Previous IPE

SOLVED PAPERS

MARCH -2020 (TS)

PREVIOUS PAPERS

IPE: MARCH-2020(TS)

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

SECTION-A

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

1. Define TLV.
2. Write any two gases responsible for Greenhouse effect.
3. How does Graphite function as a lubricant?
4. Describe the important uses of sodium carbonate.
5. Write biological importance of Na^+, Ca^{+2} ions.
6. Calculate the weight of 0.1 mole of Sodium carbonate.
7. Calculate the ratio of kinetic energies of 3g of hydrogen and 4g of oxygen at given temperature.
8. What is ZSM-5? Write its use.
9. Write chain isomer structures of carbon compound C_4H_{10}.
10. What is dynamic equilibrium?

SECTION-B

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

11. Explain the hybridisation involved in PCl_5 molecule.
12. What is ionic bond? Explain with one example.
13. Deduce (a) Boyle's law (b)Graham's law from kinetic gas equation.
14. State and explain the Hess's law of constant Heat summation.
15. A carbon compound contains 12.8% carbon, 2.1% hydrogen, 85.1% bromine. The molecular weight of the compound is 187.9. Calculate the molecular formula.
16. Explain electron deficient and electron-rich hydrides with one example each.
17. Explain Borax bead test with a suitable examples.
18. Explain Bronsted-Lowry acid base theory.

SECTION-C

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

19. What are the postulates of Bohr's model of hydrogen atom? Discuss the importance of this model to explain various series of line spectra in hydrogen atom.
20. What is periodic property ? How the following properties vary in a group and a period? Explain (a) Atomic radius (b) Electron gain enthalpy (c) Electro negativity
21. Give two methods of preparation of acetylene. How does it react with water and hydrogen bromide? Write equations.

IPE TS MARCH-2020
ANSWERS

SECTION-A

1. Define TLV.

A: TLV(Threshold Limit Value): The permissible level of a toxic pollutant without any adverse effect on a healthy industrial worker, working for 8 hours per day, in a polluted atmosphere is called TLV.

---

2. Write any two gases responsible for Greenhouse effect.

A: Green house effect is caused by the gases such as CO_2, CH_4, O_3, CFCs (Chloro Fluoro Carbons) and water vapour in the atmosphere.

---

3. 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.

---

4. Describe the important uses of sodium carbonate.

A: Sodium Carbonate (Na_2CO_3) is used

1) to remove hardness of water.
2) in the preparation of glass, caustic soda.
3) in laundries as washing soda.
4) in paper, paints and petroleum industries.

---

5. Write biological importance of Na^+, Ca^{+2} ions. [☞P 253(59)]

A: I) Sodium ion(Na^+) helps in

i) the transmission of nerve signals.
ii) regulation of flow of water across the cell membranes.
iii) transportation of sugars and aminoacids into the cells.

II) Biological importance of Ca^{2+}:

About 99% of body calcium is present in bones and teeth. It plays important roles in neuro muscular function, interneuronal transmission, cell membrane integrity and blood coagulation.

6. Calculate the weight of 0.1 mole of Sodium carbonate.

A: No. of moles of Na_2CO_3 (n) = 0.1, G.M.W of Na_2CO_3 = 106

Weight w = n × GMW = 0.1 × 106 = 10.6 g

---

7. Calculate the ratio of kinetic energies of 3g of hydrogen and 4g of oxygen at given temperature.

A: $$\frac{\text{Kinetic energy of } H_2}{\text{Kinetic energy of } O_2} = \frac{(3/2)n_{H_2}RT}{(3/2)n_{O_2}RT} = \frac{n_{H_2}}{n_{O_2}} \quad [\because \text{T is constant}]$$

$$= \frac{3\text{g of } H_2}{2} : \frac{4\text{g of } O_2}{32} = \frac{3}{2} : \frac{1}{8} = \frac{3}{2} \times \frac{8}{1} = \frac{12}{1} = 12:1$$

---

8. What is ZSM-5? Write its use.

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

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

---

9. Write chain isomer structures of carbon compound C_4H_{10}.

A: (a) $CH_3-CH_2-CH_2-CH_3$ n-Butane

(b) $CH_3-\underset{\displaystyle CH_3}{\underset{|}{CH}}-CH_3$ Isobutane

---

10. What is dynamic equilibrium?

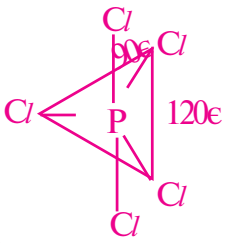
A: The forward and backward reactions of a reversible reaction continuously takes place with equal rates simultaneously, at the equilibrium stage also. Hence the equilibrium state is a dynamic equilibrium state. Any chemical equilibrium process is a dynamic equilibrium in nature.

