

G.C.E June 2010

Section A: Physical and General Chemistry:

1. a) Explain the following terms as applied to the atom

i) nucleus

ii) atomic number

iii) isotope

b.i) What information is obtained from the following about the structure of the atom?

(A) Mass spectrum

(B) The line emission spectrum

ii) In the mass spectrometer, what is the function of (A) The electron

gun (B) The magnet

iii) Calculate the relative atomic mass of neon given the following data

^{20}Ne : relative abundance 11,4

^{21}Ne : relative abundance 0.2

^{22}Ne : relative abundance 11.2

i) How many protons and neutrons are contained in ^{22}Ne ?

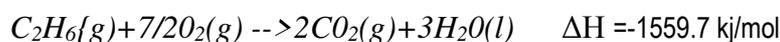
b. i) State Hess's law

i) Construct an enthalpy diagram that could be used to calculate the enthalpy of formation of ethane from carbon and hydrogen.

ii) Given that:



$$\Delta H = 286 \text{ kJ/mol}$$



Calculate the enthalpy of formation of ethane

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- c. Draw and label the diagram of a species with
- A dative covalent bond
 - a metallic bond

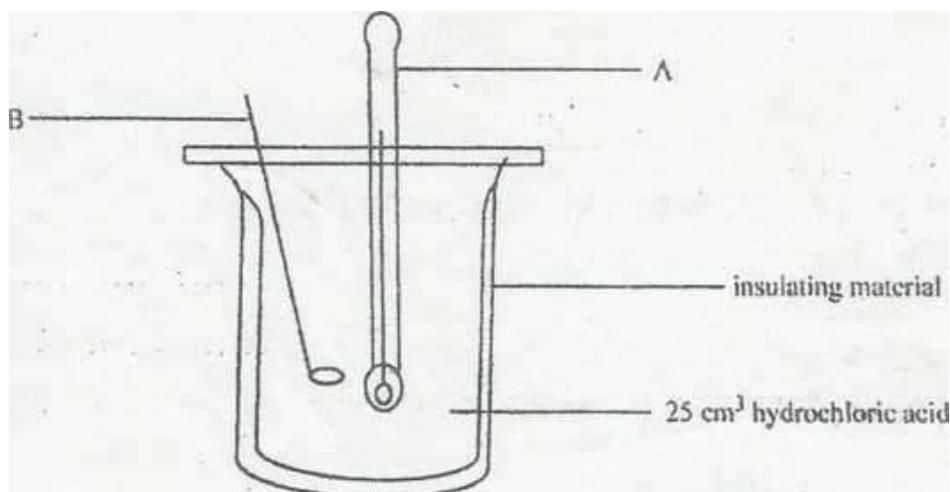
- 2) a) i) Distinguish between homogenous and heterogeneous catalysis
- What THREE steps are involved in a chain reaction?
 - How does the collision theory explain the increase of rate of reaction with concentration?

B(i) State the distribution law (or partition law) of distribution solute between two immiscible solvents?

(ii) What is meant by

- Ideal solution
- Azeotropic mixture?

(c) In order to determine the heat of neutralization of sodium hydroxide and hydrochloric acid of acid concentration 1 mol dm^{-3} , that set up below was used.



The results obtained when 2 cm^3 , NaOH portions were added are indicated.4

Volume of NaOH(aq)/ cm^3	2	4	6	8	10	12	14	16	18
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Temperature rise °C	1.6	3.7	6.0	8.4	10.2	11.5	12.2	11.0	9.0
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iii) Label:

A

B

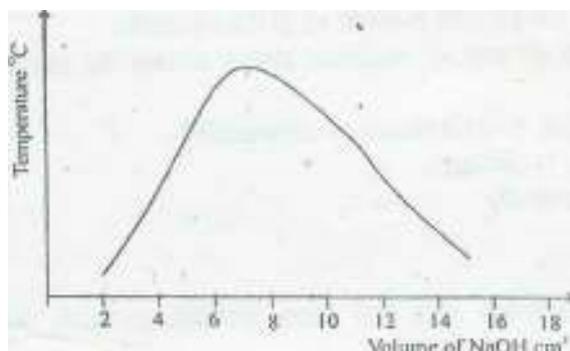
iv) Write a balanced equation for the reaction taking place

v) Why is there

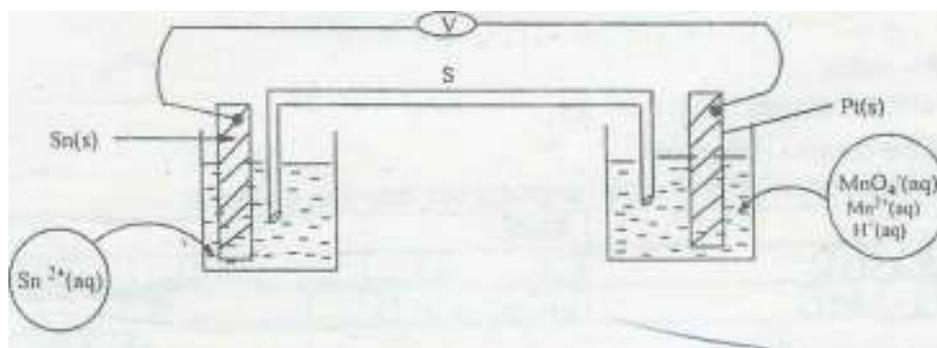
A. a temperature rise with each addition till 14cm^3 NaOH are added?

B. a temperature drop with experiment from 16cm^3 NaOH added?

vi) The graph below is obtained from the above. From the graph determine the volume of NaOH needed to neutralize the acid.

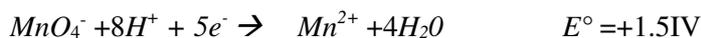


3) (a) Refers the galvanic cell below.



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Half-cell reactions:



- vii) When a current is allowed to flow
- Which species is oxidized
 - Which species is reduced
 - name a suitable instrument that can be used to determine the e.m.f of the cell
 - what is the function of the part labeled S?
- viii) (I) Calculate the value of the e.m.f of the cell
(II) Why is platinum used in the cell above?
- ix) (I) the half-equation above are balanced. Write a balanced equation for the overall redox reaction

(II) In what direction do electrons flow in the external circuit on the diagram? b. Proanoic acid, $\text{CH}_3\text{CH}_2\text{CO}_2\text{H}$ is a WEAK acid with a $K_a = 1.30 \times 10^{-5} \text{ mol dm}^{-3}$. A mixture of propanoic acid and sodium propanoate, $\text{CH}_3\text{CH}_2\text{COONa}$ in an appropriate ratio gives a buffer solution.

- (a) What is the difference, between a weak acid and a strong acid? Give one example of each
(ii) Write an equation to show the ionization of propanoic acid in aqueous⁰ medium, and give an expression for the dissociation constant of the acid.
(ii) Calculate the pH of a 0.1 mol dm^{-3} of propanoic acid.

C(i) What is a buffer solution

(ii) What kind of buffer is obtained by mixing propanoic acid and sodium propanoate?

d. By means of equations show how the buffer solution mentioned above reacts on addition of a small quantity of:

(i) Hydrochloric acid $[\text{HCl}(\text{aq})]$

(ii) $[\text{NaOH}(\text{aq})]$

3. Given 50cm^3 of 0.1 mol dm^{-3} of propanoic acid and 50cm^3 of 0.1 mol dm^{-3} of sodium propanoate. Calculate the pH for the buffer.

Section B: Inorganic chemistry

4) (a) The Group IV elements, C, Si, Ge, Sn and Pb form compounds in either +2 or the +4 states.

