BOARD OF INTERMEDIATE EDUCATION

JUNIOR INTER CHEMISTRY

MODEL PAPER (ENGLISH VERSION)

TIME: 3 HOURS **MAX.MARKS: 60**

SECTION – A

I. i) Very Short Answer Type questions.

ii) Answer ALL questions.

ii) Each question carries TWO marks. **$10 \times 2 = 20$**

1. What is "Boltzman's Constant"? Give its value in Jouls.

2. Calculate the Normality of Oxalic acid solution containing 6.3 g of $H_2C_2O_4$. 2 H_2O in 500 m*l* of solution.

3. What is 'Heterogeneous equilibrium'? Give one example.

4. SiO_2 is a solid while CO_2 is a gas. Explain.

5. What are silicones?

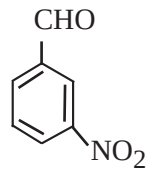
6. Why does the solubility of alkaline earth metal carbonates and sulphates in water decrease down the group?

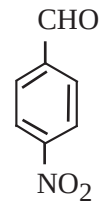
7. Give two properties of washing soda.

8. What is 'Eutrophication'?

9. What is Ozone hole? Where was it first observed?

10. Write the IUPAC names of

a) 

b) 

SECTION – B

II. i) Short Answer Type questions.

ii) Answer any SIX questions.

iii) Each question carries FOUR marks. **$6 \times 4 = 24$**

11. Deduce

a) Charles law

b) Dalton's law from the kinetic gas equation.

12. Balance the following redox reaction by half reaction method in basic medium.

$MnO_4^- + I^- \longrightarrow MnO_2 + I_2$

13. Explain spontaneity of process.

14. Explain Bronsted Acid - Base theory.

15. What is Borax? Explain the borax bead test with a suitable example.

16. Write few lines on the utility of Hydrogen as a fuel.

17. Define "Dipole moment".

Explain why H_2O has dipolemoment while CO_2 does not have.

18. State Fajan's rules with suitable examples.

SECTION – C

III. i) Long Answer Type questions.

ii) Answer any TWO questions.

iii) Each question carries EIGHT marks. **$2 \times 8 = 16$**

19. What are quantum numbers? Explain the significance of quantum numbers.

20. Write an essay on s, p, d, f block elements.

21. a) What is substitution reaction?

Explain the formation of methylbenzene and nitrobenzene.

b) Explain addition of HBr to propene with the ionic mechanism.

ANSWERS

SECTION – A

1. What is Boltzman's constant? Give its value in Joules.

A: Gas constant per molecule is called Boltzman's constant.

$K = \frac{R}{N} = 1.38 \times 10^{-23}\ JK^{-1}\ molecule^{-1}$.

2. Calculate the Normality of Oxalic acid solution containing 6.3 g of $H_2C_2O_4$. 2 H_2O in 500 m*l* of solution.

A: $\text{Normality} = \frac{\text{Weight of solute}}{\text{Gram Eq. wt. of solute}} \times \frac{1000}{\text{volume (m}l\text{)}}$

$= \frac{6.3}{63} \times \frac{1000}{500} = 0.2$ N.

3. What is 'Heterogeneous equilibrium'? Give one example.

A: The equilibrium in which reactants and products are in different physical states.

e.g.: $CaCO_3\ (s) \overset{\Delta}{\rightleftharpoons} CaO\ (s) + CO_2\ (g)$

4. SiO_2 is a solid while CO_2 is a gas. Explain.

A: Due to presence of strong covalent bonds and three dimensional polytetrahedron network SiO_2 exists as solid. Due to small atomic size of C, it can form 2 double bonds with oxygen atoms. CO_2 molecules are held together by weak Van der Waal forces and exists as a gas.

5. What are silicones?

A: Organo silicon polymers having repeating unit $\left(R_2\ SiO\right)_n$ in which alkyl or phenyl groups occupy the remaining positions.

e.g.: Grease, water proof fabrics.

6. Why does the solubility of alkaline earth metal carbonates and sulphates in water decrease down the group?

A: As the cation size increases down the group, hydration enthalpies decrease. So solubilities of metal carbonates and sulphates in water decrease down the group.

7. Give two properties of washing soda.

A: Soda ash will be formed when heated above 373 K.

