Fast Track CHEMISTRY 2011

SECTION 1

1	a
2	b
3	a
4	b
5	d
6	c
7	b
8	d
9	d
10	d
11	c
12	a
13	d
14	d
15	b
16	b
17	c
18	a
19	b
20	b
21	c
22	c
23	c
24	b
25	d
26	a
27	b
28	d
29	b
3O	b

SECTION 2

1 a) $Ag^{+}_{(aq)} + Br^{-}_{(aq)} \longrightarrow AgBr_{(s)}$

Two colourless solutions mix to form white precipitate.

b) $Cu^{2+}_{(aq)} + 4NH_{3(aq)} \longrightarrow [Cu(NH_3)_4]^{++}_{(aq)}$

Pale blue solution mixes with colourless solution to form deep blue solution.

c) $CH_3CH_2OH_{(aq)} + CH_3CH_2COOH_{(aq)} \xrightarrow{H+} CH_3CH_2COOCH_2CH_3 + H_2O$

Two colourless solutions combine to form a **sweet smelling** colourless solution.

d) $2MnO_4^-{}_{(aq)} + 6H^+ + 5H_2O_{2(aq)} \longrightarrow 2Mn^{2+}{}_{(aq)} + 8H_2O_{(l)} + 5O_{2(g)}$

Purple solution is added to colourless solution and a colourless, odourless gas is evolved.

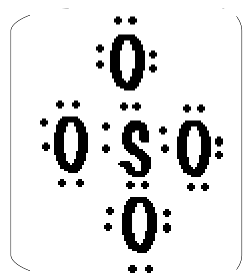
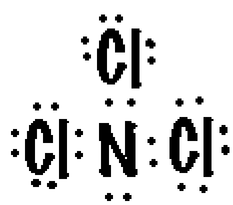
[12 MARKS]

2. a) $1s^2 2s^2 2p^6 3s^2 3p^6$

b) $1s^2 2s^2 2p^6$

[2 marks]

3.

Species	Structural formula (showing all valence shell electrons)	Shape (sketch or name)
sulfur dioxide, SO_2		**BENT**
Sulfate ion, SO_4^{2-}	 2-	**TETRAHEDRAL**
Nitrogen trichloride, NCl_3		**PYRAMIDAL**

[6 marks]

4. a) $MgCl_2$ consists of a strong ionic lattice which takes considerable energy to break, SCl_2 is a covalent substance and only relatively weak intermolecular forces need to be overcome, therefore it melts at a lower temperature.

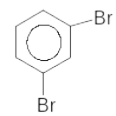
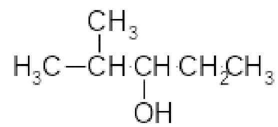
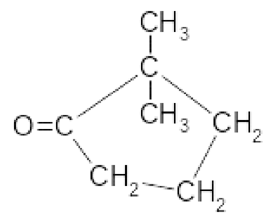
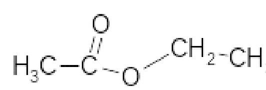
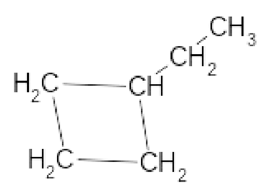
b) In the solid form all ions are in a rigid lattice and are not free to carry a charge. In the molten state, the ions are free to move and carry charge.

c) i) Yes, the solution contains mobile ions to carry charge.

ii) Yes, although PCl_3 is covalent, the pH is lower than 7, so there must be ionisation of water to some extent, therefore the solution will conduct an electric current.

[6 marks]

5.

Name of Compound	**Molecular Formula**	**Empirical Formula**	**Structural Formula**
1,3-dibromobenzene	$C_6H_4Br_2$	C_3H_2Br	
2-methyl-3-pentanol	$C_6H_{14}O$	$C_6H_{14}O$	
2,2-dimethylcyclopentanone	$C_7H_{12}O$	$C_7H_{12}O$	
Ethylethanoate	$C_4H_8O_2$	C_2H_4O	
Ethylcyclobutane	C_6H_{12}	CH_2	

[7 marks]

6. (a) methanal (b) 2-butanone (c) ethoxide ion ($CH_3CH_2O^-$)

[3 marks]

7. (a) solutions of magnesium chloride and zinc chloride.

