EXAM REVIEW

January Exam Review

① $_{18}Ar \rightarrow 1s^2 2s^2 2p^6 3s^2 3p^6$

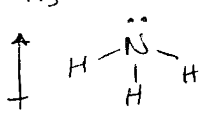
$_{26}Fe \rightarrow [Ar] 4s^2 3d_1^2 d_2^1 d_3^1 d_4^1 d_5^1$

$_{50}Sn \rightarrow [Kr] 5s^2 4d^{10} 5p_x^1 p_y^1 p_z^0$

$_{82}Pb \rightarrow [Xe] 6s^2 4f^{14} 5d^{10} 6p_x^1 p_y^1 p_z^0$

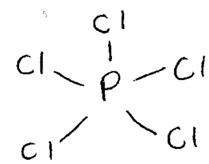
$_{92}U \rightarrow [Ra] 7s^2 5f_1^1 f_2^1 f_3^1 f_4^1 f_5^0 f_6^0 f_7^0$

② NH_3



- trigonal pyramid
- AX_3E

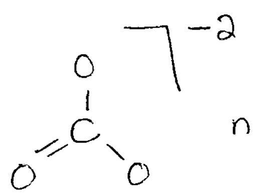
PCl_5



non-polar

- trigonal bipyramid
- AX_5

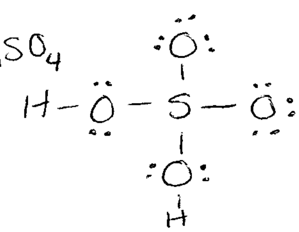
CO_3^{-2}



non-polar

- trigonal planer
- AX_3

H_2SO_4



non-polar

- tetrahedral
- AX_4

③ Increasing m.p.:

He → Cl_2 → CCl_4 → H_2O → NaCl → graphite

④ mobile sea of e^- → can transfer e^- and heat
→ can absorb and re-emit light
→ can be moved without changing environment around atom

⑤ CO_2 - Van der Waals forces only
SiO_2 - covalent network

Intermolecular Attraction:

(1.) C_9H_{20} has a higher boiling point because it has greater Van Der Waal forces.

(2.) Hydrogen bonding in H_2O is stronger than dipole interaction in H_2S
i.e. H_2S cannot hydrogen bond

(3.) metallic

(4) (a) molecular solids → Van Der Waal, London, dipole
(b) ionic solids → ionic bonds
(c) covalent crystals → covalent bonds

(5) molecular (not network)

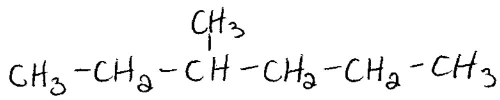
(6.) (a) dipole, hydrogen
(b) van der waals (VDW)
(c) VDW
(d) VDW
(e) metallic
(f) covalent network
(g) ionic

JER #3

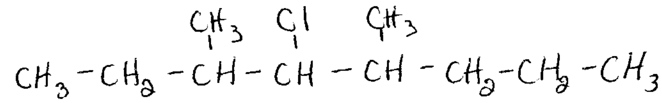
100

Organic:

