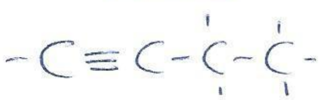
EXAM REVIEW

ORGANIC CHEMISTRY

1a) C_4H_6



1-butyne

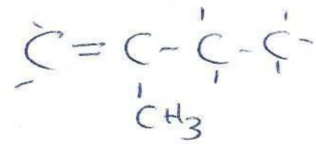
2-butyne

1,2-butadiene

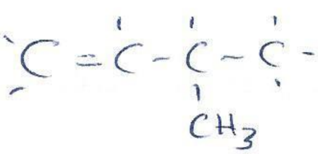
b) C_5H_{10}

1-pentene

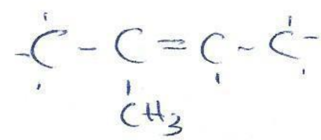
2-pentene



2-methyl-1-butene



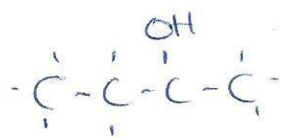
3-methyl-1-butene



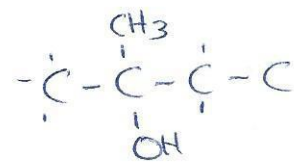
methyl-1-butene

c) $C_4H_{10}O$

1-butanol



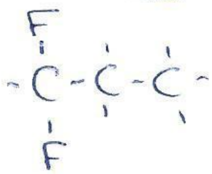
2-butanol



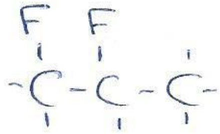
methyl-1-propanol

diethyl ether

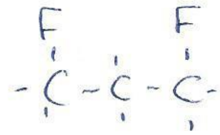
d) $C_3H_6F_2$



1,1-difluoropropane

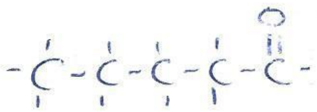


1,2-difluoropropane

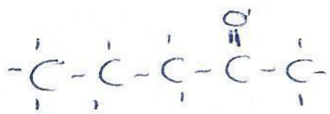


1,3-difluoropropane

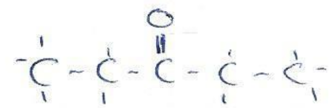
e) $C_5H_1\ O$



pentanal



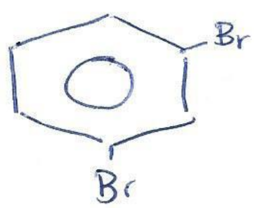
2-pentanone



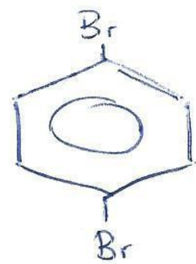
3-pentanone

f) $C_6H_4Br_2$

1,2-dibromobenzene

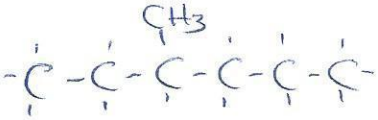


1,3-dibromobenzene



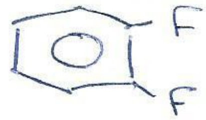
1,4-dibromobenzene

2. a) 3-methylhexane

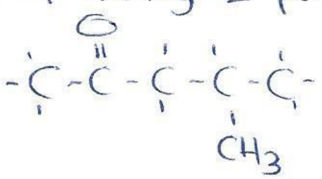


b) 1,3-pentadiene

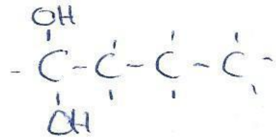
