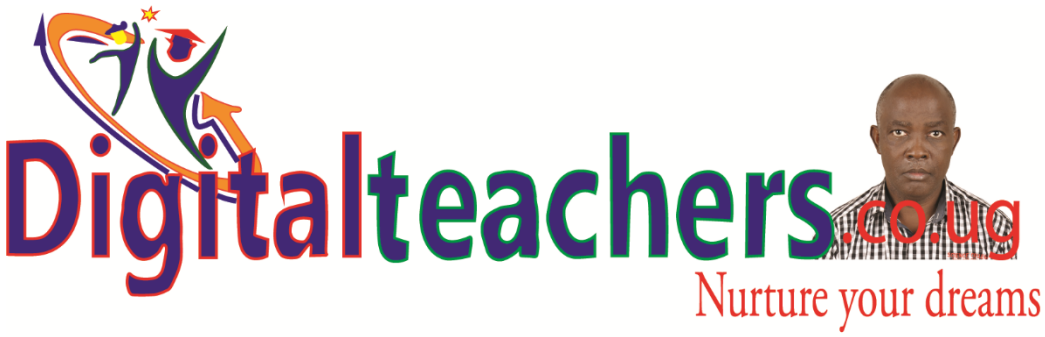


Our country, our future

525/2

S6 CHEMISTRY

Exam 7

PAPER 2

DURATION: 2 HOUR 30 MINUTES

For Marking guide contact and consultations: Dr. Bbosa Science 0778 633 682.

Instructions

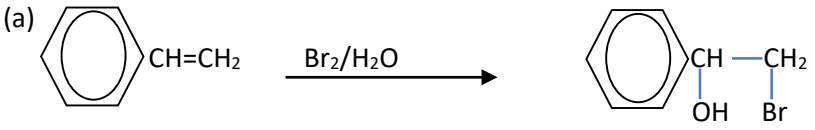
Answer five questions including **three** from section A and any **two** from section B

Begin each question on a fresh page.

SECTION A

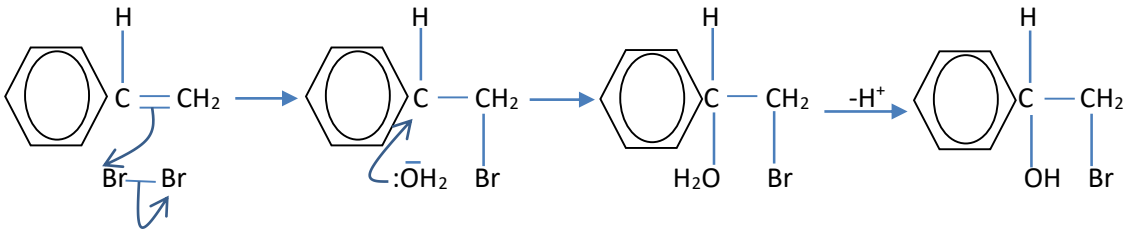
Answer any **three** questions from this section

1. Complete the following equations and in each case suggest an acceptable mechanism.

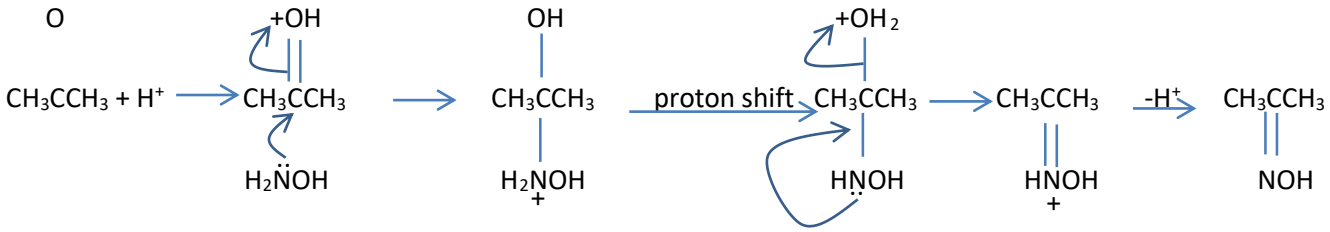
(a) 

(3 ½ marks)

