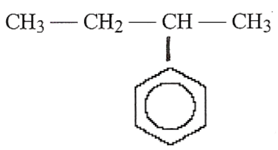
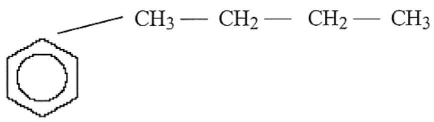
CHAPTER 22/23

1. MATCH

K	$CH_3 — CH_2 — CH_2 — CH_3$		A. 1-butyne
E	$CH_3 — CH_2 — C(=O) — CH_3$ (printed: O above CH, joined by a double bond)		B. 2 -butanol
			C. butanoic acid
L			D. butylbenzene
C	$CH_3 — CH_2 — CH_2 — C(=O) — OH$		E. 2-butanone
			F. 1-butanol
I	$CH_3—CH_2 — CH_2— C(=O)— O— CH_2 — CH_3$		G. 2-butene
F	$CH_3 — CH_2 — CH_2 — CH_2 — OH$		H. butanal
G	$CH_3 — CH = CH —CH_3$		I. methylbutanoate
B	$CH_3 — CH_2 — CH(OH) — CH_3$		J. 1,3-butadiene
A	$CH_3 — CH_2 — C \equiv CH$		K. butane
H	$CH_3 — CH_2 — CH_2 — CH(=O)$		L 2-phenylbutane
J	$CH_3 =CH — CH = CH_2$		
D			

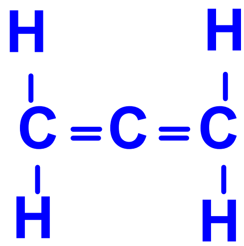
2 a. Fractional distillation

b. Cracking, reforming and combustion

c. You cannot draw a structural isomer for methene because alkenes have a double bond between two carbons and methene only has one carbon

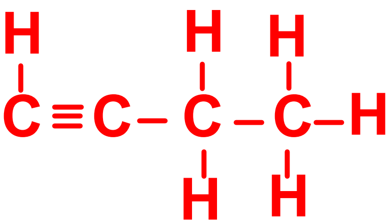
d. Alkadienes are hydrocarbons with two double bonds, draw the structural diagram for the alkadiene C_3H_4

$CH_2=C=CH_2$ or



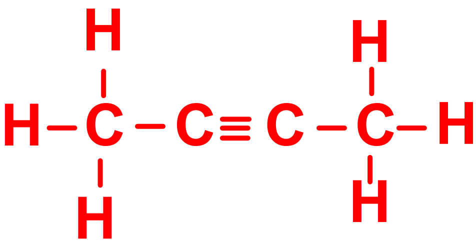
e. The structural formula C_4H_6 could represent an alkyne, cycloalkene, or alkadiene, draw structural formulas for each

Alkyne

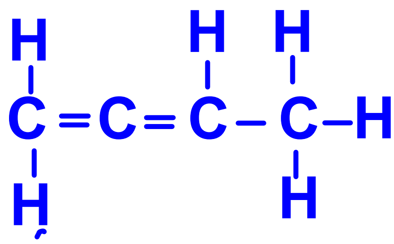


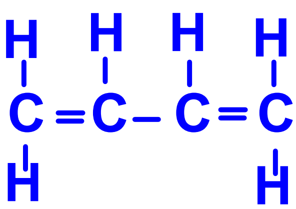
$CH\equiv C-CH_2-CH_3$

$CH_3-C\equiv C-CH_3$

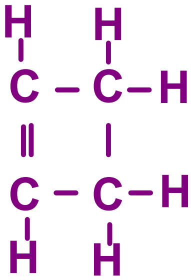


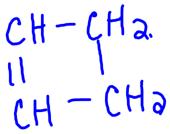
Alkdiene





cycloalkene





3.

a. $CH_3-CH_2-C(=O)-OH + CH_3-CH_2-CH_2-OH \rightarrow CH_3-CH_2-C(=O)-O-CH_2-CH_2-CH_3 + H_2O$

propyl propanoate + water

Esterfication

b. $CH_3-CH=CH-CH_3 + Br_2 \rightarrow CH_3-CH(Br)-CH(Br)-CH_3$

ADDITION

2,3-dibromobutane

c. $CH_3-CH_2-CH(OH)-CH_2-CH_3 \xrightarrow{H_2SO_4} CH_3-CH=CH-CH_2-CH_3 + H_2O$

2-pentene + water

ELIMINATION

D. 

fluorobenzene + hydrogenfluoride

SUBSTITUTION

E. $CH_3-CH_2-CH_2-CH_3 + Cl_2 \rightarrow CH_2(Cl)-CH_2-CH_2-CH_3 + HCl$

1-chlorobutane + hydrogen chloride

Substitution

OR

$CH_3-CH(Cl)-CH_2-CH_3 + HCl$

2-chlorobutane + hydrogen chloride

5. $2C_5H_{10} + 15O_2 \longrightarrow 10CO_2 + 10H_2O$

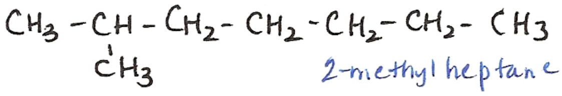
EXTRA: Write equation for the combustion of Benzene

