# Corrections for Cameroon GCE Advanced Level Chemistry Paper 2 June 2013

## SECTION A (CGCEB 2013)

### Physical chemistry

1. (a) (i) The number of atoms in exactly 12g of carbon-12 isotopes.

(ii) This is the mass of a substance that contain as many elementary particles as there are atoms in exactly 12g of carbon-12 isotope.

(b). (i) Molar mass $(2 \times 27) + (3 X 32) + (4 \times 3 \times 16) + 6(18) = 450$

Number of mole $\frac{9}{450} = 0.02$ mol

(ii) $Al_2(SO_4)_3H_2O \rightarrow 2Al^{3+} + 3SO_4^{2-} + 6H_2O$

$1 mole\ of\ Al_2(SO_4)_3H_2O\ contain\ 3 mole\ of SO_4^{2-}$

0.02mol$Al_2(SO_4)_3H_2O$ will contain $0.02x3 = 0.06$mol

(iii) $molarity = \frac{0.02}{250} \times 1000 = 0.08M$

(c). (i) It is a change that takes place in the nucleus of an atom either spontaneously or as a result of bombardment with a ray or high energy neutron. OR it involves changes in the nucleus of an atom.

$2({}^{1}_{1}\mathrm{H}) + 2{}^{1}_{0}\mathrm{n} \rightarrow {}^{4}_{2}\mathrm{He}$

${}^{238}_{92}\mathrm{U} \rightarrow {}^{4}_{2}\mathrm{He} + {}^{234}_{90}\mathrm{Th}$

(ii) ${}^{238}_{92}\mathrm{U} \rightarrow \mathrm{a}({}^{4}_{2}\alpha) + \mathrm{b}({}^{0}_{-1}\beta) + {}^{226}_{88}\mathrm{R}$

$238 = 4a + 226 \Longrightarrow a = \frac{238 - 226}{4} = 3$

$92 = 2a - b + 88 \Longrightarrow -b = 92 - 2(3) - 88 = -2$

$\Longrightarrow b = 2$

A: 3 alpha, B 2 beta

(d). (i) $\frac{10.65}{35.5} = 0.3\ mol$ (ii) $\frac{5.6}{56} = 0.1\ mol$

(iii)

| Element | Fe | Cl |
|---|---|---|
| | 0.1 | 0.3 |
| Mole ratio | $\frac{0.1}{0.1}=1$ | $\frac{0.3}{0.1}=3$ |
| Formula of chloride | $FeCl_3$ | |

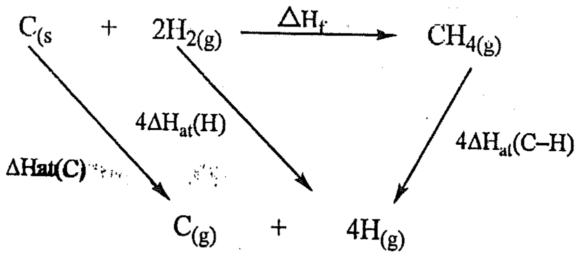
equation : $2Fe_{(s)} + 3Cl_{2(g)} \longrightarrow 2FeCl_{3(s)}$

(e). (i) It is the average bond energy per mole of a specific bond with respect to it environment (or in a range of molecules)

(ii) $CaCl_{2(s)} \longrightarrow Ca^{2+}_{(g)} + Cl^{-}_{(g)}$ $\Delta H = +Ve$

Or $Ca^{2+}_{(g)} + Cl^{-}_{(g)} \longrightarrow CaCl_{2(s)}$ $\Delta H = -Vc$

(f).



$$\Delta H_{at(C)} + 4\Delta H_{at(H_2)} = \Delta H_f + 4\Delta H_{dis(C-H)}$$

$$\Delta H_{at(C)} + 4\Delta H_{at(H_2)} - \Delta H_f = 4\Delta H_{dis(C-H)}$$

$$\frac{\Delta H_{at(C)} + 4\Delta H_{at(H_2)} - \Delta H_f}{4} = \Delta H_{dis(C-H)}$$

$$\frac{717 + 4(218) - (-75)}{4} = 416KJmol^{-1}$$

(g). (i) This is because the bond is not purely ionic but intermediate between ionic and covalent duc to bond polarization.

