Previous IPE

SOLVED PAPERS

MARCH -2019 (TS)

PREVIOUS PAPERS

IPE: MARCH-2019(TS)

Time : 3 Hours **JR.CHEMISTRY** Max.Marks : 60

SECTION-A

I. Answer ALL questions : $10 \times 2 = 20$

1. What is Bio - chemical Oxygen Demand (BOD) ?
2. What is a Bronsted base? Give an example.
3. Why is gypsum added to cement?
4. Calculate the kinetic energy of 4 moles of methane at – 73°C
5. A solution is prepared by adding 2g of a substance 'A' to 18 g of water. Calculate the mass percentage of solute.
6. Write any two uses of Mg metal.
7. Write the use of ZSM – 5.
8. How does graphite function as a lubricant?
9. Which oxides cause acid rain?
10. Write IUPAC names of the following structures:

a) $CH_2 = CH - CH = CH_2$ b) $CH_3 - \underset{\displaystyle CH_3}{\overset{\displaystyle CH_3}{\overset{|}{\underset{|}{C}}}} = CH - CH_3$

SECTION-B

II. Answer any SIX of the following Questions. $6 \times 4 = 24$

11. Derive an ideal gas equation.
12. A compound contains 4.07% Hydrogen, 24.27% Carbon and 71.65% Chlorine. Its molar mass is 98.96 g. What are its empirical and molecular formulas?
13. State and explain the Hess's law of constant heat summation.
14. Derive the relation between K_p and K_c for the equilibrium reaction. $N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$.
15. What is hard water? Write a note on the Calgon's Method for the removal of hardness of water.
16. Explain Borax Bead Test with a suitable example.
17. Explain the hybridization involved in SF_6 molecule.
18. Give the Molecular Orbital Energy Diagram (MOED) of N_2. Calculate the bond order of N_2

SECTION-C

III. Answer any TWO of the following Questions. $2 \times 8 = 16$

19. How are the quantum numbers *n, l* and *m* arrived at ? Explain the significance of these quantum numbers.
20. Define IE_1 and IE_2 . Why $IE_2 > IE_1$ for the given atom? Discuss any four factors that affect IE of an element.
21. Write any two methods of preparation of benzene with corresponding equations. How methyl benzene and acetophenone are prepared from benzene?

IPE TS MARCH-2019
ANSWERS

SECTION-A

1. What is Biochemical Oxygen Demand (BOD)?

A: **1) Biochemical Oxygen Demand (BOD):** It is the 'amount of oxygen used' by suitable micro organisms present in the water, during five days, at 20^0C .

2) It is used to measure the 'degree of pollution of water'.

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2. What is a Bronsted base? Give one example?

A: **1) Bronsted base:** A proton acceptor is called bronsted base.

2) Ex: H_2O, NH_3, Cl^-

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3. Why gypsum is added to cement?

A: 1) Gypsum is added to cement to increase the setting time.

2) So, the process of setting of the cement becomes slow and cement gets sufficiently hardened.

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4. Calculate the kinetic energy of 4 moles of methane at – 73°C

A: **Given data:** T= (– 73 + 273)K = 200 K , R = 8.314 J mol^{-1} K^{-1}

n = No. of moles of methane $\frac{4\,g}{16\,g\,mol^{-1}} = 0.25$ mol

Kinetic energy $= \frac{3}{2} nRT = \frac{3}{2} \times 0.25 \times 8.314 \times 200 = 623.6J$

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5. A solution is prepared by adding 2g of a substan ce 'A' to 18 g of water. Calculate the mass percentage of solute.

A: Mass percent of $A = \frac{\text{Mass of A}}{\text{Mass of solution}} \times 100$

$$= \frac{2\,g}{2\,g \text{ of A} + 18\,g \text{ of water}} \times 100 = \frac{2\,g}{20\,g} \times 100 = 10\%$$

6. Write any two uses of Mg metal.

A: Uses of Magnesium:

1) Mg forms alloys with A*l*, Zn, Mn and Sn.

2) Mg is used in flash powders and bulbs, signals.

3) $MgCO_3$ is an ingredient of toothpaste.

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7. Write the use of ZSM – 5.

A: 1) ZSM -5 is one type of zeolite.

2) It is used to convert alcohols directly into gasoline.

