ANDERSON JUNIOR COLLEGE
2008 H1 Chemistry Paper 2
Section A

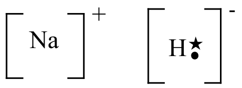
1 (a) $Li(g) \rightarrow Li^+(g) + e$

(b) (i) 519; 494; 418

(ii) Down the group, first IE decreases because increase in shielding effect outweighs increase in nuclear charge
Attraction between nucleus and valence electron decreases.

(c) (i) Na^+H^- is <u>ionic</u> compound whereas HF is <u>simple covalent</u> molecule because difference in electronegativity between atoms is high in NaH and low in HF

(ii)



NaH

HF

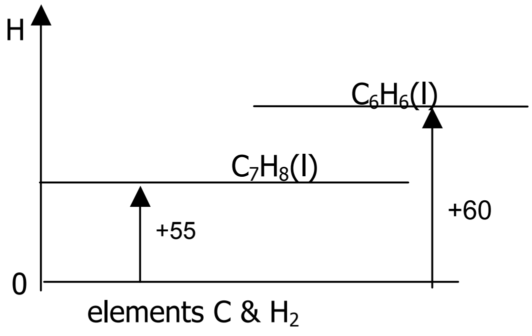
2 (a) (i) Substitution; with catalyst Fe or $FeBr_3$

(ii) Heat with acidified $KMnO_4$; methybenzene decolourises purple $KMnO_4$; benzene no change;
$C_6H_5CH_3 + 3\,[O] \rightarrow C_6H_5CO_2H + H_2O$

(b) (i) $C_6H_6 + 3O_2 \rightarrow 3C + 3CO + 3H_2O$

(ii) $\Delta H_c(C_6H_6) = -3276$ kJ mol^{-1}
$\Delta H_f = 6(-393) + 3(-286) - (-3276) = +60$ kJ mol^{-1}

(iii)



methylbenzene is at a lower energy level than benzene;
methylbenzene more stable than benzene

(c) unburnt hydrocarbons; carbon monoxide

3 (a) (i) $[\,H^+\,] = = 0.02\ mol\ dm^{-3}$
$pH = -log_{10}[\,H^+\,] = -log_{10}(0.02) = 1.70$

(ii) The acid is so dilute that H^+ from dissociation of H_2O cannot be ignored.
$[\,H^+\,] = 1.0 \times 10^{-8} + 1.0 \times 10^{-7} = 1.1 \times 10^{-7}\ mol\ dm^{-3} \Rightarrow pH = 6.96$

(b) **A** acids are H_2SO_4 and $H_2NO_3^+$ stronger acid is H_2SO_4
High $K_c \Rightarrow$ eqm lies to the right; tendency for H_2SO_4 to lose H^+ is higher

B acids are CH_3CONH_2 and NH_4^+ stronger acid is NH_4^+
Low $K_c \Rightarrow$ eqm lies to the left; tendency for NH_4^+ to lose H^+ is higher

(c) (i) NaCl pH 7 ; Al_2Cl_6 pH 3 - 4 ; $SiCl_4$ pH 2

(ii) NaCl merely dissolves to give Na^+ (aq) and Cl^- (aq);

Al_2Cl_6 undergoes partial hydrolysis
$Al_2Cl_6 + aq \rightarrow 2\,Al^{3+}(aq) + 6Cl^-(aq)$
$[Al(H_2O)_6]^{3+} \Leftrightarrow [Al(H_2O)_5(OH)]^{2+} + H^+$;

$SiC\ell_4$ undergoes strong hydrolysis.
$SiCl_4 + 2H_2O \rightarrow SiO_2 + 4HCl$

4 (a) (i) $8\,CO + 17\,H_2 \rightarrow C_8H_{18} + 8\,H_2O$

(ii) $\Delta H = [8(1074) + 17(436)] - [7(350) + 18(410) + 16(460)]$
$= -1186\ kJ\ mol^{-1}$

(b) (i)
$$K_c = \frac{[H_2][CO]}{[H_2O]}$$
Unit of K_c is $mol\ dm^{-3}$

(ii) K_c increases when temperature increases implies that forward reaction is favoured at high temperature.
Hence gasification of coal is an endothermic process.

(iii) $C\,(s) + H_2O\,(g) \rightleftharpoons H_2\,(g) + CO\,(g)$
Low pressure favours the forward reaction which is accompanied by an increase of gaseous molecules.
Hence low pressure increases the yeild of synthesis gas (H_2 & CO)

(c) The steam will react with CO and thus reduces its concentration in the synthesis gas. At the same time, H_2 concentration in the synthesis gas is increased by the reaction.

(d) Production of CO_2 leads to global warming.

(e) Abundant supply of coal relative to crude oil reserves / Coal is cheaper compared to volatile and unpredictable crude oil prices.

