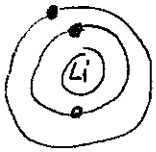
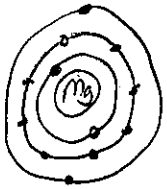
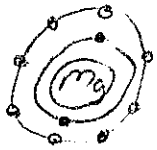
Name Key

Review of Chemistry 30

1. Complete the following table: p 17 #9

Element name		Chemical symbol	Atomic number	Group number	Period number	Metal (m) or nonmetal (nm)	State at SATP	Family/Series names
1.	chlorine	Cl	17	17	3	nm	g	halogen
2.	nitrogen	N	7	15	2	nm	g	—
3.	iodine	I	53	17	5	nm	s	halogen
4.	gold	Au	79	11	6	m	s	—
5.	sodium	Na	11	1	3	m	s	alkali metals

2. Complete the following table: p. 22 #1

Element name and symbol	Bohr diagram of atom	Energy level diagram of atom	# of valence electrons	Bohr diagram of ion
lithium		1e 2e 3p 4n Li	1	
magnesium		2e 8e 2e 12p 12n Mg	2e	
Al		3e 8e 3e 14p 14n Al	3e	

p. 27-32

3. Write the formulas for the following compounds.

(a) magnesium oxide $MgO(s)$

(b) sodium fluoride $NaF(s)$

(c) aluminium nitride $AlN(s)$

(d) potassium sulfide $K_2S(s)$

(e) lithium iodide $LiI(s)$

(f) calcium bromide $CaBr_2(s)$

(g) beryllium oxide $BeO(s)$

(h) nickel II chloride $NiCl_2(s)$

(i) magnesium nitride $Mg_3N_2(s)$

(j) aluminium sulfide $Al_2S_3(s)$

4. Write the names for the following compounds.

(a) Li_2O lithium oxide

(b) $AlCl_3$ aluminum chloride

(c) MgS magnesium sulfide

(d) CaO calcium oxide

(e) KBr potassium bromide

(f) BeF beryllium fluoride

(g) Na_3N sodium nitride

(h) Al_2O_3 aluminum oxide

(i) $CuCl_2$ copper (II) chloride

(j) $FeBr_3$ iron (III) bromide.

p. 33, p. 36 # 1, 2, 3

Acids - p. 37 # 6

5. Write the formulas for the following compounds.

(a) carbon dioxide $CO_2(g)$

(b) silicon dioxide SiO_2

(c) water $H_2O(l)$

(d) carbon disulfide CS_2

(e) sulfur trioxide $SO_3(g)$

(f) ammonia $NH_3(g)$

(g) carbon tetrachloride $CCl_4(l)$

(h) hydrogen peroxide $H_2O_2(l)$

(i) methane $CH_4(g)$

(j) ozone $O_3(g)$

6. Write the names for the following compounds.

(a) CF_4 carbon tetrafluoride

(b) NH_3 ammonia

(c) PBr_3 phosphorus tribromide

(d) O_3 ozone

(e) $F_2(g)$ fluorine

(f) CS_2 carbon disulfide

(g) N_2O_4 dinitrogen tetraoxide

(h) H_2O_2 hydrogen peroxide

(i) CO carbon monoxide

(j) SiC silicon carbide

7. How many atoms, and of which kind, do the following symbols represent?

(a) Ca - 1 calcium

(b) N_2 2 - nitrogen

(c) $Ba_3(PO_4)_2$ 3 - barium, 2 - phosphorus, 8 - oxygen

(d) $2\ H_2O$ 4 - hydrogen, 2 - oxygen.

(Try Chpt 1 Review p. 39)

8. Determine the molar mass of each of the following substances: p. 57 # 1-7

(a) $(NH_4)_2CO_3(s)$ (b) $CoCl_2 \cdot 6H_2O(s)$

96.11 g/mol 237.95 g/mol

9. Convert each of the following masses into its chemical amount:

(a) 8.40 g of NaOH(s) $n = \frac{m}{M} = \frac{8.40}{40.00} = 0.210$ mol

$M_{NaOH} = 40.00$ g/mol

(b) 4.2 kg of $H_2O(l)$

$M_{H_2O} = 18.02$ g/mol $n = \frac{m}{M} = \frac{4200}{18.02} = 2.3 \times 10^2$ mol

10. Convert each of the following amounts into a mass in grams of the given substance:

(a) 0.456 mol of $Al_2(SO_4)_3(s)$

$M_{Al_2(SO_4)_3} = 342.17$ g/mol $m = n \cdot M = 0.456 \times 342.17 = 156$ g

(b) 0.518 mmol of $CuSO_4 \cdot 5H_2O(s)$

$M_{CuSO_4 \cdot 5H_2O} = 249.72$ g/mol $m = n \cdot M = 0.518 \times 10^{-3} \times 249.72 = 0.129$ g