(ii) A: AgCl, or AgBr, or AgI

B: NaI,or NaCl, Or NaBr

(iii) Because it shows all the other energy changes which can be determined experimentally except the lattice energy. OR it is an indirect method of determining the lattice energy since the cycle shows all other enthalpy changes which can be determine experimentally.

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2. (a) (i) It is the rate at the time when the reactants are just brought together. OR it is the rate at time t=0, when an infinitely small amount of the reactant has been used up.

(ii) It is the power to which the reactant concentration is raised in an experimentally determined rate equation.

(b) It is uses to calculate the rate of a reaction when the reactant concentration has change. It is also useful in determining the mechanism of a reaction.

(c) (i) Consider experiment 1 and 2

$[CH_3COCH_3]$ is constant

$[I_2]$ is double

$[H^+]$ is constant. The rate is constant therefore, the reaction is 0th order with respect to $[I_2]$

Considering experiment 1 and 3

$$5.7 \times 10^{-5} = (0.3)^x(0.05)^y(0.05)^z \ldots\ldots..(1)$$

$$1.2 \times 10^{-4} = (0.3)^x(0.05)^y(0.1)^z \ldots\ldots\ldots.(2)$$

$$\frac{eqn(1)}{eqn(2)} \Rightarrow \frac{5.7 \times 10^{-5}}{1.2 \times 10^{-4}} = \left(\frac{0.05}{0.1}\right)^z$$

$$0.475 = (0.5)^z \Rightarrow z = 1.$$

Thus the reaction is 1st order with respect to $[H^+]$

Considering experiment 1 and 5

$$5.7 \times 10^{-5} = (0.3)^x(0.05)^y(0.05)^z \ldots\ldots..(1)$$

$$7.1 \times 10^{-5} = (0.36)^x(0.05)^y(0.05)^z \ldots\ldots\ldots.(2)$$

$$\frac{eqn(2)}{eqn(1)} \Rightarrow \frac{7.1 \times 10^{-5}}{5.7 \times 10^{-5}} = \left(\frac{0.36}{0.30}\right)^x$$

$$1.2 = (1.2)^z \Rightarrow x = 1.$$

Thus the reaction is 1st order with respect to $[CH_3COCH_3]$

(ii) Overall order is 1+1=2

(iii) $rate = K[CH_3COCCH_3]^1[H^+]^1$

(iv) $Using\ exp't\ 5$

$7.1 \times 10^{-5} = K[0.36]^1[0.05]^1$

$\Rightarrow 7.1 \times 10^{-5} = 0.018K$

$$\frac{7.1 \times 10^{-5}}{0.018} = K \Rightarrow K = 3.9 \times 10^{-3}$$

Unit$=\frac{mol}{dm^3 s} \times \frac{dm^3}{mol} \times \frac{dm^3}{mol} = dm^3 mol^{-1} s^{-1}$

Hence $K = 3.9 \times 10^{-3} dm^3 mol^{-1} s^{-1}$

(v) **Colorimetry method** since iodine is coloured while iodide is colourless.

(d) A solution with similar intermolecular forces as in the separate components of the liquid. Or a solution which obeys Raoult's law.

(e) Molar mass of methanol=12+4+16=32

Number of moles$=\frac{30}{32} = 0.94$

Molar mass of ethanol=46

Number of moles$=\frac{45}{46} = 0.98$

Total number of moles=0.94+0.98=1.92

(ii) $X_{meth} = \frac{0.94}{1.92} = 0.49$

$X_{eth} = \frac{0.98}{1.92} = 0.51$ Or $1 - 0.49 = 0.51$

Where X, is the partial pressure of each component in the liquid. (or mole fraction)

