CHEMISTRY IS NOT A MYSTERY

2021 **MEETING ID: 982 544 6766**

CHEMISTRY

FREE A level ZOOM SEMINAR ONE **PASSCODE: HELP**

CHEMISTRY (P525/2) **Saturday 25/09/2021; 2:00 pm**

Details about the seminar;

1. **The seminar will be conducted on zoom; link, meeting ID and passcode will be shared in all chemistry teachers' platforms and students' groups countrywide.**
2. **The seminars will occur every Saturday of the week at the same time. For the first one on Saturday 25/09/2021; 2:00 pm, it will be mainly teachers presenting for students to learn how they will do the same in the seminars afterwards. However any student who feels confident to present any question can email or call or whatsapp the organisers using the contacts in the footer of this document.**
3. **The mode of presentation will be using zoom where the person to present shall prepare well organized power point slides, or one can share white board of zoom and use a writing pad for presentation or any other method that is suitable virtually and can make content clearly understood. All these presentations shall be recorded for reference.**
4. **The marking scheme for the discussed questions will always be given out after the presentations.**
5. **Teacher are tasked to help our students, (those who will manage to present), in the preceeding seminars with skills like preparing slides and others, and these students will be made co-hosts of the meeting as they present.**
6. **The zoom link will be made standard for it will keep the same always for our seminars**

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Questions;

1. (a) State what is meant by the following terms;
   (i) **First electron affinity** *(01 mark)*
   (ii) **Enthalpy of displacement** *(01 mark)*

   (b) The thermochemical data of copper(II) oxide is shown below;

	$\Delta H^{\theta}(kJmol^{-1})$
Enthalpy of sublimation of copper	$+339.3$
Standard enthalpy of formation of copper(II) oxide	-155.9
First electron affinity of oxygen	-140.9
Second electron affinity of oxygen	$+770$
First ionization energy of copper	$+750.0$
Second ionization energy of copper	$+1958.0$
Lattice dissociation energy of copper(II) oxide	$+4081.5$

   Using the data above:
   (i) Explain the observed difference in the first and second electron affinity values of oxygen. *(3 ½ marks)*
   (ii) Draw an energy level diagram and use it to determine the bond dissociation energy of oxygen. *(4 ½ marks)*

   (c) Write equation to show how copper(II) oxide can be converted to copper(II) sulphate. *(1 ½ marks)*

   (d) The reaction between copper(II) sulphate solution and zinc is an exothermic reaction.
   (i) State what would be observed when zinc dust is added to an aqueous solution containing copper(II) ions and the mixture allowed to stand. *(1 ½ marks)*
   (ii) Describe an experiment to determine the standard enthalpy change for the reaction in d(i) above. *(07 marks)*

2. Describe how the following conversions can be effected.

(Equations are not required)

(a) Pent-1-yne from ethene *(04 marks)*

(b) Propanoic acid to propan-2-ol *(04 marks)*

(c) Benzene to phenol *(04 marks)*

(d) Phenylmethanal from benzene *(04 marks)*

(e) Benzene sulphonic acid from benzoic acid. *(04 marks)*

3. (a) Sodium, magnesium, silicon, phosphorus and sulphur are some of the elements in Period 3 of the Periodic Table.

The table below shows the boiling points of the elements.

Element	Na	Mg	Si	P	S
Atomic number	11	12	13	14	15
Melting point(K)	370.8	923	1687	317.2	388.2

(i) Plot a graph of melting point against atomic number of the element. *(03 marks)*

(ii) Explain the shape of your graph. *(05 marks)*

(b) Write equations for the reactions between the elements; silicon, phosphorus and sulphur with hot concentrated sodium hydroxide solution. *(03 marks)*

(c) Write the formulae of the hydrides formed by each of the elements above. *(2 ½ marks)*

(d) Describe the reactions of the hydrides in (c) above with water. *(6 ½ marks)*

4. Explain each of the following observations and illustrate your answer with equations where necessary,

(a) 2-Bromobutane reacts with hot dilute sodium hydroxide solution but bromobenzene does not. *(04 marks)*

(b) When 2-methylpropene is reacted with hydrogen bromide, the major product is 2-Bromo-2-methylpropane rather than 1-Bromo-2-methylpropane. *(04 marks)*

(c) The first ionization energy of magnesium is greater than that of aluminium. (the atomic numbers of Mg and Al are 12 and 13 respectively). *(03 marks)*

(d) The boiling point of beryllium chloride is 487˚C and that of magnesium chloride is 1418˚C. *(02 marks)*

(e) The solubility of sulphates of group II elements of the Periodic Table decreases down the group. *(2 ½ marks)*

(f) Beryllium is in group (II) of the Periodic Table, but its properties resemble those of aluminium which is in group (III) of the Periodic Table. *(02 marks)*

(g) Although benzene has carbon-carbon double bonds, it does not readily undergo electrophilic addition reaction. *(02 marks)*

5. (a) State **Graham's law**. *(01 mark)*

(b) Oxygen diffused through a porous partition in 1.87 minutes. Under similar conditions, the same volume of a hydrocarbon, ***T*** diffused in 2.15 minutes.