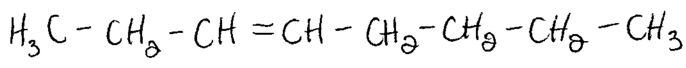
(1.) (a) 3-methylhexane



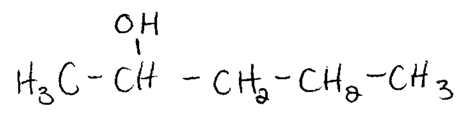
(b) 4-chloro-3,5-dimethyloctane



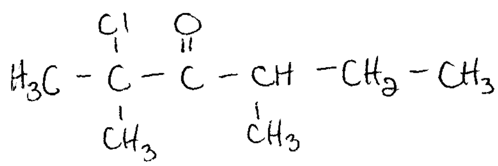
(c) 3-octene



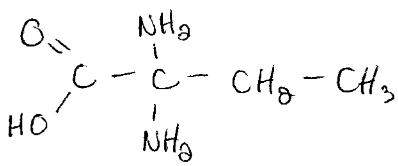
(d) 2-pentanol



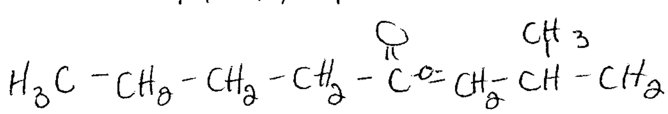
(e) 2-chloro-2,4-dimethyl-3-hexanone



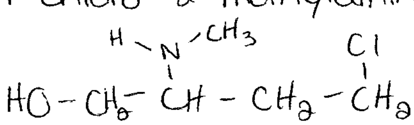
(f) 2,2-diaminobutanoic acid



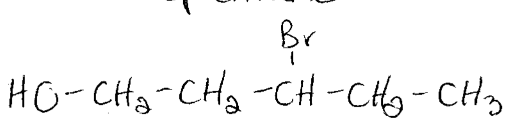
(g) 2-methylpropyl pentanoate



(h) 4-chloro-2-methylaminobutanol

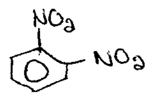


(i) 3-bromopentanol

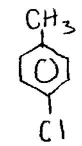


JER #4

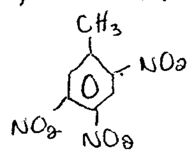
j) 1,2-dinitrobenzene



(k) p-chlorotoluene



l) 2,4,6-trinitrotoluene



(2) A. $H_2C=CH-CH_3 + Cl_2 \longrightarrow CH_2(Cl)-CH(Cl)-CH_3$

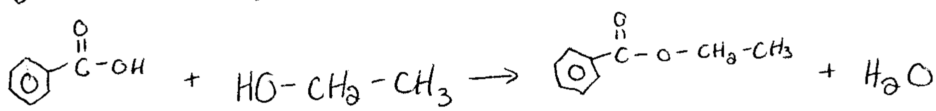
B. $CH_3-C=C-CH_3 + H_2 \rightarrow CH_3-CH_2-CH_2-CH_3$

C. $C_8H_{18} + \frac{25}{2}O_2 \xrightarrow{temp.} 8CO_2 + 9H_2O$

D. $H_3C-C\equiv C-CH_2-CH_2-CH_3 + H_2 \longrightarrow CH_3-CH=CH-CH_2-CH_2-CH_3$

E. $H_3C-C\equiv C-CH_2-CH_3 + HCl \rightarrow H_3C-CH(Cl)-CH_2-CH_2-CH_3 + H_3C-CH_2-CH(Cl)-CH_2-CH_3$

F.



G. $O=C(H)-CH_2-CH_2-CH_3 \xrightarrow{[O]} O=C(HO)-CH_2-CH_2-CH_3$

Problems:

(1.) $NaCN + BrCH_2CH_3 \rightarrow NaBr + CH_3CH_2CN$

$n = \frac{8.53g}{49 g/mol}$ $= 0.124$ mol

$n = \frac{10.98g}{109 g/mol}$ $= .101$ mol → $m = 0.101$ mol * 55 g/mol $= 5.555$ g

limiting reagent

$V = \frac{m}{d}$

$= \frac{5.555g}{0.783 g/mL}$

$= 7mL$

(2.) i) moles C = moles CO_2 = $\frac{1.039g}{44g/mol}$ = 0.02361 mol

$m_C = 0.02361$ mol * 12.0 g/mol
$= 0.2836$ g

ii) moles H = 2 (moles H_2O) = $2\left(\frac{0.6369g}{18g/mol}\right)$ = 0.07073 mol

$m_H = 0.07073$ mol * 1.0 g/mol
$= 0.07073$ g

iii) m_O = sample $- m_C - m_H$
$= 0.5438 - 0.2836 - 0.07073$
$= 0.1895$ g

$n_O = \frac{m}{mm}$
$= \frac{0.1895g}{16g/mol}$
$= 0.01184$ mol

C	H	O
$\frac{0.02361}{0.01184}$	$\frac{0.07073}{0.01184}$	$\frac{0.01184}{0.01184}$
$= 2$	$= 6$	$= 1$