11. Complete the following table.

Table 1 Molar Calculations

Substance	Molar mass (g/mol)	Mass (g)	Chemical amount (mol)
$CaCl_2(s)$	110.98	18.6	0.168
$Na_2CO_3 \cdot 10H_2O(s)$	286.19	42.9	0.150

12. (a) Classify each of the following reactions as formation, simple decomposition, single replacement, or double replacement reactions. (p. 59-60 # 1-6)

(b) Balance each equation and add symbols to indicate states of matter for all reactants and products. (p. 64 # 1-4)

(i) $2Cu + 1O_2 \rightarrow 2CuO$ sc

(ii) $2Al + Fe_2O_3 \rightarrow Al_2O_3 + 2Fe$ sr

(iii) $2H_2O +$ electricity $\rightarrow 2H_2 + 1O_2$ sd

(iv) $FeS + 2HCl \rightarrow FeCl_2 + H_2S$ dr

13. Write balanced chemical equations for the following:

(a) The decomposition reaction of hydrogen sulfide.

$8H_2S(g) \rightarrow 8H_2(g) + 1S_8(s)$

(b) The single displacement reaction of copper metal and silver nitrate.

$Cu(s) + 2AgNO_3(aq) \rightarrow Cu(NO_3)_2(aq) + 2Ag(s)$

(c) The synthesis reaction of sodium and fluorine.

$2Na(s) + F_2(g) \rightarrow 2NaF(s)$

(d) The double displacement reaction of aluminium sulfate and calcium hydroxide.

$Al_2(SO_4)_3(aq) + 3Ca(OH)_2(s) \rightarrow 3CaSO_4(s) + 2Al(OH)_3(s$

14. For each of the following questions, classify the reaction type (formation, simple decomposition, combustion, single replacement, double replacement, or other), and predict the balanced chemical equation. Provide a word equation as well.

(a) $4\ Al(s) + 3O_2(g) \rightarrow 2Al_2O_3(s)$

f

(b) $2\ Ag_2O(s) \rightarrow 4Ag(s) + O_2(g)$

sd

(c) $Br_2(l) + 2KI(aq) \rightarrow 2KBr(aq) + I_2(s)$

sr

(d) Sulfuric acid is neutralized by aqueous sodium hydroxide.

dr $H_2SO_4(aq) + 2NaOH(aq) \rightarrow Na_2SO_4(aq) + 2HOH(l)$

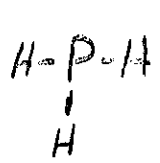
(e) Propane burns in air.

comb $C_3H_8(g) + 5O_2(g) \rightarrow 3CO_2(g) + 4H_2O(g)$

(Try p. 68-69 Review)

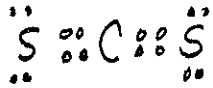
15. Use Lewis formulas and structural formulas to represent molecules of the following compounds.

(a) $PH_3(g)$ phosphine



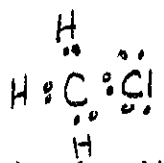
(p. 82 # 2, 3, 4)
(p. 89 # 5, 6)
(p. 90 # 1-6)

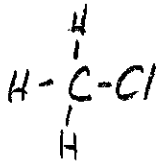
(b) $CS_2(l)$ carbon disulfide



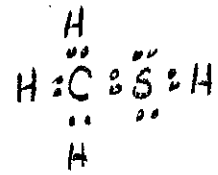
S = C = S

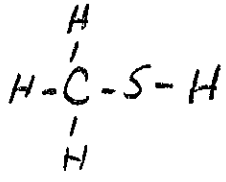
(c) $CH_3Cl(g)$, chloromethane





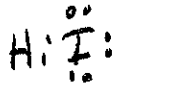
(c) $CH_3SH(g)$ methanethiol





16. For each of the following molecules, write the chemical formula (if not provided), draw the Lewis formula, and describe the shape around the central atom

(a) hydrogen iodide HI(s)



linear

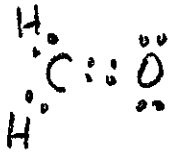
(read p. 91-96 # 1-3)

p. 98 # 7

p. 100 # 9, 10

p. 102 # 12, 13

(b) formaldehyde, H_2CO



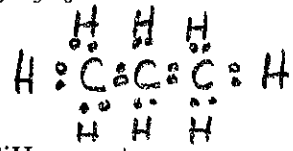
trigonal planar

(c) hydrogen peroxide

$H_2O_2(l)$

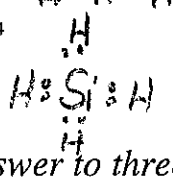
V-shaped

(d) propane, C_3H_8



tetrahedral

(e) silane, SiH_4



tetrahedral.