(i) Determine the molecular formula of ***T***. *(2 ½ marks)*

(ii) Write all the possible isomers of ***T*** and their IUPAC names. *(02 marks)*

(c) ***T*** decolourises cold dilute alkaline potassium manganate(VII) solution.

(i) Identify ***T*** *(01 mark)*

(ii) Write equation for the reaction. *(01 mark)*

(d) Write equation and outline the mechanism for the reaction between ***T*** and dilute sulphuric acid. *(3 ½ marks)*

(e) Without using equations, describe how ***T*** can be:

(i) converted to 1-bromopropane. *(01 mark)*

(ii) obtained from 1,2-dibromoethane. *(04 marks)*

(iii) converted to 1-chlorohexane *(3 ½ marks)*

(f) State **one** industrial use of ***T***. *(½ mark)*

6. (a) Define the terms:

(i) **Relative atomic mass** *(01 mark)*

(ii) **Radioisotopes** *(01 mark)*

(b) A naturally occurring element ***Q*** has two isotopes, ^{20}Q and ^{22}Q. The relative atomic mass of ***Q*** is 20.2.

(i) Briefly describe how the essential parts and operation of a modern mass spectrometer. [*No diagram is required*]*(06 marks)*

(ii) Calculate the relative abundances of the each of the two isotopes of ***Q***. *(03 marks)*

(c) State;

(i) **two** uses of isotopes. *(02 marks)*

(ii) **one** limitation in using mass spectrometer for relative atomic mass determination. *(01 mark)*

(d) One of the reasons why isotopes of elements undergo radioactive decay is to achieve stability in the nuclei. The graph in ***figure 1*** shows a plot of number of neutrons against number of protons for stable nuclei.

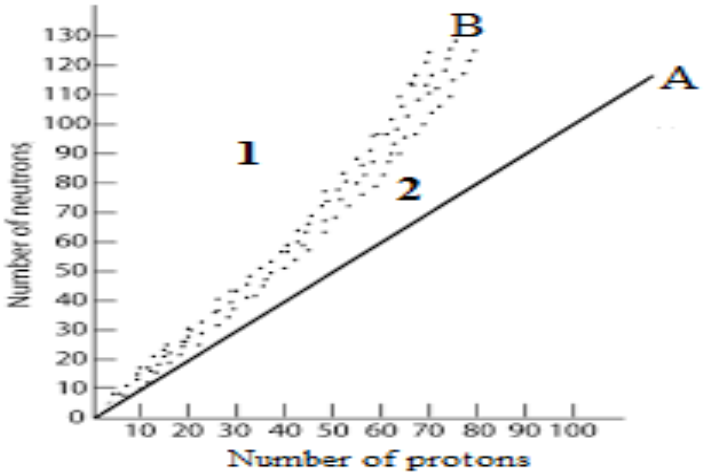

Figure 1

State;

(i) **two** factors that determine the stability of a nucleus of an atom. *(01 mark)*

(ii) what line ***A*** represents. *(½ mark)*

(iii) what region ***B*** represents. *(½ mark)*

(e) Briefly describe how isotopes in regions ***1*** and ***2*** in ***Figure 1*** can achieve stability. *(04 marks)*

7. Beryllium, Magnesium, Calcium, Strontium and barium belong to group II of the Periodic Table.

(a) State and explain the trend in each of the following periodic properties among the elements.

(i) Atomic radius. *(2 ½ marks)*

(ii) Electropositivity *(2 ½ marks)*

(b) In some of its properties, beryllium behaves differently as compared to other elements. State any reasons for the anomalous behavior of beryllium. *(1 ½ marks)*

(c) The table below shows the variation in decomposition temperatures of the carbonates of group II elements.

Carbonate	$BeCO_3$	$MgCO_3$	$CaCO_3$	$SrCO_3$	$BaCO_3$
Decomposition temperature(℃)	25	540	900	1290	1360

(i) State and explain the trend in the decomposition temperature of the carbonates formed by the elements. *(2 ½ marks)*

(ii) Discuss the reactions of the carbonates above with dilute sulphuric acid. *(4 ½ marks)*

(iii) Briefly describe any chemical test that can be used to distinguish between calcium carbonate and barium carbonate. *(2 ½ marks)*

(d) When ammonia solution was separately added to magnesium chloride solution and calcium chloride solution, a white precipitate insoluble in excess was formed with magnesium chloride solution but not calcium chloride solution. Explain this observation. *(04 marks)*

8. (a) State the;