$P_{meth} = X_{met}P^0_{met} = 0.49 \times 94 = 46.06 mmHg$

$P_{eth} = X_{eth}P^0_{eth} = 0.51 \times 44 = 22.44 mmHg$

(iii) $P_T = P_{meth} + P_{eth} = 46.06 + 22.44 = 68.49 mmHg$

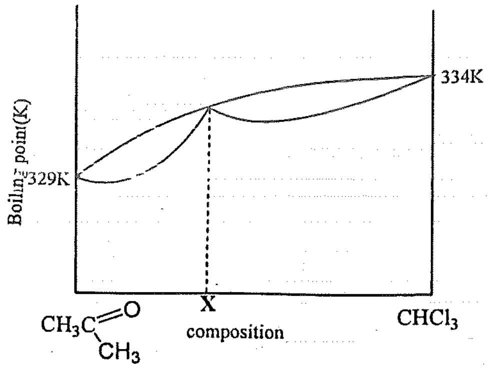
(iv) Mole fraction of methanol in vapour

$$y_{meth} = \frac{P_{meth}}{P_T} = \frac{46.06}{68.49} = 0.68$$

Where y is the partial pressure of each component in the vapour

(f) (i) Fractional distillation.

(ii)



X=azeotropic mixture

(iii) No. Because of the presence of constant boiling point mixture with the same composition in the vapour as in the liquid called azeotropic mixture.

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3. (a) It states that for a system in equilibrium, at constant temperature, the product of the concentrations of the products divided by the product of the concentrations of the reactants each raised to a power equal to the coefficient in a chemical balanced equation is a constant.

i.e. $aA+bB \rightleftharpoons cC+dD$

$$Kc = \frac{[C]^c_{eqm}[D]^d_{eqm}}{[A]^a_{eqm}[B]^b_{eqm}}$$

(b) (i) The reaction is exothermic since the value of the Kp decreases when the temperature increases from 500°C to 1100°C indicating that the concentration of $NH_3$ is decreasing as it decomposes to $N_2$ and $H_2$.

(ii) (A): The equilibrium will shift to the left since the reaction is exothermic thus more $N_2$ and $H_2$ will be produced.

(B) The equilibrium will shift to the right since the number of gaseous molecules (number of moles) of reactants is greater than those of the product. The shift is to minimize the change.

(C) It does not affect the equilibrium position. It increases the rate of the forward and backward reaction at the same rate.

(iii) The equilibrium position will decrease as more $NH_3$ dissociates to $H_2$ and $N_2$ thus reducing the concentration of the product and reducing the equilibrium constant

(c). It is the e.m.f of that half cell measured between a standard hydrogen electrode and the electrode system under standard conditions of 1 molar solution, 25°C (298K) and 1atm.

(d). (i) (A) $S_2O_3^{2-}$

(B) $I_2$

(ii) $Pt/2S_2O^{2-}_{3(aq)}, S_2O^{2-}_{6(aq)} \vdots\vdots I_{2(aq)}, 2I^-_{(aq)}/Pt$

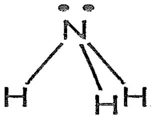
$E.m.f = E_R - E_L = 0.54 - 0.10V = +0.64V$

(e) (i) In $H^+$, the positive charge nuclei repel each other and are attracted by a single electron in the covalent bond thus $H\text{-}H^+$ is weaken while in $H_2$ the positive charge nuclei repel each other and are attracted by two electrons in the covalent bond which stabilize the H-H bond.

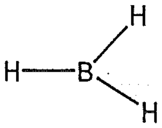
(ii) Aluminium atom are held by metallic bonds when deformed, the metal ions slide past each other and are attracted by the delocalized electrons but carbon is held by a covalent bond which when broken the positive charge nuclei repel each other.

(iii) The presence of hydrogen bonds between ammonia molecules due to high electronegativety of nitrogen than phosphorus

(f). (i)

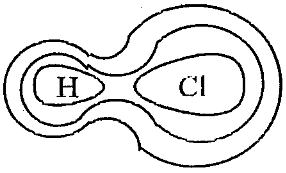


Trigonal pyramidal. The lone pair of electron on nitrogen repels the three bonded pair as far apart as possible than the way bonded pair repel each other



Trigonal planar. These bonded pairs repel each other equally to a maximum bond angle of 120°C

(ii)



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Section B continues below...

# Inorganic Chemistry starts...

## SECTION B: GCEB 2013

### Inorganic chemistry

4. (a) (i) the physical states change from gas to liquid to solid. Due to an increase in the strength of van der waal force as molar weight and number of electrons increases down the group.

