FINAL REVIEW : SCH4U: ANSWERS

THERMOCHEMISTRY (CH.5)

1. a) Q = 33.45 KJ
= 3.345 x 10^4 J

M = 244.0 g

$\Delta T = T_2 - T_1$
$= 70.9 - 31.8\ ^0C$
$= 39.1\ ^0C$

$$c = \frac{Q}{m\Delta T}$$
$$= \frac{3.345\times 10^4 J}{(244.0g)(39.1^oC)}$$
$$= 3.506\, J/g^oC$$

$$\therefore c = 3.506\, J/g^oC$$

b)

$$c_p{}^o = C.M$$
$$= (3.506\frac{J}{g^oC})(27.0\frac{g}{mol})$$
$$= 94.67\, J/mol^oC$$

$$\therefore c_p{}^o = 94.7\, J/mol^oC$$

2. a) $2\ C_8H_8\,(g) + 25\ O_2\,(g) \longrightarrow 16\ CO_2\,(g) + 18\ H_2O\,(l)$

b)

$$\Delta H^o = \Delta H^o{}_{f(p)} - \Delta H^o{}_{f(R)}$$
$$-4597 = [16(-393.5) + 18(-285.8)] - [2x + 25(0.0)]$$
$$-4597 = -11440.4 - 2x$$
$$x = -3421.7$$
$$\Delta H^o{}_f = -3422\ kJ$$

3.

	ΔH^0 (kJ)
$Fe_2O_3(s) \rightarrow 2\ FeO(s) + \frac{1}{2}\ O_2(g)$	$-\frac{1}{2}$ (-560.4)
$2\ FeO(s) \rightarrow 2\ Fe(s) + O_2(g)$	+1 (+ 544.0)
$3\ CO(g) \rightarrow 3\ C(s) + 3/2\ O_2(g)$	+ 3/2 (+ 221.0)
$3\ C(s) + 6\ H_2(g) \rightarrow 3\ CH_4(g)$	-3 (+74.8)
$3\ CH_4(g) + 6\ O_2(g) \rightarrow 3\ CO_2(g) + 6\ H_2O(g)$	+3 (- 371.5)
$6\ H_2O(g) \rightarrow 6\ H_2(g) + 3\ O_2(g)$	-3 (-241.6)
$Fe_2O_3(s) + 3\ CO(g) \rightarrow 2\ Fe(s) + 3\ CO_2(g)$	+ 541.6

$\therefore \Delta H^0 = 542$ kJ

4. a) $\Delta H < 0$ & $\Delta S > 0$
i.e. Minimum enthalpy & maximum entropy

b) (i) $\Delta H > 0$ $\therefore$ tendency towards increasing enthalpy
$\therefore$ does NOT favour spontaneity

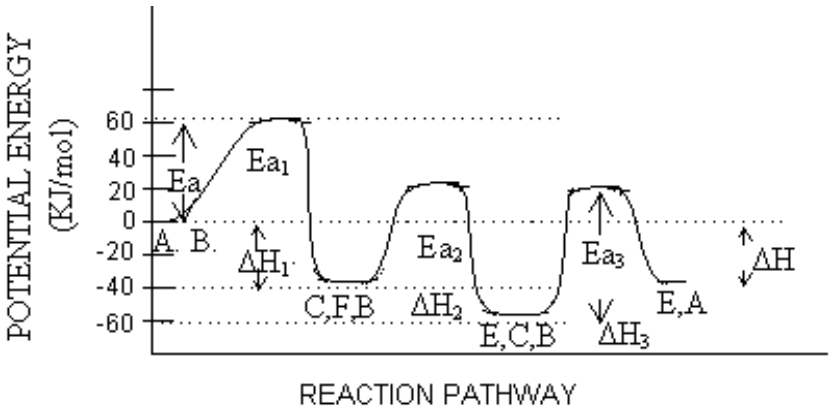
(ii) $\Delta S > 0$ $\therefore$ tendency towards increasing entropy
(More moles gas on product side)
$\therefore$ favours spontaneity