(i) laws of osmotic pressure. *(02marks)*

(ii) conditions under which the laws in (a)(i) are invalid. *(02marks)*

(b) (i) Describe an experiment that can be used to determine the relative molecular mass of water soluble starch, ***P*** , $(\boldsymbol{C_6H_{10}O_5})_n$ using osmotic pressure measurements. *(05 marks)*

(ii) The osmotic pressure of an aqueous solution of ***P*** containing 2.56gdm^{-3} at 23°C is 0.146mmHg. Calculate the number of monomer units in ***P*** *(02marks)*

(c) (i) Calculate the freezing point of 2% aqueous solution of ***P*** at atmospheric pressure. (K_f for water = 1.86°Cmol^{-1}kg^{-1}) *(02 marks)*

(ii) Comment on your answer in c(i) above. *(02marks)*

(d) Vinyl chloride polymerizes according to the following to the equation

$$nCH_2 = CHCl \longrightarrow -(CH_2\underset{Cl}{CH})_n-$$

Concentration (gl^{-1})	1.25	4.40	6.25	10.65	12.50	15.65
Osmotic pressure (Nm^{-2})	48.7	171.3	243.7	414.2	487.4	609.2

(i) Plot a graph of osmotic pressure against concentration. *(03 marks)*

(ii) Use the graph you have drawn to determine the value of n in

$$-(CH_2\underset{Cl}{CH})_n-$$ *(02 marks)*

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9. A hydrocarbon ***D***, on complete combustion yielded 4.05g of water and 10080cm^3 of carbon dioxide at s.t.p. When 5.845g of ***D*** was vapourised at s.t.p, it occupied a volume of $1.829 \times 10^{-3} m^3$.

(a) (i) Calculate the empirical formula of ***D***. *(2 ½ marks)*

(ii) Determine the molecular formula of ***D***. *(03 marks)*

(b) ***D*** burns with a sooty flame. Write;

(i) the structural formula and IUPAC name of ***D*** *(01 mark)*

(ii) equation for complete combustion of ***D***. *(1 ½ marks)*

(c) Describe the reactions of ***D*** with:

(i) nitric acid *(4 ½ marks)*
(ii) propylchloride *(04 marks)*
(iii) bromine *(3 ½ marks)*

10. Beryllium, an element in group II of the Periodic Table shows diagonal relationship with aluminium, which is an element in group III.
    (a) Define the term **diagonal relationship**. *(01mark)*
    (b) State;
        (i) **four** reasons why beryllium and aluminium resemble. *(02 marks)*
        (ii) **three** properties in which the two elements resemble. *(03 marks)*
    (c) Write equation for the reaction of beryllium and aluminium with sodium hydroxide solution
    (d) Explain why calcium chloride is more soluble in water than calcium sulphate. *(03 marks)*
    (e) State what would observed and write equation for the reaction when;
        (i) water was added to calcium nitride. *(03marks)*
        (ii) potassium chromate solution was added to barium nitrate solution. *(02 marks)*
        (iii) dilute hydrochloric acid was added to magnesium carbide. *(03 arks)*

11. Explain each of the following observations.
    (a) Aluminium chloride dissolves in methylbenzene whereas sodium chloride does not. *(04 marks)*
    (b) When a hot mixture of concentrated phosphoric(V) acid and cyclobutanol was cooled and the resultant mixture added to bromine in tetrachloromethane, the reddish brown solution turned colourless. *(04 marks)*
    (c) The molar mass of sodium chloride determined by the method of depression of freezing point of water was found to be 29.25. *(04 marks)*
    (d) Sodium iodide forms a white precipitate in a brown solution with copper(II) sulphate solution whereas addition of sodium chloride to copper(II) sulphate solution gives no observable change.

(04 marks)

(e) Alkenes undergo electrophilic addition reactions while carbonyl compounds under go nucleophilic addition reactions. *(04 marks)*

12. Carbon is both isotopic and allotropic.

(a) (i) Distinguish between the terms **isotopes** and **allotropes**. *(02 marks)*

(ii) Write the full symbols of the isotopes of carbon. *(02 marks)*

(b) (i) Describe how the relative atomic mass of carbon can be determined using a mass spectrometer. *(10 marks)*

(ii) State any **two** advantages of using a mass spectrometer to determine relative atomic mass of an element. *(01 mark)*

(c) The mass spectrum of an element, ***A***, contained two lines at mass/charge values of 79 and 81 in a ratio 11: 9 respectively. Calculate the relative atomic mass of ***A***. *(03marks)*

(d) The half-life of a radioactive element is 150 seconds. Calculate the percentage of the element that will have decayed after 600 seconds. (*02 marks)*

13. (a) An organic compound ***Q*** (molecular mass 109) consists of 22.0% by mass of carbon, 4.6% by mass of hydrogen and the rest being bromine.