$Na_2CO_3.\ 10\ H_2O \xrightarrow{373\ K} Na_2CO_3.\ H_2O + 9\ H_2O$

$Na_2CO_3.\ H_2O \xrightarrow{> 373\ K} Na_2CO_3 + H_2O$

★ Due to hydrolysis, it gives alkaline solution.

$CO_3^{-2} + 2\ H_2O \longrightarrow H_2CO_3 + 2\ OH^-$

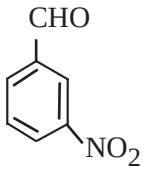
8. What is "Eutrophication"?

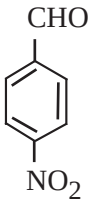
A: The process in which death of aquatic animals, over growth of unwanted plants, finally drying of lakes and ponds due to the release of nutrients, phosphates other carbon compounds by fields and industries is called "Eutrophication".

9. What is "Ozone hole"? Where was it first observed?

A: The phenomenon in which depletion of ozone layer present in stratosphere due to NO_2 and Chloro Fluoro Carbons (CFCs) is called "Ozone hole". First it was observed at south pole (Antarctica).

10. Write IUPAC names of

a) 

b) 

A: a) 3–Nitro Benzaldehyde b) 4–Nitro Benzaldehyde

SECTION – B

11. Deduce

a) Charles law

b) Dalton's law from kinetic gas equation.

A: **a) Charles law:** At constant pressure the volume of gas is directly proportional to absolute temperature.

$$PV = \frac{1}{3} mnc^2$$

$$PV = \frac{2}{3} \times \frac{1}{2} mnc^2$$

$$\frac{1}{2} mnc^2 \propto T = KT$$

$$\therefore PV = \frac{2}{3} KT$$

$$\frac{V}{T} = \frac{2}{3} \frac{K}{P}$$

at constant pressure $= \frac{V}{T} = \frac{2}{3} K$ = constant.

b) Dalton's law: Total pressure of a mixture of non reacting gases is equal to the sum of the partial pressures of component gases. If P_1, P_2 are partial pressures of 1^{st} & 2^{nd} gases.

$$P_1 = \frac{1}{3} \frac{m_1 n_1 u_1^2}{v} \longrightarrow (1)$$

$$P_2 = \frac{1}{3} \frac{m_2 n_2 u_2^2}{v} \longrightarrow (2)$$

If two gases are mixed in the same vessel,

$$P_{total} = \frac{1}{3} \frac{m_1 n_1 u_1^2}{v} + \frac{1}{3} \frac{m_2 n_2 u_2^2}{v}$$

$$\therefore P_{total} = P_1 + P_2$$

12. Balance the following redox reaction by half reaction method in basic medium.

$MnO_4^- + I^- \longrightarrow MnO_2 + I_2$

A:

Oxidation	Reduction
$I^- \rightarrow I_2$	$MnO_4^- \rightarrow MnO_2$
$2\ I^- \rightarrow I_2$	$MnO_4^- \rightarrow MnO_2 + 2\ H_2O$
$(2\ I^- \rightarrow I_2 + 2\ e^-) \times 3$	$MnO_4^- + 4\ H_2O \rightarrow MnO_2 + 2\ H_2O + 4\ OH^-$
$6\ I^- \rightarrow 3\ I_2 + 6\ e^-$	$MnO_4^- + 2\ H_2O + 3\ e^- \rightarrow MnO_2 + 4\ OH^-$
	$(MnO_4^- + 2\ H_2O + 3\ e^- \rightarrow MnO_2 + 4\ OH^-) \times 2$
	$2\ MnO_4^- + 4\ H_2O + 6\ e^- \rightarrow 2\ MnO_2 + 8\ OH^-$

By adding L.H.S. of both halves and R.H.S. of both halves separately we will get

$2\ MnO_4^- + 4\ H_2O + 6\ e^- + 6\ I^- \rightarrow 2\ MnO_2 + 8\ OH^- + 3\ I_2 + 6\ e^-$

$2\ MnO_4^- + 4\ H_2O + 6\ I^- \rightarrow 2\ MnO_2 + 3\ I_2 + 8\ OH^-$

13. Explain spontaneity of process.

A: A process is said to be spontaneous if it occurs by its own without any external agency.

e.g.: Water flows from hill to valley.

$\Delta G = \Delta H - T\Delta S$

If ΔG = –ve, the reaction or process is spontaneous predicting the spontaneity of a reaction.