Description of Test

e.g.: Add excess sodium hydroxide to samples of each.

Observation with magnesium chloride

White precipitate forms that does not re-dissolve.

Observation with zinc chloride

White precipitate forms that re-dissolves in excess sodium hydroxide (i.e.: soluble $[Zn(OH)_4]^{2-}$ forms)

(b) Samples of ammonia gas and nitrogen gas.

Description of Test

e.g.: Bubble each through distilled water and test with red litmus paper.

Observation with ammonia gas

Turns red litmus blue.

Observation with nitrogen gas

No observable reaction with red litmus.

[8 marks]

8. (a) bromine and chlorine incorrectly placed.

(b) e.g.: $Cl_{2(g)} + 2Na_{(s)} \longrightarrow 2NaCl_{(s)}$

(c) I^-, Br^-, Cl^-, F^-

(d) e.g.: $2Ag^+_{(aq)} + 2I^-_{(aq)} \longrightarrow 2Ag_{(s)} + I_{2(aq)}$

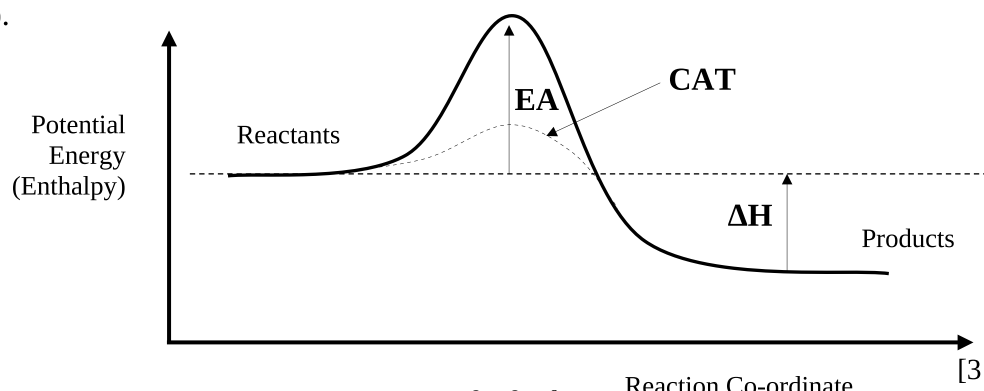
(e) Fluorine would oxidise all of the halides present producing free halogens in the solution and fluoride ions.

(f) Fluorine would also oxidise some of the water present

i.e.: $2F_{2(g)} + 2H_2O_{(l)} \longrightarrow O_{2(g)} + 4F^-_{(aq)} + 4H^+_{(aq)}$

[8 marks]

9. (a).



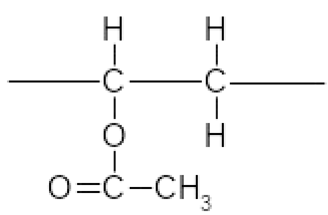
[3 marks]

(b) (i) A Neon atom: $1s^2 2s^2 2p^6$ [1]

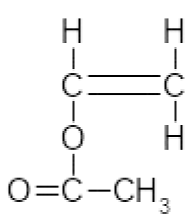
(ii) A Potassium ion: $1s^2 2s^2 2p^3 3s^2 3p^6$ [1]

[4 marks]

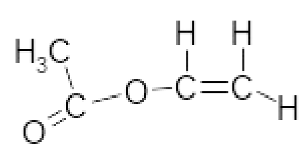
10. a)



b)



Or other representation eg:



c) Addition Polymerision

d) For example: Add bromine water, if the bromine water decolorised it would indicate unsaturation and that the reaction was incomplete.