∴ EF = C_2H_6O

JER #6

(3) $MnO_2 \rightarrow 2 \times 3.15\ mol * 6.022 \times 10^{23} = 3.79 \times 10^{24}$

(4) $Na_2SO_4 \rightarrow 2(23) + 32 + 4(16) = 142\ g/mol$

$m_{Na_2SO_4} = 142g/mol * 1\ mol$

$= 142g$

(5) $n = \frac{53g}{106g/mol}$

$= 0.5\ mol$

(6) (a) ? g/mol (b) 98 g/mol (c) 78 g/mol

(7) $m_{H_2SO_4} = n \times mm$

$= 2.50\ mol \times 98\ g/mol$

$= 245\ g$

(8) $NH_4NO_3 \rightarrow 2N \rightarrow 28\ g/mol$ — $28g/mol \div 80\ g/mol \times 100\% = 35\%$

$3O \rightarrow 48\ g/mol$ — $48g/mol \div 80g/mol \times 100\% = 60\%$

$4H \rightarrow 4g/mol$ — $4g/mol \div 80g/mol \times 100\% = 5\%$

80g/mol

(9) $CuSO_4 \cdot 5H_2O \rightarrow 1\ Cu \rightarrow 63.5g/mol \div 249.5g/mol \times 100\% = 25.45\%$

$1\ S \rightarrow 32\ g/mol \div 249.5g/mol \times 100\% = 12.80\%$

$9\ O \rightarrow 144\ g/mol \div 249.5g/mol \times 100\% = 57.70\%$

$10\ H \rightarrow 10g/mol \div 249.5g/mol \times 100\% = 4.00\%$

249.5g/mol

10)

	Ba	C	O
%	69.58	6.09	24.32
mass	69.58g	6.09g	24.32g

$n_{Ba} = \frac{69.58g}{137 g/mol}$ $n_C = \frac{6.09g}{12g/mol}$ $n_O = \frac{24.32g}{16g/mol}$

$= \frac{0.507mol}{0.507}$ $= \frac{0.508mol}{0.507}$ $= \frac{1.52 mol}{0.507}$

$= 1$ $= 1$ $= 3$

$\therefore EF = BaCO_3$

11.)

	C	H
%	92.3%	7.7%
mass	92.3g	7.7g

$n_C = \frac{92.3g}{12g/mol}$ $n_H = \frac{7.7g}{1g/mol}$

$= 7.7mol$ $= 7.7 mol$

$\therefore EF = CH$

$MF = EF \left(\frac{MFm}{EFm}\right)$

$MF = C_1H_1 \left(\frac{104 g/mol}{13g/mol}\right)$

$MF = C_1H_1 (8)$

$= C_8H_8$

Organic Continued:

12) (a) propane (b) 1-ethanol (c) ethanal
(d) 2-methylbutane (e) 1-methoxyethane
(f) 2-pentanone (g) 1-butene
(h) 2,3-dichloro-3-methylhexane
(i) propanoic acid
(j) ethyl ethanoate (k) N-methylpropanamide
(l) m-dinitrobenzene (m) toluene
(n) phenol (o) 2-ethylamino-5-chlorohexane
(p) p-dichlorobenzene (q) 4-amino-5-bromo-2-hexyne
(r) 1-bromo-2-methylcyclobutane

thermochemistry

1.) $\Delta H^\circ_r = \Sigma \Delta H^\circ_f \text{ prod} - \Sigma \Delta H^\circ_f \text{ react}$
$= 1(C_6H_{12}O_6) - [6(CO_2) + 6(H_2O)]$
$= -1265.4 - [6(-393.8) + 6(-285.5)]$
$= 2810.4 \text{ kJ}$

2.) $\Delta H^\circ_r = \Sigma \Delta H^\circ_f \text{ prod} - \Sigma \Delta H^\circ_f \text{ react}$
$5.4 = 1(H_2) + 1(CO) - \Delta H^\circ_f \ CH_2O$
$5.4 = 0 + (-110) - \Delta H^\circ_f \ CH_2O$
$\Delta H^\circ_f \ CH_2O = -115.4 \text{ kJ}$