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8. How does Graphite function as a lubricant ?

A: 1) Graphite has two -dimensional layer structure.

2) These layers can easily slide one over the other because of weak vanderwaal forces. Hence graphite is used as a lubricant.

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9. Which oxides cause acid rain? and What is its pH value?

A: 1) Oxides of Nitrogen, Sulphur and Carbon dissolved in 'rain water' causes acid rain.

2) pH of Acid rain is 5.6.

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10. Write IUPAC names of the following structures:

a) $CH_2 = CH - CH = CH_2$ **b)** $CH_3 - \overset{\overset{CH_3}{|}}{C} = CH - CH_3$

A: (a) 1, 3 - butadiene (b) 2- Methyl 2 butene

SECTION-B

11. Derive the ideal gas equation from gas laws.

A: 1) Boyle's law: "The volume of a given mass of gas is inversely proportional to its pressure", at constant temperature.

Thus, $V \propto \frac{1}{P}$ (n, T are constant) .....(i)

2) Charles law: "The volume of a given mass of gas is directly proportional to its absolute temperature", at constant pressure

Thus, $V \propto T$ (n, P are constant) .....(ii)

3) Avogadro's law : "The volume of given mass of a gas is directly proportional to the number of moles" at constant temperature and pressure.

Thus, $V \propto n$ (P, T are constant) .....(iii)

From (i), (ii), (iii); we get $V \propto \frac{1}{P} \times T \times n$

4) $V = R\frac{1}{P}T.n$. This proportionality constant 'R' is called universal gas constant.

$\therefore$ PV = nRT Thus, ideal gas equation is derived.

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12. A compound contains 4.07 % hydrogen, 24.27% carbon and 71.65% chlorine. Its molar mass is 98.96 g. What are its empirical and molecular formulas?

Sol:

S.No	Element	% by weight	$\frac{\%\text{ by weight}}{\text{At.wt}}$	Simple ratio
1)	Hydrogen(H)	4.07	$\frac{4.07}{1} = 4.07$	$\frac{4.07}{2.01} \simeq 2$
2)	Carbon (C)	24.27	$\frac{24.27}{12} = 2.02$	$\frac{2.02}{2.02} = 1$
3)	Chlorine(C*l*)	71.65	$\frac{71.65}{35.5} = 2.01$	$\frac{2.01}{2.01} = 1$

Ratio of H:C:C*l*= 2:1:1. Hence Empirical Formula $= H_2C_1Cl_1$

Empirical Formula weight = 2+12+35.5=49.5

Given Molecular formula weight = 98.96

$$n = \frac{\text{Molecular formula weight}}{\text{Empirical formula weight}} = \frac{98.96}{49.5} = 2$$

$\therefore$ Molecular formula = (Empirical formula)$_n$= $(H_2CCl)_2 = H_4C_2Cl_2 = C_2H_4Cl_2$

13. State and explain"Hess law of constant heat summation" with example.

A: 1) Hess Law: 'The total heat change in a chemical reaction is the same, whether the chemical reaction takes place in one step or several steps'.

2) Suppose that D is formed from A in two different paths.

Path - I: $A \rightarrow D, \Delta H$

Path - II: $A \rightarrow B, \Delta H_1$

$B \rightarrow C, \Delta H_2$

$C \rightarrow D, \Delta H_3$

Total heat change in path - II= $\Delta H_1+\Delta H_2+\Delta H_3$

Total heat change in path - I $= \Delta H$

From Hess law, $\Delta H = \Delta H_1+\Delta H_2+\Delta H_3$

3) Example: CO_2 can be obtained from $C_{(graphite)}$ and $O_{2(g)}$ in two different ways.

Path - I : $C_{(graphite)} + O_{2(g)} \rightarrow CO_{2(g)}$; $\Delta H = -393.5$ KJ

Path - II : $C_{(graphite)} + 1/2\ O_{2(g)} \rightarrow CO_{(g)}$; $\Delta H_1 = -110.5$ KJ

$CO_{(g)} + 1/2O_{2(g)} \rightarrow CO_{2(g)}$; $\Delta H_2 = -283.02$ KJ

4) Total heat change in path-II = $\Delta H_1+\Delta H_2 = (-110.5)+(-283.02) = -393.52$ KJ.