c) ortho-difluorobenzene



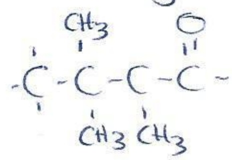
d) 4-methyl-2-pentanone



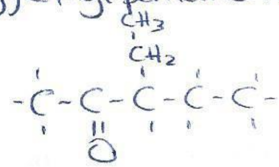
e) 1,1-butanediol



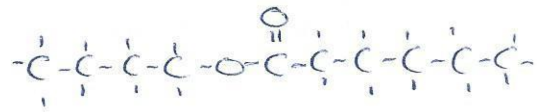
f) trimethylbutanal



g) ethyl pentanone

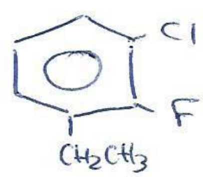


h) butyl hexanoate

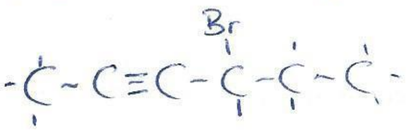


i) 1,3-dimethylcyclopentane

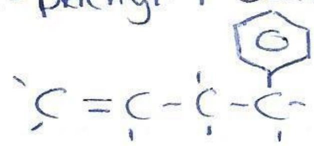
j) 1-chloro-3-ethyl-2-fluorobenzene



k) 4-bromo-2-hexyne

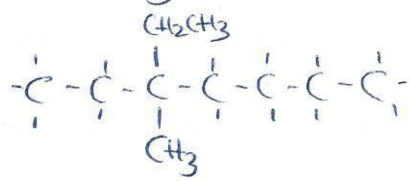


l) 4-phenyl-1-butene



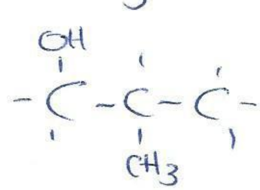
m) dibutyl ether

n) 3-ethyl-3-methylheptane

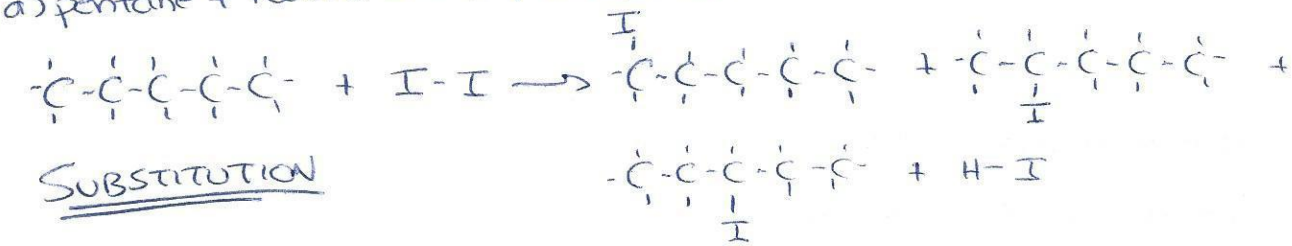


o) cyclohexene

p) methyl-1-propanol

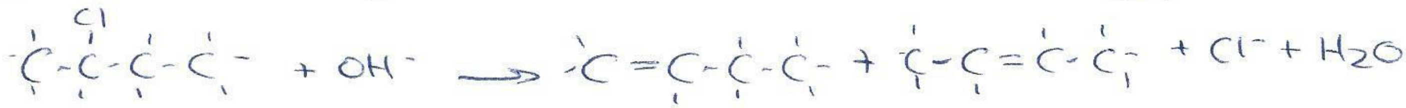


3. a) pentane + iodine ⟶ 1-iodopentane + 2-iodopentane + 3-iodopentane + hydrogen iodide



<u>SUBSTITUTION</u>

b) 2-chlorobutane + hydroxide ions ⟶ 1-butene + 2-butene + chloride ions + water



<u>ELIMINATION</u>

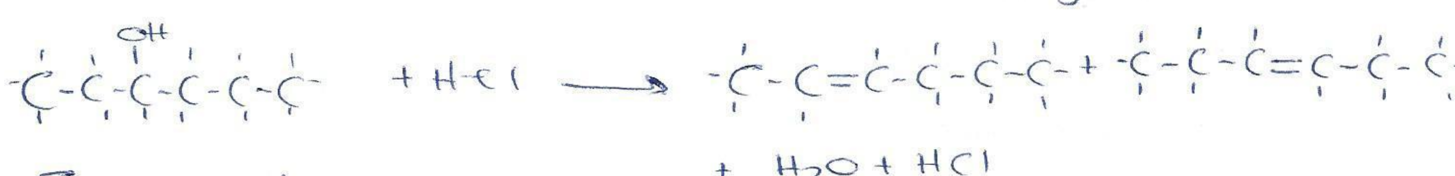
c) ethene + hydrogen ⟶ ethane

<u>ADDITION</u>

d) benzene + chlorine ⟶ chlorobenzene + hydrogen chloride

<u>SUBSTITUTION</u>

e) 3-hexanol + hydrochloric acid ⟶ 2-hexene + 3-hexene + water + hydrochloric acid