(3.) $CH_4 + 2O_2 \rightarrow CO_2 + 2H_2O$

H_r = sum of (formation of products) − (formation of reactants)
= −898.9 /16 = 56.2

$CH_3OH + \frac{3}{2}O_2 \rightarrow CO_2 + 2H_2O$ = −735.3/32
= 23 kJ/g

$C_7H_{16} + 11O_2 \rightarrow 7CO_2 + 8H_2O$ = −4852/100
= 48.5 kJ/g

(4.) $\Delta H^\circ_r = \Sigma \Delta H^\circ_f$ prod $- \Sigma \Delta H^\circ_f$ react

$-710 = [1(CO_2) + \frac{1}{2}(N_2) + \frac{3}{2}(H_2)] - \Delta H^\circ_f\ CH_3NO_2$

$-710 = [-393.8 + 0 + 0] - \Delta H^\circ_f\ CH_3NO_2$

$\Delta H^\circ_f\ CH_3NO_2 = 316$ kJ/mol

Rates

(1.) (a) $NOBr_2\ (g)$

(b) i) $r = k_1[NO][Br_2]$
ii) $r = k_2[NOBr_2][NO]$

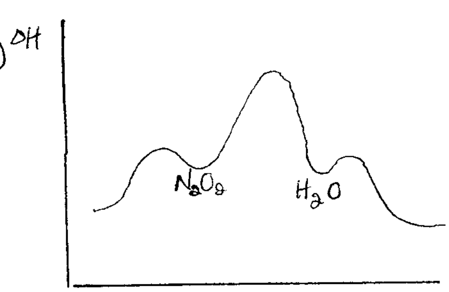
(c) $r = k_1[NO][Br_2]$

(d) step 1 and step 2 must be the same speed

(2.) (a) 8 (b) 4 (c) 2

(3.)

$$2NO \rightarrow \cancel{N_2O_2}$$
$$\cancel{N_2O_2} + H_2 \rightarrow \cancel{H_2O} + H_2O$$
$$\cancel{H_2O} + H_2 \rightarrow N_2 + H_2O$$
$$2NO + 2H_2 \rightarrow N_2 + 2H_2O$$

(b) 

(c) $r = k[N_2O_2][H_2]$ or $r = k[NO]^x[H_2]^y$

Energy:

(1.) (a) $^{211}_{82}Pb \rightarrow {}^{0}_{-1}e + {}^{211}_{83}Bi$ (b) $^{251}_{98}Cf \rightarrow {}^{4}_{2}He + {}^{247}_{96}Cm$

(c) $^{209}_{82}Pb \rightarrow {}^{209}_{83}Bi + {}^{0}_{-1}e + {}^{0}_{0}\gamma$

June Exam Review

1. (a) $K_{eq} = \frac{[NH_{3(g)}]^2}{[N_{2(g)}][H_{2(g)}]^3}$

(b) $K_{eq} = \frac{[MgCl_{2(aq)}][H_{2(g)}]}{[HCl_{(g)}]^2[Mg_{(s)}]}$

(c) $K_{eq} = \frac{[AgCl_{3(s)}]}{[Ag^{+3}_{(aq)}][Cl^{-}_{(aq)}]^3}$

2. (a) no change
(b) shift to the left
(c) no change
(d) shift to the right
(e) no change

3.

	$CO_{(g)}$ +	$H_2O_{(g)}$ ⇌	$CO_{2(g)}$ +	$H_{2(g)}$
I	0.750	0.275	0	0
C	−0.25	−0.25	+0.25	+0.25
E	0.50	0.025	0.25	0.25

$$K_{eq} = \frac{[CO_{2(g)}][H_{2(g)}]}{[CO_{(g)}][H_2O_{(g)}]} = \frac{(0.25)(0.25)}{(0.5)(0.025)} = 5$$

4.