SECTION-B

11. Explain the hybridisation involved in PCl_5 molecule.

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

II) Structure of PCl_5 molecule:



1) In PCl_5, the central atom is P(15).
2) It's ground state E.C= $[Ne]3s^23p^3$

   It's excited state E.C= $[Ne]\,3s^1 3p_x^1 3p_y^1 3p_z^1 3d^1$
3) In its excited state, the central P atom undergoes sp^3d hybridisation.
4) Central P forms 'five sp^3d hybrid orbitals', and each sp^3d orbital contains one electron.
5) 'Five sp^3d hybrid orbitals' of P, overlap axially with $3p_z$ orbital of five C*l* atoms to form five σ bonds.
6) Shape of PCl_5 is Trigonal bipyramid and the bond angles are 120°,90°.

---

12. What is ionic bond? Explain with one example.

A: An ionic bond is formed by the **complete transfer** of electrons from the outer most shell of one atom (with low I.P) to outer most shell of another atom (with high E.A). In this process, each atom attains the **nearest noble gas configuration** or **octet** configuration.

The atom which looses electrons becomes cation and the atom which gains electrons becomes anion.The attractive force between those oppositely charged ions is called ionic bond.

Explanation using the formation ionic bond in NaCl.

The electronic configuration of Na is $1s^2\,2s^22p^63s^1$

The electronic configuration of C*l* is $1s^22s^22p^63s^23p^5$

Na atom is electropositive and has low I.P, and C*l* is electronegative and has high E.A.

So, Na atom looses one electron and transfers it to C*l* atom. Then Na atom becomes Na^+ cation and C*l* atom becomes Cl^- anion.

Now the electronic configuration of the cation Na^+ becomes $1s^22s^22p^6$.= Ne configuration.

The electronic configuration of the anion Cl^- becomes $1s^22s^22p^63s^23p^6$=Ar configuration.

Hence, both the ions get the octet configuration.

Thus Na^+ and Cl^- are held together by strong electrostatic forces of attraction called ionic bond.

13. Deduce (a) Boyle's law (b)Graham's law from kinetic gas equation.

A: a) Boyle's law:

From kinetic gas equation $PV = \frac{1}{3}mnu_{rms}^2 = \frac{2}{3}\times\frac{1}{2}mnu_{rms}^2$

$$PV = \frac{2}{3}KE \text{ .....(1)}, \qquad \left(\text{Since, } K.E = \frac{1}{2}mnu_{rms}^2\right)$$

According to kinetic gas theory, $KE \propto T \Rightarrow KE = kT$ .....(2)

From (1) & (2), $PV = \frac{2}{3}kT$ .....(3)

If 'T' is kept constant in the above relation then PV = constant.

Thus Boyle's law is proved.

(b) Graham's law: "The **rate of diffusion** (r)of a gas is inversely proportional to the square root of its **density**(d)", at constant temperature and pressure. Thus, $r \propto \frac{1}{\sqrt{d}}$

From kinetic gas equation, $PV = \frac{1}{3}mnu_{rms}^2 = \frac{1}{3}Mu_{rms}^2$ ($\because$ mn=M, total mass of gas)

$$\Rightarrow u_{rms}^2 = 3\frac{PV}{M} = \frac{3P}{d}, \left(\because d = \frac{M}{V}\right)$$

$$\Rightarrow u_{rms}^2 \propto \frac{1}{d} \Rightarrow u_{rms} \propto \frac{1}{\sqrt{d}}$$

But RMS velocity, $u_{rms} \propto r$.

Hence $r \propto \frac{1}{\sqrt{d}}$

Thus Graham's law is derived.

14. 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.

---

15. A carbon compound contains 12.8% carbon, 2.1% hydrogen, 85.1% bromine. The molecular weight of the compound is 187.9. Calculate the molecular formula.

