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 × 2 = 20**

1. What is 'Critical Temperature'? Give its value for CO_2.

2. Calculate Oxidation Number of S, Cr in H_2SO_5 and $Cr_2O_7^{-2}$

3. Boron is unable to form BF_6^{-3} ion. Explain.

4. What is "Common ion effect"?

5. Give the formulae of

a) Borax b) Colemanite

6. Why crude Na*Cl* absorbs moisture from atmosphere?

7. Give two uses of Caustic soda.

8. What is PAN? What is the ill effect caused by it?

9. How is Ozone formed in Stratosphere?

10. Give the Principle of Chromatography?

SECTION – B

II. i) Short Answer Type questions.
ii) Answer any SIX questions.
iii) Each question carries FOUR marks. **6 × 4 = 24**

11. Calculate RMS, Average and most probable velocities of CO_2 at 27°C.

12. Balance the following redox reaction by ion electron method in acid medium

$Cr_2O_7^{-2} + NO_2^- \longrightarrow Cr^{+3} + NO_3^-$

13. State and explain Hess's Law of Constant heat summation.

14. Derive the relation between K_c and K_p for the equilibrium reaction

$2\ SO_2\ (g) + O_2\ (g) \rightleftharpoons 2\ SO_3\ (g)$

15. Write a short note on

a) Silicones b) Fullerenes

16. Explain the terms "Hard water" and "Soft water". How hardness of water can be removed by Calgon method?

17. Which type of compounds react with Ozone? Explain the reaction of Ozone with one aliphatic and one aromatic compound.

18. What do you understand about Geometrical isomerism? Write E, Z isomers for CHCl = CFBr.

SECTION – C

III. i) Long Answer Type questions.

ii) Answer any TWO questions.

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

19. EXplain

a) Heisenberg's uncertainty Principle.

b) de Broglie's Principle.

c) What is nodal plane? How many nodal planes are possbile for 2p and 3d orbitals.

20. What are first and second ionistation enthalpy? Why $IE_2 > IE_1$. Explain 4 factors influencing it.

21. a) Explain the formation of Coordinate covalent bond with 2 examples.

b) Explain sp^3d hybridization with one example.

ANSWERS

SECTION – A

1. What is 'Critical temperature? Give its value for CO_2.

A: The temperature above which a gas can not be liquified by appliying any pressure.

T_c for CO_2 = 30.98°C.

2. Calculate Oxidation number of S, Cr in H_2SO_5 and $Cr_2O_7^{-2}$.

A:

$$\overset{+1}{H}-\overset{-2}{O}-\overset{}{\underset{\overset{\overset{-2}{O}}{||}}{\overset{+6}{S}}}-\overset{-1}{O}-\overset{-1}{O}-\overset{+1}{H}$$

$Cr_2O_7^{-2}$

$\therefore x - 6 = 0$

$x = +6$

O.No. of S = +6

$2x + 7(-2) = -2$

$2x = -2 + 14 = 12$

$\therefore x = +6$

O.No. of Cr = +6

3. Boron is unable to form BF_6^{-3} Explain.

A: B = $1s^2\ 2s^2\ 2p_x^1$ (ground state)

B = $\boxed{1s^2\ 2s^1\ 2p_x^1\ 2p_y^1\ 2p_z^0}$ (1^{st} excited state)

In the valency shell only 4 orbitals are avaialble to take electrons. The maximum covalency of B is 4. Due to non-avaiability of d orbitals, boron is unable to expand its octet to form BF_6^{-3}.

4. What is "Common ion effect"?

A: The phenomenon of suppression of solubility of a weak electrolyte by the addition of strong electrolyte having common ion with it.

e.g.: Suppression of ionisation of CH_3COOH when CH_3COONa is added (due to common ion CH_3COO^-)

5. Give the formulae of

a) Borax **b) Colemanite**

A: a) Borax – $Na_2B_4O_7.10\ H_2O$

b) Colemanite – $Ca_2B_6O_{11}.5\ H_2O$

6. Why crude NaC*l* absorbs moisture from atmosphere?

A: Crude NaC*l* is contaminated with $CaCl_2$ and $MgCl_2$. As they are deliquescent, they absorb moisture from atmosphere.

7. Give two uses of Caustic Soda.

A: ★ It is used in the manufacture of soap, paper.

★ It is used in the purification of bauxite.

8. What is PAN? What is the ill effect caused by it?

A: Peroxy Acetyl Nitrate is called PAN. It is formed when O_3 reacts with unburnt hydrocarbons in air in presence of NO_2. Its formula is $H_3C - \overset{\overset{O}{\|}}{C} - O - O - NO_2$. It is powerful irritant of eyes.