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- (i) State the trend and explain the stability of the +2 and +4 oxidation states among the elements. Trend, Explanation
- (ii) The Group IV elements have the ability to catenate, What is meant by catenation? Arrange the elements in order of increasing ability to catenate
- (iii) State one way in which the element carbon is chemically
Similar to the rest of the elements
Different from the rest of the elements
- (b) The d-block elements characteristically form complex ions and show variable oxidation states in their compounds.
- (i) What is a d-block element?
- (ii) Give one reason in each case to explain why d-block elements
Form complexes
Show variable oxidation states.
- (c) Given the following complex compounds: $[Cr(H_2O)_6]Cl_3$
- (i) Identify the ligands in the complex compound
- (ii) Give the structural formulae of two isomers of the compound and state their systematic names
- (iii) What is the coordination number and oxidation state of chromium in the complex?

Coordination number	
Oxidation state	

(iv) State the electron configuration of chromium in the complex using s,p,d notation (atomic number = 24)

d(i) Complete the following table that concerns that halogens

Element		Physical state at 25°C
Fluorine		
Chlorine		
Bromine		
Iodine		

ii)

explain the change in the physical states of the substance

iii) write an equation in each case to show how HCl and HI could be prepared from solid NaCl and NaI respectively

5. These questions concern some elements of groups I and II and periods 2 and 3 of the periodic table,

a. Give the formulae of the simple oxides of the elements in the table

Element	Sodium	Phosphorus	Sulphur	Aluminium
Oxide				

B. Write an equation in each case to show

i) how the oxide of sodium reacts with an acid.

ii) the oxide of phosphorus reacts with a base

iii) the oxide of aluminium reacts with

A: an acid

B: a Base

C. Give the reaction of the following chlorides with water

i) PCl_5

ii) MgCl_2

iii) AlCl_3

d. From the following group I and II elements, Li, Na, K, Mg, Ca, Sr, Ba; choose the element:

i) with the smallest first ionisation energy

ii) with the smallest atomic radius

iii) with the highest melting point

e. Write a reaction in which Lithium

i) behaves like magnesium

ii) behaves like sodium

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f. Explain how a pure sample of $AlCl_3$ can be produced in the laboratory from pure Al metal.

6. This question concerns the chemistry of nitrogen.

a. Ammonia is manufactured by the Haber process.



i) Name the catalyst used in this reaction

ii) What is the role of the catalyst?

iii) State Le Chatelier's principle

iv) Briefly explain how a change in temperature and pressure would affect the yield of NH_3 in the reaction.

A: Temperature

B: Pressure

How is ammonia useful in agriculture?

b.

The principal oxidation states of nitrogen are -3, +3, +4 and +5.

For each oxidation state, give the formula and name of one compound of nitrogen.

(4 mks)

<i>Oxidation state</i>	<i>Formula of Compound</i>	<i>Name</i>
-3		
+ 3		
+ 4		
+ 5		

or the elements of period 2:(Li - Ne), sketch a graph to show the variation of:

(i) 1st ionization energy and

(ii) melting point with atomic number

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d. You are given the following data

<i>Chloride</i>	<i>Lattice energy (kJ/mol)</i>
<i>MgCl₂</i>	<i>-2526</i>
<i>CaCl₂</i>	<i>-2258</i>
<i>SrCl₂</i>	<i>-2156</i>
<i>BaCl₂</i>	<i>-2056</i>

Which chloride is likely to be:

i) most soluble?

ii) most stable?