(ii) Oxidizing power increases up the group due to increase in electronegativity.

(iii) The acid strength of H-X (hydrogen halide) increases down the group because the H-X bond length becomes longer and weaker from HF to HI hence eases ionization.

(b) (i) A reaction in which a species (atoms, molecule or ions) is simultaneously reduced and oxidized.

(ii) Dilute KOH

$$Cl_{2(g)} + 2KOH_{(aq)} \rightarrow KCl_{(aq)} + KClO_{(aq)} + H_2O_{(aq)}$$

Conc. KOH

$$3Cl_{2(g)} + 2KOH_{(aq)} \rightarrow 5KCl_{(aq)} + KClO_{3(aq)} + 3H_2O_{(aq)}$$

(c). (i)

$$2NaCl_{(aq)} + H_2SO_{4(aq)} \rightarrow Na_2\,SO_{4(aq)} + 2HCl_{(aq)}$$

$$2NaI_{(aq)} + 2H_2SO_{4(aq)} \rightarrow Na_2SO_{4(aq)} + SO_{2(g)} + 2H_2O_{(l)} + I_{2(aq)}$$

(ii) Sulphuric acid is a stronger oxidizing agent than HI thus it will oxidize HI to iodine.

(iii)

| Oxidation state | Formula of compound | Name of compound |
|---|---|---|
| +6 | $H_2SO_4$<br>$Na_2SO_4$<br>$SO_3$ | Sulphuric acid<br>Sodium Sulphate<br>Sulphur trioxide |
| +4 | $SO_2$<br>$Na_2SO_3$ | Sulphur dioxide<br>Sodium sulphite |
| +2 | $Na_2S_2O_3$<br>$SCl_2$ | Sodium thiosulphate<br>Sulphur dichloride |
| -2 | $H_2S$<br>$FeS$<br>$Na_2S$ | Hydrogen sulphide<br>Iron(II) sulphide<br>Sodium sulphide |

(e). (i) $S_{(s)} + O_{2(g)} \rightarrow SO_{2(g)}$

$H_2S_{(g)} + Cl_{2(g)} \rightarrow 2HCl_{(g)} + S_{(s)}$

$2H_2S_{(g)} + 3O_{2(g)} \rightarrow 2SO_{2(g)} + 2H_2O_{(l)}$

(ii) $2I^-_{(aq)} + S_2O_8^{2-} \rightarrow I_{2(aq)} + 2SO_4^{2-}$

$Na_2SO_{3(s)} + 2HCl_{(aq)} \rightarrow 2NaCl_{(aq)} + SO_{2(g)} + H_2O_{(l)}$

$Cu_{(s)} + 2H_2SO_{4(aq)} \rightarrow CuSO_{4(aq)} + 2H_2O_{(l)} + SO_{2(g)}$

(f). It causes atmospheric pollution by dissolving in water to form acid rain which promote corrosion

(g). Use as fertilizers e.g.$(NH_4)_2SO_4$, $NH_4NO_3$

5. (a) (i) d-block arc element whose valence electrons enter the inner d-subshell while transition metals are elements that form at least one stable ion or compound with a partially filled d-orbital

(ii) Transition metals are elements that form at least one stable ion with a partially filled d-orbital

(iii) (A) Scandium, zinc (B) titanium, copper, Vanadium, nickel, manganese, chromium, cobalt, iron etc

(b) (i) $Cu^+ = [Ar]3d^{10}4s^0$

$Cu^{2+} = [Ar]3d^9 4s^0$

$Cu^{2+}$is more stable than $Cu^+$ because high charge density of $Cu^{2+}$increases salvation.

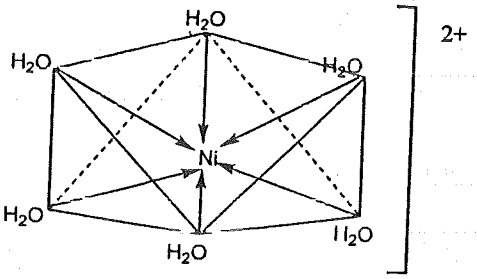
| | Explanation | Example |
|---|---|---|
| Bidentate | **It is a ligand** which forms two coordinate bond (with the central metal ion with two donor atoms) | *Ethylenediamine<br>*Ethandioate<br>*2-hydroxylbenzoate |
| polydentate | A ligand which forms more than two coordinate bonds with the central metal ion using more than two donor atoms | Ethylenediaminetetraacetate(EDTA) |

(c) (i) $x + 6(0) = +2 \Rightarrow x = +2$

NB: water is a neutral ligand.