Round your answer to three significant digits for each of the following questions.

17. What is the pressure required to compress hydrogen at 1.00 atm from 300 mL to 200 mL at a constant temperature? (p.151) Boyle's Law (constant T & n)

$P_1V_1 = P_2V_2$ $(1)(300) = x(200)$ $\boxed{x = 1.50\ atm}$

18. A 400 mL sample of a gas at 10 °C is warmed to 25 °C at a constant pressure. Calculate the final volume. (p.154) Charles' Law (constant P & n)

$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\frac{400}{283} = \frac{x}{298}$ $\boxed{x = 421\ mL}$ $273 + 10 = 283\ K$ $273 + 25 = 298\ K$

19. A bicycle tire has a pressure of 450 kPa at 20 °C. Assuming the volume does not change, what is the new pressure at 35 °C? (p.157) Combined law (constant n)

$V_1 = V_2$ $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ $\frac{450}{293} = \frac{x}{308}$ $\boxed{x = 473\ kPa.}$

20. Nitrogen in a 250 mL container at 65.0 kPa is transferred to a container with a volume of 600 mL.

(a) Calculate the new pressure if the temperature is kept constant.

$P_1V_1 = P_2V_2$ $(65)(250) = P_2(600)$ $\boxed{P_2 = 27.1\ KPa}$

(b) Calculate the new pressure if the temperature changes from 20 °C to 15 °C.

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ $\frac{65(250)}{293} = \frac{600(P_2)}{288}$ $\boxed{P_2 = 26.6\ KPa}$

21. A 450 mL sample of freon gas at 1.50 atm and 15 °C was compressed to 300 mL at a pressure of 2.00 atm. Calculate the final temperature in degrees Celsius.

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$\frac{(1.50)(450)}{288} = \frac{(2.00)(300)}{T_2}$ $T = 256\ K$ or $-17°C$

22. A 2.75 L sample of helium gas at 99.0 kPa was heated from 21.0 °C to 71.0 °C and the pressure changed to 100 kPa. Calculate the final volume. $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

$\frac{99(2.75)}{294} = \frac{100(V_2)}{344}$

$V_2 = 3.19\ L$

- also Ideal Law $PV = nRT$ (p.174-175)

23. List some properties that could be used to construct diagnostic tests to identify the type of solute that is in each of the following solutions. (review p. 181)

(a) An aqueous solution of a molecular substance

- nonconducting solution

(b) An aqueous solution of a neutral ionic compound

- conducting / & does not change litmus

(c) An aqueous solution of an acid

- conducting solution, pH turns red

(d) An aqueous solution of a base

- conducting solution, pH turns blue.

24. The following substances are common chemicals:
butane, $C_4H_{10}(g)$ (lighters)
ethanol, $C_2H_5OH(l)$ (alcoholic drinks)
dichloromethane, $CH_2Cl_2(l)$ (solvent in correction fluid)

(p. 105 – 109 # 1-4)

(a) Classify the type(s) of intermolecular forces present among molecules of each of these substances.

$C_4H_{10}(g)$ - L.D.

CH_2Cl_2 - L.D & dipole dipole

$C_2H_5OH(l)$ - L.D, dip-dipole, hydrogen

(b) Predict the solubility (low, moderate, or high) of each substance in water.

least ⟶ high

C_4H_{10} CH_2Cl_2 C_2H_5OH

25. For each of the following substances, write the chemical formula including pure state of matter at SATP, predict the solubility (low/high) in water, and if appropriate, write a balanced dissociation equation. (p. 197) (p. 201-Table) (p. 202 # 1-8)