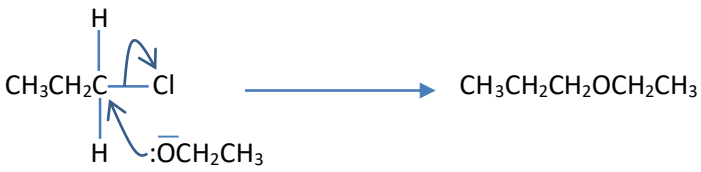
Mechanism



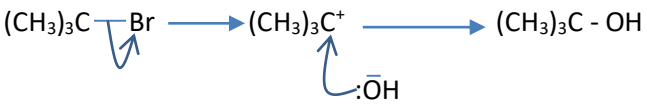
(b) $CH_3COCH_3 + H_2NOH \xrightarrow{H^+} (CH_3)_2C{=}NOH$ (5 ½ marks)

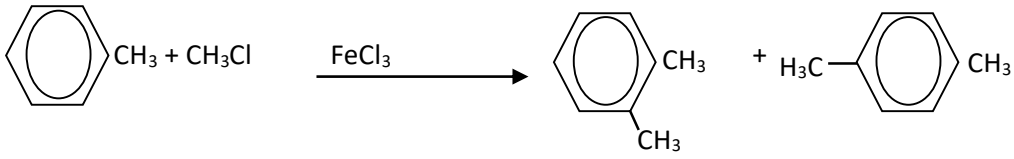


(c) $CH_3CH_2CH_2Cl \xrightarrow{CH_3CH_2O^-Na^+} CH_3\ CH_2CH_2OCH_2CH_3$ (2 marks)

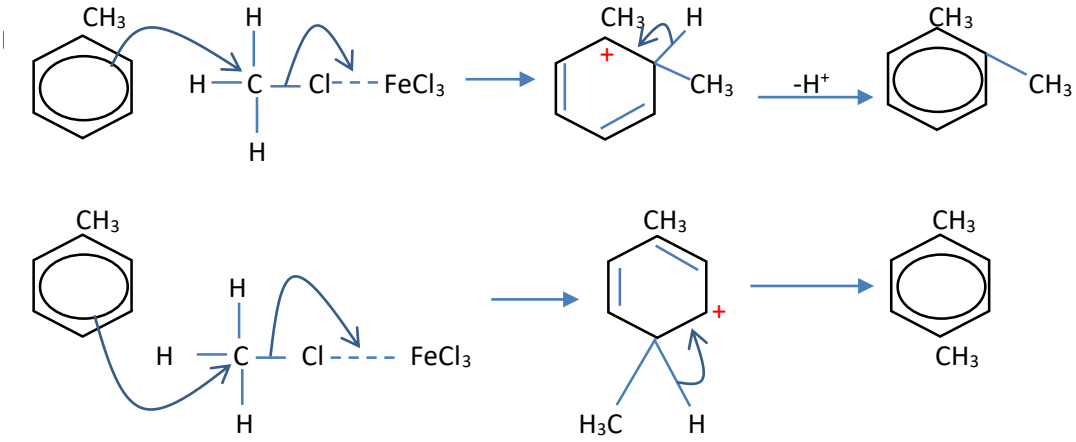


(d) $(CH_3)_3C\text{-}Br \xrightarrow{NaOH(aq)} (CH_3)_3C\text{-}OH$ (3marks)

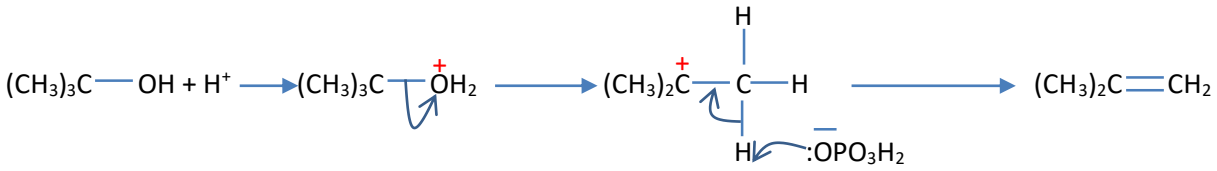


(e) 

(3marks)



(e) $(CH_3)_3COH$ $\xrightarrow{\text{Conc. } H_3PO_4, \text{ heat}}$ $(CH_3)_2C=CH_2$ (3mark each)



2. (a) Explain what is meant by terms (3marks each)

(i) Activation energy

It is the minimum amount of energy required by the reactants to react

(ii) Order of reaction

It is the sum exponents to the concentration terms in a rate law

(iii) Half life of a reaction

Is the time taken by a reactant to reduce to half its initial concentration

(iv) Rate determining step

Is the slowest step in a reaction

(b) The rate of reaction;

$H_2O_2(aq) + 2I^-(aq) + 2H^+(aq) \longrightarrow I_2(aq) + 2H_2O(l)$

May be calculated by measuring the time for the first appearance of I_2 in solution i.e. the time required for the concentration of iodine to reach 10^{-5} moldm^{-3}.