$2C_6H_6 + 15O_2 \rightarrow 12CO_2 + 6H_2O$

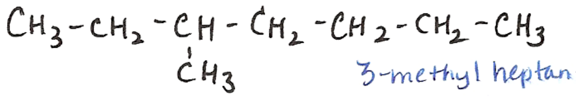
6. C_8H_{18}

$CH_3-CH_2-CH_2-CH_2-CH_2-CH_2-CH_2-CH_3$

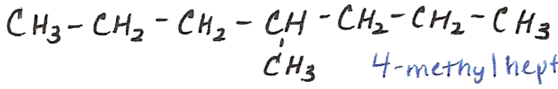
octane



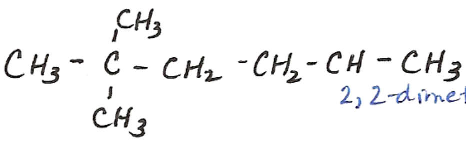
2-methylheptane



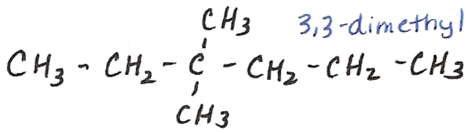
3-methylheptane



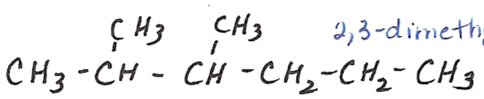
4-methylheptane



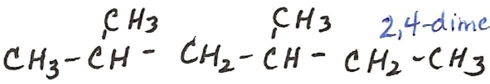
2,2-dimethylhexane



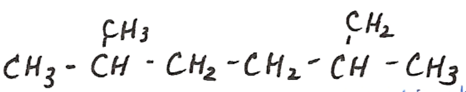
3,3-dimethylhexane



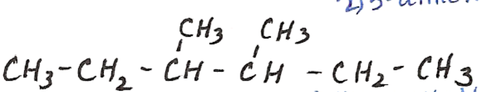
2,3-dimethylhexane



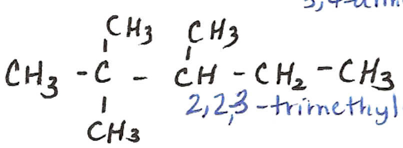
2,4-dimethylhexane



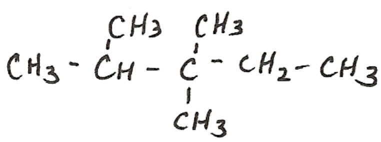
2,5-dimethylhexane



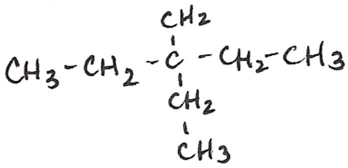
3,4-dimethylhexane



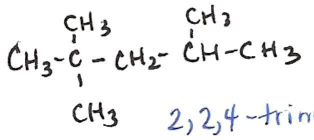
2,2,3-trimethylpentane



2,3,3-trimethylpentane

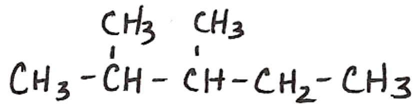


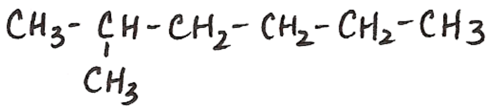
3-ethyl-2-methylpentane

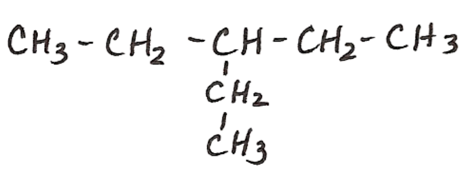


2,2,4-trimethylpentane

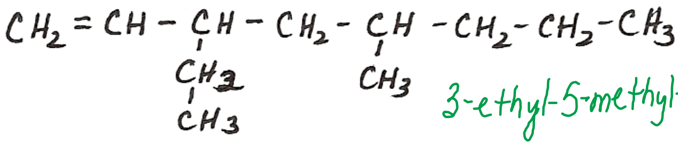
etc

1. a.  2,3 dimethyl pentane

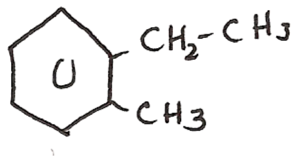
b.  2-methylhexane

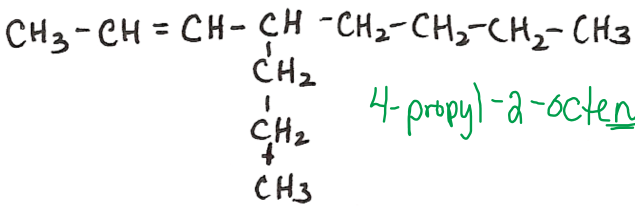
c.  3-ethylpentane

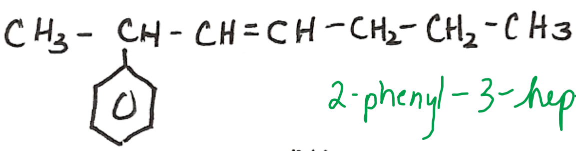
d. $CH_3-CH_2-C\equiv C-CH_2-CH_2-CH_3$ 3-heptyne

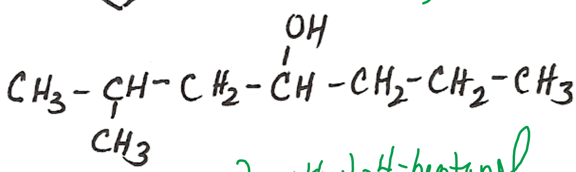
e.  3-ethyl-5-methyl-1-octene

f.  1-chlorocyclopentane

g.  1-ethyl-2-methylbenzene

h.  4-propyl-2-octene

(i)  2-phenyl-3-heptene

(j)  2-methyl-4-heptanol

8(a) 2,3-dimethyl hexane

(b) 3-ethyl hexane

(c) 4-methyl-1-pentene

(d) 3,3-dimethyl-1-butene

(e) 5-ethyl-3,4-dimethyloctane

(f) butanoic acid

g) ethyl butanoate

h) 2-chloro-1-ethanol

9. pentanol and propanoic acid

10. $CH_3-CH_2-CH=CH-CH_2-CH_3 + Br_2 \rightarrow CH_3-CH_2-CH(Br)-CH(Br)-CH_2-CH_3$

Addition

11. $CH_3-C(=O)-OH + CH_3-CH_2-CH_2(OH) \rightarrow CH_3-C(=O)-O-CH_2-CH_2-CH_3 + H_2O$

Esterification

12. $CH_3-CH_2-CH_2-CH_3 + Cl_2 \rightarrow CH_2(Cl)-CH_2-CH_2-CH_3 + HCl$

OR

$CH_3-CH(Cl)-CH_2-CH_3 + HCl$

Substitution

13. $CH_3-CH_2-CH(OH)-CH_2-CH_2-CH_2-CH_2-CH_3 \xrightarrow{ACID} CH_3-CH=CH-CH_2-CH_2-CH_2-CH_2-C$ $+ H_2$

OR

$CH_3-CH_2-CH=CH-CH_2-CH_2-CH_2-CH_3 + H_2$

Elimination

14. C_5H_8O

Bromine (no color) ∴ reaction alkene

Fehlings (red) ∴ aldehyde

$CH_2=CH-CH_2-CH_2-\overset{\overset{O}{\|}}{C}H$ OR $CH_3-CH=CH-CH_2-\overset{\overset{O}{\|}}{C}H$

OR

$CH_3-CH_2-CH=CH-\overset{\overset{O}{\|}}{C}H$ OR ~~$CH_3-CH_2-CH_2-CH=\overset{\overset{O}{\|}}{C}H$~~

can't be too many bonds

Chapter 17:

1. temperature

2. a) endothermic

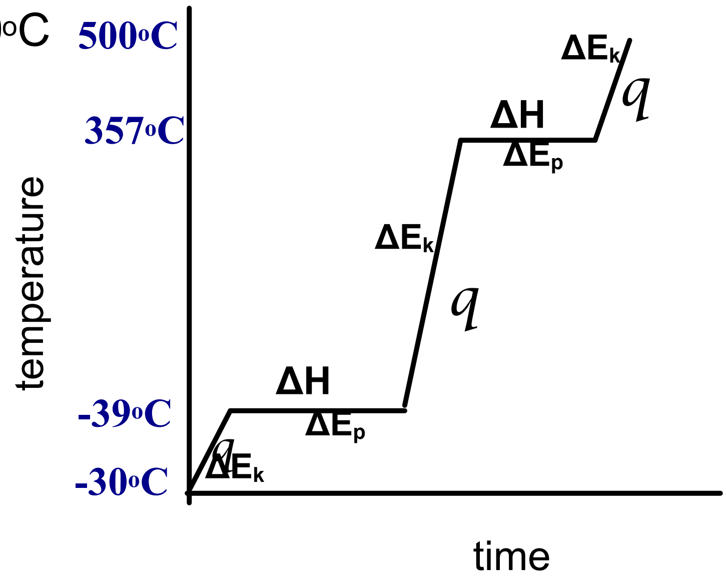
   b) endothermic

   c) endothermic

   d) endothermic

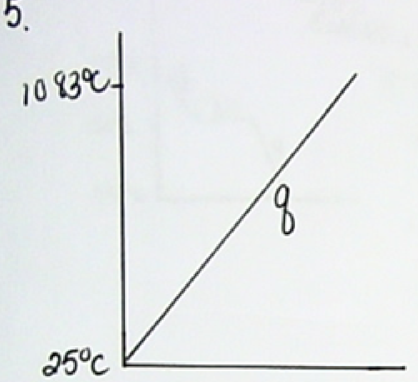
3. Mercury (Hg) BP = 357°C
   MP = -39°C

   from -30°C to 500°C



4. According to the Kinetic Molecular Theory substances are composed of particles in constant random motion. During an exothermic process ~~process~~ these particles lose energy to the surroundings causing the temperature of the surroundings to increase

5.



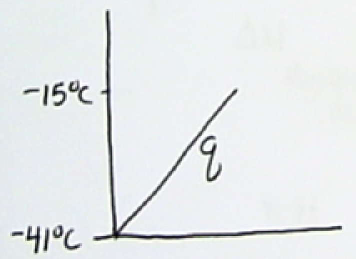
$q = mc\Delta t$

$= 850g \times 0.385 \frac{J}{g°C} \times 1058°C$

$= 34623.05 J$ or

$34.6 KJ$

6.



$q = mc\Delta t$

$= 7500g \times 2.1 \frac{J}{g°C} \times 26°C$

$= 409500 J$

or

$409.5 KJ$

7.

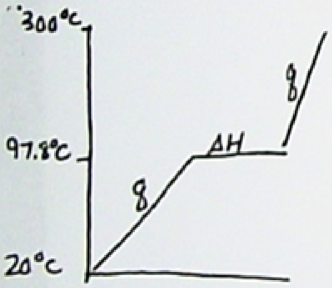
$\Delta H = nH$

$= 1200g\ F_2 \times \frac{1 mol\ F_2}{38\ g F_2} \times 3.1567 \frac{kJ}{mol}$

$= 99.69\ kJ$

-188°C | ΔH vaporize only

8.



Na

20°C - 97.8°C

$q = mc\Delta t$

$= 350g \times 1.226 \frac{J}{g°C} \times 77.8°C$

$\approx 33383.98 J$

33.4 kJ

Melts

$\Delta H = nH$

$= 350g \times \frac{1 mol}{22.99 g} \times 2.6 \frac{kJ}{mol}$

$= 39.58\ kJ$

39.6 kJ

97.8°C-300°C

$q = mc\Delta t$

$= 350g \times 1.226 \times 202.2$

$= 86764.0 J$

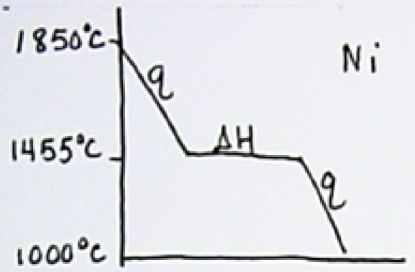
86.8 kJ

TOTAL ENERGY = 33.4 kJ + 39.6 kJ + 86.8 kJ = 159.8 kJ

Na : MP = 97.8°C

~~BP = 883°C~~

9.



1455°C MP
2730 BP

1850°C − 1455°C

$q = mc\Delta t$

$= 2500\,g \times 0.44\,\frac{J}{g\,°C} \times 395\,°C$

$= 434500\,J$

$434.5\,kJ$

(solidifying) freezing (fusion)

$\Delta H = nH$

$= 2500\,g \times \frac{1\,mol}{58.69\,g} \times 17.6\,\frac{kJ}{mol}$

$= 749.7\,kJ$

1455°C − 1000°C

$q = mc\Delta t$

$= 2500\,g \times 0.44\,\frac{J}{g\,°C} \times 455\,°C$

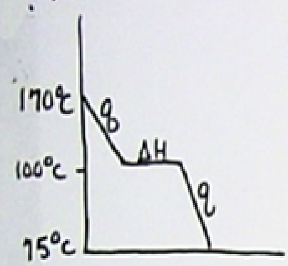
$= 500500\,J$

$= 500.5\,kJ$

TOTAL ENERGY: $(434.5 + 749.7 + 500.5)\,kJ$

$= 1684.7\,kJ$

10.



170 - 100°C

$q = mc\Delta t$

$= 200000g \times 1.7 \frac{J}{g°C} \times 70°C$

$= 23800000 J$

23800 KJ

23.8 MJ

Condensing

$\Delta H = nH$

$= 200000g \times \frac{1 mol}{18.02 g} \times 40.7 \frac{KJ}{mol}$

$= 451720.31 KJ$

$= 451.72 MJ$

100 - 75°C

$q = mc\Delta t$

$= 200000g \times 4.18 \frac{J}{g°C} \times 25°C$

$= 20900000 J$

$= 20900 KJ$

20.9 MJ

TOTAL ENERGY: 496.42 MJ

11.