The oxidation state is +2

(ii) hexaaquanickel(II) ion



(iii)$[Ni(EDTA)]^{2-}$

(iv)6

(v)Use to absorb poisonous metal from the body, it can also be used in titration to determine the concentration of metal ions in solutions

Use as water softener

(e) (i) It decreases down the group because of faster decrease in hydration energy and compared to the decrease in lattice energy.

(ii) It decreases up the group because of faster increase in lattice energy and as compared to increase in hydration energy.

(iii)It decreases down the group due to decrease in the polarizing power of the cation as the ionic size increases causing the resulting oxide to be less stable

(f). (i) A white precipitate is observed when few drops were added which is insoluble in excess sodium hydroxide.

(ii) A white precipitates insoluble in excess reagent.

(iii) No precipitate was observed when few drops were added $Mg(OH)_2$ is slightly soluble and precipitates immediately

$Mg^{2+}_{(aq)} + OH^-_{(aq)} \rightleftharpoons Mg(OH)_{2(aq)}$

$Ba(OH)_2$ is more soluble

$Ba(OH)_{2(aq)} \longrightarrow Ba^{2+}_{(aq)} + OH^-_{(aq)}$

6. (a) (i) **CO** carbon monoxide

(ii) $SiO_2$ silicon dioxide

(iii) $GeCl_2$ germanium (II) chloride

Or $SnCl_2$ tin(II) chloride

(iv)$CCl_4$ carbon tetrachloride

(b) Because the +2 oxidation state is more stable in lead compounds than the +4 oxidation state due to inert pair effect.

(c) (i) Diamond and graphite

(ii) Graphite

Because only 3-electrons per atom are involved in covalent bond formation and one electron per atom is donated to a sea of delocalize electrons in the crystal.

(d) (i) $2NaOH_{(aq)} + SiO_{2(s)} \longrightarrow Na_2SiO_{3(s)} + H_2O_{(l)}$

(ii) $PbO_{(s)} + 2HNO_{3(aq)} \longrightarrow Pb(NO_3)_{2(aq)} + H_2O_{(l)}$

(e) Sn, $Sn^{2+}$ is a good reducing agent which ends up being oxidized

(f) Because of the strength of the C-C, C=C, and C ≡ C bond and the ability of carbon to catenate than other group IV elements.

(g) (i) chlorine

(ii) Argon

(e). (i) Increase in metallic strength in magnesium because of one extra electron per atom donated to the sea of delocalize electron

(ii) Si has a giant covalent structure thus; strong covalent bond has to be broken.

(iii) Sulphur exists as $S_8$ molecule while phosphorus as $P_4$ molecule thus; the strength of the van der waal force is stronger in sulphur than in phosphorus.

(f). It changes from ionic in the oxide of Na Mg, intermediate ionic-covalent in Al to covalent in the rest as electronegativity increases across the period.

(g). (i) $Na_2O_{(s)} + H_2O_{(l)} \longrightarrow 2NaOH_{(aq)}$

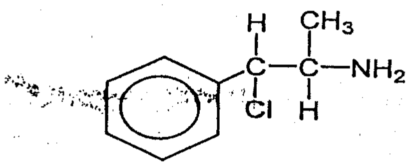
(ii) $SiCl_{4(l)} + 4H_2O_{(l)} \longrightarrow SiO_2.2H_2O + 4HCl_{(aq)}$

Section C: Organic Chemistry continues below...