S.No.	ΔH	ΔS	ΔG	Description
1	–	–	–	Spontaneous at low T
2	+	+	+	Non spontaneous at low T
3	+	+	–	Spontaneous at high T
4	–	–	+	Non spontaneous at high T
5	–	+	–	Spontaneous at all T
6	+	–	+	Non spontaneous at all T

14. Explain Bronsted Acid - Base theory.

A: **Acid:** A proton donor **e.g.:** HC*l*

Base: A proton acceptor. **e.g.:** HSO_4^-

Neutralisation: Transfer of a proton from acid to base.

e.g.: $HCl + H_2O \rightleftharpoons H_3O^+ + Cl^-$

Conjugate acid – base pair: A pair of acid and base for differed by one proton.

Base + Proton $\rightleftharpoons$ Conjugate acid

Acid – Proton $\rightleftharpoons$ Conjugate base

Conjugate of a strong acid or base is weak.

Conjugate of a weak acid or base is strong.

e.g.: Conjugate acid of $H_2O = H_3O^+$

Conjugate base of $H_2O = OH^-$

15. What is Borax? Explain the borax bead test with a suitable example.

A: Sodium tetraborate decahydrate is called borax. It's formula is $Na_2B_4O_7 \cdot 10\ H_2O$

Borax bead Test: This test is used in the detection of basic radicals (**e.g.:** Transition elements). When

borax is heated, loses water to form opaque mass of sodium tetraborate. On fusion, it gives B_2O_3 & Sodium metaborate (borax glass). Metal metaborates are coloured and formed when B_2O_3 combines with metal oxides.

$$Na_2B_4O_7 \cdot 10\ H_2O \xrightarrow[\Delta]{-H_2O} Na_2B_4O_7 \xrightarrow{\Delta} B_2O_3 + 2\ NaBO_2$$

$$B_2O_3 + CoO \longrightarrow Co(BO_2)_2 \text{ (Blue bead)}$$

16. Write few lines on the utility of Hydrogen as a fuel.

A:

★ H_2 has high enthalpy of combustion.

★ Oxyhydrogen blow torch is used for welding and cutting of the metals.

★ H_2 is used as rocket fuel.

★ H_2 is used in the fuel cell to generate electrical energy.

★ H_2 is used to prepare water gas ($CO + H_2$)

★ H_2 is used to prepare semi water gas ($CO + H_2 + N_2$)

★ Atomic hydrogen torch is used for cutting of welding.

★ H_2 is used as industrial fuel.

17. Define Dipole moment.

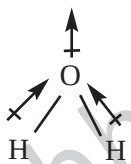
Explain why H_2O has dipole moment while CO_2 does not have?

A: The product of charge on one of the poles and the distance between the two poles is called dipolemoment (μ).

$\mu = Q \times r$

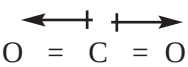
Units: Debye.

1 Debye = 3.36×10^{-30} columb meter.



H_2O has bent structure, so the net dipole moment is not zero.

Where as CO_2 has linear structure.



So the net dipole moment is zero for CO_2.

18. State Fajan's rules with suitable examples.

A: The partial covalent character of ionic bond was explained by Fajan's rules.

★ Covalent character increases with the increase in size of the anion.

e.g.: KI is more covalent than KF .

★ Covalent character inreases with the decrease in size of the cation.

e.g.: LiF is more covalent compared to KF.

★ Covalent character increases with the increase in the charge on either cation or anion.

e.g.: $SnCl_4$ is more covalent than $SnCl_2$.

★ Compounds with cations having pseudo noble gas configuration are more covalent than that of noble gas configuration.

e.g.: CuCl is more covalent than NaCl.

SECTION – C

19. What are quantum numbers? Explain the significance of quantum numbers.

A: In order to explain complete address, arrangement of electrons in various shells, sub-shells 4 quantum numbers are introduced. They are principal quantum number, Azimuthal quantun number, magnetic quantum number and spin quantum number.

1. Principal quantum number (n):

★ It was proposed by Neils Bohr.

★ It is denoted by 'n'.

★ 'n' values can be denoted either by K, L, M, N, ... or by 1, 2, 3, 4, ...

★ As 'n' value increases the size, energy of orbit increases.

★ Energy of electron in n^{th} orbit $E_n = \frac{-13.6}{n^2}$ e.v./atom.

★ This quantum number also represents the radius of the orbit (size of orbit or the distance between the electron and the nucleus).

