For Ni recovery by the process: $Ni_3S_2 + O_2 = NiO + SO_2$ $NiO + C = Ni + CO$
   a. How many grams of Ni metal can be produced per kg of Ni_3S_2? Ans. 736 g.
   b. How many liters of dry SO_2 gas at 620.0 mm Hg and 21.0'C are generated per kg N_3S_2 processed? Ans. 246 liter.

5. Calculate the equivalent weight of Monel alloy (67.0% Ni, 28.0% Cu, other components disregarded in the calculation) for dissolving in HNO_3, to produce $Ni(NO_3)_2$ and $Cu(NO_3)_2$. Ans. 31.6.

6. If 5.60 kg CO were reacted with 1470 gm Ni, what would be the mole fraction $Ni(CO)_4$ in the effluent gas stream? $Ni + 4\ CO(g) = Ni(CO)_4$. Ans. .200.

7. a. How many grams Ti metal may be produced from 5.00 kg illmenite, $FeTiO_3$ (MW=151.75)? Ans. 1.58×10^3.
   $FeTiO_3 + Cl_2 + C = TiC1_4 + FeCl_3 + CO_2$ $TiCl_4 + Mg = Ti + MgCl_2$
   b. How many liters CO, at 550 mm Hg and 23.0°C are co-produced? Ans. 1.66×10^3 L.

8. a. If 1.00 gm. MnO_2, 1.00 gm NaCl, and 5.00 gm H_2SO_4, are mixed, then calculate the maximum mLs dry Cl_2, gas at 25.0°C, and 620.0 mm Hg which could be produced. Ans. 260.
   $MnO_2 + NaCl + H_2SO_4 = MnSO_4 + Cl_2 + H_2O + Na_2SO_4$
   b. Calculate the mLs of 95.0 wt% H_2SO_4 solution (sp gr 1.84) needed per liter of Cl_2 evolved. Ans. 3.74 ml.

9. Which ore has the greater wt % Cu: an ore 20.0 wt% $CuFeS_2$ or an ore 16.0 wt% $Cu_2(OH)_2CO_3$? Ans. $Cu_2(OH)_2CO_3$ ore - 9.2 wt% Cu.

10. Titration of 100.0 ml of $KMnO_4$ solution required 48.6 ml of a 2.50 N $Fe(NO_3)_2$ solution.
    $8\ H_3O^+ + MnO_4^- + 5\ Fe^{++} = 5\ Fe^{+++} + Mn^{++} + 12\ H_2O$
    a. Calculate the normality of the $KMnO_4$ solution. Ans. 1.22.
    b. Calculate the molarity of the $KMnO_4$ solution. Ans. .243.
    c. Calculate the molality of the $KMnO_4$ solution (sp gr 1.35).

11. An aqueous NH_3 solution is 18.0 wt% NH_3 and has density of .9295g/mL. MW NH_3 = 17.0, H_2O= 18.0. Calculate a. M Ans. 9.84 b. m Ans. 12.9 c. mole fraction NH_3 Ans. .189

12. What is the maximum volume of H_2 gas, measured at 30°C and 685 torr that will combine with 12.00 grams of oxygen and 6.00 grams of carbon to produce CH_3OH? (27.6L)

13. A mixture of gases contains 4.00 mole N_2, 19.00 grams F_2, and 1.204×10^{24} atoms of Ar. Calculate the average molecular weight of the mixture. Calculate the density at 50.0°C and 625 torr. Calculate the mole fraction of F_2. (M = 32.4)

14. 800.0 ml of an aqueous solution contains 19.62 grams of H_2SO_4, and has a density of 1.0115 g/ml. (a) What is the molarity of H_2SO_4, in the solution? (b) What is the mole fraction of H_2SO_4? (c) What volume of the solution would be required to make 100.0 ml of a 0.2000 M solution by dilution with water? (d) How many moles of H_2SO_4 are in 100.0 ml of the original solution? (a. .2500M)

15. A solution is prepared by dissolving 29.0 g CsCl in 21.0 g H_2O, giving a 6.00 M solution. Calculate the density of the solution. (1.75g/ml)

16. A solution is prepared by mixing 35.0 mL 2.50 M HCl and 50.0 mL 0.150 M HCl. Assuming the volumes are additive, calculate the molarity of the resulting solution. (1.12M)