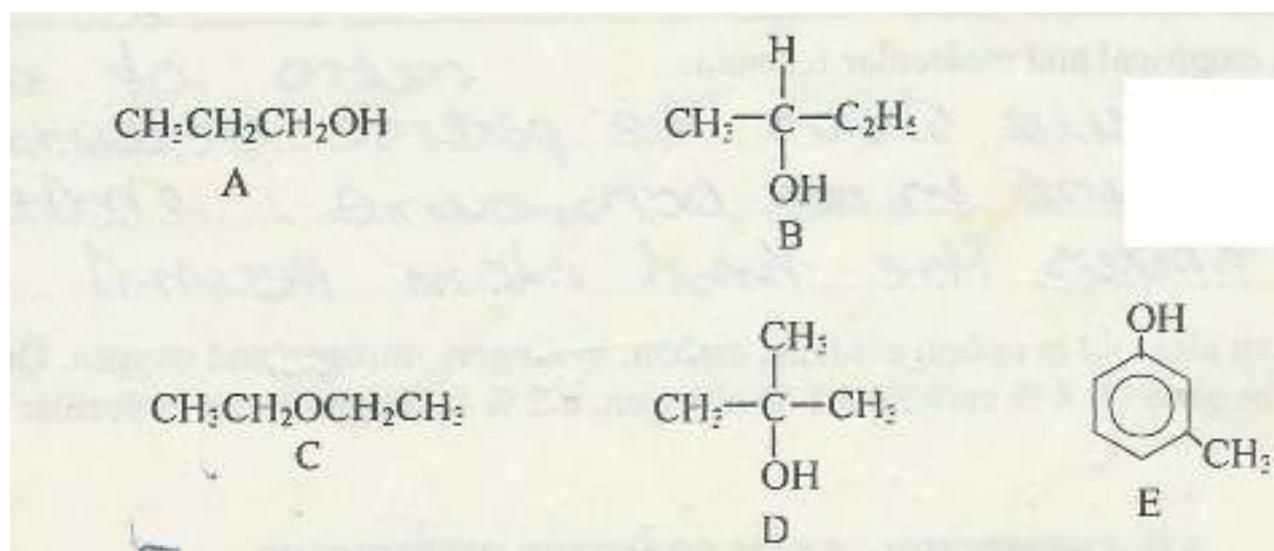
iii) Suggest an explanation for the trend in the lattice energies.

iv) From electronic configuration consideration, which of these chlorides would you expect to be most stable:
MgCl, MgCl₂, MgCl₃. (RAM: Mg = 12, Cl = 17)

SECTION C: ORGANIC CHEMISTRY

This question concerns the compounds A to E shown below

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- a. Using the letters A to E, identify the compounds which are:
- of the same homologous series....
 - choose a PAIR that shows functional group isomerism
- b. Give the molecular formula of B and its systematic name.
- Molecular formula.....
- Systematic name (2 mks)
- c. Identify:
- a primary alcohol
 - a tertiary alcohol (2 mks)
- d. State what would be observed and the product when D is treated with cone. HCl/ZnCl₂ (Lucas reagent) and warmed.

e(i) What compound is obtained when A and B react separately with acidified potassium dichromate.

A:.....

B:.....

ii) How would the products of the reactions of e(i) above be distinguished by means of a chemical test? Give reagents, reaction conditions and observations.

(4marks)

f. When D is treated with cone. H₂SO₄ at 170°C, it gives a compound F. Give the structure of F: **g(i)**

(1mark)

Which one of the two A or B will have the higher boiling point? Give a reason

ii) What is the most common use of C in the laboratory and what precaution must be taken when using C?

Use

.....

Precaution.....

h. Give the product(s) (if any) when A and E are separately treated with bromine water.

A:

.....

B:.....

8) (a) Distinguish between empirical and molecular formulae

(b) Papaverine which is an alkaloid in opium contains carbon, hydrogen, nitrogen and oxygen. Qualitative analysis of papaverine gave 70.8% carbon, 4.1% nitrogen, 6.2% hydrogen and a molecular mass of 339.

(i) Determine the empirical formula of papaverine

(ii) The molecular formula of papaverine.

(iii) Comment on the two formulae obtained in b(i) and b(ii) above

(c) The compound A $C_4H_{10}O$, gives white fumes when treated with solid PCl_5 and is optically active. It reacts with concentrated sulphuric acid at $170^\circ C$ to give the alkene B, $CH_3CH=CHCH_3$

(i) Give the organic product of the reaction of A with PCl_5

(ii) What is the structural formula of A?