$\Delta H_{Mg(OH)_2 \text{ dissolving}} = q_{\text{calorimeter water}}$

$nH = mc\Delta t$

$8g\ Mg(OH)_2 \times \frac{1 mol\ Mg(OH)_2}{58.33 g\ Mg(OH)_2} \times H = 100g \times 4.18 \frac{J}{g°C} \times 12.3°C$

$H = 37487.23\ J/mol$

$= 37.487\ KJ/mol$

$0.137 mol\ Mg(OH)_2 \times H = 5141.4 J$

$H = \frac{5141.4 J}{0.137 mol}$

12.

① $H_{2(g)} + F_{2(g)} \rightarrow 2HF_{(g)}$ $\Delta H = -537$ kJ

② $C_{(s)} + 2F_{2(g)} \rightarrow CF_{4(g)}$ $\Delta H = -680$ kJ

③ $2C_{(s)} + 2H_{2(g)} \rightarrow C_2H_{4(g)}$ $\Delta H = 52.3$

①×2 $2H_{2(g)} + 2F_{2(g)} \rightarrow 4HF_{(g)}$ $\Delta H = -1074$ kJ

②×2 $2C_{(s)} + 4F_{2(g)} \rightarrow 2CF_4$ $\Delta H = -1360$ kJ

③ ↔ $C_2H_{4(g)} \rightarrow 2C_{(s)} + 2H_{2(g)}$ $\Delta H = -52.3$ kJ

$C_2H_{4(g)} + 6F_{2(g)} \rightarrow 4HF_{(g)} + 2CF_{4}$ **-2486.3 kJ**

13.

	Reaction	ΔH
①	$N_{2(g)} + O_{2(g)} \rightarrow 2NO_{(g)}$	$\Delta H = 180.7\ kJ$
② ↔ ÷2	$NO_{2(g)} \longrightarrow NO_{(g)} + \frac{1}{2}O_{2(g)}$	$\Delta H = 56.55\ kJ$
③ ÷2	$N_2O_{(g)} \longrightarrow N_{2(g)} + \frac{1}{2}O_{2(g)}$	$\Delta H = -81.15\ kJ$

$$NO_{2(g)} + N_2O_{(g)} \rightarrow 3NO_{(g)}$$

$\Delta H = 156.1\ kJ$

14.

	Reaction	ΔH (kJ)
①	$C_2H_{4(g)} + 3O_{2(g)} \rightarrow 2CO_{2(g)} + 2H_2O_{(l)}$	-1411
② ↔	$2CO_{2(g)} + 3H_2O_{(l)} \rightarrow C_2H_{6(g)} + 3\frac{1}{2}O_{2(g)}$	1560
③	$H_{2(g)} + \frac{1}{2}O_{2(g)} \rightarrow H_2O_{(l)}$	$-285.8\ kJ$

$$C_2H_{4(g)} + H_{2(g)} \rightarrow C_2H_{6(g)}$$

$\Delta H = -136.8\ kJ$

15.

① × 2 $$2N_{2(g)} + 2O_{2(g)} \longrightarrow 4NO_{(g)} \qquad \Delta H = -361\ kJ$$

② ↔ × 2 $$4NH_{3(g)} \longrightarrow 2N_{2(g)} + 6H_{2(g)} \qquad \Delta H = 183.6\ kJ$$

③ × 3 $$6H_{2(g)} + 3O_{2(g)} \longrightarrow 6H_2O_{(g)} \qquad \Delta H = -1450.8\ kJ$$

$$4NH_{3(g)} + 5O_{2(g)} \longrightarrow 4NO_{(g)} + 6H_2O_{(g)} \qquad -1628.2\ kJ$$

16.

① ↔ $$2CO_{2(g)} + 2H_2O_{(l)} \longrightarrow C_2H_5OH_{(l)} + 2O_{2(g)} \qquad \Delta H = 875\ kJ$$

② × 2 $$2C_{(s)} + 2O_{2(g)} \longrightarrow 2CO_{2(g)} \qquad \Delta H = -789.02\ kJ$$

③ × 2 $$2H_{2(g)} + O_{2(g)} \longrightarrow 2H_2O_{(l)} \qquad \Delta H = -571.6\ kJ$$

$$-485.62\ kJ$$

$$2H_{2(g)} + 2C_{(s)} + O_{2(g)} \longrightarrow C_2H_5OH_{(l)}$$

17.

①	$2Al_{(s)} + 6HCl_{(aq)} \rightarrow 2AlCl_{3(aq)} + 3H_{2(g)}$	$\Delta H = -1049\ kJ$
② ×6	$6HCl_{(g)} \rightarrow 6HCl_{(aq)}$	$\Delta H = -448.8\ kJ$
③ ×3	$3H_{2(g)} + 3Cl_{2(g)} \rightarrow 6HCl_{(g)}$	$\Delta H = -5535\ kJ$
④ ⇆ ×2	$2AlCl_{3(aq)} \rightarrow 2AlCl_{3(s)}$	$\Delta H = 646.\ kJ$
	$2Al_{(s)} + 3Cl_{2(g)} \rightarrow 2AlCl_{3(s)}$	$\Delta H = -6386.8\ kJ$

18. 100°C | vaporize water

$$\Delta H = nH$$

$$\frac{300\ kJ}{40.7\ kJ/mol} = \frac{n \times 40.7\ \frac{kJ}{mol}}{40.7\ kJ/mol}$$

$$7.36\ mol = n$$

7.36 mol H_2O to grams

$$7.36\ moles \times \frac{18.02\ g}{1\ mol} = 132.8\ g$$

19. $Al_2(SO_4)_{3\,(aq)} + 3H_{2(g)} \rightarrow 2Al_{(s)} + 3H_2SO_{4(aq)}$

$\Delta H = 2650 kJ$

$125g\ H_2SO_4 \times \frac{1mol\ H_2SO_4}{98.08g\ H_2SO_4} \times \frac{2650 kJ}{3mol\ H_2SO_4}$

$= 1125.78 J$

---

20. $C_5H_{12} + 8O_2 \rightarrow 5CO_2 + 6H_2O$

173.5kJ 0.0 -393.5 -285.8

$\Delta H = \sum \Delta H_{prod} - \sum \Delta H_{reactants}$

$= [5(-393.5) + 6(-285.8)] - [-173.5kJ + 8(0)]$

-3508.8 kJ

---

21. $CaCO_3 \rightarrow CO_2 + CaO$

-1207kJ -394 -635

$\Delta H = [-394 + (-635)] - [-1207]$

$= 178 kJ$

22. $CH_4 + 2Cl_2 \rightarrow CCl_4 + 2H_2$

-75 kJ/mol 0 135 kJ/mol 0

$\Delta H = (135) - (-75)$

$= 210\text{ kJ}$

23. $2KCl + 3O_2 \longrightarrow 2KClO_3$

-436 -391

$\Delta H = [2(-391)] - [2(-436)]$

$= 90\text{ kJ}$

The heat of formation of calcium hydroxide is -986.1 kJ/mol → amt of energy req'd to form a compound from its component elements