	$CO_{(g)}$ +	$H_2O_{(g)}$ ⇌	$CO_{2(g)}$ +	$H_{2(g)}$
I	0.1	0.1	0	0
C	$-x$	$-x$	$+x$	$+x$
E	$0.1-x$	$0.1-x$	x	x

$$K_{eq} = \frac{[CO_{2(g)}][H_{2(g)}]}{[CO_{(g)}][H_2O_{(g)}]}$$

$$4.06 = \frac{x^2}{(0.1-x)^2}$$

$$2.01 = \frac{x}{0.1-x}$$

$0.201 - 2.01x = x$

$0.201 = 3.01x$

$x = 0.0668$

∴ the concentrations at eq'm are:

$[CO_{(g)}] \rightarrow 0.03317$

$[H_2O_{(g)}] \rightarrow 0.03317$

$[CO_{2(g)}] \rightarrow 0.0668$

$[H_{2(g)}] \rightarrow 0.0668$

(5.) macroscopic → colour, temperature, mass
microscopic → interaction angle (collision geometry)

Solubility Product

(6.) i) (a) $NaCl_{(aq)} + AgNO_{3(aq)} \rightarrow NaNO_{3(aq)} + AgOH_{(aq)}$
(b) $Na^+_{(aq)} + Cl^-_{(aq)} + Ag^+_{(aq)} + NO_3^-_{(aq)} \rightarrow Na^+_{(aq)} + NO_3^-_{(aq)} + Ag^+_{(aq)} + OH^-_{(aq)}$
(c) no net ionic equation

ii) (a) $H_3PO_{4(aq)} + NaOH_{(aq)} \rightarrow NaH_2PO_{4(aq)} + H_2O_{(l)}$
(b) $H^+_{(aq)} + H_2PO_4^-_{(aq)} + Na^+_{(aq)} + OH^-_{(aq)} \rightarrow Na^+_{(aq)} + H_2PO_4^-_{(aq)} + H_2O_{(l)}$
(c) $H^+_{(aq)} + OH^-_{(aq)} \rightarrow H_2O_{(l)}$

iii) (a) $MgCl_{2(aq)} + 2NaNO_{3(aq)} \rightarrow Mg(NO_3)_{2(aq)} + 2NaCl_{(aq)}$
(b) $Mg^{+2}_{(aq)} + Cl^-_{(aq)} + 2Na^+_{(aq)} + 2NO_3^-_{(aq)} \rightarrow Mg^{+2}_{(aq)} + 2NO_3^-_{(aq)} + 2Na^+_{(aq)} + Cl^-_{(aq)}$
(c) no net ionic equation

iv) (a) $3Ba(NO_3)_{2(aq)} + Al_2(SO_4)_{3(aq)} \rightarrow 3BaSO_{4(s)} + 2Al(NO_3)_{3(aq)}$
(b) $3Ba^{+2}_{(aq)} + 6NO_3^-_{(aq)} + 2Al^{+3}_{(aq)} + 3SO_4^{-2}_{(aq)} \rightarrow 3BaSO_{4(s)} + 2Al^+_{(aq)} + 6NO_3^-_{(aq)}$
(c) $3Ba^{+2} + 3SO_4^{-2} \rightarrow 3BaSO_{4(s)}$

(7.) 25g of MnS is excess MnS, ∴ saturated solution

	$MnS_{(s)} \rightleftharpoons$	$Mn^{+2}_{(aq)}$	$+\ S^{-2}_{(aq)}$
I	(MnS doesn't matter because it's a solid)	0	0
E		x	x

$K_{sp} = [Mn^{+2}_{(aq)}][S^{-2}_{(aq)}]$
$5.6 \times 10^{-16} = x^2$
$x = 2.37 \times 10^{-8}$

∴ The $[Mn^{+2}_{(aq)}]$ is 2.37×10^{-8} mol/L

(8) (a) Concentration after addition is 5.0×10^{-6} mol/L $BaCl_2$
5.0×10^{-6} mol/L H_2SO_4