(i) For a particular experiment in which initially

$[H_2O_2]$ = 0.01M

$[I^-]$ = 0.010M

$[H^+]$ =0.10M

Calculate the reaction rate if I_2 first appears after 6 seconds (2marks)

Rate = $\frac{[I_2]}{time} = \frac{10^{-5}}{6}$ = 1.7 x10^{-6} moldm^{-3}s^{-1}

(ii) For a particular experiment in which initially

$[H_2O_2]$ = 0.005M

$[I^-]$ = 0.010M

$[H^+]$ =0.10M

Calculate the reaction rate if I_2 first appears after 12 seconds (2marks)

Rate = $\frac{[I_2]}{time} = \frac{10^{-5}}{12}$ = 8.3 x 10^{-7}moldm^{-3}s^{-1}

(iii) From the calculations b(i) and b(ii) determine the order of reaction with respect to H_2O_2. (2marks)

It is first order because halving concentration halves the rate

(iv) Given that the rate law is; rate = K$[H_2O_2][H^+][I^-]$, calculate the rate constant, K, giving it units. (2marks)

Using conditions in (i)

1.7 x 10^{-6} = K(0.01)(0.01)(0.1)

K = 0.17mol^{-2}dm^{6}s^{-1}

(v) Predict the rate of reaction when $[H_2O_2]$= 0.05M, $[H^+]$ = 0.10M, and $[I^-]$0.02M (2marks)

Rate = 0.17 x 0.05 x 0.1 x0.02 = 1.7 x 10^{-5} moldm^{-3}s^{-1}

3. Halogens, fluorine, chlorine, bromine and iodine show close group similarities

(a) Explain how the variation of the following physical quantities among the elements

(3marks each)

(i) Atomic radii

Atomic radii increase down the group due to increase in the number of electron shells and screening effect on outer electrons.

(ii) First ionization energy

First ionization energy decreases down the group due to increase in atomic sizes and reduction in effective nuclear charge on valence electrons.

(iii) First electron affinity

Decreases down the group due to decrease in electronegativity.

(iv) Melting points

Increase down the group due to increase molecular mass and strength of molecular forces

(b) Write equations to show how fluorine and chlorine react with

(i) Water (3marks)

$Cl_2(g) + H_2O(l) \rightarrow HCl(aq) + HOCl\ (aq)$

$2F_2\ (g) + 2H_2O(l) \rightarrow 4HF(aq) + O_2(g)$

(ii) Sodium hydroxide (5marks)

Dilute

$2F_2(g) + 2OH^-(aq) \rightarrow F_2O(g) + H_2O(l) + 2F^-(aq)$

$Cl_2(g) + 2OH^-\ (aq) \rightarrow ClO^-(aq) + Cl^-\ (aq) + H_2O(l)$

Concentrated

$2F_2(g) + 4OH^-(aq) \rightarrow O_2(g) + H_2O(l) + 4F^-(aq)$

$3Cl_2(g) + 6OH^-\ (aq) \rightarrow ClO_3^-(aq) + 5Cl^-\ (aq) + 3H_2O(l)$

4. (a) What is meant by the term 'colligative properties?' (2marks)

Colligative property is a property of dilute solution that depends on the number of dissolved particles rather than their chemical composition

(b) Write an experiment that can be used to determine the molecular mass of a substance using freezing point depression method. (6marks)

The freezing point (t) a solution that contain Xg of solute of molecular mass M in y g of a solvent is determine. Suppose the freezing point of the solvent is t^0 and freezing point depression constant = Kf. Then,

Mass of a solute in 1000g of a solvent = $\frac{1000X}{y}$ g

Freezing point depression = $(t - t^0)$

It implies that

$(t - t^0)$ is caused by $\frac{1000X}{y}$ g

Kf is caused by M

The molecular mass, M = $\frac{1000X\ x\ K_f}{y\ (t - t^0)}$

(c) State four limitations of the method used in (b) (4marks)