5. (i) Graph (a) represents an exothermic reaction
(ii) Graph (a) is the fastest, since lowest Ea

RATE OF REACTION

1. a) Temperature, concentration of reactants, Nature of reactants, presence of catalyst
b) Collision Theory to explain each:

2. a)



$b)\quad 3B \xrightarrow{A} 2E$

$c)\quad \Delta H = -41\ kJ$

d) RDS is step III, since largest Ea

e) C and F

f) A

g) Steps I & II are exothermic

4. a) 1st order b) zero order c) 1st order d) Rate = k $[C_4H_{11}CF]^1$

e) $k = \dfrac{5.5\times10^{-4}\ mol/L/s}{0.10\ mol/L}$

$= 5.5\times10^{-3}\ s^{-1}$

f) molecularity is 1 or unimolecular

CHEMICAL EQUILIBRIUM

1.

$a)\quad Kc = \dfrac{[H_2O]}{[CO][H_2]}$

$b)\quad Kc = \dfrac{5.4\times10^{-4}}{(3.2\times10^{-3})(2.5\times10^{-4})}$

$Kc = 675$

2.

$a)\quad Kc = \dfrac{[Na^+]}{[H^+]}$

$b)\quad Kc = [Al^{3+}]^2\,[SO_4{}^{2-}]^3$

3. a) same as physical or chemical change

b) (i) homogeneous (ii) heterogeneous

4. a) $Keq = \dfrac{[C]^3[D]}{[A]^2[B]}$

b)

	[A]	[B]	[C]	[D]
	(mol/L)	(mol/L)	(mol/L)	(mol/L)
Initial	1.75	1.75	_____	_____
Change	-0.433	-0.217	0.65	0.217
Equilibrium	1.317	1.533	0.65	0.217

$$Keq = \frac{(0.65)^3(0.217)}{(1.317)^2(1.533)}$$

$$= 0.02241$$

$$Keq = 2.24 \times 10^{-2}$$

5. Low temperature, Low volume, High pressure, decrease $[NH_3]$, increase $[N_2]$ or $[H_2]$

6.

	$[N_2]$	$[O_2]$	[NO]
	(mol/L)	(mol/L)	(mol/L)
Initial	0.1375	0.0875	---------
Change	- x	-x	+ x
Equilibrium	0.1375 - x	0.0875 - x	x

Let x represent $[NO]_{equilibrium}$ in mol/L

$$Kc = \frac{[NO]}{[N_2][O_2]} \qquad \because Kc < 1.0 \times 10^{-3}$$

$$\therefore 0.1375 >> x$$

$$2.51 \times 10^{-7} = \frac{x}{(0.1375 - x)(0.0875 - x)}$$

$$2.51 \times 10^{-7} = \frac{x}{(0.1375)(0.0875)}$$

$$x = 3.0198 \times 10^{-9}$$

$$[NO] = 3.02 \times 10^{-9}\, mol / L$$

$$[N_2] = 0.138\, mol / L$$

$$[O_2] = 8.75 \times 10^{-2}\, mol / L$$

SOLUBILITY EQUILIBRIUM

1.

a) $2\ K_3PO_4(aq) + 3\ Mg(NO_3)_2(aq) \longrightarrow Mg_3(PO_4)_2(s) + 6\ KNO_3$

b) $6K^+(aq) + 2\ PO_4^{3-}(aq) + 3\ Mg^{2+}(aq) + 6\ NO_3^-(aq) \rightarrow Mg_3(PO_4)_2(s) + 6\ K^+(aq) + 6\ NO_3^-(aq)$