17. What volume of 0.250 M HCl must be added to 155 mL of 2.00 M HCl to yield 1.50 M HCl?

18. What volume of 0.150 M NaOH is required for the titration of 30.0 mL of 0.125 HCl? (25.0 mL)

19. A base solution is standardized by titration with potassium hydrogen phthalate (MW = 204.2). It requires 43.85 ml of the base solution to react with 0.8650 grams of the acid, which is99.95% pure. Determine the molarity of the base (NaOH). (.09655M)

20. A solid sample is a mixture of KCl and Na_2CO_3. 0.485 g of the solid is dissolved in water, and titrated with HCl, requiring 23.65 mL of 0.1120 M HCl. Calculate the percent of Na_2CO_3 in the sample. $2H^+ + CO_3^{=} = CO_2 + H_2O$ (28.9%)

21. It requires 43.20 mL of 0.0904 M NaOH to titrate 0.7515 grams of a monoprotic acid. Calculate the molecular weight of the acid. (175.0)

22. Calculate the concentrations of all ionic species in the solution resulting from mixing 25.00 mL of 0.1500 M NaOH with 15.00 mL of 0.2000 M HNO_3. (.01875M OH^-)

23. Calculate the molarities of NH_3 and NH_4^+ in the solution resulting from mixing 25.00 mL of 0.1500 M NH_3 with 10.00 mL of 0.1200 M HCl, assuming complete reaction (.07286 M NH_3)

24. Calculate the molarities of H^+ and Cl^- in the resulting solution when 55.0 mL of 0.200 M HCl and 45.0 mL of 0.150 M NaOH are mixed. (.0425 M H^+)

25. Complete and balance the reaction (acidic solution) $MnO_4^- + I^- = Mn^{++} + I_2$. What volume of 0.150 M $KMnO_4$ will react with 1.25 g KI? (10.0 mL)

26. What volume of 0.150M $KMnO_4$ will react with 50.0 mL of 0.100 M $FeCl_2$? $KMnO_4 + FeCl_2 = MnC1_2 + FeC1_3$ (unbalanced) (6.67 mL)

27. Complete and balance the reaction (basic solution): $S_2O_3^{=} + I_2 = S_4O_6^{=} + I^-$. What volume of 0.200 M $Na_2S_2O_3$ react with 0.300 grams of I_2? (11.8 mL)

28. It requires 28.7 mL of 0.0600 M $HAsO_2$ to titrate a 0.200 gram sample containing MnO_2, What is the percent MnO_2 in the sample? $MnO_2 + HAsO_2 = Mn^{++} + H_3AsO_4$ (unbalanced) (74.9%)

29. Complete and balance the following reactions:
$N_2H_4 + MnO_4^- = NO_3^- + MnO_2$ (basic)
$AuCl_6^{3-} + H_2O_2 = O_2 + Au$ (acidic)
$As_2S_3 + Ce^{4+} = H_3AsO_4 + SO_2 + Ce^{3+}$ (acidic)
$Cu_2S + NO_3^- = Cu^{++} + NO + S$ (acidic)

30. 5.60 g N_2 and 7.20 g O_2 are put into a previously evacuated container at a total pressure of 700.0 torr and 40°C. (a) What is the partial pressure of N_2? (b) What is the average molecular weight? (c) What is the volume of the container? (329 torr; 30.1; 11.9 L)

31. Calculate the resulting temperature when 60.0 grams of Cu at 80.0°C are poured into 20.0 grams of water at 10.0°C. The specific heat of Cu is 0.0924 cal/g-°C. (25.2°C)

32. Determine the final state of the system when 155 grams of iron (sp. ht. = 0.106 ca1/g-°C) at 215°C are mixed with 95.0 grams of ice at O.O°C. ΔH_{fusion} of water = 1435 cal/mole. (50.7 g ice at O°C)

33. Enthalpies of combustion of graphite, H_2, and C_2H_6 (g) are -94.05, -68.32, and -372.8 kcal/mole, resp. Calculate the enthalpy of formation of C_2H_6(g). (-20.3 kcal/mole)

34. Circle that solution in each set having the highest pH:
a. 0.100 M HCl, 0.100 M HF, 0.100 M NaCl, 0.100 M NaF
b. 0.100 mole NaCl dissolved in 1.00 liter 0.100 M HCl, 0.100 mole NaF dissolved in 1.00 liter 0.100 M HF, 0.100 M HF
c. 0.100 M NH_3 , 0.100 M NH_4Cl, 0.100 mole NH_4Cl dissolved in 1.00 liter 0.100 M NH_3
d. 0.100 M NH_4Cl , 0.100 M NaCl, 0.100 M NH_4F.
e. At the equivalence point in the titration of. 0.100 M HC1 with 0.100 M NaOH, 0.100 M HF with 0.100 M NaOH, 0.100 M HC1 with 0.100 M NH_3.