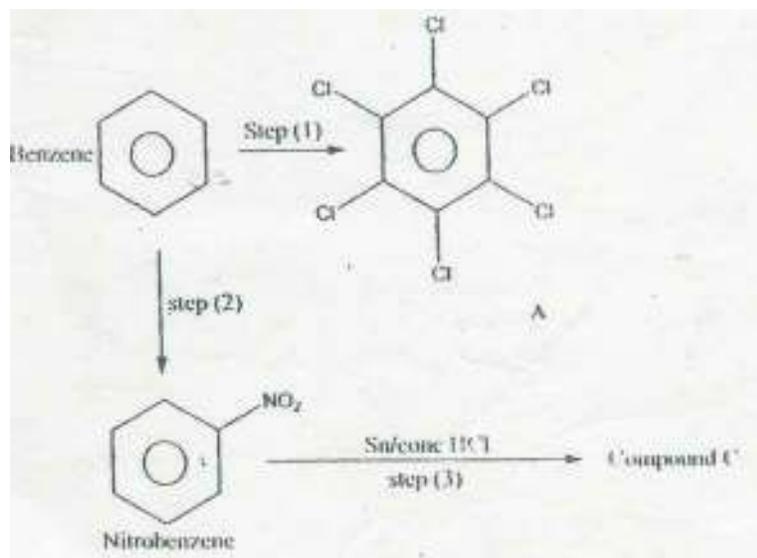
(iii) Compound A shows optical isomerism. Draw and indicate the structural features of A that make it optically active.

(iv) Give the name of the product B.

(d) Give the structure of the product and type of reaction when ethanal reacts with reagents below

Reactant	Structure of Product	Types of reaction
$NaBH_4$		
$HCN(aq)$		
Acidified MnO_4^-		

9) Below is a reaction scheme



a(i) Draw another way of representing the benzene molecule

ii) What type of hybridization is shown by the carbon of benzene?(2 marks)

b(i) Give the reactants, conditions, and type of reaction represented by step(1).

Reactants ..

Conditions.....

Type of reaction.....

ii) Give the name of the compound C (3 marks)

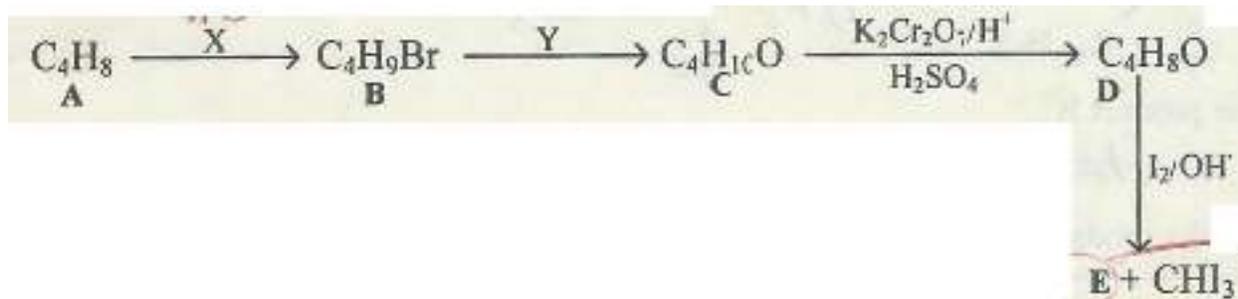
c. Give the reagents, conditions and type of reaction represented by step (2)

Reactants

Conditions ..

Type of reaction (3 marks)

d. Give the name and structure at compound C.



i) Identify the reagents

ii) **X** and **Y**.....

iii) What are the structures of:

A

B

C

iv) What would be observed when the reaction of C to D is taking place?

Reasons

v) Identify product E.....

vi) Of what importance is the reaction that yields E and CHI₃ in organic chemistry?