## Organic Chemistry section starts

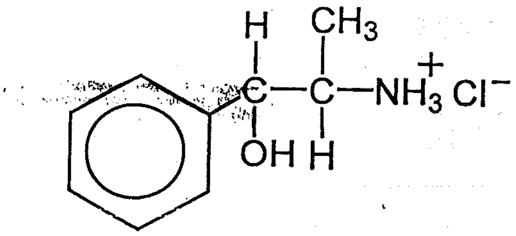
### SECTION C (CGCEB 2013)
### ORGANIC CHEMISTRY

7. (i) (A)

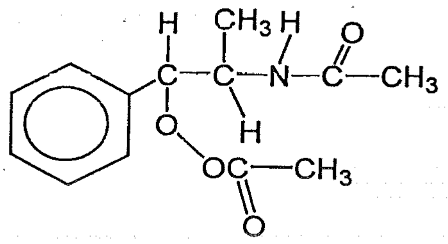


1-chloro-1-phenylpropan-2-amine

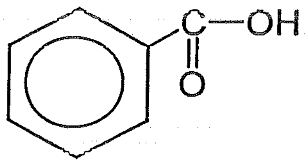
(B)



(C)



(D)



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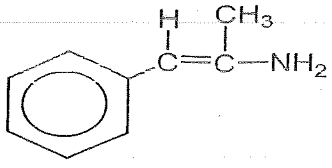
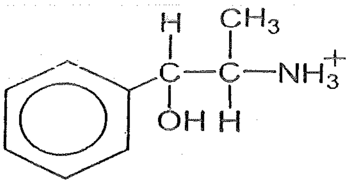
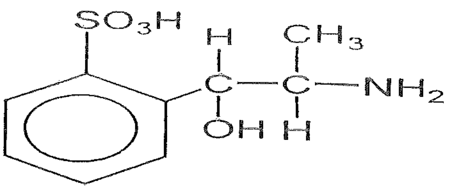


cis-1-phenylprop-1-en-2-amine

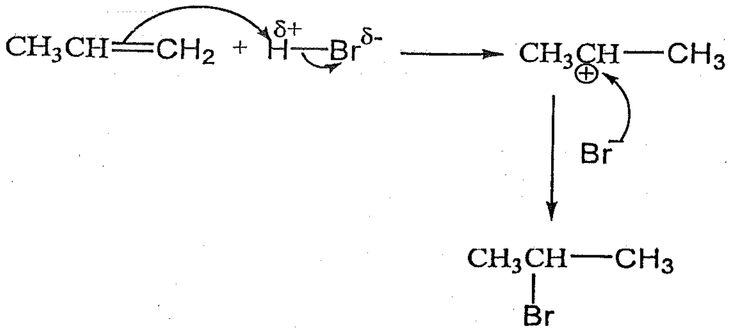




(ii) Crystallization (NB: compound A is a solid)

(iii) The compound should have a constant melting point.

(b).



(c). (i) step 1 $H^+/KMnO_4$, heat

Step 2 $PCl_5$; at room temperature or $SOCl_2$, heat under reflux

Step3 methanol/ warm

(ii) $C_6H_5COOH + NaOH/CaO \xrightarrow[\Delta]{} C_6H_6 + Na_2CO_3$

Decarboxylation

(d). (i) $CH_3COOH$ will liberate $CO_2$ with sodium carbonate or $NaHCO_3$. The $CO_2$ turn lime water milky. $HCOOCH_3$ will not.

(ii) $CH_3COCH_3$ will give an orange precipitate with 2,4-dinitrophenylhydrazine while $CH_3CO_2CH_3$ will not

OR $CH_3COCH_3$ will give a yellow precipitate with $I_2/NaOH$ While $CH_3CO_2CH_3$ will not.

(iii) $CH_3CONH_3$ will liberate ammonia when warm with sodium hydroxide. The ammonia turns red litmus paper blue while $CH_3CH_2NH_2$ will not

8. *(a)*

| Spectroscopic method | Information obtained |
|---|---|
| Mass Spectrometer | Molar mass or Fragmentation Patterns |
| Infrared spectrometer | Bond types or functional group |
| NMR spectroscopy | Identification of the environment of H-atom or C-13 atom or atom with odd number of electrons. |

(b) (A)

| Element | C | H | Cl |
|---|---|---|---|
| No. mole | $\frac{0.24}{12} = 0.020$ | $\frac{0.05}{1} = 0.0500$ | $\frac{0.355}{35.5} = 0.0100$ |
| Mole ratio | $\frac{0.0200}{0.0100} = 2$ | $\frac{0.050}{0.0100}0 = 5$ | $\frac{0.0100}{0.0100} = 1$ |
| Empirical formula | $C_2H_5Cl$ | | |

(B) The molar mass of the compound is 64.5g/mol. This is the fragment with the highest mass known as the molecular fragment.