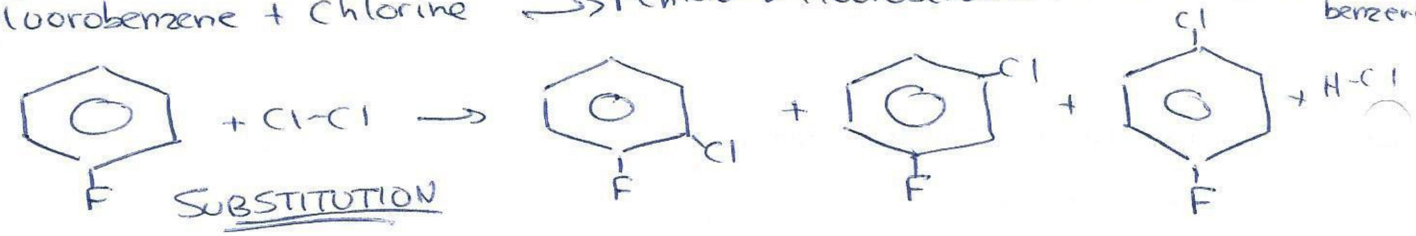
<u>ELIMINATION</u>

f) 2-butene + hydrogen fluoride ⟶ 2-fluorobutane

<u>ADDITION</u>

+ 1-chloro-4-fluorobenzene + hydrogen fluoride

g) fluorobenzene + chlorine → 1-chloro-2-fluorobenzene + 1-chloro-3-fluoro benzene

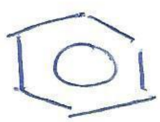


SUBSTITUTION

h) cyclopentene + iodine → 1,2-diiodocyclopentane

ADDITION

*4.



C_6H_6

All bond lengths and strengths are equal. Empirical evidence shows no reactivity - pi electrons are shared amongst all carbons.

One pi bond suggests a reactive molecule.

C_6H_{10}

*5. a) 2,4-dimethylhexane

b) 1,2,5-hexatriene

c) 1-bromo 4-chloro-1-methylcyclohexane

d) 6-phenyl-2,4-heptadiene

e) ethylpropyl ether

f) butyl ethanoate

g) 4-methyl-1-pentanol

h) 1-methyl-4-propylbenzene

i) propanal

j) hexanoic acid

k) 1,1,4,4-tetrafluorobutane

l) diphenyl ether

m) 3-ethyl-2-methyl heptane

n) 1,2-cyclobutanediol

Energy Changes

6. $q = ?$

$m = 27.0 g$

$T_i = -31.0°C$

$T_f = -14.0°C$

$q = mC\Delta T$

$q = (27.0 g)(2.01 \frac{J}{g°C})(17.0°C)$

$q = 923 J$

7. $q = 1.60 kJ$

$m = 25.0 g$

$C = 0.129 \frac{J}{g°C}$

$\Delta T = ?$

$q = mC\Delta T$

$1600 J = (25.0 g)(0.129 \frac{J}{g°C})(\Delta T)$

$\Delta T = \frac{1600 J}{(25.0 g)(0.129 \frac{J}{g°C})}$

$\Delta T = 496°C$

8. $\Delta H_{cond} = ?$

$m = 75.0 g$

NaCl

$\Delta H_{cond} = nH_{cond}$

$\Delta H_{cond} = \left(\frac{75.0 g}{58.44 g/mol}\right)\left(-171 \frac{kJ}{mol}\right)$

$\Delta H_{cond} = -219 kJ$

9. $\Delta H_{fus} = 7.90 kJ$

$m = ?$

Cl_2

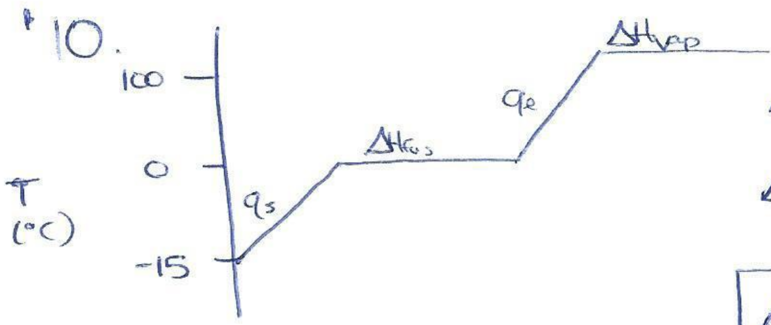
$\Delta H_{fus} = nH_{fus}$

$7.90 kJ = \left(\frac{m}{70.90 g/mol}\right)\left(6.40 \frac{kJ}{mol}\right)$

$m = \frac{(7.90 kJ)(70.90 g/mol)}{(6.40 kJ/mol)}$

$m = 87.5 g$

#10.