$[Ba^{+2}] = 5 \times 10^{-6}$ mol/L
$[Cl^-] = 2(5 \times 10^{-6}$ mol/L$) = 1 \times 10^{-5}$ mol/L
$[H^+] = 2(5 \times 10^{-6}$ mol/L$) = 1 \times 10^{-5}$ mol/L
$[SO_4^{-2}] = 5 \times 10^{-6}$ mol/L

possible ppts $BaSO_4$ $K_{sp} = 1.1 \times 10^{-10}$, HCl K_{sp} = large

$Q = [Ba^{+2}][SO_4^{-2}]$
$= (5 \times 10^{-6})(5 \times 10^{-6})$
$= 2.5 \times 10^{-11}$

$K_{sp} = 1.1 \times 10^{-10}$

Since K_{sp} > product, no ppt

(b) 1×10^{-9} mol/L $*$ 0.01 L $= 1 \times 10^{-11}$ mol Ca^{+2}, in 40 mL → 2.5×10^{-10} mol/L
∴ 2×10^{-11} mol Cl^-, in 40 mL → 5×10^{-10} mol/L

2×10^{-3} mol/L $*$ 0.03 L $= 6 \times 10^{-5}$ mol Na^+, in 40 mL → 1.5×10^{-3} mol/L
∴ 6×10^{-5} mol F^-, in 40 mL → 1.5×10^{-3} mol/L

possible ppts CaF_2 → $K_{sp} = 3.9 \times 10^{-11}$
NaCl → K_{sp} = large

$Q = [Ca^{+2}][F^-]^2$
$= (2.5 \times 10^{-10})(1.5 \times 10^{-3})^2$
$= 5.63 \times 10^{-16}$

$K_{sp} = 3.9 \times 10^{-11}$

Since K_{sp} > product, no ppt

(9) BOOM!!

(10) $Cu(OH)_{2(s)} \rightleftharpoons Cu^{+2}_{(aq)} + 2OH^{-}_{(aq)}$ $K_{sp} = [Cu^{+2}_{(aq)}][OH^{-}_{(aq)}]^2$

I	–	0	0
C	–	$+x$	$+2x$
E	–	x	$2x$

$x = 3.42 \times 10^{-7}$
$2x = 2(3.42 \times 10^{-7})$
$= 6.84 \times 10^{-7}$

$K_{sp} = [Cu^{+2}_{(aq)}][OH^{-}_{(aq)}]^2$
$= (3.42 \times 10^{-7})(6.84 \times 10^{-7})^2$
$= 1.60 \times 10^{-19}$

$\therefore$ the K_{sp} for $Cu(OH)_{2(s)}$ is 1.60×10^{-19}

(11.) (a) $Ag_2CO_{3(s)} \rightleftharpoons 2Ag^{+}_{(aq)} + CO_3^{-2}{}_{(aq)}$

I	excess	0	0
E	excess $-x$	$2x$	x

$K_{sp} = [Ag^{+}_{(aq)}]^2[CO_{3(aq)}^{-2}]$
$8.4 \times 10^{-12} = (2x)^2(x)$
$8.4 \times 10^{-12} = 4x^3$
$x = 1.28 \times 10^{-4}$

$\therefore$ the solubility of $Ag_2CO_{3(s)}$ in pure water is 1.28×10^{-4} mol/L

(b) $Ag_2CO_{3(aq)} \rightleftharpoons 2Ag^+_{(aq)} + CO_3^{-2}{}_{(aq)}$

I	excess	0	0.1
E	excess − x	2x	0.1 + x

$Ksp = [Ag^+_{(aq)}][CO_3^{-2}{}_{(aq)}]$

$8.4 \times 10^{-12} = (2x)^2(0.1 + x)$ ← assume x is small compared to 0.1

$8.4 \times 10^{-12} = 0.4x^2$

$2.1 \times 10^{-11} = x^2$

$x = 4.58 \times 10^{-6}$

∴ the solubility of Ag_2CO_3 in 0.1 mol/L CO_3^{-2} is 4.58×10^{-6} mol/L

Acids and Bases

(12) Arrehnius: Acid → solutes that produces hydrogen ions, H^+, in aqueous solutions
Base → produce hydroxide ions, $OH^-_{(aq)}$, when dissolved in water

Brønsted-Lowry:
Acid → proton donor
Base → proton acceptor

(13) acid of fwd reaction - HCN
base of fwd reaction - H_2O
conjugate acid-base pairs - $HCN : CN^-$, $H_2O : H_3O^+$