9. How is Ozone formed in the Stratosphere?

A: In Stratosphere O_2 absorbs ultra violet radiation to form O_3.

$$3\,O_2 \overset{u.v.}{\rightleftharpoons} 2\,O_3$$

10. Give the Principle of Chromatography?

A: The Principle of adsorption is used to separate the substances of a mixture over the stationary phase with the help of mobile phase. It involves

★ Adsorption & Retention of a mixture.

★ Elution: Recovery of substances in the mixture.

★ Qualitative & Quantitative analysis of eluted substances.

SECTION – B

11. Calculate RMS, Average and most probable velocities of CO_2 at 27°C.

A: $U_{RMS} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3 \times 8.314 \times 300 \times 1000}{44}} = 4.12 \times 10^2$ m/sec

$U_{Average} = 0.9213 \times$ RMS speed $= 0.9213 \times 4.12 \times 10^2$

$= 3.8 \times 10^2$ m/sec.

$U_{mp} = 0.8166 \times$ RMS speed $= 0.8166 \times 4.12 \times 10^2$

$= 3.36 \times 10^2$ m/sec

12. Balance the following redox reaction by ion-electron method in acid medium.

$Cr_2O_7^{-2} + NO_2^- \longrightarrow Cr^{+3} + NO_3^-$

A:

OXIDATION	REDUCTON
$NO_2^- \longrightarrow NO_3^-$	$Cr_2O_7^{-2} \longrightarrow Cr^{+3}$
$NO_2^- + H_2O \longrightarrow NO_3^-$	$Cr_2O_7^{-2} \longrightarrow 2\,Cr^{+3}$
$NO_2^- + H_2O \longrightarrow NO_3^- + 2\,H^+$	$Cr_2O_7^{-2} \longrightarrow 2\,Cr^{+3} + 7\,H_2O$
$NO_2^- + H_2O \longrightarrow NO_3^- + 2\,H^+ + 2\,e^-$	$Cr_2O_7^{-2} + 14\,H^+ \longrightarrow 2\,Cr^{+3} + 7\,H_2O$
$3\,(NO_2^- + H_2O \longrightarrow NO_3^- + 2\,H^+ + 2e^-$	$Cr_2O_7^{-2} + 14\,H^+ + 6\,e^- \longrightarrow 2\,Cr^{+3} + 7\,H_2O$
$3\,NO_2^- + 3\,H_2O \longrightarrow 3\,NO_3^- + 6\,H^+ + 6e^-$	

By adding both the L.H.S. and R.H.S. of 2 Half reactions separately

$3\ NO_2^- + 3\ H_2O + Cr_2O_7^{-2} + 14\ H^+ + 6\ e^- \longrightarrow 3\ NO_3^- + 6\ H^+ + 6\ e^- + 2\ Cr^{+3} + 7\ H_2O$

$3\ NO_2^- + Cr_2O_7^{-2} + 8\ H^+ \longrightarrow 3\ NO_3^- + 2\ Cr^{+3} + 4\ H_2O$

13. State and explain Hess's Law of Constant heat summation.

A: **Hess's law:** The total change in enthalpy of a reaction is same whether the reaction takes place in single step or several steps.

Path I: C (graphite) + $\frac{1}{2}\ O_2$ (g) $\longrightarrow$ CO (g) $\quad \Delta H = -110.5\ KJmol^{-1}$

2 Steps CO (g) + $\frac{1}{2}\ O_2$ (g) $\longrightarrow CO_2$ (g) $\quad \Delta H = -283\ KJmol^{-1}$

Path II: C (graphite) + O_2 (g) $\longrightarrow CO_2$ (g) $\quad \Delta H = -393.5\ KJmol^{-1}$

1 step

14. Derive the realtion between K_c and K_p for the equilibrium reaction

$2\ SO_2$ (g) + O_2 (g) $\rightleftharpoons$ $2\ SO_3$ (g)

A: $K_c = \dfrac{[SO_3]^2}{[SO_2]^2\,[O_2]}$

$K_p = \dfrac{P^2_{SO_3}}{P^2_{SO_2} \cdot P_{O_2}}$ $\qquad PV = nRT$

$= \dfrac{[SO_3]^2\,[RT]^2}{[SO_2]^2\,[RT]^2, [O_2]\,[RT]}$ $\qquad P = \dfrac{n}{v}\,RT = CRT$

$= K_c \cdot (RT)^{2-(2+1)}$

$\therefore K_p = K_c\,(RT)^{-1}$

15. Write a short note on

(a) Silicones

b) Fullerenes

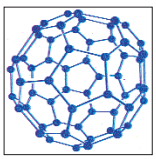
A: **a) Silicones:** Organosilicon polymers having repeating unit $\left(R_2\ SiO\right)_n$ in which alkyl or phenyl groups occupy the remaining positions. They are prepared from hydrolysis of dialkyl dichloro silane and polymerisation.