★ If the number of shells are 'n' in an atom, maximum number of orbitals in an orbit = n^2.

★ Maximum number of electrons in an orbit = $2n^2$.

★ This quantum number describes the size and energy of the orbit.

2. Azimuthal quantum number (*l*):

★ It was proposed by Sommerfeld.

★ It is denoted by '*l*'.

★ '*l*' values are ranging from 0 to n – 1.

★ It represents number of sub-shells (s, p, d, f) in a shell.

★ The number of sub-shells in an orbit = n

★ The first shell contains only one sub-shell 's'.

★ The second shell contains two sub-shells s, p.

★ The third shell contains three sub-shells s, p, d.

★ The fourth shell contains 4 sub-shells s, p, d, f.

★ The number of orbitals (sub sub shells) in a sub-shell = $2l + 1$

★ The number of electrons present in a sub-shell = $2(2l + 1)$

i.e. 2 electrons in s, 6 e^- in p, 10 e^- in d, 14 e^- in f sub-shells.

★ This quantum number describes the shape of the orbital.

n	*l*	sub-shell notation
1	0	1 s
2	0	2 s
2	1	2 p
3	0	3 s
3	1	3 p
3	2	3 d
4	0	4 s
4	1	4 p
4	2	4 d
4	3	4 f

l	**sub-shell**	**shape**
0	s	spherical
1	p	dumb-bell
2	d	double dumb-bell
3	f	4 fold dumb-bell

Order of energy: s < p < d < f.

Value of *l*	0	1	2	3	4	5
Sub shell notation	s	p	d	f	g	h
Number of orbitals	1	3	5	7	9	11
Number of e^- in orbitals	2	6	10	14	18	22

3. Magnetic quantum number (m):

★ It was proposed by Lande in order to explain "Zeeman effect" and "Stark effect".

★ It can be denoted by 'm' or m_l.

★ 'm' values are ranging from $-l$ to 0 to $+l$.

★ The total number of 'm' values = $2l + 1$.

★ 'm' values are 1, 3, 5, 7 if the '*l*' values are 0, 1, 2, 3 respectively.

★ The energy of all the obitals present in a sub-shell is same.

★ This quantum number describes orientation of the orbitals in space.

Sub-level	*l* value	m values	no. of orbitals
s	0	0	1
p	1	−1, 0, +1	3
d	2	−2, −1, 0, +1, +2	5
f	3	−3, −2, −1, 0, +1, +2, +3	7

4. Spin quantum number (s):

★ It was proposed by Uhlenbeck and Goud Smit.

★ It was denoted by 's'.

★ If the spin of the electron is clock wise, the value of s $= +\frac{1}{2}$.

★ If the spin of the electron is anti clock wise, the value of s $= -\frac{1}{2}$.

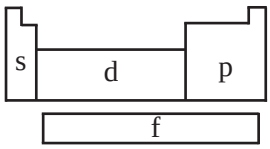
★ Maximum number of electrons in an orbital = 2

★ This quantum number describes the direction of spin of the electron (Orientation of spin).

S.No.	Name of the quantum number	Significance
1.	Principal quantum number	Size & energy of the orbit.
2.	Azimuthal Quantum number	Shape of the orbital.
3.	Magnetic quantum number	Orientation of the orbital.
4.	Spin quantum number	Direction of spin of the electron.

20. Write an essay on s, p, d, f block elements.

A:



Based on the electronic configuration, the entry of last electron into s, p, d, f sub-levels, the elements of long form of periodic table are divided into 4 blocks.

s-block elements: The elements in which the last electron enters in 's' subshell of valency shell. As the maximum capacity of s-sub shell is 2 electrons. s-block contains 2 groups I A and II A. They are placed at the left side of the periodic table. I A has ns^1, II A has ns^2 configuration in their valency shell. Except H rest of the elements are metals. They are soft, having low M.P.s and B.P.s. They have low ionisation enthalpies. They form ionic compounds. They import characteristic colours to the flame. They are strong reducing agents.

p-block elements: The elements in which the last electron enters in 'p' sub shell of valency shell. Since the maximum capacity of p sub shell is 6 electrons. It consists 6 groups III A to VII A and 'O'. They are placed at the right side of the periodic table. Their general electronic configuration is $ns^2\ np^{1-6}$. This block consists metals, non metals and semi-metals. They form mostly covalent compounds. 'O' group elements are inert and mono atomic. As they found in air, they are called 'aerogens'. p-block elements can also form ionic compounds. As the 16th group elements produce minerals, called 'Chalcogens'. As 17^{th} group elements are sea salt producers, are called 'Halogens'. Halogens are good oxidising agents.

d-block elements: The elements in which the last electron enters the d sub shell of penultimate shell. Since 'd' subshell accommodates 10 electrons, there are 10 groups I B to VII B and VIII B.