(14) i) 0.1 mol/L HCl → $pH = -\log[H^+]$
$= -\log(0.1)$
$= 1$

ii) 0.020 L NaOH * 0.15 mol/L = 0.003 mol NaOH added

initial HCl = 0.05 L * 0.1 mol/L = 0.005 mol HCl

base neutralizes 0.003 mol of HCl

∴ there are 0.002 mol of HCl in 20 mL

$\frac{0.002 \text{ mol}}{0.07 \text{ L}} = 0.02857 \text{ mol/L HCl} = [H_3O^+]$

$pH = -\log[H_3O^+]$
$= -\log(0.02857)$
$= 1.54$

iii) 0.04 L NaOH * 0.15 mol/L = 0.006 mol NaOH

∴ there is 0.001 mol of excess NaOH in 90mL
(0.006 mol NaOH − 0.005 mol HCl)   (40 mL + 50mL HCl)

$$\frac{0.001 \text{ mol}}{0.09 \text{ L}} = 0.0111 \text{ mol/L NaOH} = [OH^-]$$

$$pOH = -\log[OH^-] = -\log(0.0111) = 1.95$$

$$pH = 14 - pOH = 14 - 1.95 = 12.05$$

(15) pH = 2.87

$$[H^+_{(aq)}] = 10^{-pH} = 10^{-2.87} = 1.35 \times 10^{-3} \text{ mol/L}$$

$$HC_2H_3O_{2(aq)} \rightleftharpoons H^+_{(aq)} + C_2H_3O_2^-{}_{(aq)}$$

$$K_a = \frac{[H^+_{(aq)}][C_2H_3O_2^-{}_{(aq)}]}{[HC_2H_3O_{2(aq)}]}$$

$$[H^+_{(aq)}] = [C_2H_3O_2^-{}_{(aq)}] = 1.35 \times 10^{-3} \text{ mol/L}$$

$$K_a = \frac{(1.35 \times 10^{-3})^2}{0.100} = 1.8225 \times 10^{-5}$$

∴ the K_a of acetic acid is 1.8225×10^{-5}

(16) $CH_3COONa_{(aq)} \rightleftharpoons Na^+_{(aq)} + CH_3COO^-_{(aq)}$ very soluble

Na^+: eq'm; CH_3COO^-: not at eq'm

∴ we have 0.2 mol/L of Ac^- (CH_3COO^-)

$$Ac^- + H_2O \rightleftharpoons HAc + OH^-$$

	Ac^-		HAc	OH^-
I	0.2		0	0
E	0.2 − x		x	x

$$K_b = \frac{K_w}{K_a} = \frac{1 \times 10^{-14}}{1.8 \times 10^{-5}} = 5.56 \times 10^{-10}$$

$$K_b = \frac{[HAc][OH^-]}{[Ac^-]}$$

$$5.56 \times 10^{-10} = \frac{x^2}{0.2 - x}$$

← assume x is small compared to 0.2 - check assumption

$$x = 1.054 \times 10^{-5}$$

∴ $[OH^-] = 1.054 \times 10^{-5}$

$pOH = -\log(1.054 \times 10^{-5})$
$= 4.977$

$pH = 14 - 4.977$
$= 9.023$

(17) $NH_4Cl \xrightarrow{H_2O} NH_4^+ + Cl^-$

$$NH_4^+ + H_2O \rightleftharpoons NH_3 + H_3O^+$$

	NH_4^+		NH_3	H_3O^+
I	0.15		0	0
E	0.15 − x		x	x

$$K_a = \frac{K_w}{K_b} = \frac{1 \times 10^{-14}}{1.8 \times 10^{-5}} = 5.56 \times 10^{-10}$$

$$K_a = \frac{[NH_3][H_3O^+]}{[NH_4^+]}$$

$$5.56 \times 10^{-10} = \frac{x^2}{0.15 - x}$$

← assume x is small compared to 0.15, do 5% check

$$x = 9.13 \times 10^{-6}$$

∴ $[H_3O^+] = 9.13 \times 10^{-6}$

$pH = -\log[H_3O^+]$
$= 5.04$

(18.) see assignment!!