[6 marks]

11. a) $k = \frac{[CO][Br_2]}{[COBr_2]}$

b)

CHANGE	EFFECT ON NUMBER OF MOLES OF $COBr_2$	REASON
Bromine gas is rapidly introduced to the reaction flask at a constant volume and temperature.	$\uparrow$	Reverse reaction favoured when extra product introduced
Ethene gas is rapidly introduced to the reaction flask at a constant volume and temperature.	$\downarrow$	Ethene is unsaturated $\therefore Br_2$ reacts and is consumed. $\therefore$FWD reaction favoured
The volume of the system is allowed to expand at a constant temperature	$\downarrow$	Greater volume will cause equilibrium position to shift to side with greatest moles of gas $\therefore$favour FWD reaction

[7 marks]

SECTION THREE

1. $2Al^{3+} + 3CO_3^{2-} \rightarrow Al_2(CO_3)_3$

n = cV

$n(Al(NO_3)_3) = 1.00 \times 0.250 = 0.250$ mol

$\therefore n(Al^{3+}) = 0.250$ mol [1]

$n(Na_2CO_3) = .500 \times 0.500 = 0.250$ mol

$\therefore n(CO_3^{2-}) = 0.250$ mol [1]

$n(CO_3^{2-})_{required} = (3/2) \times n(Al)$
$= (3/2) \times 0.250 = 0.375$ [1]

$\therefore$ (CO_3^{2-}) is the limiting reagent as there is only 0.250 mol present. [1]

$\therefore n(Al_2(CO_3)_3) = (1/3) \times n(CO_3^{2-})$
$= (1/3) \times 0.250 = 0.0833$ mol [1]

m = n x M

$\therefore m(Al_2(CO_3)_3) = 0.0833 \times 233.99$ **<u>= 19.5 g</u>** [1]

[6 marks]

(b) $c(CO_3^{2-}) = 0$ *(as carbonate is the limiting reagent.)*

[2 marks]

2. (a) $m(H)_{in\ 10.15\ g}$ = (2.016 / 18.016) x 4.40 = 0.492 g [1]

% (H) = (0.492 / 10.15) x 100 <u>= 4.90 %</u>

n (AgCl) = 12.54 / 143.35
= 0.0875 [1]

$m(Cl)_{in\ 5.48\ g}$ = 0.0875 x 35.45
= 3.101g [1]

% (Cl) = (3.101 /5.48) x 100 <u>= 56.6 %</u>

%(C) = 100% – (56.6% + 4.90%) <u>= 38.5 %</u> [1]

	C	H	Cl	
M	*(12.01)*	*(1.008)*	*(35.45)*	
n = m/M =	38.5 / 12.01	4.90 / 1.008	56.6 / 35.45	
n =	3.21	4.86	1.597	[1]
mole ratio =	3.21/1.597	4.86/1.597	1.597/1.597	[1]
	2.01 :	3.04 :	1	[1]

<u>Empirical Formula is C_2H_3Cl</u> [1]

[8 marks]

(b) **PV = nRT** **n = PV / RT**

n = (150 x 1.05) / (8.315 x 473)
= 4.00×10^{-2} mol [1]

M = m / n = $5.00 / 4.00 \times 10^{-2}$ = 125 g mol^{-1} [1]

M (C_2H_3Cl) = 62.49 g mol^{-1}

125/ 62.49 = 2 [1]

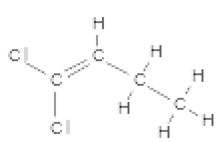
∴ molecular Formula = 2 x Emp. Form. **= $C_4H_6Cl_2$** [1]

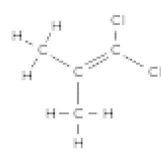
[4 marks]

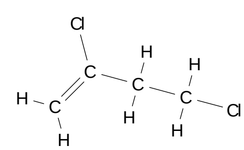
(c) *many possibilities, such as:*

1,1-dichloro-1-butene 1,1-dichloro-2-methyl-1-propene 2,4-dichloro-1-butene [1]

[1]







[2 marks]

3. (a) $MnO_4^-{}_{(aq)} + 8H^+{}_{(aq)} + 5Fe^{2+}{}_{(aq)} \rightarrow Mn^{2+}{}_{(aq)} + 4H_2O_{(l)} + 5Fe^{3+}{}_{(aq)}$ [1]

n = cV

$n(MnO_4^-)_{titration}$ = 0.0345 x 0.02468 [1]
= 8.515×10^{-4} mol [1]