- Solution is dilute
- Solute does not react with solvent
- Solute does associate
- Solute is nonvolatile
- Solute does not dissociate

(d) Give one reason why method in (b) is not suitable to determine the molecular mass of polyethene. (2marks)

Dilute solutions of polyethene give negligible freezing point depression since it is a polymer

(e) Calculate the freezing point of solution containing 1.5g of ethanoic acid in 250g of camphor. The freezing point depression and freezing point of camphor are $40^0 mol^{-1}$ per 1000g and 193^0C respectively. (4marks)

Mass of ethanoic acid in 1000g of camphor

250g of camphor contain 1.5g of ethanoic acid

1000g of camphor contain = $\frac{1.5\ x\ 1000}{250}$ = 6g

Formula mass of ethanoic acid CH3COOH = 15 + 12+ 32 + 1 = 60

Freezing point depression

60g cause 40^0C

6g cause $\frac{40\ x\ 6}{60}$ = 4g

Freezing point of solution = 193 – 4 = 189^0C

(f) Name two other colligative properties (2marks)

- Elevation of boiling point
- Lowering of vapor pressure
- Osmotic pressure

SECTION B

(Answer any **two** question)

5. Elements beryllium, magnesium, calcium and barium belong to group II of the periodic table.

(a) Describe the reaction of the elements with

(i) Water (7marks)

Beryllium does not react with water

Magnesium reacts steam to form magnesium oxide and hydrogen

$Mg(s) + H_2O(g) \rightarrow MgO(s) + H_2(g)$

Magnesium, calcium, barium react with water with increasing vigour to form hydroxides

$M\ (Mg, Ca, Ba)\ (s) + 2H_2O(l) \rightarrow M(OH)_2\ (aq) + H_2(g)$

(ii) Sulphuric acid (5marks)

Beryllium, magnesium, calcium and barium react with dilute sulpuric acid liberating hydrogen

$Be\ (s) + H_2SO_4\ (aq) \rightarrow BeSO_4\ (aq) + H_2(g)$

Beryllium, magnesium, calcium and barium react with hot concentrated sulpuric acid liberating sulphur dioxide and water

$Be\ (s) + 2H_2SO_4\ (aq) \rightarrow BeSO_4\ (aq) + 2H_2O(g) + SO_2(g)$

Barium reacts shortly with dilute and concentrated sulphuric acid due to the formation of insoluble sulphates.

(b) Explain the trend in

(i) Solubility of their hydroxides (3marks)

Solubility decreases increases down the group because lattice energy decreases more rapidly than the decrease in hydration energy.

(ii) Thermostability of carbonates (3marks)

Thermostability of carbonates increase down the group due to increase in ionic character and lattice energy of the carbonates. Beryllium ion with high charge density strongly polarizes carbonate ions to form covalent bond.

(c) Write the equation for the reaction between:

(i) Beryllium and sodium hydroxide (1mark)

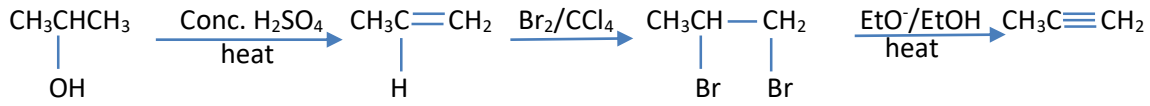
$Be\ (s) + 2OH^-(aq) \rightarrow BeO_2^{2-}(aq) + H_2\ (g)$

(ii) Beryllium carbide with water (1mark)

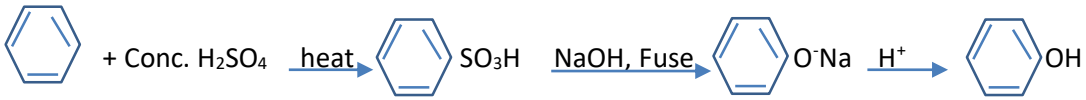
$Be_2C\ (s) + 4H_2O(l) \rightarrow 2Be(OH)_2(aq) + CH_4\ (g)$

6. Write equations to show how the following compounds can be synthesized

(a) Propyne from propan-2-ol (4 ½ marks)