(19)

$$HB + H_2O \rightleftharpoons H_3O^+ + B^-$$

	HB	H_3O^+	B^-
I	0.1	0	0
E	0.1−x	x	x

pOH = 10.59
pH = 14 − 10.59
= 3.41
$[H^+] = 10^{-3.41}$
$= 3.89 \times 10^{-4}$
$x = 3.89 \times 10^{-4}$

$$Ka = \frac{[H_3O^+][B^-]}{[HB]}$$

$$= \frac{x^2}{0.1 - x}$$

$$= \frac{(3.89 \times 10^{-4})^2}{0.1 - 3.89 \times 10^{-4}}$$

$$= 1.52 \times 10^{-6}$$

(20) (a) i)

+7 gain $5e^-$ +2

$$MnO_4^- + H_2SO_3 \rightarrow Mn^{+2} + HSO_4^- + H_2O \quad \text{(acid)}$$

+4 lose $2e^-$ +6

$$H^+ + 2MnO_4^- + 5H_2SO_3 \rightarrow 2Mn^{+2} + 5HSO_4^- + 3H_2O$$

ii)

0 lose $5e^-$ (10e^-) extras +5

$$ClO_3^- + I_2 \longrightarrow 2IO_3^- + Cl^-$$

+5 gain $6e^-$ −1

$$3H_2O + 5ClO_3^- + 3I_2 \rightarrow 6IO_3^- + 5Cl^- + 6H^+$$

(b) i) $Cu \rightarrow Cu^{+2} + 2e$ (acid)

$$1e^- + H^+ + HNO_3 \rightarrow NO_2 + H_2O$$

$$Cu + 2H^+ + 2HNO_3 \rightarrow Cu^{+2} + 2NO_2 + 2H_2O$$

(ii) $NO_3^- + Zn \rightarrow NH_3 + Zn(OH)_4^{-2}$ (basic)

$9OH^- + 9H^+ + NO_3^- \rightarrow NH_3 + 3H_2O + 9OH^-$
$6\,9H_2O + NO_3^- \rightarrow NH_3 + \cancel{3H_2O} + 9OH^-$

$4OH^- + 4H_2O + Zn \rightarrow Zn(OH)_4^{-2} + 4H^+ + 4OH^-$
$4OH^- + \cancel{4H_2O} + Zn \rightarrow Zn(OH)_4^{-2} + \cancel{4H_2O}$

$8e^- + 6H_2O + NO_3^- \rightarrow NH_3 + 9OH^-$
$4[4OH^- + Zn \rightarrow Zn(OH)_4^{-2} + 2e^-]$
$16OH^- + 4Zn \rightarrow 4Zn(OH)_4^{-2} + 8e^-$

$6H_2O + NO_3^- + \cancel{16}\,7\,OH^- + 4Zn \rightarrow 4Zn(OH)_4^{-2} + NH_3 + \cancel{9OH}$
$6H_2O + NO_3^- + 7OH^- + 4Zn \rightarrow 4Zn(OH)_4^{-2} + NH_3$

(21) The difference between their tendency to be reduced and the tendency of hydrogen to be reduced.

(22) (a) $Cu^{+2} + 2e^- \rightarrow Cu$ $E° = +0.34$
$Zn^{+2} + 2e^- \rightarrow Zn$ $E° = -0.76$

Copper has a greater tendency to be reduced so the rxn is:

$Cu^{+2} + Zn \rightarrow Cu + Zn^{+2}$

$\therefore$ $Cu^{+2} + 2e^- \rightarrow Cu$ $E° = +0.34$
$Zn \rightarrow Zn^{+2} + 2e^-$ $E° = +0.76$
$Cu^{+2} + Zn \rightarrow Cu + Zn^{+2}$ $E° = +1.10V$

$\therefore$ the voltage of the cell is 1.10V

b) Current flows from the Zn electrode to the Cu electrode

(c) anode → where oxid. occurs → zinc
cathode → where red. occurs → copper

(d) +ve electrode → copper
-ve electrode → zinc