TEE CHEMISTRY

Semester 1 Examination 2002

SOLUTIONS

Part 1

1. d	6. c	11. a	16. d
2. a	7. b	12. b	17. d
3. b	8. d	13. b	18. d
4. b	9. a	14. c	19. c
5. d	10. b	15. b	20. a

Part 2

1.

a) Equation $Fe_{(s)} + 2H^+_{(aq)} \rightarrow Fe^{+2}_{(aq)} + H_{2(g)}$

Observation Bubbles of colourless gas evolve. The solid dissolves. The solution may be pale green.

b) Equation $NiCO_{3(s)} + 2OH^+_{(aq)} \rightarrow Ni^{+2}_{(aq)} + H_2O_{(e)} + CO_{2(g)}$

Observation Effervescence releases colourless bubbles of gas. The solid dissolves. The final solution is green.

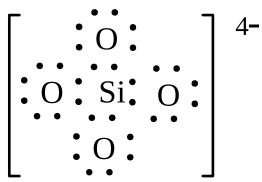
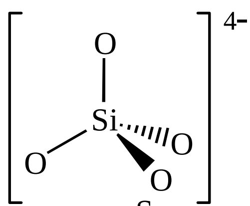
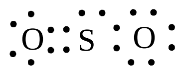
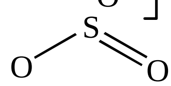
c) Equation $Mn^{+2}_{(aq)} + 2OH^-_{(aq)} \rightarrow Mn(OH)_{2(s)}$

Observation The two colourless solutions when mixed result in a white precipitate.

d) Equation $Zn(OH)_{2(s)} + 2OH^-_{(aq)} \rightarrow [Zn(OH)_4]^{-2}_{(aq)}$

Observation The white powder dissolves to form a colourless solution.

2.

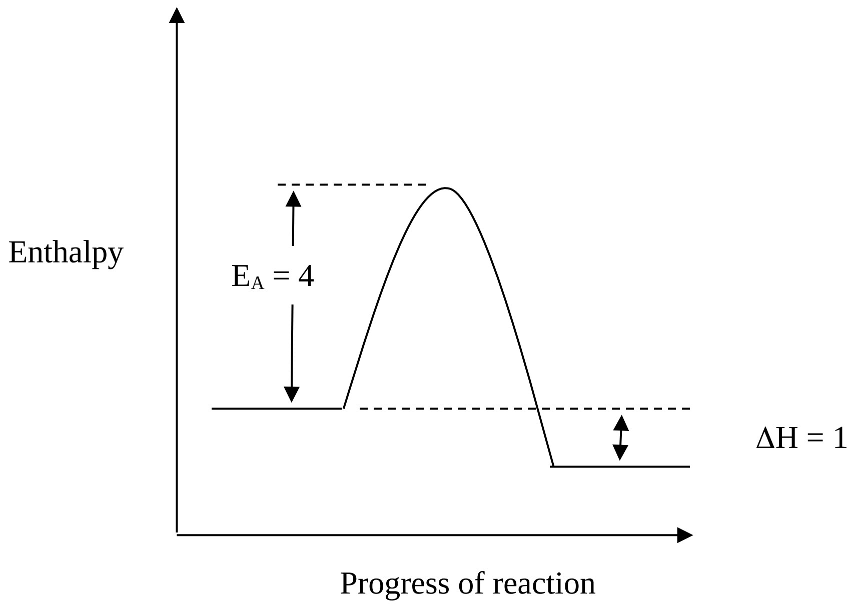
Species	Electron dot diagram	Draw the shape showing all atoms
Ortho silicate ion SiO_4^{-4}		
Sulfur dioxide SO_2		

3. (a) The end point is the point at which an indicator changes colour. The equivalence point is the point at which chemically equivalent amounts of acid and base have been combined.