$$2\ CH_3Cl + Si \xrightarrow[570\ K]{Cu} Cl - \underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\underset{|}{\overset{|}{Si}}}} - Cl \xrightarrow[-2\ HCl]{+\ 2\ H_2O} HO - \underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\underset{|}{\overset{|}{Si}}}} - OH$$

$$H\left[O - \underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\underset{|}{\overset{|}{Si}}}} - O\boxed{H + HO} - \underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\underset{|}{\overset{|}{Si}}}} - O\right]H \xrightarrow[-H_2O]{\text{Polymerisation}} \left(\underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\underset{|}{\overset{|}{Si}}}} - O\right)_n$$

They are used as sealant, grease, water proofing of fabrics.

b) Fullerenes: It is made by heating graphite in presence of noble gas like He. They are purest forms of Carbon. C_{60} molecule is cage like (Soccer ball shaped) molecule.



The sturucture of C_{60} Buckminster fullerene

It contains 20 six membered rings and 12 five membered rings. They undergo sp^2 hybridisation. Due to presence of free electrons it has aromatic character. It has C – C single bonds (143.5 pm) and double bonds (138.3 pm)

16. Explain the terms "hard water" and "soft water". How hardness of water can be removed by calgon method?

A: **Soft water:** The water that gives good lather easily with soap water.

Hard Water: The water that does not give lather readily with soap water due to presence of

Ca^{+2}, Mg^{+2}, C*l*, SO_4^{-2}, HCO^{-3} ions.

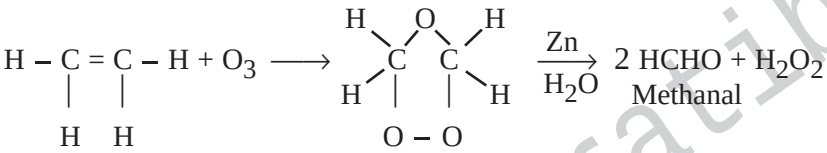
Calgon method: Sodium hexa meta phosphate is called calgon. ('cal' means Calcium 'gon' means gone.) When hard water containing Ca^{+2} or Mg^{+2} ions is passed through calgon, Na^+ ions are released.

$$Na_2\left[Na_4(PO_3)_6\right] + 2\,Ca^{+2} \longrightarrow Na_2\left[Ca_2(PO_3)_6\right] + 4\,Na^+$$

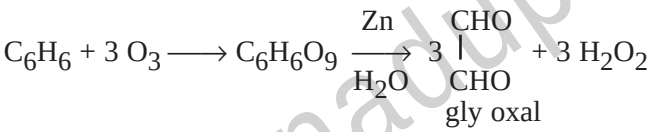
17. Which type of compounds react with Ozone? Explain the reaction of Ozone with one aliphatic and one aromatic compound.

A: Unsaturated compounds like alkenes, alkynes, C_6H_6 react with O_3 to form respective Ozomides. Which on hydrolysis gives carbonyl compounds.

Reactoin with aliphatic compound:

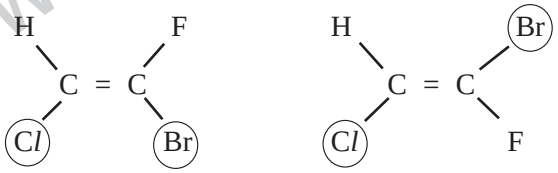


Reaction with aromatic compund.



18. What do you understand about geometrical isomerism? Write E, Z isomers for CHC*l* = CFBr.

A: Compounds having same molecular formula and same structural forumula but differ in the special arrangement of atoms or groups around C = C are called geometrical isomers and this phenomenon is called geometrical isomerism. When similar gropus are on the same side of C = C, it is called "cis" isomer and on opposite side of C = C, it is called 'trans' isomer.



SECTION – C

19. Explain:

a) Heisenberg's uncertainty Principle.

b) de Broglie's principle

c) What is nodal plane? How many nodal planes are possible for 2p and 3d orbitals.

A: a) Heisenberg's uncertainty Principle: It is impossible to determine simultaneously and accurately both the position & momentum of a tiny moving sub atomic particle like electron.

$$\Delta x.\ \Delta p \geq \frac{h}{4\Pi}$$

when Δx is very small, Δp will be very large.

Where Δx = Uncertainty in position

Δp = Uncertainty in momentum = $m \times \Delta v$

h = Planck's Constant = 6.626×10^{-34} JS

b) de Broglie's Principle: All tiny particles like electron moving with high velocity possess both the particle nature and wave nature.