Section B

5 (a) Na_2O is giant ionic with strong ionic bonds between Na^+ and O^{2-} ions.
Dissolves readily in water to give a stong alkali
$Na_2O + H_2O \rightarrow 2NaOH$

SiO_2 is is giant molecular with strong covalent bonds between Si and O atoms.
It is insoluble in water.

P_4O_{10} is simple covalent with weak intermolecular forces of attractions. It dissolves readily in water to given a strong acid.
$P_4O_{10} + 6H_2O \rightarrow 4H_3PO_4$

(b) (i) GeO_2 high melting point ⇒ giant ionic
SeO_2 low melting point ⇒ simple covalent

(ii) GeO_2 amphoteric oxide
With NaOH: $GeO_2 + 2OH^- + 2H_2O \rightarrow Ge(OH)_6^{2-}$
With HCl : $GeO_2 + 4HCl \rightarrow GeCl_4 + 2H_2O$

SeO_2 is acidic oxide
With NaOH: $SeO_2 + 2OH^- \rightarrow SeO_3^{2-} + H_2O$
With HCl : No reaction

(c) (i) Amt of Cl in 0.10 g $SOCl_2$ = (0.10 ÷ 119.1) x 2 = 0.00168 mol
Amt of Cl in 0.10 g SO_2Cl_2 = (0.10 ÷ 135.1) x 2 = 0.00148 mol

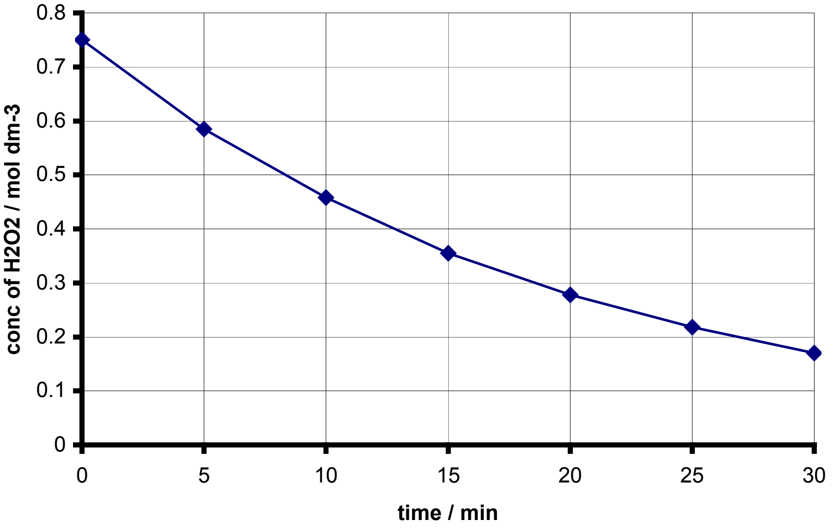
mole of Cl^- formed = mole of AgCl = 0.240 ÷ 143.5 = 0.00167 mol
Oxochloride is $SOCl_2$

(ii) Other than HCl,
$SOCl_2$ gives H_2SO_3 / SO_2Cl_2 gives H_2SO_4

(d) (from alcohols) e.g. CH_3CH_2OH
(from carboxylic acids) e.g. CH_3COOH

(e) elimination of HCl; NaOH in alcohol

6 (a) (i)

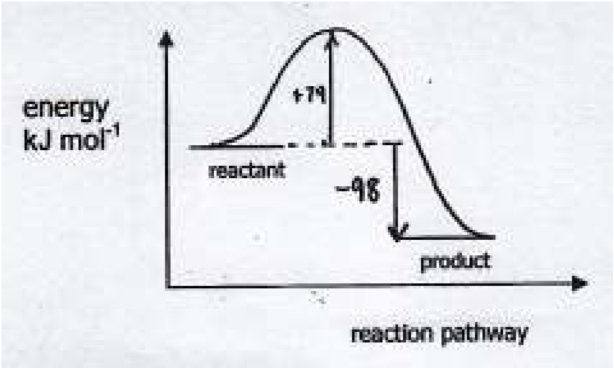


(ii) measure 2 successive half lives
→ $t_{½}$ constant (13.5 to 14.5 min)
→ reaction 1st order w.r.t. H_2O_2
rate = $k[H_2O_2]$

(iii) draw tangent at t = 0
initial rate = 0.0355 to 0.0385 mol dm^{-3} min^{-1}
k = initial rate ÷ $[H_2O_2]$ = 0.0480 to 0.0510 min^{-1}

(iv) Name any one : MnO_2 / Fe^{3+} / Pt etc

(b) (i)



(ii) value of k increases
since rate increases without increase in concentration of reactant

(c) (i)
- concentration increase causes molecules to be closer together
- Increased collision rate

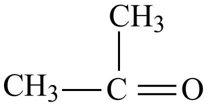
(ii)
- temperature increase causes kinetic energy to increase
- more molecules will possess energy equal to or exceeding activation energy