$$\Delta E_T = q_s + \Delta H_{fus} + q_l + \Delta H_{vap}$$

$$\Delta E_T = (0.9045\ kJ) + (10.039\ kJ) + (12.570\ kJ) + (67.925\ kJ)$$

$$\boxed{\Delta E_T = 91.4\ kJ}$$

$$q_s = mC\Delta T$$

$$q_s = (30.0g)(2.01 \tfrac{J}{g \cdot °C})(15.0°C)$$

$$q_s = 904.5\ J$$

$$\Delta H_{fus} = nH_{fus}$$

$$\Delta H_{fus} = \left(\frac{30.0g}{18.02 g/mol}\right)\left(6.03 \frac{kJ}{mol}\right)$$

$$\Delta H_{fus} = 10.039\ kJ$$

$$q_l = mC\Delta T$$

$$q_l = (30.0g)(4.19 \tfrac{J}{g \cdot °C})(100°C)$$

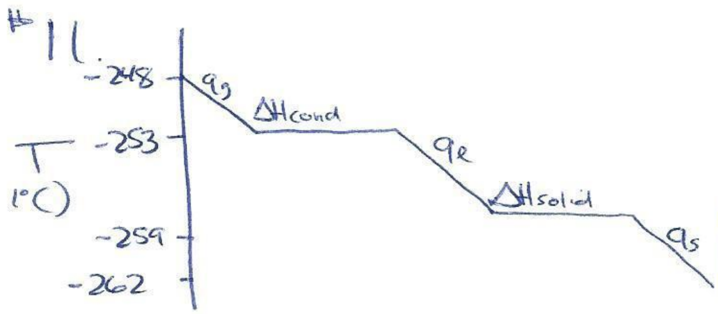
$$q_l = 12570\ J$$

$$\Delta H_{vap} = nH_{vap}$$

$$\Delta H_{vap} = \left(\frac{30.0g}{18.02 g/mol}\right)\left(40.8 \frac{kJ}{mol}\right)$$

$$\Delta H_{vap} = 67.925\ kJ$$

#11.



$$\Delta E_T = q_g + \Delta H_{cond} + q_l + \Delta H_{solid} + q_s$$

$$\Delta E_T = (-0.285\ kJ) + (-1.796\ kJ) + (-0.342\ kJ) + (-0.232\ kJ) + (-0.171\ kJ)$$

$$\boxed{\Delta E_T = -2.83\ kJ}$$

$$q_g = mC\Delta T$$

$$q_g = (4.00g)(14.267 \tfrac{J}{g \cdot °C})(-5.0°C)$$

$$q_g = 285.34\ J$$

$$\Delta H_{cond} = nH_{cond}$$

$$\Delta H_{cond} = \left(\frac{4.00g}{2.02 g/mol}\right)\left(-0.907 \frac{kJ}{mol}\right)$$

$$\Delta H_{cond} = -1.796\ kJ$$

$$q_l = mC\Delta T$$

$$q_l = (4.00g)(14.267 \tfrac{J}{g \cdot °C})(-6.0°C)$$

$$q_l = -342.408\ J$$

$$\Delta H_{solid} = nH_{solid}$$

$$\Delta H_{solid} = \left(\frac{4.00g}{2.02 g/mol}\right)\left(-0.117 \frac{kJ}{mol}\right)$$

$$\Delta H_{solid} = -0.232\ kJ$$

$$q_s = mC\Delta T \quad (-3.0°C)$$

$$q_s = (4.00g)(14.267 \tfrac{J}{g°C})$$

$$q_s = -171.204\ J$$

\# 12. Brass

$C = 0.368 \frac{J}{g\cdot°C}$

$m = ?$

$T_i = 109°C$

H_2O

$m = 47.4 g$

$T_i = 19.8°C$

$T_f = 24.2°C$

$q_{Brass} = -q_{H_2O}$

$mC\Delta T = -mC\Delta T$

$m(0.368 \frac{J}{g\cdot°C})(84.8°C) = -(47.4g)(4.19 \frac{J}{g\cdot°C})(4.4°C)$

$m = -\frac{(47.4g)(4.19 \frac{J}{g\cdot°C})(4.4°C)}{(0.368 \frac{J}{g\cdot°C})(-84.8°C)}$

$m = 28.0 g$

\# 13. KCl

$m = 92.5 g$

$H_s = ?$

H_2O

$V = 100.0 mL$

$\Delta T = 3.8°C$

$\Delta H_s = -q$

$nH_s = -VC\Delta T$

$\left(\frac{m}{74.55 g/mol}\right) H_s = -(0.100L)(4.19 \frac{kJ}{L\cdot°C})(3.8°C)$

$H_s = -\frac{(0.100L)(4.19 \frac{kJ}{L\cdot°C})(3.8°C)}{1.241 \text{ mol}}$

$H_s = -1.28 kJ/mol$

\# 14. Al

$m = 5.00 g$

$T_i = 97.0°C$

H_2O

$m = 195 g$

$T_i = 19.0°C$

$T_f = ?$

$m_{Al} = -m_{H_2O}$

$mC(T_f - T_i) = -mC(T_f - T_i)$

$(5.00g)(0.900 \frac{J}{g\cdot°C})(T_f - 97.0°C) = -(195g)(4.19 \frac{J}{g°C})(T_f - 19.0°C)$