$Ca + O_2 + H_2 \rightarrow Ca(OH)_2$

Given: The Heat of combustion for the following:

① Combustion of Benzene

$2C_6H_{6(l)} + 15O_{2(g)} \rightarrow 12CO_{2(g)} + 6H_2O_{(g)}$

$(+49) \quad (0.0) \quad (-393.5) \quad (-241.8)$

$\Delta H = \sum H_{prod} - \sum H_{react}$

$(12(-393.5) + 6(-241.8)) - (2(49)) =$

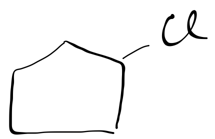
$Ca + 2H_2O_{(l)} \rightarrow Ca(OH)_2 + H_2$

$\Delta H_{rxn} = \left(\sum H_{prod}\right) - \left(\sum H_{react}\right)$ (0, −285.8, −986.1, 0)

$[1(-986.1) + 0] - [1(0) + 2(-285.8)]$

$-986.1 - (-571.6) =$

1-chloro cyclopentane



CHAPTER 18

1. (a) Left
(b) Left
(c) Left
(d) Right
(e) No change in equil
(f) $K = \frac{[M][N]^4}{[J]^6[K]^2}$

2. (a) Left
(b) Left
(c) Left
(d) Right
(e) No Change in equil
(f) $K = \frac{[NO]^4[H_2O]^6}{[NH_3]^4[O_2]^5}$
(g) $K = \frac{[0.14]^4[0.09]^6}{[0.11]^4[0.2]^5}$
$= 0.004$ ∴ favors reactants
$K<1$

3. (a) Right

(b) Right

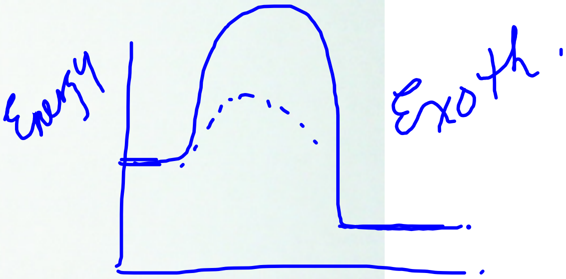
(c) Lowers activation energy

(d) Left (Common Ion Ba^{2+})

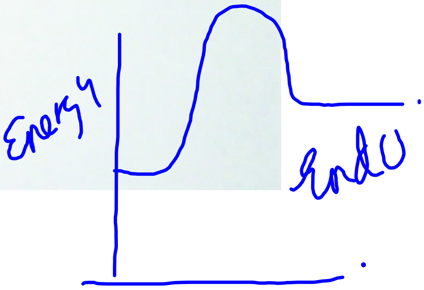
(e) No change in equil

(f) $K = \frac{[Ba^{2+}]^3[PO_4^{3-}]^2}{[Ba_3(PO_4)_2]}$

(g) $K_{sp} = [Ba^{2+}]^3[PO_4^{3-}]^2$



4. $Cd_3(PO_4)_2$ because it has the higher Ksp



5. $Co_3(AsO_4)_2 \rightleftharpoons \underset{3x}{3Co^{2+}} + \underset{2x}{2AsO_4^{3-}}$

$K_{sp} = [Co^{2+}]^3[AsO_4^{3-}]^2$

$6.8 \times 10^{-29} = (3x)^3(2x)^2$

$6.8 \times 10^{-29} = 27x^3 \cdot 4x^2$

$6.8 \times 10^{-29} = 108x^5$

$6.296 \times 10^{-31} = x^5$

$9.12 \times 10^{-7} = x$

$\therefore [Co^{2+}] = 3x$

$= 3(9.12 \times 10^{-7})$

$= 2.736 \times 10^{-6} M$

$[AsO_4^{3-}] = 2x$

$= 1.824 \times 10^{-6} M$

6. What is the concentration of lithium ion and phosphate ions in a saturated solution of Li_3PO_4 at 25°C. (Ksp lithium phosphate = 2.37×10^{-4})

6. $Li_3PO_4 \rightleftharpoons 3Li^+ + PO_4^{3-}$

$3x \qquad x$

$K_{sp} = [Li^+]^3[PO_4^{3-}]$

$2.37 \times 10^{-4} = (3x)^3(x)$

$2.37 \times 10^{-4} = 27x^4$

$8.78 \times 10^{-6} = x^4$ → $(8.78 \times 10^{-6})^{1/4}$

$5.44 \times 10^{-2} = x$

$[Li^+] = 3x = 0.1632\,M$

$[PO_4^{3-}] = x = 5.44 \times 10^{-2}\,M$

7. What is the equilibrium concentration of carbonate ions in a 1.0L solution of nickel(II) carbonate $NiCO_3$, to which 0.43 mol of nickel(II) sulfate is added.
Ksp $NiCO_3$ = 1.42×10^{-7}

7. $NiCO_3 \rightleftharpoons Ni^{2+} + CO_3^{2-}$

~~x~~ 0.43mol $\qquad x$

$K_{sp} = [Ni^{2+}][CO_3^{2-}]$

$1.42 \times 10^{-7} = (0.43)\,x$

$3.33 \times 10^{-7} = x$

$CO_3^{2-} = 3.33 \times 10^{-7}\,M$

8. Given the equilibrium equation: 3A + 2B $\rightleftharpoons$ 5C . When 3.5 moles of A and 5.5 moles of B are added to a 6.0 L container, an equilibrium established in which 1.8 moles of C are found. Find the equilibrium concentrations of A, B and C and Keq

8. $3A + 2B \rightleftharpoons 5C$

	3A	2B	5C
I:	$\frac{3.5 mol}{6 L}$ = 0.583M	$\frac{5.5 mol}{6 L}$ = 0.917M	0
C	0.583-3x	0.917-2x	0+5x
E	0.583-3(0.06) = 0.403M [A]	0.917-2(0.06) = 0.797M [B]	[C] = 0.3M

$5x = \frac{1.8 mol}{6L}$

$5x = 0.3M$

$x = 0.06$

[C] = 0.3M ; $\frac{1.8mol}{6L}$

$$K_{eq} = \frac{[C]^5}{[A]^3[B]^2} = \frac{(0.3)^5}{(0.403)^3(0.797)^2} = \boxed{0.058}$$

9. Given the equilibrium: Cu(s) + $4HNO_3$(aq) $\rightleftharpoons$ $Cu(NO_3)_2$ (aq) + $2NO_2$(g) + $2H_2O$ (g) . If 2.2 moles of Cu and 3.6 moles HNO_3 are added to a 2.5 L container, an equilibrium is established in which the $[NO_2]$ = 0.44M.

a) Calculate the equilibrium $[NO_2]$, $[Cu(NO_3)_2]$ and $[H_2O]$ b) Calculate the value of Keq

9.