(i) Calculate the empirical formula of ***Q*** *(02 marks)*

(ii) Determine the molecular formula of ***Q*** *(01mark)*

(b) Write;

(i) the structural formula and IUPAC name of ***Q.*** *(01 mark)*

(ii) equations to show how ***Q*** can be synthesized from but-2- ene. *(04 marks)*

(c) Briefly describe a chemical test that can be used to distinguish between ***Q*** and chloroethane. *(03 marks)*

(d) Discuss the reactions of **Q** with

(ii) sodium hydroxide

(iii) alkaline solution of phenol

(iv) benzene

(Your answer should include conditions and mechanisms for the reactions)

(09 marks)

14. (a) Explain what is meant by the following terms as used in volumetric analysis.

(i) **Primary standard** *(01 mark)*

(ii) **Secondary standard** *(01 mark)*

(b) Sodium thiosulphate pentahydrate ($Na_2S_2O_3.5H_2O$) and disodium tetraborate decahydrate ($Na_2B_4O_7.10H_2O$) are useful compounds in volumetric analysis. State **two**;

(i) reasons why disodium tetraborate decahydrate is a good primary standard. *(02 marks)*

(ii) reasons why sodium thiosulphate pentahydrate is not a good primary standard. *(02 marks)*

(iii) substances that can standardize the compound in b(ii) above. *(01 mark)*

(c) 6.2g of disodium tetraborate decahydrate (Borax) was dissolved in 100 cm^3 water and the resultant solution made up to 250cm^3 with more water. 25.0 cm^3 of the resultant solution required 18.0 cm^3 of dilute hydrochloric acid for complete reaction using methyl orange indicator. Calculate the molarity of the hydrochloric acid solution. *(5 ½ marks)*

Borax reacts with hydrochloric acid according to the following equation.

$$B_4O_7^{2-}(aq) + 2H^+(aq) + 5H_2O(l) \longrightarrow 4H_3BO_3(aq)$$

(d) The table below shows data for titration of sodium thiosulphate solution of various concentration with a fixed volume of with dilute hydrochloric acid.

Volume of sodium thiosulphate solution used (cm^3)	100	90	80	70	60
Time(s)	24.9	32	42.2	74.07	202.8

(i) State what is observed and write equation for the reaction that

takes place when dilute hydrochloric acid is added to sodium thiosulphate solution. *(2 ½ marks)*

(ii) Plot a graph of volume of sodium thiosulphate solution against time.

(04 marks)

(iii) Use your graph to determine the time required for 112cm^3 of sodium thiosulphate solution to completely react with hydrochloric acid. *(01 mark)*

15. (a)The table below shows the first ionization energies of the elements in third short period of the Periodic Table.

Element	Na	Mg	Al	Si	P	S	Cl	Ar
First ionization energy(kJmol^{-1})	494	736	577	786	1060	1000	1260	1520
Atomic number	11	12	13	14	15	16	17	18

(i) What is meant by the term **first ionization energy ?** Illustrate your answer using the phosphorus atom. *(02 marks)*

(ii) Plot a graph of $log_{10}(first\ ionisation\ energy)$ against atomic number. *(05 marks)*

(iii) Explain the shape of the graph you have drawn in (a) (ii) above. *(07 marks)*

(b) (i) State and explain the first ionization energies vary among group I elements. *(03 marks)*

(ii) Explain how the first ionization energy affects reactivity of group I. (Illustrate your answer using the reaction of group (I) elements with water). *(03 marks)*

16. (a) State;

(i) what is meant by the term **lattice energy**. *(01 mark)*

(ii)**two** factors that affect the magnitude of lattice energy. *(02 marks)*

(b) Explain how the factors you have stated in (a)(ii) above affect the magnitude of the lattice energy. *(04 marks)*

(c) (i) Draw a Born – Haber cycle for the first formation of solid Rubidium chloride from its elements. *(03 marks)*

(ii) Calculate the electron affinity of chlorine from the following data.

Lattice energy of rubidium chloride = $-675 kJmol^{-1}$

Bond dissociation energy of chlorine = $+242 kJmol^{-1}$

Atomisation energy of rubidium = $+84 kJmol^{-1}$

Ionisation energy of rubidium = $+397 kJmol^{-1}$

Standard enthalpy of formation of rubidium chloride = $-431 kJmol^{-1}$

(03 marks)

(d) Given that the hydration energies of rubidium ions and chloride ions are -301 and $-364 kJmol^{-1}$ respectively.

(i) Determine the enthalpy of solution of rubidium chloride.

(03 marks)

(ii) Comment on the solubility of rubidium chloride in water. *(01 mark)*

$[H = 1, \quad B = 11, \quad C = 12, \quad O = 16.0, \quad Na = 23, \quad Cl = 35.5]$

END