$4.5(T_f - 97.0°C) = -817.05(T_f - 19.0°C)$

$4.5T_f - 436.5 = -817.05 T_f + 15523.95$

$817.05 T_f + 4.5 T_f = 15523.95 + 436.5$

$821.55 T_f = 15960.45$

$T_f = 19.4°C$

THERMOCHEMISTRY

15. $N_2H_{4(l)} + 3O_{2(g)} \longrightarrow 2NO_{2(g)} + 2H_2O_{(g)} + 400\ kJ$

a) $\Delta H_c = nH_c$

$H_c = \frac{\Delta H_c}{n} = \frac{-400\ kJ}{3\ mol} = \boxed{-133.33\ kJ/mol}$

b) $\Delta H_c = nH_c$

$H_c = \frac{\Delta H_c}{n} = -\frac{400\ kJ}{3\ mol} = \boxed{-133.33\ kJ/mol}$

16. Rev ① ÷ 2

④ $CO_{(g)} \longrightarrow C_{(s)} + \frac{1}{2}O_{2(g)}$ $\Delta H_r = 110.5\ kJ$

② $C_{(s)} + O_{2(g)} \longrightarrow CO_{2(g)}$ $\Delta H_r = -393.5\ kJ$

③ ÷ 2

⑤ $H_{2(g)} + \frac{1}{2}O_{2(g)} \longrightarrow H_2O_{(g)}$ $\Delta H_r = -241.8\ kJ$

② + ④ + ⑤

$CO_{(g)} + O_{2(g)} + H_{2(g)} \longrightarrow CO_{2(g)} + H_2O_{(g)}$ $\boxed{\Delta H_r = -524.8\ kJ}$

17. ① $2Al_{(s)} + 6HCl_{(aq)} \longrightarrow 2AlCl_{3(aq)} + 3H_{2(g)}$ $\Delta H_r = -1049\ kJ$

② × 6

⑤ $6HCl_{(g)} \longrightarrow 6HCl_{(aq)}$ $\Delta H_r = -448.8\ kJ$

③ × 3

⑥ $3H_{2(g)} + 3Cl_{2(g)} \longrightarrow 6HCl_{(g)}$ $\Delta H_r = -5535\ kJ$

Rev ④ × 2

⑦ $2AlCl_{3(aq)} \longrightarrow 2AlCl_{3(s)}$ $\Delta H_r = 646\ kJ$

① + ⑤ + ⑥ + ⑦

$2Al_{(s)} + 3Cl_{2(g)} \longrightarrow 2AlCl_{3(s)}$ $\boxed{\Delta H_r = -6386.8\ kJ}$

18. a) $(CH_3)_2CO_{(l)} + O_{2(g)} \longrightarrow CO_{2(g)} + H_{2(g)}$

$\Delta H_r = \Sigma nH_{fp} - \Sigma nH_{fr}$

$\Delta H_r = [(1\,mol)(-393.5\,\frac{kJ}{mol}) + (1\,mol)(0\,\frac{kJ}{mol})] - [(1\,mol)(-248.1\,\frac{kJ}{mol}) + (1\,mol)(0\,\frac{kJ}{mol})]$

$\Delta H_r = (-393.5\,kJ) - (-248.1\,kJ)$

$\boxed{\Delta H_r = -145.4\,kJ}$

19. $C_6H_{14(g)} + \frac{19}{2}O_{2(g)} \longrightarrow 6CO_{2(g)} + 7H_2O_{(g)}$

Step 1: H_r (general)

$\Delta H_r = \Sigma nH_{fp} - \Sigma nH_{fr}$

$\Delta H_r = [(6\,mol)(-393.5\,\frac{kJ}{mol}) + (7\,mol)(-241.8\,\frac{kJ}{mol})] - [(1\,mol)(-198.7\,\frac{kJ}{mol}) + (\frac{19}{2}\,mol)(0\,\frac{kJ}{mol})]$

$\Delta H_r = -3854.9\,kJ$

$H_r = \frac{\Delta H_r}{n} = \frac{-3854.9\,kJ}{1\,mol} = \underline{-3854.9\,kJ/mol}$

Step 2: n (specific)

$\Delta H_c = -q$

$nH_c = -vc\Delta T$

$n = \frac{-(1.75\,L)(4.19\,\frac{kJ}{L \cdot °C})(58.0\,°C)}{-3854.9\,kJ/mol}$

$n = 0.110\,mol$

Step 3: m (specific)