Total heat change in path-I $= \Delta H = -393.5$ KJ.

Thus $\Delta H \simeq \Delta H_1+\Delta H_2$. Hence the Hess law is proved.

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

$N_{2(g)} + 3H_{2(g)} \rightleftharpoons 2NH_{3(g)}$.

A: 1) Relation between K_P & K_C is $K_P = K_C(RT)^{\Delta n}$

Given equation is $N_2(g) + 3H_2(g) \rightleftharpoons 2NH_3(g)$

Here $n_R = 4$ and $n_P = 2$

$\Delta n = n_P - n_R = 2-(1+3) = -2$

$\therefore K_P = K_C(RT)^{-2}$

$\therefore K_P < K_C$

15. What is hard water? Write a note on the Calgon's Method for the removal of hard ness of water.

15. 1) Soft water: Water which gives 'good lather readily with soap' is called soft water.

2) Hard water: Water which 'does not give good lather readily with soap' is called hard water.

Hardness of water is due to the presence of **soluble chlorides, sulphates and bicarbonates** of **Calcium and Magnesium**.

3) Calgon method: Sodium hexametaphosphate $(NaPO_3)_6$ is commercially called as calgon. When calgon is added to hard water it reacts with calcium and magnesium ions to displace them. Hence hard water becomes soft water.

4) $Na_6P_6O_{18} \rightarrow 2Na^+ + [Na_4P_6O_{18}]^{-2}$

$[Na_4P_6O_{18}]^{2-} + M^{2+} \rightarrow [Na_2MP_6O_{18}]^{2-} + 2Na^+,$ (M= Mg, Ca)

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16. Explain Borax bead test with suitable examples.

A: 1) Borax bead test: This test is useful for the identification of basic radicals in 'qualitative analysis'.

2) On heating, borax swells into a white, opaque mass of anhydrous sodium tetraborate. When it is fused, borax glass is obtained. This contains sodium metaborate and B_2O_3.

3) The boric anhydride combines with metal oxides to form metal metaborates as coloured beads.

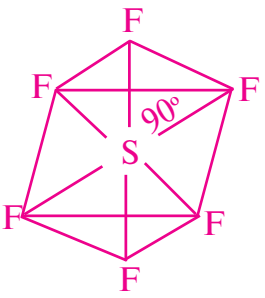
4) The reactions:

$$Na_2B_4O_7.10H_2O \longrightarrow Na_2B_4O_7 \xrightarrow{\text{fused}} 2\underbrace{NaBO_2 + B_2O_3}_{\text{Borax glass}}$$

$$B_2O_3 + Co.O \longrightarrow \underset{\substack{\text{Cobalt metaborate}\\(\text{Blue bead})}}{Co(BO_2)_2}$$

17. Explain the hybridization involved in SF_6 molecule.

A: I) sp^3d^2 hybridisation: One s-orbital, three p-orbitals and two d-orbitals mix together to form six sp^3d^2 hybrid orbitals .



II) Structure of SF_6 molecule:

1) In SF_6, the central atom is S(16).

2) It's ground state E.C is $[Ne]3s^23p^4$

It's excited state E.C is $[Ne]\,3s^1 3p_x^1 3p_y^1 3p_z^1 3d^1_{(x^2-y^2)} 3d^1_{z^2}$

3) In its excited state, the central S atom undergoes sp^3d^2 hybridisation.

4) Central S forms 'six sp^3d^2 hybrid orbitals', each with one electron.

5) 'Six sp^3d^2 hybrid orbitals' of S overlap axially with p orbital of six F atoms to form six σ bonds.