$Cu_{(s)} + 4HNO_{3(s)} \rightleftharpoons Cu(NO_3)_2 + 2NO_2 + 2H_2O$

	Cu	HNO_3	$Cu(NO_3)_2$	NO_2	H_2O
I	$\frac{2.2 mol}{2.5 L}$ = 0.88M	$\frac{3.6 mol}{2.5 L}$ = 1.44M	0	0	0
C	0.88-x	1.44-4x	0+x	0+2x	0+2y
E	0.66M	0.56M	0.22M	0.44M	0.44

$2x = 0.44$

$x = 0.22$

$$K_{eq} = \frac{[Cu(NO_3)_2][NO_2]^2[H_2O]^2}{[Cu][HNO_3]^4} = \frac{(0.22)(0.44)^2(0.44)^2}{(0.66)(0.56)^4} = 0.127$$

10. What is the equilibrium concentration of Nickel ions in a 1.0L solution of nickel(ll) sulfide to which 0.0035 mol of zinc sulfide , ZnS, has been added .
Ksp NiS = 4.0 x 10^{-20}

$NiS \rightleftharpoons Ni^{2+} + S^{2-}$

Ni^{2+}: x; S^{2-}: ~~x~~ 0.0035

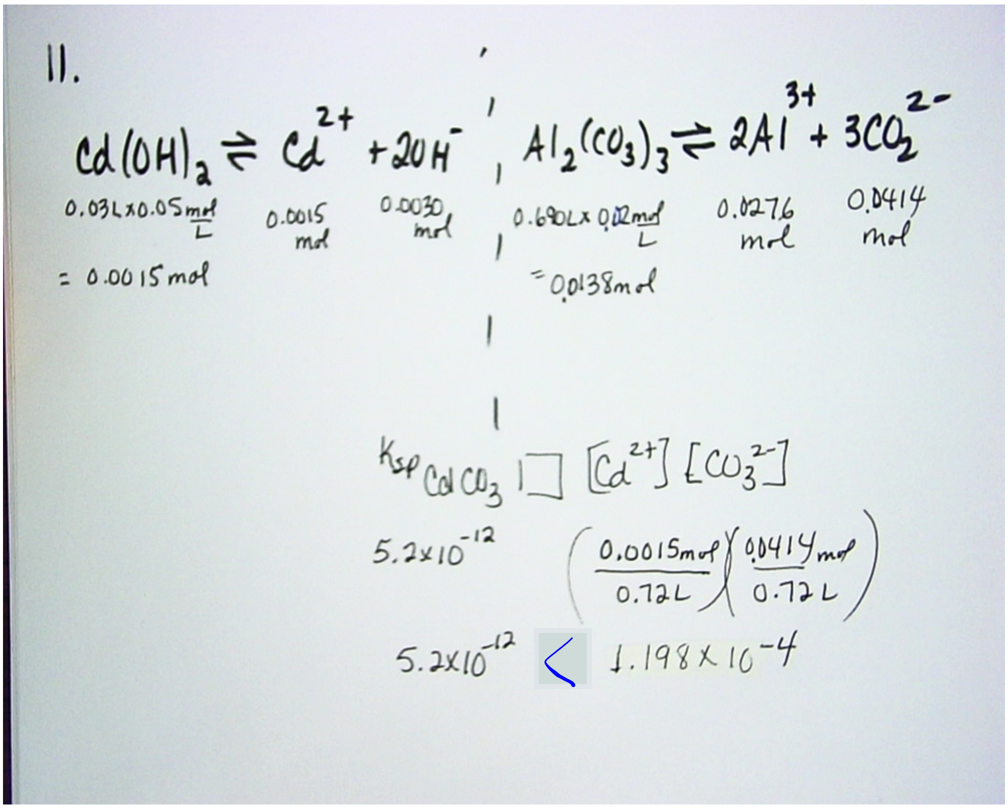
$K_{sp} = [Ni^{2+}][S^{2-}]$

$4.0 \times 10^{-20} = (x)(0.0035)$

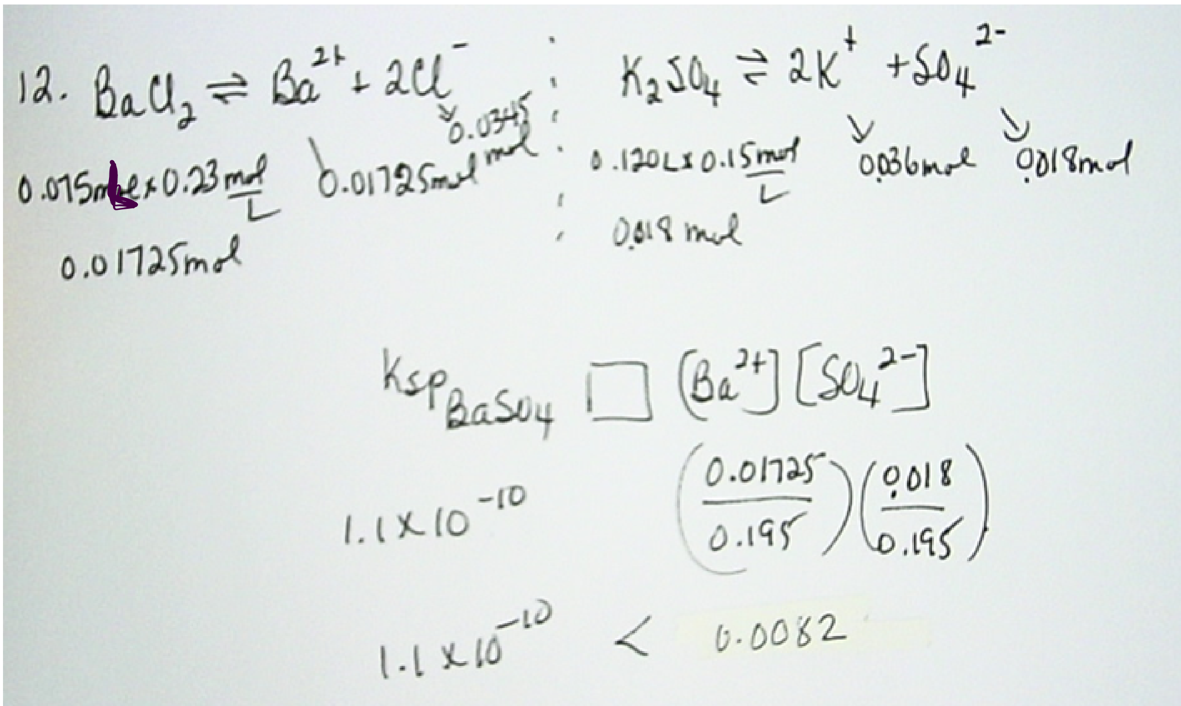
$1.143 \times 10^{-17} = x$

$Ni^{2+} = 1.143 \times 10^{-17} M$

11. Will a precipitate of cadmium carbonate form if 350ml of 0.05 M cadmium hydroxide , $Cd(OH)_2$, is mixed with 690ml of 0.02M aluminum carbonate, $Al_2(CO_3)_3$?
(Ksp $CdCO_3$ = 5.2x 10^{-12})



12. Will a precipitate of barium sulfate form if 75ml of 0.23 M barium chloride, $BaCl_2$, is mixed with 120ml of 0.15M potassium sulfate, K_2SO_4 ? (Ksp $BaSO_4$ = 1.1×10^{-10})



13. Given the reaction: $H_2O_{(l)} \rightarrow H_2O_{(g)}$ will the entropy increase or decrease in this reaction?

$H_2O_{(l)} \rightarrow H_2O_{(g)}$

gets more disorderly

∴ Entropy increases

14. Given the following reactions , state the rate law:

$2K + 3B + C \rightarrow 10D + E$

rate law: rate $= k[K]^2[B]^3[C]$

6th order

15 A combination reaction gave the following data: A + B -> C

Trial #	[A]	[B]	Rate mol/L s
1	0.25	0.70	0.03
2	0.25	3.5	18.75
3	0.75	0.70	0.27

const ×5 ×625 $[5^4]$ 3× 9× (3^2)

Determine the order for each reactant and the overall order for the reaction

Write the rate law.

rate law $= [A]^2[B]^4$

6th order overall

16. $2SO_2 + O_2 \xrightarrow{\text{Catalyst}} 2SO_3$

a) ↗

b) $K = \frac{[SO_3]^2}{[SO_2]^2[O_2]}$

(c) $K = \frac{(0.075)^2}{[0.025]^2(0.012)}$

$= 750$ ∴ favors products

17 If. $SO_{2(g)} + O_{2(g)} \rightleftharpoons 2SO_{3(g)}$ at 25°C