(a) silver sulfide $Ag_2S(s)$

low solubility

(b) ammonium borate $(NH_4)_3BO_3(s)$

high solubility

$(NH_4)_3BO_3(s) \longrightarrow 3NH_4^+(aq) + BO_3^{3-}(aq)$

(c) copper(II) nitrate trihydrate

$Cu(NO_3)_2 \cdot 3H_2O(s)$ - high solubility

$Cu(NO_3)_2 \cdot 3H_2O(s) \longrightarrow Cu^{2+}(aq) + 2NO_3^-(aq) + 3H_2O(l)$

(d) glucose, $C_6H_{12}O_6(s)$ $C_6H_{12}O_6(s)$ - high solubility

$$C_6H_{12}O_6(s) \rightarrow C_6H_{12}O_6(aq)$$

26. What volume of concentrated 14.6 mol/L phosphoric acid would contain 2.00 mol of solute? (p. 210 #13-16)

$$V = \frac{n}{c} = \frac{2.00}{14.6} = 0.137\ L \quad \text{or} \quad 137\ mL$$

27. What mass of table salt is needed to prepare 1.20 L of 5.20 mol/L solution? $M_{NaCl} = 58.44\ g/mol$

$n = V \cdot C$
$= (1.20)(5.20)$
$= 6.24\ mol$

$m = n \cdot M$
$= 6.24(58.44)$
$= 364.66\ g \rightarrow \boxed{365\ g}$

28. What is the amount concentration of zinc nitrate if 94.2 g of solute is dissolved to make 2.00 L of solution? $M_{Zn(NO_3)_2(s)} = 189.$

$$n = \frac{m}{M} = \frac{94.2}{189.43} = 0.49728\ mol$$

$$C = \frac{n}{V} = \frac{0.49728\ mol}{2\ L} = \boxed{0.249\ mol/L}$$

29. An ammonia solution is made by diluting 150 mL of the concentrated commercial reagent until the final volume reaches 1000 mL. What is the final amount concentration?

$C_1V_1 = C_2V_2$
$150(14.8) = x\,(1000)$
$\boxed{C_2 = 2.22\ mol/L}$

30. What volume of a 500 ppm reagent solution is required to prepare a 2.5 L solution with a 100 ppm concentration?

$C_1V_1 = C_2V_2$
$(500)V_1 = (100)(2.5)$
$\boxed{V_1 = 0.50\ L}$

31. A 500 mL bottle of concentrated acetic acid is diluted to make a 5.0% solution. Find the volume of diluted solution that is prepared.

$C_1V_1 = C_2V_2$
$99.5(500) = (5)V_2$
$\boxed{V_2 = 9.95\ L}$

(Review p. 231)

32. (a) What is the pH of a solution with a hydronium ion concentration of 1×10^{-7} mol/L?

$pH = -\log[H_3O^+] = 7$

p 240-241

(b) What is the pH of a solution with a hydronium ion concentration of 1×10^{-5} mol/L?

$= 5$

(p 242 #4-6)

(c) Compare the hydronium ion concentrations and pHs in (a) and (b).

higher pH's have lower $[H_3O^+(aq)]$

33. What happens to the pH of a solution when:

(a) the hydronium ion concentration increases?

goes down

(b) the hydronium ion concentration decreases?

goes up

(c) a strong acid is diluted?

goes down.

34. Complete the following table.

Substance		$[H_3O^+(aq)]$ (mol/L)	pH	Acidic, basic, or neutral
(a)	milk	3.2×10^{-8}	7.50	base.
(b)	pure water	1×10^{-7}	7.0	neutral
(c)	blood	4.0×10^{-8}	7.40	base
(d)	drain cleaner	1×10^{-15}	15.0	base.

35. Write complete balanced chemical equations, complete ionic equations, and net ionic equations to represent the following reactions.

(a) A zinc strip is dipped into an aqueous solution of silver nitrate.

$$Zn(s) + 2AgNO_3(aq) \rightarrow Zn(NO_3)_2(aq) + 2Ag(s)$$
$$Zn(s) + 2Ag^+(aq) + 2NO_3^-(aq) \rightarrow Zn^{2+}(aq) + 2NO_3^-(aq) + 2Ag(s)$$
$$Zn(s) + 2Ag^+(aq) \rightarrow Zn^{2+}(aq) + 2Ag(s)$$

(b) Solutions of lead(II) nitrate and potassium chloride are mixed.

$$Pb(NO_3)_2(aq) + 2KCl(aq) \rightarrow PbCl_2(s) + 2KNO_3(aq)$$
$$Pb^{2+}(aq) + 2NO_3^-(aq) + 2K^+(aq) + 2Cl^-(aq) \rightarrow PbCl_2(s) + 2K^+(aq) + 2NO_3^-(aq)$$
$$Pb^{2+}(aq) + 2Cl^-(aq) \rightarrow PbCl_2(s)$$

(e) Aqueous solutions of aluminium sulfate and calcium hydroxide are mixed.

$$Al_2(SO_4)_3(aq) + Ca(OH)_2(s) \rightarrow CaSO_4(s) + Al(OH)_3(s)$$
$$Al^{3+}(aq) + 3SO_4^{2-} + Ca(OH)_2(s) \rightarrow CaSO_4(s) + Al(OH)_3(s)$$