(C) (i)

$$(C_2H_5Cl)n = Mf$$
$$\Rightarrow (2 \times 12 + 5 \times 1 + 35.5)n = 64.5$$
$$(64.5)n = 64.5 \Rightarrow n = \frac{64.5}{64.5} = 1$$
$$Mf = C_2H_5Cl$$

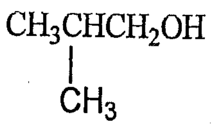
(ii)

| Mass point | Species |
|---|---|
| 15 | $^+CH_3$ |
| 49 | $^+CH_2Cl$ |
| 51 | $^+CH_3Cl$ (isotopes possible) |

(iii) The organic compound is heated with sodium to convert any halide present to sodium halide. The sodium halide is treated with silver nitrate acidified with dilute nitric acid. If a white precipitate is observed, then chlorine is present in the compound.

(c). (i) Chain isomerism

$CH_3CH_2CH_2CH_2OH$ and



$CH_3\underset{\underset{CH_3}{|}}{CH}CH_2OH$

(ii) Functional group isomerism

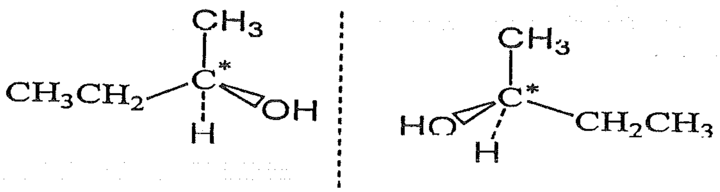
$CH_3CH_2CH(OH)CH_3$ and $CH_3CH_2$-O-$CH_2CH_3$

(iii) Position isomerism

$CH_3CH_2CH_2CH_2OH$ and $CH_3CH_2CH(OH)CH_3$

(iv) Optical isomerism

$CH_3CH_2CH(OH)CH_3$

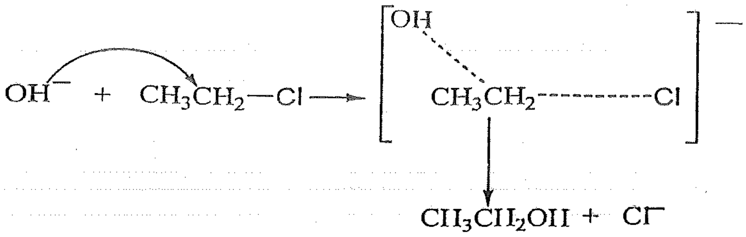


Enantiomers

(d). (i) Dilute KOH or NaOH : *reflux*

(ii) Hot conc.NaOH/alcohol or conc.KOH/alcohol. Condition: *reflux*

(e).



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9. (a) (i)

10. $CH_3COOH + SOCl_2 \xrightarrow[heat]{} CH_3COCl + SO_2 + HCl$

$CH_3COOH + PCl_5 \rightarrow CH_3COCl + POCl_3 + HCl$

(ii) $CH_3COOH + conc.\ NH_3 \xrightarrow[\Delta]{} CH_3CONH_3 + H_2O_{(g)}$

(iii) $CH_3COOH + CH_3OH \xrightleftharpoons{Conc.H_2SO_4} CH_3COOCH_3 + H_2O$

(f) (i) $CH_3COOH$ carbon dioxide with $Na_2CO_3$ while $CH_3COCl$ will not.