has $K = 2.9 \times 10^{-5}$

then very little SO_3 forms since

$K < 1$ (less than 50% reacts

18.

$$K = \frac{(PCl_3)^4}{(P_4)(Cl_2)^6}$$

$$= \frac{(0.23)^4}{(0.34)(0.21)^6}$$

$$= 95.95$$

favors products

19. (a) Addition of a catalyst increases the rate of a reaction by lowering the activation energy

b) Position of equilibrium is not affected by a catalyst.

20

Table 18.2

Solubility Product Constants (K_{sp}) at 25°C

Salt	K_{sp}	Salt	K_{sp}	Salt	K_{sp}
Halides		**Sulfates**		**Hydroxides**	
AgCl	1.8×10^{-10}	$PbSO_4$	6.3×10^{-7}	$Al(OH)_3$	3.0×10^{-34}
AgBr	5.0×10^{-13}	$BaSO_4$	1.1×10^{-10}	$Zn(OH)_2$	3.0×10^{-16}
AgI	8.3×10^{-17}	$CaSO_4$	2.4×10^{-5}	$Ca(OH)_2$	6.5×10^{-6}
$PbCl_2$	1.7×10^{-5}	**Sulfides**		$Mg(OH)_2$	7.1×10^{-12}
$PbBr_2$	2.1×10^{-6}	NiS	4.0×10^{-20}	$Fe(OH)_2$	7.9×10^{-16}
PbI_2	7.9×10^{-9}	CuS	8.0×10^{-37}	**Carbonates**	
PbF_2	3.6×10^{-8}	Ag_2S	8.0×10^{-51}	$CaCO_3$	4.5×10^{-9}
CaF_2	3.9×10^{-11}	ZnS	3.0×10^{-23}	$SrCO_3$	9.3×10^{-10}
Chromates		FeS	8.0×10^{-19}	$ZnCO_3$	1.0×10^{-10}
$PbCrO_4$	1.8×10^{-14}	CdS	1.0×10^{-27}	Ag_2CO_3	8.1×10^{-12}
Ag_2CrO_4	1.2×10^{-12}	PbS	3.0×10^{-28}	$BaCO_3$	5.0×10^{-9}

9.3×10^{-10}

$CaSO_4$, 9.3×10^{-10} $SrCO_3$, 1.1×10^{-10} $BaSO_4$, CaF_2, CuS

21. Inc

22. Entropy i Enthalpy.

Chapter 19

1. (a) $[OH^-] = 1.59 \times 10^{-10}$ mol/L

$[H^+] = 6.3 \times 10^{-5}$

$pH = -\log(H^+) = 4.2$ $pOH = 9.8$ $[OH^-] = 10^{-pOH} = 10^{-9.8}$

(b) $pOH = 10.3$
$pH = 3.7$
$[H^+] = 10^{-3.7}$
$= 1.995 \times 10^{-4}$ mol/L

2. (a) $pOH = 9.9$

(b) $[H^+] = 10^{-pH}$
$= 10^{-4.1}$
$= 7.94 \times 10^{-5}$ mol/L

(c) $[OH^-] = 10^{-pOH}$
$= 10^{-9.9}$
$= 1.26 \times 10^{-10}$ mol/L

3. (a) ① < 3.2 to 4.4
② 10.6 to 11.4
③ 8.0 to 8.2
④ 5.4 to 6.0

ACID to BASIC
①, ④, ③ ②

3. Four separate unknown solutions were tested with indicators.

Solution	Evidence	
1	Methyl orange was orange	3.2 – 4.4
2	Both thymolphthalein and indigo carmine were blue.	10.6 – 11.4
3	Litmus was blue and phenolphthalein was colorless.	8.0 to 8.2
4	Bromocresol green was blue and bromothymol blue was yellow.	5.4 to 6.0