$n(MnO_4^-)_{total}$ = (250/20) x 8.515×10^{-4}
= 0.01064 mol [1]

n (Fe^{2+}) = (5/1) x $n(MnO_4^-)_{total}$
= 0.05322 mol [1]

	m	**= n x M**
m(Fe)		= 0.05322 x 55.85
		= 2.972 g [1]

%(Fe) = (2.972/4.910) x 100 **= 60.5%** [1]

[7 marks]

(b) H^+ ions are required for the reduction of the MnO_4^- ion. [1]
In this reaction sulfuric acid is used to dissolve the alloy so the solution is already acidic [1]

[2 marks]

4. (a)

	Titrations		
	1	2	3
Final Reading (mL)	15.90	31.75	47.65
Initial Reading (mL)	0.00	15.90	31.75
Titre (mL)	**15.90**	**15.85**	**15.90**

[1]

Average Titre = 15.88 mL = 0.01588 L [1]

n **= cV**

n(HCl) = 1.05 x 0.01588 = 0.01668 mol [1]

$n(NaOH)_{unreacted}$ = n(HCl) = 0.01668 mol [1]

$n(NaOH)_{initial}$ = 0.500 x 0.0500 = 0.0250 mol [1]

'back titration'

$n(NaOH)_{reacted}$ = $n(NaOH)_{initial}$ - $n(NaOH)_{unreacted}$ [1] = 0.0250 - 0.01668
= 8.32 x 10^{-3} mol [1]

triprotic acid

$C_6H_8O_{7(aq)} + 3OH^-_{(aq)} \rightarrow C_6H_5O_7^{3-}{}_{(aq)} + 3H_2O_{(l)}$ [1]

∴ $n(C_6H_8O_7)$ = (1/3) x $n(NaOH)_{reacted}$ = (1/3) x 8.320 x 10^{-3} mol
= 2.773 x 10^{-3} mol [1]

m **= n x M** $M(C_6H_8O_7)$ = 192.124

$m(C_6H_8O_7)$ = 2.773 x 10^{-3} x 192.124 = 0.5327g [1]

∴ % by mass = (0.5327/8.00) x 100 <u>**= 6.66%**</u> [1]

[11 marks]

5. a) $n(FeS_2)$ = m/M
= 9.00 x 10^6/119.97
= 7.502 x 10^4 moles

∴ $n(H_2SO_4)$= 8/4 x 7.502 x 10^4
= 1.500 x 10^5 moles

∴ $n(H^+)$ = 1.500 x 10^5 x 2

$= 3.00 \times 10^5$ moles

$\therefore [H^+] = 3.00 \times 10^5 / 3.00 \times 10^7$

$= 1.00 \times 10^{-2}$ $molL^{-1}$ [3 marks]

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

$= -\log(1.00 \times 10^{-2})$

$= 2.00$ [2 marks]

c) n (NaOH)= m/M

$= 9.00 \times 10^6 / 39.998$

$= 2.25 \times 10^5$ mol

$= n(OH^-)$ [3 marks]

i.e.: needed 3.00×10^5 moles of OH^- ions to neutralise acid, $\therefore$ insufficient base added.

SECTION FOUR

Essay One

The following points should be included in a *good* essay:

- General discussion of electrical conductivity and how it relates to dissolved ions in solution
- Discussion of polar vs. non-polar and how the polar substances are only weakly ionised, this discussion should also include strong vs weak acids and electrolyte strength
- Discussion of how all of the purely ionics compounds are good electrolytes due to the formation of ions in solution
- A thorough discussion of the halogen halides and how although covalent, generally are good electrolytes due to their acidic nature, i.e.: they protonate to form H_3O^+ ions as well as halide ions so that charge can be carried.
- Notably, HF is a weak electrolyte due to the strong covalent bond between H and F. ie: F is very electronegative, $\therefore$HF is a weak acid and a weak electrolyte. Discussion should involve distance between valence shell and charge centre for fluorine.