$0.110\,mol\,C_6H_{14} \times \frac{86.20\,g\,C_6H_{14}}{1\,mol\,C_6H_{14}} = \boxed{9.48\,g\,C_6H_{14}}$

20. $2C_4H_{10(l)} + 13O_{2(g)} \longrightarrow 8CO_{2(g)} + 10H_2O_{(g)} + 5754.8\ kJ$

Step 1: H_r (general)

$$H_r = \frac{\Delta H_r}{n} = \frac{-5754.8\ kJ}{2\ mol} = -2877.4\ kJ/mol$$

Step 2: n (specific)

$$50.0g\ C_6H_{14} \times \frac{1\ mol\ C_4H_{10}}{58.14g\ C_4H_{10}} = 0.85999\ mol$$

Step 3: ΔH

$$\Delta H_c = -q$$

$$nH_c = -vc\Delta T$$

$$(0.85999mol)(-2877.4\tfrac{kJ}{mol}) = -(7.50L)(4.19\tfrac{kJ}{L \cdot ^\circ C})\Delta T$$

$$\Delta T = \frac{(0.85999mol)(-2877.4\tfrac{kJ}{mol})}{-(7.50L)(4.19\tfrac{kJ}{L \cdot ^\circ C})}$$

$$\boxed{\Delta T = 78.7^\circ C}$$

Chemical Equilibrium

*21. A system has reached equilibrium when the reaction rates are equal. At this time, the concentration of all entities are constant.

*22. $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$

init. 12.10g 4.00g

eqm. 9.80g

If N_2 is L.R.:

$$12.10g\ N_2 \times \frac{1\ mol\ N_2}{28.02g\ N_2} \times \frac{2\ mol\ NH_3}{1\ mol\ N_2} \times \frac{17.04g\ NH_3}{1\ mol\ NH_3} = 14.72g\ NH_3$$

If H_2 is L.R.:

$$4.00g\ H_2 \times \frac{1\ mol\ H_2}{2.02g\ H_2} \times \frac{2\ mol\ NH_3}{3\ mol\ H_2} \times \frac{17.04g\ NH_3}{1\ mol\ NH_3} = 22.50g\ NH_3$$

∴ N_2 is L.R.

$$\%\ rxn = \frac{exp.}{theor.} \times 100\%$$

$$\%\ rxn = \frac{9.80g}{14.72g} \times 100\%$$

% rxn = 66.6%

$N_{2(g)} + 3H_{2(g)} \underset{}{\overset{66.6\%}{\rightleftharpoons}} 2NH_{3(g)}$

Products-favoured

23. $S_{8(s)} + 8O_{2(g)} \rightleftharpoons 8SO_{2(g)}$

init. 405g 215g

eqm. 180.g

If S_8 is L.R.:

$$405g\ S_8 \times \frac{1\ mol\ S_8}{256.48g\ S_8} \times \frac{8\ mol\ SO_2}{1\ mol\ S_8} \times \frac{64.06g\ SO_2}{1\ mol\ SO_2} = 809.24g\ SO_2$$

If O_2 is L.R.

$$215g\ O_2 \times \frac{1\ mol\ O_2}{32.00g\ O_2} \times \frac{8\ mol\ SO_2}{8\ mol\ O_2} \times \frac{64.06g\ SO_2}{1\ mol\ SO_2} = 430.40g\ SO_2$$

∴ O_2 is L.R.

$$\%rxn = \frac{exp.}{theor.} \times 100\%$$

$$\%rxn = \frac{180.g}{430.40g} \times 100\%$$

%rxn = 41.8%

$$S_{8(s)} + 8O_{2(g)} \overset{41.8\%}{\rightleftharpoons} 8SO_{2(g)}$$

Reactants favoured

24. $C_6H_6 + Cl_2 \rightleftharpoons C_6H_5Cl + HCl$

$$\%rxn = \frac{exp.}{theor.} \times 100\%$$

$$0.65 = \frac{100g}{theor}$$

theor. = 153.8g

$$153.8g\ C_6H_5Cl \times \frac{1\ mol\ C_6H_5Cl}{112.56g\ C_6H_5Cl} \times \frac{1\ mol\ C_6H_6}{1\ mol\ C_6H_5Cl} \times \frac{78.12g\ C_6H_6}{1\ mol\ C_6H_6}$$

= **107g C_6H_6**

25. $H_{2(g)} + I_{2(s)} \rightleftharpoons 2HI_{(g)}$ K = ?