General valency shell configuration is $(n-1)d^{1-10}\ ns^{1-2}$. They are placed between s & p block elements in 4 rows (3d, 4d, 5d, 6d series). All are hard metals with high M.P.s and B.P.s. They form coloured compounds, complex compounds, alloys. They act as catalysts. They are generally paramagnetic. They exhibit variable oxidation states.

f-block elements: The elements in which the last electron enters the f sub-shell of anti penultimate shell. They are placed at the bottom of the main periodic table in 2 series (4f – Lanthanides, 5f – Actinides). The outermost electronic configuration is $(n-2)f^{1-14}\ (n-1)d^{0-1}\ ns^2$. They are heavy metals with high M.P.s and B.P.s. They form coloured, complete compounds. They are radioactive. Exhibit variable oxidation states. Most of them are man made and radioactive.

Advantages of classification:

★ Proper position is given to the elements according to their properties. Special position is given for radioactive elements.

★ Proper gradation in metallic & non-metallic nature is observed.

★ Proper gradation in physical and chemical properties of elements is observed.

Drawbacks:

★ Though He has $1s^2$ configuration, it is placed under noble gas elements of p-block according to its similarity in properties.

★ The position of H is uncertain as it possess some properties of 1^{st} group and some properties of 7^{th} group.

21. a) What is "substitution reaction"?

Explain the formation of methyl benzene and nitro benzene.

b) Explain addition of HBr to propene with the ionic mechanism.

A: a) Substitution reaction: The reaction in which one atom or group present in a molecule is substituted by another atom or group.

★ Methyl benzene is formed when C_6H_6 reacts with CH_3Cl and anhydrous $AlCl_3$. This reaction is called "Friedel Craft's alkylation".

$$C_6H_5 - \boxed{H + Cl} - CH_3 \xrightarrow{\text{Anhydrous } AlCl_3} C_6H_5 - CH_3 + HCl$$

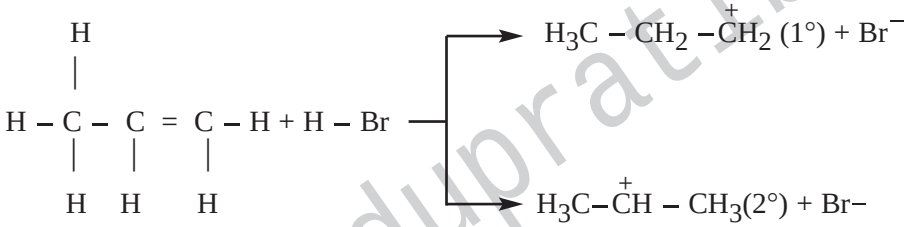
★ Nitrobenzene is formed when C_6H_6 is heated below 60°C with nitration mixture (Conc. HNO_3 + Conc. H_2SO_4).

$$C_6H_5 - \boxed{H + \text{Conc. } HO} - NO_2 \xrightarrow[< 60°C]{\text{Conc. } H_2SO_4} C_6H_5 - NO_2 + H_2O$$

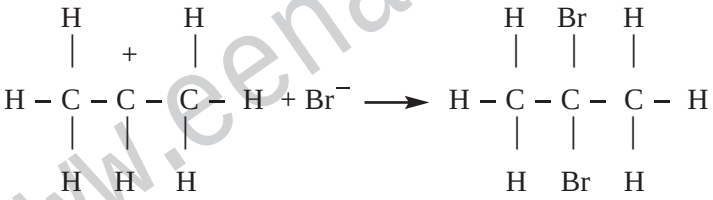
b) Mechanism: When HBr reacts with propene (Unsysmmetrical alkene), 2-bromopropane is formed as major product as per mechanism given below.

★ HBr gives electrophile H^+.

★ H^+ attacks propene to give less stable primary (1°) Carbocation and more secondary (2°) Carbo cation.



★ 2° Carbocation is attacked by the nucleophile Br^- to form 2-bromopropane as major product.



2 – bromopropane

(major product)

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