Arrange the solutions in order from most acidic to most basic

1 4 3 2

4. Amphiprotic substance - can behave as an acid or a base .... HPO_4^{2-}, H_2O, HCO_3^-, $H_2PO_4^-$

5. (a) $HS^-_{(aq)} + HBO_3^{2-}{}_{(aq)} \rightleftharpoons S^{2-}{}_{(aq)} + H_2BO_3^-{}_{(aq)}$

ACID BASE Conj. Base Conj. Acid

(Lost H) (G H^+)

(b) HS^-/S^{2-} ACID BASE $HBO_3^{2-}/H_2BO_3^-$ BASE ACID

6. >7.6 $\approx pH = 8.1$

<8.2 $[H^+] = 10^{-8.1}$

>8.0 $= 7.94 \times 10^{-9}$ mol/L

7. (a) Base.
(b) EQUIVALENCE pt : ~25mL
ENDPOINT : ~ 6.
(c) chlorphenol red,

8. unknown acid: $HA \rightleftharpoons H^+ + A^-$

ionization of acid HA

$pH = 2.64$

$[H^+] = 10^{-2.64}$

$= 0.00229 \text{ mol/L}$

HA: 0.34 mol/L; H^+: 0.00229; A^-: 0.00229

$$K_a = \frac{[H^+][A^-]}{[HA]}$$

$$K_a = \frac{(0.00229)(0.00229)}{0.34}$$

$$K_a = 1.54 \times 10^{-5}$$

9. $H_2CO_3 \rightleftharpoons H^+ + HCO_3^-$

10. Given the Ka of HNO_2 is $7.2x10^{-4}$ determine the pH of a 0.045M solution of HNO_2

$HNO_2 \rightleftharpoons H^+ + NO_2^-$

0.045 x x

$7.2 \times 10^{-4} = \frac{x \cdot x}{0.045}$

$\sqrt{3.24 \times 10^{-5}} = x$

$5.69 \times 10^{-3} = x$

$pH = -\log(5.69 \times 10^{-3})$

$= 2.24$

11. Strong acid $HClO_4 \rightarrow H^+ + ClO_4^-$

0.22 0.22 0.22

$pH = -\log [H^+]$

$= -\log 0.22$

$pH = 0.66$

12. $HF \rightarrow H^+ + F^-$

~~0.15 mol/L~~ 0.15 mol/L Strong acid

$pH = -\log[H^+]$

$= -\log 0.15$

$pH = 0.82$

13. EXTRA : $120g\ CH_3COOH \times \frac{1 mol}{60.06 g} = 1.998 mol\ CH_3COOH$

$[CH_3COOH] = \frac{1.998 mol}{0.75 L}$

$= 2.664 mol/L$

$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$

2.664 mol/L x x

$Ka = \frac{x \cdot x}{2.664}$

$1.8 \times 10^{-5} = \frac{x^2}{2.664}$

$0.00692 = x$

$[H^+] = 0.00692$

$pH = -\log[H^+]$

$= 2.16$

EXTRA

13. A 750mL solution is prepared by adding 120g of acetic acid acid. What is the pH of the solution? (note ; the ka of acetic acid is $1.8x10^{-5}$

$CH_3COOH \rightleftharpoons CH_3COO^- + H^+$

$x \quad x$

$120g \times \frac{1mol}{52.04g} \times \frac{}{0.75L}$

$\downarrow$

$\frac{mol}{L}$ $= 3.07 \frac{mol}{L}$

$Ka = \frac{x \cdot x}{3.07}$

$1.8 \times 10^{-5} = \frac{x^2}{3.07}$

$5.526 \times 10^{-5} = x^2$

$0.007 = x$

$[H^+] = 0.007M$

$pH = -\log[H^+]$

$= 2.2$

14. What is the mass of $Al(OH)_{3(s)}$ required to prepare 600 mL of solution that has a pH of 12.2

15. A titration of 10.00 ml of barium hydroxide, $Ba(OH)_2$, required 38.57 ml of 0.250 mol/ L hydrobromic acid HBr in a neutralization reaction. Calculate the concentration of the barium hydroxide.

$$Ba(OH)_2 + 2HBr \rightarrow BaBr_2 + 2H_2O$$

0.01 L ? mol/L — 0.03857 L 0.25 mol/L

$$0.03857\,L\,HBr \times \frac{0.25\,mol\,HBr}{L\,HBr} \times \frac{1\,mol\,Ba(OH)_2}{2\,mol\,HBr} \times \frac{}{0.01\,L\,Ba(OH)_2}$$

$$= 0.48\,\frac{mol}{L}\,Ba(OH)_2$$

EXTRA

14. $Al(OH)_3 \rightarrow Al^{3+} + 3OH^-$ $pOH = 1.8$

.00527 mol/L 0.00527 mol/L 0.0158 mol/L $[OH^-] = 0.0158$ mol/L

$[Al(OH)_3] = 0.00527$ mol/L

$\frac{0.00527 \text{ mol}}{L} \times 0.60 \text{ L} = 0.003162 \text{ mol } Al(OH)_3$

[illegible] $Al(OH)_3 = 0.003162$ mol

$0.003162 \text{ mol} \times \frac{78.01 \text{ g } Al(OH)_3}{1 \text{ mol}} = \boxed{0.247 \text{ g}}$

15. $Ba(OH)_2 + 2HBr \rightarrow BaBr_2 + 2H_2O$

$Ba(OH)_2$: 0.01L

HBr: 0.03875 L, 0.25mol/L

$$0.03875L\ HBr \times \frac{0.25mol\ HBr}{L\ HBr} \times \frac{1mol\ Ba(OH)_2}{2mol\ HBr} \times \frac{}{0.01L\ HBr}$$

$= 0.484375 mol/L$

16. $2Al(OH)_3 + 3H_2CO_3 \rightleftharpoons Al_2(CO_3)_3 + 6H_2O$

$Al(OH)_3$: 0.09L

H_2CO_3: 0.125L, 0.250mol/L HBr

$$0.125L\ H_2CO_3 \times \frac{0.250\ mol\ H_2CO_3}{L\ H_2CO_3} \times \frac{2mol\ Al(OH)_3}{3mol\ H_2CO_3} \times \frac{}{0.09L\ Al(OH)_3}$$

$= 0.23 mol/L\ Al(OH)_3$