c) $3\ Mg^{2+}(aq) + 2\ PO_4^{3-}(aq) \rightarrow Mg_3(PO_4)_2(s)$

d) $Mg_3(PO_4)_2(s) \rightarrow 3\ Mg^{2+}(aq) + 2\ PO_4^{3-}(aq)$

e) $Ksp = [Mg^{2+}]^3\,[PO_4^{3-}]^2$

2. $CaCO_3(s) \rightleftharpoons Ca^{2+}(aq) + CO_3^{2-}(aq)$

Ksp = $[Ca^{2+}][CO_3^{2-}]$ Let x represent $[Ca^{2+}]$ in mol/L

$8.7 \times 10^{-9} = (x)(x)$

$x = 9.33 \times 10^{-5}$

$[Ca^{2+}] = 9.33 \times 10^{-5}$ mol/L

$= 9.3 \times 10^{-6}$ mol/100 mL

3. $Ag_2CrO_4(s) \rightleftharpoons 2\,Ag^+(aq) + CrO_4^{2-}(aq)$

$Ksp = [Ag^+]^2[CrO_4^{2-}]$ *Let x rep* $[CrO_4^{2-}]$ *in mol / L*

$5.02 \times 10^{-13} = (2x)^2(x)$ *Than* $2x$ *rep* $[Ag^+]$ *in mol / L*

$5.02 \times 10^{-13} = 4x^3$ Then x represents $[Ag_2CrO_4]$ in mol / L

$x = 5.007 \times 10^{-5}$

$[Ag_2CrO_4] = 5.007 \times 10^{-5}\ mol / L$ $m = n.M$

$= (5.007 \times 10^{-5}\ mol)(331.8\ g / mol) / L$

$= 1.661 \times 10^{-2}\ g / L$

∴ Solubility of silver chromate is 1.66×10^{-2} g / L

4.

$$[Ca(NO_3)_2] = \frac{50.0\ mL}{200.0\ mL} \times 0.0420\ mol / L$$

$$= 0.0105 \quad mol / L$$

$$[Ca^{2+}] = 0.0105\ mol / L$$

$$[(NH_4)_2 SO_4] = \frac{150.0\ mL}{200.0\ mL} \times 0.00810\ mol / L$$

$$= 0.006075 \quad mol / L$$

$$[SO_4^{2-}] = 0.006075\ mol / L$$

Trial Ksp = $[Ca^{2+}][SO_4^{2-}]$

$= (0.0105)(0.006075)$

$= 6.379 \times 10^{-5}$

TRIAL Ksp < ACTUAL Ksp

$6.379 \times 10^{-5} < 2.61 \times 10^{-4}$

∴ precipitate will NOT form

5. $BaF_2(s) \rightleftharpoons Ba^{2+}(aq) + 2F^-(aq)$
$Ba(NO_3)_2(aq) \longrightarrow Ba^{2+}(aq) + 2NO_3^-(aq)$

∴ **common ion is the Ba^{2+}**

$$Ksp = [Ba^{2+}][F^-]^2$$
$$1.71 \times 10^{-6} = (0.750)[F^-]^2$$
$$[F^-]^2 = 2.28 \times 10^{-6}$$
$$[F^-] = 1.51 \times 10^{-3}\ mol/L$$

6.

IONIC EQUILIBRIUM

1. H_2PO_4 - strongest, most oxygens in the formula

2.

Definition	ACID	BASE
ARRHENIUS	H^+ in H_2O	OH^- in H_2O
BRONSTED – LOWRY	H^+ donor	H^+ acceptor
LEWIS	e^- pair acceptor	e^- pair donor

3. a) Na^+ would NOT hydrolyze
∵ NaOH strong base

$C_2H_3O_2$ would hydrolyse to form a <u>base</u>
∵ $HC_2H_3O_2$ weak acid

b) sodium acetate solution would be basic

4. $CH_3COOH(aq) + H_2O_{(l)} \rightleftharpoons H_3O^+(aq) + CH_3COO^-(aq)$

	$[CH_3COOH]$	$[H_3O^+]$	$[CH_3COO^-]$
	(mol/L)	(mol/L)	(mol/L)
Initial	0.0020	---------	-----
Change	-0.056×0.002	0.056×0.002	0.056×0.002
Equilibrium	1.89×10^{-3}	1.12×10^{-4}	1.12×10^{-4}

$$Ka = \frac{[H^+][CH_3CO_2^-]}{[CH_3CO_2H]}$$

$$= \frac{(1.12\times10^{-4})(1.12\times10^{-4})}{1.89\times10^{-3}}$$

$$= 6.64\times10^{-6}$$

5.