(f) An iron nail is dropped into a beaker of sulfuric acid.

$$2Fe(s) + 3H_2SO_4(aq) \rightarrow Fe_2(SO_4)_3(aq) + 3H_2(g)$$
$$2Fe(s) + 6H^+(aq) + 3SO_4^{2-}(aq) \rightarrow 2Fe^{3+}(aq) + 3SO_4^{2-} + 3H_2(g)$$
$$2Fe(s) + 6H^+(aq) \rightarrow 2Fe^{3+}(aq) + 3H_2(g)$$

36. Calculate the mass of iron(III) oxide (rust) produced by the reaction of 500 g of iron with oxygen from the air.

$$4Fe(s) + 3O_2(g) \rightarrow 2Fe_2O_3(s)$$

$m = 500\,g$

$n = m/M$

$= 500/55.85$

$= 8.95\ mol$

$n = 4.476\ mol$ $\quad M_{Fe_2O_3} = 159.7$

$m = n \cdot M$

$= 4.476 \times 159.7$

$= 714.8\ g$

715 g

37. What mass of precipitate should form if 2.00 g of silver nitrate in solution is reacted with excess sodium sulfide solution? $2AgNO_3(aq) + Na_2S(aq) \rightarrow 2NaNO_3(aq) + Ag_2S(s)$

$m = 2.00g$

① $n = \frac{m}{M}$

$= \frac{2.00}{169.88}$

$= 0.011773$

② moles Ag_2S

$= 0.0058865$

③ mass $Ag_2S(s)$

$m = n \cdot M$

$= 0.0058865 \times 247.8$

$= \boxed{1.46g}$

38. The first step in the industrial manufacture of sulfuric acid is the complete combustion of octasulfur, $S_8(s)$. What mass of octasulfur is required to produce 112 L of sulfur dioxide at STP?

$1\ S_8(s) + O_2(g) \rightarrow 8\ SO_2(g)$

$m = ?$ $\quad 112L$

① moles SO_2

$n = \frac{V}{V} = \frac{112}{22.4} = 5\ mol$

② moles S_8

$5mol \div 8$

$= 0.625$

③ m S_8

$m = n \cdot M$

$= 0.625 \times 256.56$

$= \boxed{160g}$

36. A 6.72 g sample of zinc was placed in 100.0 mL of 1.50 mol/L hydrochloric acid. After all reaction stops, how much zinc should remain?

$Zn(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$

$n = 0.075$ $\quad n = V \cdot C$

$m = n \cdot M$ $\quad = 0.100 \times 1.5$

$= 4.90575$ $\quad = 0.15\ mol$

mass used

mass left

$6.72 - 4.90575 = \boxed{1.81g}$

40. What is the amount concentration of a KOH(aq) solution if 12.8 mL of this solution is required to react with 25.0 mL of 0.110 mol/L $H_2SO_4(aq)$?

$2KOH(aq) + H_2SO_4(aq) \rightarrow 2HOH(l) + K_2SO_4(aq)$

$n = 0.0055$ $\quad n = 0.025 \times 0.110$

$= 0.00275\ mol$

$C = \frac{n}{V}$

$= \frac{0.0055}{0.0128}$

$= \boxed{0.430\ mol/L}$

41. What volume of 0.125 mol/L NaOH(aq) is required to react completely with 15.0 mL of 0.100 mol/L $Al_2(SO_4)_3(aq)$?

$Al_2(SO_4)_3(aq) + 6NaOH(aq) \rightarrow 3Na_2SO_4(aq) + 2Al(OH)_3(s)$

$n = V \cdot C$ $\quad V = ?$

$= 0.015 \times 0.1$ $\quad C = 0.125$

$= 0.0015\ mol$ $\quad V = \frac{n}{C} = \frac{0.009}{0.125}$

$n = 0.009$

$V = 0.072\ L$

$\boxed{72\ mL}$

SUMMARY Titration Analysis

- Titration is the technique of carefully controlling the addition of a volume of solution (the titrant) from a burette into a measured fixed volume of a sample solution until the reaction is complete.
- The concentration of one reactant must be accurately known.
- The equivalence point is the point at which the exact theoretical (stoichiometric) reacting amount of titrant has been added to the sample.
- The endpoint is the point during the titration at which the sudden change of an observable property indicates that the reaction is complete.
- Several trials must be completed. When at least three trials result in values that are all within a range of 0.2 mL, those values are averaged. The average value is used for the stoichiometry calculation.