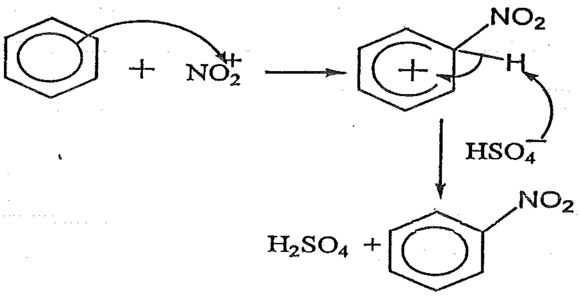
(ii) $CH_3CONH_3$ releases ammonia when warm with conc. NaOH while $CH_3COOH$ will not

(g) (i) C Phenylamine

(D) Benzenediazonium chloride or Phenyldiazonium chloride

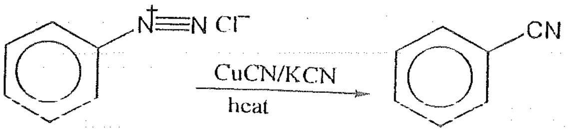
| Stage 1 | Type of reaction | Reagent/reaction condition |
|---|---|---|
| Step 1 | Electrophilic substitution | Conc.$H_2SO_4$ + conc. $HNO_3$, >55°C, reflux<br>Acid must be concentrated |
| Step 2 | Reduction | Sn/conc. HCl: heat under reflux |
| Step 3 | Diazotization reaction | Conc. HCl/$NaNO_2$, temperature <5°C in ice bath. |

**(iii)**

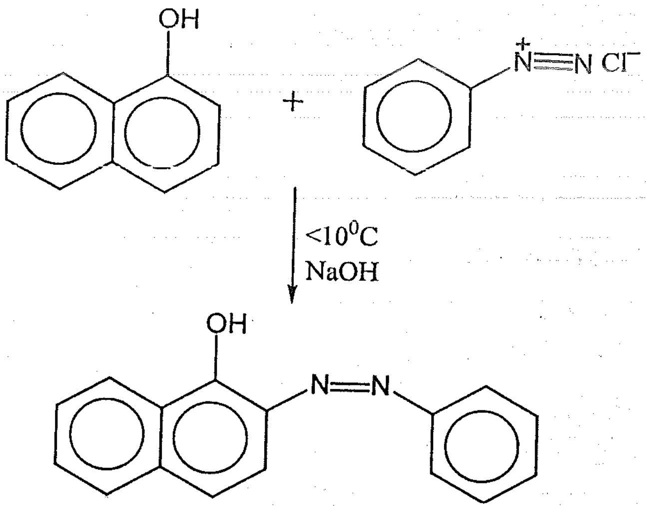


**(iv)** **Steam distillation**

(v) (A)



(B)



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**SET 6: SECTION C (CGCEB 2014)**

**Organic Chemistry**

7. **(a) ether**

(b) **J the molecule** contains weak intermolecular dipole-dipole force while the other molecule (K, L, M and N) contain intermolecular hydrogen bond between their molecules.

(c) Functional group isomerism

(d) L will give **cloudiness** with Lucas reagent (Zn/conc.HCl) after 5minute while K (primary alcohol) will not at room temperature.

$$CH_3CH(OH)CH_3 \xrightarrow{Zn/Conc.HCl} CH_3CH(Cl)CH_3$$

L will give a (positive iodoform test) yellow precipitate of $CHI_3$ with $NaOH/I_2$ (iodoform reagent) but K (give a negative iodoform test) will not

(e) (i) $HOOC-CH=CH-COOH$

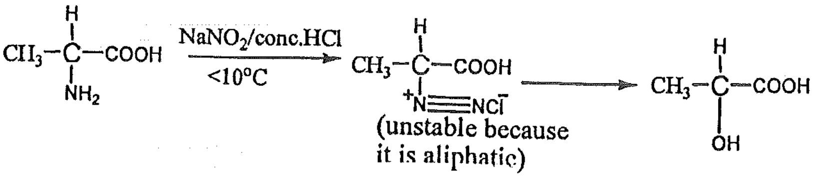
Geometric isomerism

(ii) The presence of a double bond in the molecule which prevents free rotation in space

(iii) The cis isomer will dehydrate at a temperature of 150°C while the trans isomer will simply sublimes. OR the cis isomer will have intramolecular hydrogen bond hence low boling point while the trans will have intermolecular hydrogen bond hence high boiling point.

(f) (i) amino acid

(ii) (A)



(unstable because it is aliphatic)