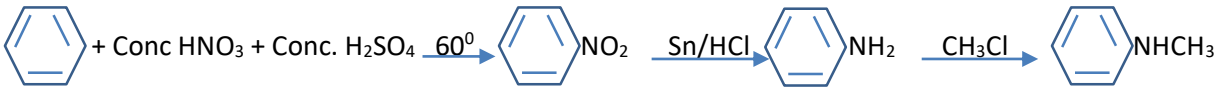


(b) Phenol from benzene (3 ½ marks)

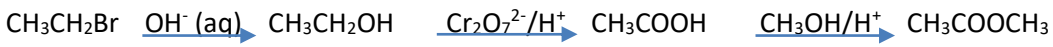


(c) Ethanoylchloride from ethane (4marks)

(d) Methylphenylamine from benzene (4marks)



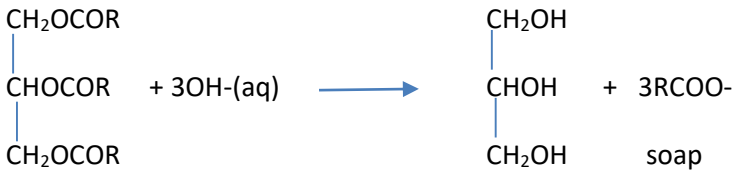
(e) Methylethanoate from bromoethane (4marks)



7. (a) (i) Briefly describe how a sample of soap can be prepared (4marks])

Sodium hydroxide is boiled with vegetable oil, a concentrated solution of sodium chloride is added to precipitate soap. On cooling soap is skemmed off.

(iii) Write equation(s) for the reaction leading to the formation of soap (01mark)



(b) Explain why soap cannot be used effectively in:

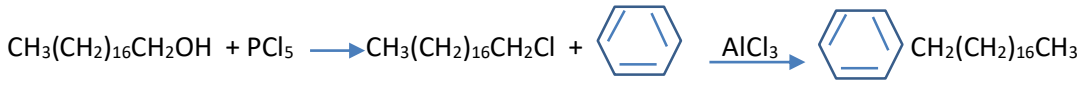
(i) Hard water

Soap fails to lather due to formation of insoluble salts with magnesium and calcium ions in hard water

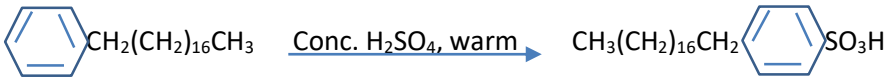
(ii) Strongly acidic solution (05marks)

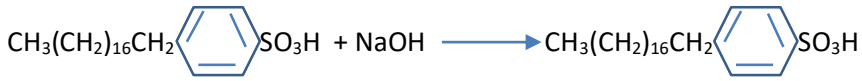
Soap form insoluble fatty acid that are weak surfactants

(c) Write equations to show how alkylbenzenesulphonate can be prepared from octadecan-1-ol, $CH_3(CH_2)_{16}CH_2OH$. (06marks)



then





(d) Explain why the following compound are added to soapless detergents:

(i) Polyphosphates (02marks)

Complex and prevent calcium ions from forming scum with soap

(ii) Disodium sulphate (02marks)

(8) Explain the following observations

(a) Lithium is in group (I) but its properties resemble those of magnesium in group (II) of the periodic table. (4marks)

Both lithium and magnesium have the same electronegativity and their ions have the same polarizing power because increase in electronegativity across the periodic table one step right is cancelled bay a decrease in electronegativity one step down the group.

(b) Aluminium triflouride is ionic, while aluminium trichloride is covalent (05marks)

Chloride ion is bigger than fluoride ions, thus is more easily polarized to form a covalent bond with aluminium ions.

(c) Boron trichloride BCl_3 is non polar molecule whereas nitrogen trichloride, NCl_3 is polar (4marks)

Boron trichloride is a symmetrical molecule leading to cancellation of the dipole moments in its molecules while nitrogen trichloride is asymmetric molecule and the dipole moments do not cancel.

(d) The elements of group (II) of the Periodic Table are harder and have higher melting points and boiling points than those of group (I) elements (02marks)

Group (II) elements are bonded by stronger metallic bonds than group (I) elements because group (II) elements use two electrons per atom to form metallic bonds while group (I) elements use one electron

(e) Lead (II) chloride is more soluble in concentrated hydrochloric acid than in dilute hydrochloric acid (5marks)

Lead (II) chloride is soluble in concentrated hydrochloric acid due to formation of soluble complex

$PbCl_2(s) + 2Cl^-(aq) \rightarrow PbCl_4^{2-}(aq)$

End