A:

S.No	Element	% by weight	$\frac{\%\ \text{by weight}}{\text{At.wt}}$	Simple ratio
1)	Carbon (C)	12.8	$\frac{12.8}{12}=1.067$	$\frac{1.067}{1.063}=1$
2)	Hydrogen(H)	2.1	$\frac{2.1}{1}=2.1$	$\frac{2.1}{1.063}=2$
3)	Bromine(Br)	85.1	$\frac{85.1}{80}=1.063$	$\frac{1.063}{1.063}=1$

Ratio of C:H:Br= 1:2:1. Hence Empirical formula = CH_2Br

$\therefore$ Empirical formula weight = 12 + (2 x 1) + 80 = 94.

Given molecular formula weight = 187.9

$$n = \frac{\text{Molecular formula weight}}{\text{Empirical formula weight}} = \frac{187.9}{94} = 2$$

$\therefore$ Molecular formula = $(\text{Empirical formula})_n = (CH_2Br)_2 = C_2H_4Br_2$

16. Explain electron deficient and electron-rich hydrides with one example each.

A: i) Electron deficient compounds of hydrogen:

These compounds have less number of electrons than required for conventional Lewis structure.

Elements of group-13 form such compounds.

Ex: B_2H_6 (Diborane)

ii) Electron precise compounds of hydrogen:

They have exactly equal number of electrons required for conventional Lewis structure.

Elements of group -14 form such compounds . They are tetrahedral in geometry.

Ex: Methane (CH_4).

iii) Electron rich hydrides:

These compounds have excess number of electrons than required for conventional Lewis structure.

Elements of group 15-17 form such compounds. They behave as Lewis bases.

Ex: Ammonia (NH_3)

---

17. Explain Borax bead test with a 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:

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

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

18. Explain Bronsted-Lowry acid base theory.

A: **1) Bronsted acid :** A proton donor is called bronsted acid.

Ex: HCl, H_2SO_4, CH_3COOH...

2) Bronsted base : A proton acceptor is called bronsted base.

Ex: H_2O, NH_3, OH^-.....

3) Neutralization: Transfer of a proton from acid to base is called neutralization.

Ex: $\underset{\text{(Hydrochloric acid)}}{HCl} + \underset{\text{(water)}}{H_2O} \rightleftharpoons \underset{\text{(Hydronium ion)}}{H_3O^+} + \underset{\text{(chloride ion)}}{Cl^-}$

Here 'HCl' donates one proton to H_2O. So, HCl is a Bronsted acid.

H_2O accepts one proton from HCl. So, H_2O is a Bronsted base.

4) Conjugate acid-base pair: It is an 'acid-base pair' which differs by one proton.

Ex: $\underset{\text{Acid}_1}{HCl} + \underset{\text{Base}_2}{H_2O} \rightleftharpoons \underset{\text{Acid}_2}{H_3O^+} + \underset{\text{Base}_1}{Cl^-}$

In this reaction, HCl & Cl^- and H_2O & H_3O^+ are conjugate acid-base pairs.

SECTION-C

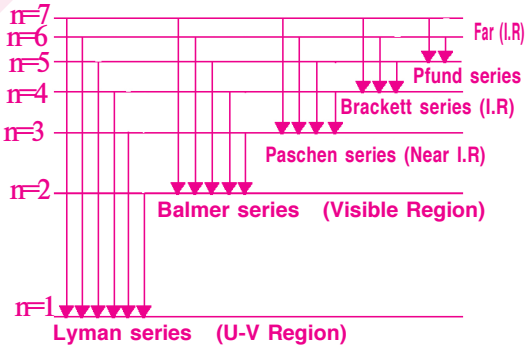
19. What are postulates of Bohr's model of hydrogen atom? Discuss the importance of this model to explain various series of line spectra in hydrogen atom.

A: I) Postulates of Bohr's model :

1) Electron in an atom revolve around the nucleus in certain fixed **circular paths** called **orbits.**
2) Each orbit has **fixed amount of energy**. So these orbits are also called **energy levels**. These orbits are denoted by 1,2,3,4,..... (or) K, L, M, N.....
3) As long as an electron revolves around the nucleus in a fixed orbit it **does not emit** (or) **absorb energy**. So these orbits are also called as **Stationary orbits**.
4) **Angular momentum** of revolving electron is **quantised** and is an integral multiple of $\frac{h}{2\pi}$.
$\therefore mvr = \frac{nh}{2\pi}$. Here, m= mass of electron, v= velocity, r= radius and h= Planck's constant
5) Energy is emitted (or) absorbed when electron jumps from one orbit to another orbit.
The energy difference between two orbits is $\Delta E = E_2 - E_1 = h\nu$
Here, E_2= Energy of the higher orbit, E_1= Energy of the lower orbit

II) Hydrogen spectrum- Bohr's Explanation:

1) When electric discharge is passed through gaseous hydrogen, the electrons in atoms **absorb** energy.
2) Then they **jump** into **higher energy orbits**.
3) In higher orbits, they have **more energy and less stability.**
4) Then the excited electrons **come back** to **lower orbits** in **one** or **multiple steps**.