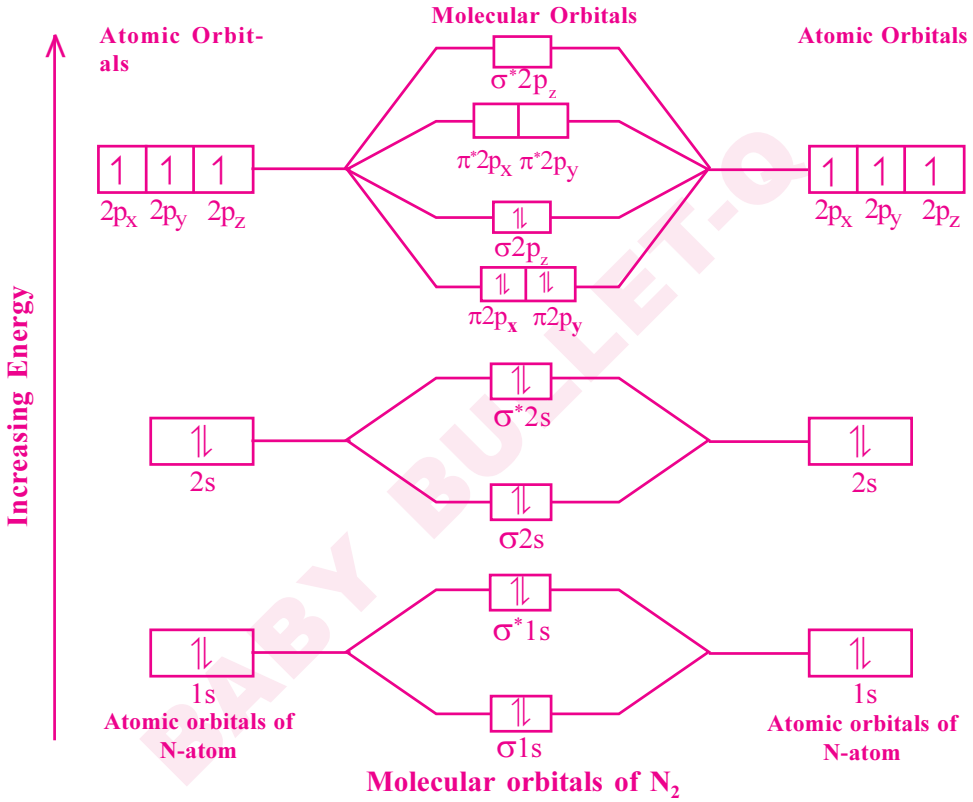
6) Shape of SF_6 is Octahedral and the bond angles are 90° and 180°.

18. Give the Molecular Orbital Energy Diagram (MOED) of N_2. Calculate the bond order of N_2

A: Electronic configuration of N (7) = $1s^2\ 2s^2\ 2p_x^1\ 2p_y^1\ 2p_z^1$.

N atom has 7 electrons. So the molecular orbital of N_2 contains 14 electrons.

MOED of N_2 molecule:



Electronic Configuration of molecular orbitals of N_2 :

$$(\sigma 1s^2)(\sigma^* 1s^2)(\sigma 2s^2)(\sigma^* 2s^2)(\pi 2p_x^2 = \pi 2p_y^2)(\sigma 2p_z^2)$$

Here, the number of bonding electrons (N_b)= 10

the number of anti-bonding electrons (N_a)=4

Bond order $= \frac{N_b - N_a}{2} = \frac{10-4}{2} = \frac{6}{2} = 3$

N_2 is diamagnetic due to the absence of unpaired electrons.

SECTION-C

19. How are the quantum numbers n, *l* and m_l arrived at? Explain the significance of these quantum numbers.

A: The quantum numbers n, *l*, m_l are arrived by solving Schrodinger wave equation.
They explain
(i) the position of electron
(ii) size of the orbit, shape and orientation of orbitals.

1) Principal quantum number (n) :

i) It was proposed by **Bohr.**
ii) It is denoted by '**n**'.
iii) The values of 'n' are **1,2,3,4.**.....(or) **K,L,M,N.**....
iv) Significance: 'n' denotes
(a) **size** of the orbit (r_n) (b) **energy** of the orbit (E_n)
(v)The maximum number of electrons in n^{th} orbit = $2n^2$.

2) Azimuthal quantum number (*l*) :

i) It was proposed by **Sommerfeld**.
ii) It is denoted by '***l***'.
iii) The values of '*l*' are **0,1,2,.**....,(n–1).
iv) Significance: '*l*' denotes
a) **shape** of the orbitals b) number of subshells in a main shell
(v)The '*l*' values 0,1,2,3 correspond to the sub shells s, p, d, f respectively.

3) Magnetic quantum number (m):

i) It was proposed by **Lande**.
ii) It is denoted by '**m**'(or) m_l.
iii) For a given value of *l*, we have, $m=2l+1$
iv) Significance: 'm' denotes
(a) '**orientation**' of the orbital in **space.** (b) number of orbitals in a subshell
v) It explains the Zeeman and Stark effect.