1.15M 0.915M 1.15M

$$K = \frac{[HI_{(g)}]^2}{[H_{2(g)}][I_{2(s)}]}$$

$$K = \frac{[1.15]^2}{[1.15][0.915]}$$

K = 1.26. Products favoured

26. $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$ K = 2.7

1.87M ? 5.40M

$$K = \frac{[NH_{3(g)}]^2}{[N_{2(g)}][H_{2(g)}]^3}$$

$$2.7 = \frac{[5.40]^2}{[1.87][H_2]^3}$$

$$[H_2] = \sqrt[3]{\frac{(5.40)^2}{2.7[1.87]}}$$

$[H_{2(g)}] = 1.8\,M$

V = 2.50L

27. $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$

1.750mol 0.980mol 1.470mol

0.700M 0.392M 0.588M

$$K = \frac{[NH_3]^2}{[N_2][H_2]^3}$$

$$K = \frac{[0.588]^2}{[0.700][0.392]^3} = \boxed{8.20}$$

*28. Le Chatelier's Principle states when a system at equilibrium is subject to a stress, the system will act to relieve that stress and re-achieve equilibrium.

*29. $4HCl_{(g)} + O_{2(g)} \rightleftharpoons 2H_2O_{(g)} + 2Cl_{2(g)} + 113\ kJ$

a) decrease temp. shift right
b) decrease volume shift right
c) increase $[Cl_2]$ shift left
d) decrease $[HCl]$ shift left

*30. $8H_2S_{(g)} \rightleftharpoons 8H_{2(g)} + S_{8(g)}$

Shift left
Increase $[H_2]$/$[S_8]$
Decrease $[H_2S]$
Increase pressure
Decrease volume

31.

ACID-BASE	ACIDS	BASES
Arrhenius	Contain H^+	Contain OH^-
Bronsted-Lowry	H^+ donor	H^+ acceptor
Lewis	Electron acceptor	Electron donor

32.

a) $\underset{A}{HCOOH_{(aq)}} + \underset{B}{CN^-_{(aq)}} \rightleftharpoons \underset{B}{HCOO^-_{(aq)}} + \underset{A}{HCN_{(aq)}}$

b) $\underset{A}{H_2S_{(aq)}} + \underset{B}{NH_{3(aq)}} \rightleftharpoons \underset{B}{HS^-_{(aq)}} + \underset{A}{NH^+_{4(aq)}}$

c) $\underset{B}{F^-_{(aq)}} + \underset{A}{C_6H_5COOH_{(aq)}} \rightleftharpoons \underset{A}{HF_{(aq)}} + \underset{B}{C_6H_5COO^-_{(aq)}}$

33. $[H_3O^+_{(aq)}] = 1.39 \times 10^{-5}$ mol/L

$[OH^-_{(aq)}] = ?$

pH = ?

pOH = ?

$pH = -\log[H_3O^+_{(aq)}]$

$pH = -\log[1.39 \times 10^{-5}]$

$pH = 4.857$

$pOH + pH = 14.000$

$pOH = 14.000 - 4.857$

$pOH = 9.143$

$[OH^-_{(aq)}] = 10^{-pOH}$

$[OH^-_{(aq)}] = 10^{-9.143}$

$[OH^-_{(aq)}] = 7.19 \times 10^{-10}$ mol/L

34. $NaOH_{(aq)} \longrightarrow Na^+_{(aq)} + OH^-_{(aq)}$ STRONG BASE

25g

0.417 mol/L 0.417 mol/L

$25g\ NaOH \times \frac{1\ mol\ NaOH}{40.00g\ NaOH} = 0.625\ mol\ NaOH$

$C = \frac{n}{V} = \frac{0.625\ mol}{1.50L}$

$C = 0.417$ mol/L

$pOH = -\log[OH^-]$

$pOH = -\log[0.417]$

$pOH = 0.38$

$pH + pOH = 14.00$

$pH = 14.00 - 0.38$

$pH = 13.62$

35. $H_2SO_{4(aq)} \rightarrow 2H^+_{(aq)} + SO_4^{2-}{}_{(aq)}$ STRONG ACID

0.042 mol/L 0.084 mol/L

$[H^+] = [H_3O^+]$

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

$pH = -\log[0.084]$

$pH = 1.08$

36. $NH_{3(aq)} + H_2O_{(l)} \rightleftharpoons NH_4^+{}_{(aq)} + OH^-_{(aq)}$ WEAK BASE

0.850 M

$K_b = \frac{[NH_4^+{}_{(aq)}][OH^-_{(aq)}]}{[NH_{3(aq)}]}$, $[NH_4^+{}_{(aq)}] = [OH^-_{(aq)}]$

$K_b = \frac{[OH^-]^2}{[NH_{3(aq)}]}$

$K_aK_b = K_w$

$K_b = \frac{K_w}{K_a} = \frac{1.0\times10^{-14}}{5.8\times10^{-10}} = 1.7\times10^{-5}$