35. Calculate the pH at the equivalence point in the titration of 50.0 mL 0.100 M HF ($K_a = 4.8 \times 10^{-4}$) with 0.400 M NaOH. (Ans. 8.11)

36. When 25.0 mL 0.200 M HC1 are added to 50.0 mL 0.300 M solution of an unknown monoprotic base, B, the resulting solution pH is 8.25. Calculate K_b of B. (Ans. 8.9×10^{-7})

37. Consider the titration of 50.0 mL 0.100 M HSCN (HSCN $K_a = 0.14$) with 0.200 M NaOH.
a. Calculate pH prior to the addition of any NaOH. (Ans. 1.17)
b. Calculate pH after addition of 15.0 mL NaOH. (Ans. 1.68)

38. Which of the following has the greatest electronegativity? Be, K, S, As, Se
Which of the following has the smallest ionization potential? Be, K, K^+, As, F

Which of the following has the largest ionization potential? S, $S^{=}$, Ar, Ca, Ca^{++}
Which of the following has the largest radius? Ca, Ca^{++}, $S^{=}$, Br, I^{-}

39. Consider the voltaic cell: $Hg(l)/Hg_2Cl_2(s)/Cl^-$ (.100M)//H_3O^+ (pH 3.00), I^- (.500M), IO_3^- (5.00M)/Pt.
    a. Diagram the cell, label all features.
    b. Write the balanced anode, cathode, and cell reactions.
    c. Calculate E^o for the cell. (Ans. +.730 volt)
    d. Calculate E for the cell. (Ans. +.503 volt)
    c. If both half-cells have constant 200.0 mL volume, calculate the final $[I^-]$ after the cell operates at 0.600 amp for 3.00 hours. (Ans. 0.556M)

40. Calculate E^o for HBrO => Br_2 in acid-solution. (Ans. +1.24v).

41. Calculate K_{sp} AgBr. (Ans. 5×10^{-10}).

42. Calculate E^o for $S_2O_4^{=}$ => $SO_3^{=}$ in basic solution. (Ans. +1.11v)

43. Calculate E^o for $PbSO_4$,(s) => Pb + $SO_4^{=}$. (Ans. -0.36v)

44. For electrolysis of 3.00M $CdCl_2$. using Pt electrodes, the unbalanced cell reaction is $Cd^{2+} + Cl^- \Rightarrow Cd + Cl_2$(g, 1.00 atm).
    a. Calculate the cell decomposition potential. (Ans. 1.701v)
    b. Write the balanced anode reaction.
    c. Is the electrode at which Cd deposits connected to the + or – pole of the power supply?

45. When a 0.500M $NiCl_2$ solution is electrolyzed with Pt electrodes:
    a. Calculate the cell decomposition potential. (Ans. 1.075v)
    b. Write the balanced cell reaction.
    c. Is the electrode connected to the + or - pole of the power supply; to the anode, or cathode of the electrolysis cell?

DATA: <u>Reduction Potentials (volts at 25.0'C)</u>

Na^+ => Na	-2.714	Pb^{2+} => Pb	-. 126
Mn^{++} => Mn	-1.05	AgBr => Ag+Br	+.071
$SO_4^{=}$ => $S_2O_4^{=}$ + OH^-	- .99	Hg_2Cl_2 => Hg + $C1^-$	+.355
$SO_4^{=}$ => $SO_3^{=}$ + OH^-	- .93	IO_3^- +H_3O^+ => I^-	1.085
Cd^{2+} => Cd	-.402	O_2 + H_2O+ => H_2O	1.229
Ni^{2+} => Ni	-.250	$C1_2$ => Cl-	1.3595
MnO_4^- + H_3O^+ => Mn^{2+}	1.51	BrO_3^- => HBrO	1.59
BrO_3^- + H_3O^+ => Br_2	1.52		

Other data: $K_{sp}(PbSO_4) = 1.6 \times 10^{-8}$
1.00 cal = 4.18 Joule 2.303 RT/P = .0591 at 25.0°C 1.000 F = 96500 coulomb/equivalent