4) Spin Quantum number (s):

i) It was proposed by Uhlenbeck and Goudsmith..
ii) It is denoted by '**s**'.
iii) The values of 's' are $+\frac{1}{2}$ (clockwise spin) and $-\frac{1}{2}$ (anti-clockwise spin).
iv) Significance: 's' signifies direction of spin of electrons.

20. Define IE_1 and IE_2. Why is $IE_2 > IE_1$ for a given atom? Discuss the factors that effect IE of an element.

A: **1) First Ionisation Enthalpy (IE_1):** It is the **minimum** amount of energy required to remove a valence electron from an **isolated, neutral**, **gaseous atom(X)**.

$$X(g) \xrightarrow{IE_1} X^+(g) + e^-$$

2) Second Ionisation Enthalpy (IE_2): It is the minimum amount of energy required to remove the valence electron from the **unipositive gaseous ion(X^+).**

$$X^+(g) \xrightarrow{IE_2} X^{2+}(g) + e^-$$

3) $IE_2 > IE_1$:

Reason: When compared to the parent atom X, the unipositive ion X^+ contains more protons than electrons. So its positive nuclear charge increase. Hence the force of attraction on the valence electrons increases. So more energy is required to remove the electron in the second case . Hence IE_2 is greater than IE_1.

4) Factors that effect IE :

BULLET HINT

IE
↑AR ↑
↑NC↑
↑EC↑
↑SE ↓
↓PE ↓

i) Atomic Radius(AR) : As atomic radius decreases, the nuclear force of attraction on the valence electrons increases. So, IE value also increases.

ii) Nuclear Charge(NC): When the 'effective nuclear charge' increases, the force of attraction on the valence electrons increases. So, IE value also increases.

iii) Electronic Configuration(EC): Atoms with completely filled (or) half-filled sub-shells are more **stable** than the others. So, IE values are more for stable atoms.

iv) Screening Effect(SE): The electrons present in the 'inner orbits', act as a 'screen' between nucleus and valance electrons. When the number of electrons in the inner orbits increases, the screening effect also increases. This screening effect reduces the effective nuclear charge. So, IE value decreases.

v) Penetrating Effect (PE): In a given shell ,the penetrating power of the 'valence electrons' decreases in the order of s > p > d > f. So, IE value decreases in the same order.

21. Write any two methods of preparation of benzene with corresponding equations.

How methyl benzene and acetophenone are prepared from benzene?

A : Two Methods of preparation of Benzene:

1) Laboratory Method: Sodium benzoate on distillation with soda lime gives benzene.

$$C_6H_5COONa + NaOH \xrightarrow[\Delta]{CaO} C_6H_6 + Na_2CO_3$$

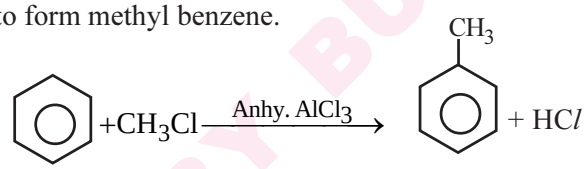
Sod. benzoate Benzene

A mixture of NaOH and CaO is called soda lime.

2) Benzene from acetylene: Acetylene is passed through red hot Cu to form benzene.

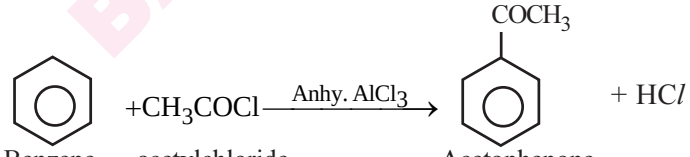
$$3C_2H_2 \xrightarrow[600°C]{\text{Red hot Cu}} C_6H_6$$

1) Friedel - Craft's alkylation: Benzene reacts with alkyl chloride in the presence of anhy. $AlCl_3$ to form methyl benzene.



Benzene methylchloride Methyl Benzene

2) Friedel - Craft's acylation: Benzene reacts with acetyl chloride in the presence of anhy. $AlCl_3$ to form acetophenone.



Benzene acetylchloride Acetophenone