$$[H^+]_i = \frac{17.5\,mL}{28.0\,mL}\times 0.20\,mol/L$$

$$= 0.125\,mol/L$$

$$[OH^-]_i = \frac{10.5\,mL}{28.0\,mL}\times 0.12\,mol/L$$

$$= 0.045\,mol/L$$

$$[H^+] = [H^+]_i - [OH^-]_i$$

$$= 0.125 - 0.045\,mol/L$$

$$= 0.0800\,mol/L$$

$$pH = 1.10$$

$$pOH = 12.9$$

$$[OH^-] = 1.25\times10^{-13}\,mol/L$$

6.

$$[HF] = \frac{m/M}{V}$$

$$= \frac{39.98\ g \Big/ 20.0\ {}^{g}/_{mol}}{5.00\ L}$$

$$= 3.998\ \text{mol / L}$$

	[HF]	$[H^+]$	$[F^-]$
	(mol/L)	(mol/L)	(mol/L)
Initial	3.998	---------	---------
Change	- x	x	x
Equilibrium	3.998 - x	x	x

Let x represent $[H^+]$ in mol/L

$$Ka = \frac{[H^+][F^-]}{[HF]}$$

$$2.56 \times 10^{-4} = \frac{(x)(x)}{3.998 - x}$$

$$x = 9.9896 \times 10^{-3}$$

$$[H^+] = 9.99 \times 10^{-3}\ mol / L$$

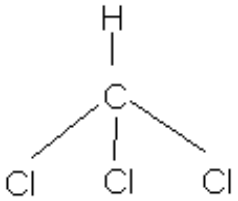
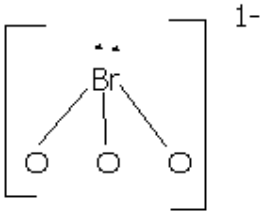
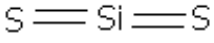
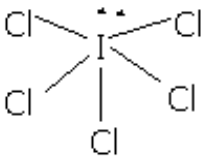
pH = $-\log [9.99 \times 10^{-3}]$ =

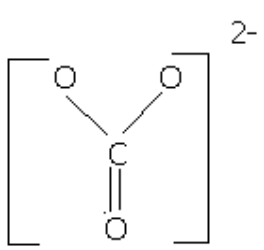
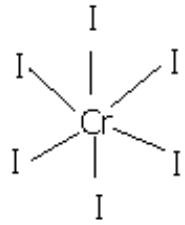
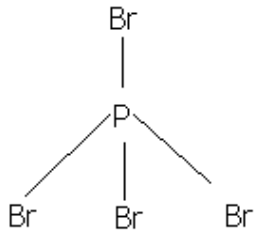
Now: Try questions # 7 — 14 on your own !!!

BONDING & SHAPES (CH 2,3)

1c) Bent: 4 charge centers, however two lone pairs cause greater repulsion with the bonding pairs

2.

$CHCl_3$		tetrahedral	Polar, 109.5 ^{0}, individual bond polar forces that do not cancel.
BrO_3^-		(Trigonal) pyramidal	Polar, 107 ^{0}
SiS_2		linear	Non-polar, 180^0 ; all polar forces cancel
ICl_5		square based pyramid	Polar

CO_3^{2-}		trigonal planar	polar
CrI_6		octahedral	non-polar
PBr_4^+		tetrahedral	polar

3. a) S^{-2}: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$, Fe^3: $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^5$, Br^{-1} : $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}4s^24p^6$
   b) p^5