$E = h\upsilon$ (Planck's theory) .....(1)

$E = mc^2$ (Einstein's theory) .....(2)

from (1) & (2)

$h\upsilon = mc^2$

$$h\upsilon = h\frac{c}{\lambda} = mc^2 \text{ or } \lambda = \frac{h}{mc} \text{ or } \lambda = \frac{h}{p}$$

c) Nodal Plane: The plane that passes through nodal point is called nodal plane. The density of electron in this plane is Zero.

no. of nodal planes for any orbital = l

no. of nodal planes for 2 P = 1 ($\because l = 1$)

no. of nodal planes for 3d = 2 ($\because l = 2$)

20. What is first and second ionisation enthalpy?

Why $IE_2 > IE_1$. Explain 4 factors influencing it.

A: The minimum amount of energy required to remove an electron from an isolated gaseous atom (M) in its ground state is called first ionisation enthalpy ($I.E_1$)

$M(g) \longrightarrow M^+(g) + e^-$

The energy required to remove an electron from unipositive gaseous atom, is called second ionisation enthalpy ($I.E_2$)

$M^+(g) \longrightarrow M^{+2}(g) + e^-$

Unit of ionisation enthalpy is K.J./mole

Due to increase in effective nuclear charge, the magnitude of the force of attraction between the nucleus and valence electrons also increases.

So $I.E_2 \longrightarrow I.E_1$

FACTORS:

a) Atomic radius: As atomic radius increases, the distance between nucleus and valence electron increases, attractive force decreases. Hence it requires less amount of energy to remove electron i.e. I.E. decreases in a group. In a period, I.E. increases from left to right due to decrease in atomic radius.

$$I.E. \propto \frac{1}{\text{Atomic radius}}$$

b) Nuclear Charge: As the nuclear charge increases, the attractive force between the nucleus and valence electron increases. I.E. also increases as it requires more energy to remove an electron.

$$I.E. \propto \frac{1}{\text{nuclear charge}}$$

c) Screening effect: In multi electron atoms, valence electrons are screened from the nucleus by inner electrons. Therefore the outer most electron feel less attraction, can be removed easily.

$$I.E. \propto \frac{1}{\text{Screening effect}}$$

d) Electronic configuration: Atoms having half filled or completely filled shells are more stable an atom with more stable electronic configuration has greater ionisation enthalpy.

e.g.: $N = 1s^2\ 2s^2\ 2p_x^1\ 2p_y^1\ 2p_z^1$ (Half – filled orbitals)

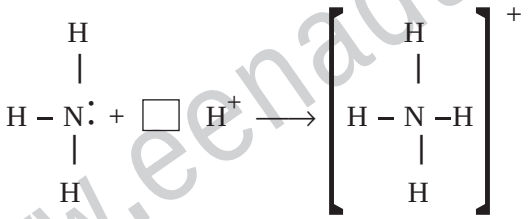
$Ne = 1s^2\ 2s^2\ 2p_x^2\ 2p_y^2\ 2p_z^2$ (Completely filled orbitals)

21. a) Explain the formation of coordinate covalent bond with 2 examples.

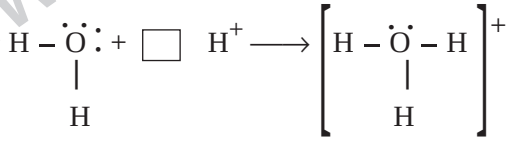
b) Explain sp^3d hybridization with one example.

A: a) Coodiate covalent bond: Convalent bond formed between electron pair donor atom and electron pair acceptor atom or ion is called coordinate covalent bond or dative bond. It is represented by "→" Where donor atom possess lone pair of electrons. Acceptor species possess empty orbital.

e.g.: NH_4^+, H_3O^+



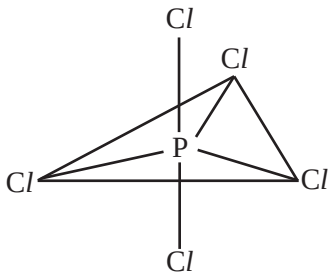
★ "N" donates electron pair to H^+ and shares with it to form a dative bond.



★ "O" donates electron pair to H^+ and shares with it to form a dative bond.

b) **sp^3d hybridization:** The phenomenon of inter mixing of one s, three p and one d orbitals to form five identical sp^3d hybrid orbitals is called sp^3d hybridization.

e.g.: PCl_5



Phosphorous in its 1^{st} excited state has $3s^1\ 3p_x^1\ 3p_y^1\ 3p_z^1\ 3d^1$ configuration and undergoes sp^3d hyrbridization. Five sp^3d orbitals or Phosphorous overlap with five p orbitals of Chlorine to give trigonal bipyramidal geometry for PCl_5. The bond angles are 120° & 90°.

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