Hydrogen Spectrum

5) **Energy** is **released** during this process and it appears in the form of **spectral lines.**
6) When an electron jumps from any higher orbit to
i) **n=1** produces spectral lines in the **UV** region.This is named as **Lyman series.**
ii) **n=2** produces spectral lines in the **visible** region.This is named as **Balmer series.**
iii) **n=3,4,5** produces spectral lines in near IR, IR, far IR regions.
These are named as **Paschen** ,**Brackett** and **Pfund** series respectively.
7) From the Rydberg equation, wavenumber $\bar{\nu} = \frac{1}{\lambda} = R_H\left[\frac{1}{n_1^2} - \frac{1}{n_2^2}\right]$

20. What is periodic property ? How the following properties vary in a group and a period? Explain (a) Atomic radius (b) Electron gain enthalpy (c) Electro negativity

A: **Periodic properties:** They are the **repeating trends** in physical and chemical properties of elements in the periodic table.

1) Atomic radius (AR): It is the distance between the 'nucleus and the outer most orbit' of the atom

i) In a **group,** from top to bottom, the **atomic radius increases .**

Reason : In a group, the differentiating electron enters the next orbit.
So atomic radius **increases**

ii) In a **period,** from left to right, the **atomic radius decreases.**

Reason: In a period ,the differentiating electron enters into the same orbit.
So, the effective nuclear charge increases. Hence atomic radius decreases.

2) Electron gain enthalpy [Electron affinity(EA)]: It is the amount of **energy released** when an electron is added to an 'isolated gaseous neutral atom'.

i) In a **group,** from top to bottom, **electron affinity decreases.**

Reason : In a group, the atomic size increases.
So, the effective nuclear charge decreases.
Hence electron affinity decreases in a group.

ii) In a **period**, from left to right, the **electron affinity increases.**

Reason : In a period, the atomic size decreases.
So, the effective nuclear charge increases.
Hence electron affinity increases in a period.

3) Electronegativity(EN) : It is the **tendency of an atom** in a molecule 'to attract the shared pair of electrons towards itself ' .

i) In a **group,** from top to bottom, the **E.N. value decreases.**

Reason: In a group, the atomic size increases.
So, the effective nuclear charge decreases.
Hence E.N value decreases in a group.

ii) In a **period,** from left to right, the **E.N value increases**

Reason: In a period ,the atomic size decreases.
So, the effective nuclear charge increases.
Hence E.N increases in a period.

21. Give two methods of preparation of acetylene. How does it react with water and hydrogen bromide? Write equations.

A: Preparation of Acetylene(C_2H_2):

1) From Calcium carbide: Calcium carbide on hydrolysis forms **Acetylene**.

$$CaC_2 + 2H_2O \longrightarrow Ca(OH)_2 + C_2H_2 \uparrow$$

2) From iodoform: Iodoform is heated with silver powder to form **Acetylene**.

$$CHI_3 + 6Ag + CHI_3 \xrightarrow{\Delta} C_2H_2 + 6AgI$$

Iodoform Acetylene

Properties of Acetylene:

(i) Action with water: Acetylene reacts with water in the presence of 1% $HgSO_4$ and 30% H_2SO_4 to form Vinyl alcohol. This on rearrangement form acetaldehyde.

$$HC \equiv CH + HOH \xrightarrow[30\%H_2SO_4]{1\%HgSO_4} [CH_2 = CH.OH] \underset{\text{Rearrangement}}{\rightleftharpoons} CH_3CHO$$

Acetylene Vinyl alcohol Acetaldehyde

ii) Action with Hydrogen halides: Acetylene undergoes addition with hydrogen halides and gives finally 1,2–dibromoethane. **[TS 20]**

$$H-C \equiv C-H + HBr \longrightarrow H_2C = \underset{|}{\overset{Br}{C}}\,H \xrightarrow{HBr} CH_3 - \underset{|}{\overset{Br}{C}}\,H \text{ or } CH_3 - CHBr_2$$
$$\qquad\qquad\qquad\qquad\qquad\qquad\qquad\qquad\quad\; Br$$

Acetylene Vinyl bromide 1,2-dibromoethane