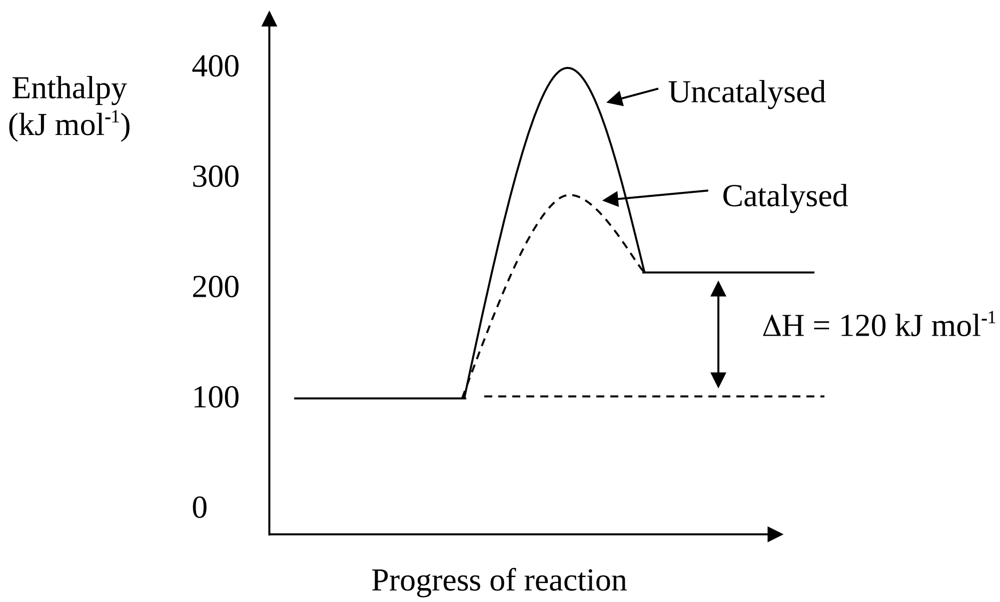
(b) A dilute acid is one having more water than acid present. It has less acid than a more concentrated acid in solution. It may be a strong or a weak acid. A weak acid is only partially ionised in aqueous solution. Most of it is as molecules in solution.

4.

a)



b)



5.

a) The Na_2CO_3 is of high purity and stable during the weighing process so its mass can be determined accurately.
The NaOH is unstable – it absorbs $CO_{2(g)}$ and $H_2O_{(e)}$ from the air – so its mass cannot be accurately measured.

b) Name: <u>Methyl Orange</u>

Colour change: From yellow/orange to pink/red

c) At equivalence point hydrolysis makes the strong acid (HCl) and weak base (sodium carbonate) solution acidic. We choose methyl orange since it changes colour in the acid range and minimised titration error.

6.

Compound name	Formula	Aqueous solution would be Acidic/Basic/Neutral?
Potassium sulfate	K_2SO_4	basic
Ammonium chloride	NH_4Cl	acidic
Sulfur dioxide	SO_2	acidic
Sodium ethanoate	CH_3COONa	basic

7.

Name of solid	Bonding type
graphite	CN
lead	M
calcium carbonate	I
ice	CM

8.

Aqueous solution	strong electrolyte	weak electrolyte	non electrolyte
Sodium carbonate	✓		
ethanoic acid		✓	
barium chloride	✓		
ammonium ethanoate	✓		
sucrose (sugar)			✓
water		✓	

Part 3

1.

a) $n(AgC\ell) = \frac{m}{M} = \frac{0.246}{143.35} = 1.72 \times 10^{-3}$ mol [M $AgC\ell$ = 143·35]

b) $C\ell^-_{(aq)} + Ag^+_{(aq)} \rightarrow AgC\ell_{(s)}$

$n(NaC\ell) = n(C\ell^-) = n(Ag^+) = n(AgC\ell) = 1{\cdot}72 \times 10^{-3}$ mol

c) $n(NaC\ell)_{\text{in } 250\cdot0 \text{ mL}} = \frac{250}{20} \times n(NaC\ell)_{\text{in 20 mL}} = \frac{250}{20} \times \frac{1{\cdot}72 \times 10^{-3}}{1} = 2{\cdot}15 \times 10^{-2}$ mol

d) All the $NaC\ell$ in 250·0 mL came from the 14·962g sample. So

[M $NaC\ell$ = 58·44]

$m(NaC\ell)_{\text{in sample}} = M \times n(NaC\ell)_{\text{in 250 mL}} = 2{\cdot}15 \times 10^{-2} \times 58{\cdot}4 = \underline{\underline{1{\cdot}26\text{g}}}$

e) % $NaC\ell$ by mass $= \frac{m(NaC\ell)}{m(\text{soup})} \times \frac{100}{1} = \frac{1{\cdot}26}{14{\cdot}962} \times \frac{100}{1} = 8{\cdot}42\%$

2. $n(C) = n(CO_2) = \frac{m}{M} = \frac{1{\cdot}366}{44{\cdot}01} = 0{\cdot}0310$ mol

$m(C) = n \times M = 0{\cdot}0310 \times 12{\cdot}01 = 0{\cdot}3723\text{g}$

$H^+ + OH^- \rightarrow H_2O$

$n(C\ell) = n(H^+) = n(OH^-) = c \times V = 2{\cdot}007 \times 29{\cdot}12 \times 10^{-3} = 0{\cdot}05844$ mol