6 (d) (i) $H_2O_2 \rightarrow O_2 + 2H^+ + 2e$
$MnO_4^- + 8H^+ + 5e \rightarrow Mn^{2+} + 4H_2O$
$5H_2O_2 + 2MnO_4^- + 6H^+ \rightarrow 5O_2 + 2Mn^{2+} + 8H_2O$
mole of H_2O_2 used = 50/1000 x 0.0100 = 5×10^{-4} mol
mole of MnO_4^- needed = 2/5 x 5×10^{-4} = 2×10^{-4} mol

volume of MnO_4^- = 2×10^{-4} / 0.02 = 0.01 dm^3 = $\underline{10\ cm^3}$

(ii) In this titration, 1 mol $H_2O_2 \equiv$ 1 mole O_2
mole O_2 produced = 5×10^{-4} mol
volume of O_2 at room condtions = 5×10^{-4} x 24 dm^3 = $\underline{12\ cm^3}$

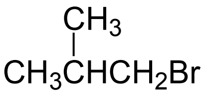
(e)



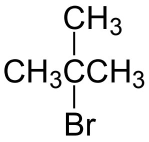
$CH_3-C(CH_3)=O$ CO_2

7 (a) (i) 2-bromobutane
(ii)

$CH_3CH_2CH_2CH_2Br$

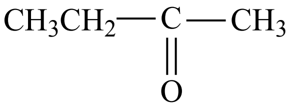


$CH_3CH(CH_3)CH_2Br$



$CH_3C(CH_3)(Br)CH_3$

(b) (i) oxidiation
(ii)



$CH_3CH_2-C(=O)-CH_3$

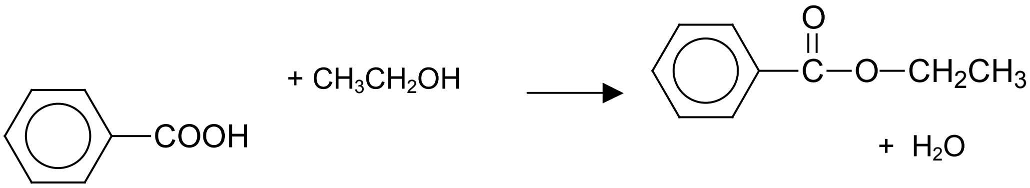
(iii) Yellow precipitate formed.
CHI_3 and $CH_3CH_2COO^-Na^+$

(c) (i) Boiling point: Compound **E** < Compound **F** < Compound **A**
lowest highest

E is non-polar with weak van der Waals's forces between molecules.
F and **A** are polar with stronger dipole-dipole attraction b/w molecules.
A has more electrons than **F.** Van der Waals' forces stronger in **A** than in **F.**

(ii) CFCs lead to the depletion of the ozone layer.

7 (d) (i)



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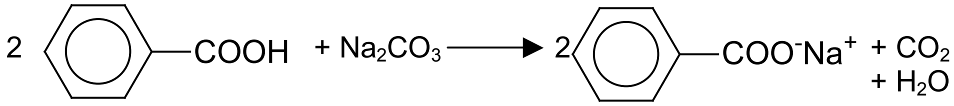

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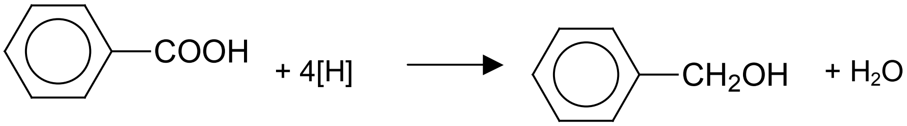

(e) 2,2-dichlorobutanoic acid has 2 highly electronegative Cl atoms to exert electron-withdrawing effect on the $–COO^-$ ion / COOH group.

The negative charge becomes more delocalized and the ion becomes more stable. / The dissociation 2,2-dichlorobutanoic acid is more favoured.

Hence 2,2-dichlorobutanoic acid is a stronger acid.

(f) (i) Add 2,4-dinitrophenylhydrazine to both compounds.

Compound S will give a yellow/orange precipitate but Tamoxifen will not.

(ii)

$$\text{Percentage mass of C} = \frac{26(12.0)}{26(12.0)+31(1.0)+14.0+16.0} \times 100\%$$

$$= \frac{312}{373} \times 100\%$$

$$= 83.6\ \%$$

Paper 1 (MCQ) Answers

1	B	**7**	D	**13**	A	**19**	D	**25**	C
2	D	**8**	B	**14**	B	**20**	C	**26**	B
3	C	**9**	D	**15**	C	**21**	B	**27**	B
4	B	**10**	C	**16**	D	**22**	D	**28**	D
5	A	**11**	A	**17**	C	**23**	C	**29**	C
6	A	**12**	C	**18**	A	**24**	A	**30**	A