$[OH^-_{(aq)}] = \sqrt{(1.7\times10^{-5})[0.850]}$

$[OH^-_{(aq)}] = 0.00380\ M$

$pOH = -\log[OH^-]$

$pOH = -\log[0.00380]$

$pOH = 2.420$

$pH + pOH = 14.000$

$pH = 14.000 - 2.420$

$pH = 11.580$

37. $HCN_{(aq)} + H_2O_{(l)} \rightleftharpoons CN^-_{(aq)} + H_3O^+_{(aq)}$ WEAK ACID

0.970 M

$K_a = \frac{[CN^-_{(aq)}][H_3O^+_{(aq)}]}{[HCN_{(aq)}]}$, $[CN^-_{(aq)}] = [H_3O^+_{(aq)}]$

$K_a = \frac{[H_3O^+_{(aq)}]^2}{[HCN_{(aq)}]}$

$[H_3O^+_{(aq)}] = \sqrt{(6.2\times10^{-10})[0.970]}$

$[H_3O^+_{(aq)}] = 2.45\times10^{-5}\ M$

$pH = -\log[H_3O^+_{(aq)}]$

$pH = -\log[2.45\times10^{-5}]$

$pH = 4.611$

38. $HA_{(aq)} + H_2O_{(l)} \rightleftharpoons A^-_{(aq)} + H_3O^+_{(aq)}$ WEAK ACID

0.278 M

$K_a = \frac{[A^-_{(aq)}][H_3O^+_{(aq)}]}{[HA_{(aq)}]}$, $[A^-_{(aq)}] = [H_3O^+_{(aq)}]$

$[H_3O^+_{(aq)}] = 10^{-pH}$

$[H_3O^+_{(aq)}] = 10^{-2.020}$

$[H_3O^+_{(aq)}] = 9.55 \times 10^{-3}$ M

$K_a = \frac{[H_3O^+_{(aq)}]^2}{[HA_{(aq)}]}$

$K_a = \frac{[9.55 \times 10^{-3}]^2}{[0.278]}$

$\boxed{K_a = 3.28 \times 10^{-4}}$

39. Benzoic

$C_6H_5COOH_{(aq)} + H_2O_{(l)} \rightleftharpoons C_6H_5COO^-_{(aq)} + H_3O^+_{(aq)}$

0.600M

$K_a = \frac{[C_6H_5COO^-_{(aq)}][H_3O^+_{(aq)}]}{[C_6H_5COOH_{(aq)}]}$, $[C_6H_5COO^-_{(aq)}] = [H_3O^+_{(aq)}]$

$K_a = \frac{[H_3O^+_{(aq)}]^2}{[C_6H_5COOH_{(aq)}]}$

$[H_3O^+_{(aq)}] = \sqrt{(6.3 \times 10^{-5})[0.600]}$

$[H_3O^+_{(aq)}] = 0.00615$ M

Hydrofluoric

$HF_{(aq)} + H_2O_{(l)} \rightleftharpoons F^-_{(aq)} + H_3O^+_{(aq)}$

0.400M

$K_a = \frac{[F^-_{(aq)}][H_3O^+_{(aq)}]}{[HF_{(aq)}]}$, $[F^-_{(aq)}] = [H_3O^+_{(aq)}]$

$K_a = \frac{[H_3O^+_{(aq)}]^2}{[HF_{(aq)}]}$

$[H_3O^+_{(aq)}] = \sqrt{(6.6 \times 10^{-4})[0.400]}$

$[H_3O^+_{(aq)}] = 0.0162$ M

Total $[H_3O^+_{(aq)}] = 0.00615$ M $+ 0.0162$ M

Total $[H_3O^+_{(aq)}] = 0.0224$ M

$pH = -\log[H_3O^+_{(aq)}] =$

$pH = -\log[0.0224]$

$\boxed{pH = 1.650}$

40. $HCl_{(aq)} \longrightarrow H^+_{(aq)} + Cl^-_{(aq)}$ STRONG ACID

0.0178M   0.0178M

$[H^+] = [H_3O^+]$

$[H_3O^+_{(aq)}] = 10^{-pH}$

$[H_3O^+_{(aq)}] = 10^{-1.750}$

$[H_3O^+_{(aq)}] = 0.0178M$

$$\frac{0.0178 \text{ mol HCl}}{1 \text{ L HCl}} \times 0.275 \text{ L HCl} \times \frac{36.46 \text{ g HCl}}{1 \text{ mol HCl}} = \boxed{0.178 \text{ g HCl}}$$