$m(C\ell) = n \times M = 0{\cdot}05844 \times 35{\cdot}45 = 2{\cdot}0717$ g

$m(F) = m(\text{sample}) - (m(C) + m(C\ell)) = 3{\cdot}034 - 2{\cdot}444 = 0{\cdot}59$ g

$n(F) = \frac{m}{M} = \frac{0{\cdot}59}{19} = 0{\cdot}0311$ mol

	C	$C\ell$	F
mols	0·0310	0·05844	0·0311
smallest ratio	$\frac{0{\cdot}0310}{0{\cdot}0311} = 0{\cdot}997$	$\frac{0{\cdot}05844}{0{\cdot}0311} = 1{\cdot}88$	1
	1	2	1

E F = $CC\ell_2F$

$$n(\text{Compound}) = \frac{V_{STP}}{22.41} = \frac{0.1453}{22.41} = .006483 \text{ mol}$$

$$M(\text{Compound}) = \frac{m}{n} = \frac{1 \cdot 322}{0.006483} = 203.896 \approx 204 \text{ g mol}^{-1}$$

$M(CC\ell_2F) = 101.91 \text{ g mol}^{-1}$

$\therefore$ molecular formula = 2 $\times$ Empirical formula

$= C_2C\ell_4F_2$

3. (a) find $V(N_2)$ at S.T.P.

$P_1 = 96 \cdot 0$ kPa	$P_2 = 101 \cdot 3$ kPa
$V_1 = 1 \cdot 728$ L	$V_2 = ?$
$T_1 = 298$ K	$T_2 = 273$ K

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \quad \text{so} \quad V_2 = \frac{P_1V_1T_2}{T_1P_2} = \frac{96 \times 1 \cdot 728 \times 273}{298 \times 101 \cdot 3} = 1.5002 \text{ L at STP}$$

$$n(N_2) = \frac{V_{(STP)}}{22 \cdot 41} = \frac{1 \cdot 5002}{22.41} = 0.0669 \text{ mol}$$

$\therefore m(N_2) = n \times M = 0 \cdot 0669 \times 28 \cdot 02 = 1 \cdot 87$ g

(b) find $n(N_2 + CO_2)$

$$n(N_2 + CO_2) = \frac{V(\text{total})_{STP}}{22 \cdot 41} = \frac{4 \cdot 50}{22 \cdot 41} = 0.2008 \text{ mol}$$

$n(CO_2) = n(N_2 + CO_2) - n(N_2) = 0 \cdot 2008 - 0 \cdot 0669 = 0 \cdot 1339$ mol

from the equation $n(CaCO_3) = n(CO_2) = 0 \cdot 1339$ mol

$m(CaCO_3) = n \times M = 0 \cdot 1339 \times 100 \cdot 09$ [$M(CaCO_3) = 100 \cdot 09$ g mol^{-1}]

$= 13 \cdot 4$g

4. (a) $n(Na_2CO_3) = \frac{m}{M} = \frac{2 \cdot 12}{105 \cdot 99} = 0 \cdot 02$ mol

$n(Cu(NO_3)_2) = c \times V = 1 \cdot 00 \times 10^{-2} = 0 \cdot 01$ mol [M $Na_2CO_3 = 105 \cdot 99$ g mol^{-1}]

$$Cu^{+2}{}_{(aq)} + CO_3^{-2}{}_{(aq)} \rightarrow CuCO_{3(s)}$$

from equation $\frac{n(Cu^{+2})}{n(CO_3^{-2})} = \frac{1}{1}$

L.R is Cu^{+2} ($Cu(NO_3)_2$)

from data $\frac{n(Cu^{+2})}{n(CO_3^{-2})} = \frac{1}{2}$

(b) from equation $n(CuCO_3) = n(Cu^{+2}) = 0 \cdot 01$ mol

$\therefore mCuCO_3 = n \times m = 0 \cdot 01 \times 123 \cdot 56$ [$M(CuCO_3) = 123 \cdot 56$ g mol^{-1}]

$= 1 \cdot 24$g

(c) $CuCO_{3(s)} + 2H^+(aq) \rightarrow CuSO_{4(aq)} + H_2O(\ell) + CO_2\,(g)$

$nCuSO_4 \cdot 5H_2O = n(CuSO_4) = n(CuCO_3) = 0{\cdot}01$ mol
$[M(CuSO_4 \cdot H_2O) = 249.69\ g\ mol^{-1}]$
$m(CuSO_4 \cdot 5H_2O) = n \times M = 0{\cdot}01 \times 249{\cdot}69 = 2{\cdot}4969$ g

For 90% recovery $m(CuSO_4 \cdot 5H_2O) = 2{\cdot}4969 \times \frac{9}{10} = 2.25$ g