Previous IPE

SOLVED PAPERS

MARCH-2020 (AP)

PREVIOUS PAPERS

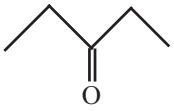
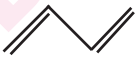
IPE: MARCH-2020(AP)

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

SECTION-A

I. Answer ALL questions : **10 × 2 = 20**

1. What is Biochemical Oxygen Demand (BOD)?
2. Green house effect is caused by .....and.....gases.
3. Why does the solubility of alkaline earth metal hydroxides in water increases down the group?
4. Describe the important uses of sodium carbonate.
5. On a ship sailing in pacific ocean where temperature is 23.4ºC , a balloon is filled with 2 L air. What will be the volume of the balloon when the ship reaches Indian ocean. Where temperature is 26.1ºC?
6. Calculate the normality of oxalic acid solutions containing 6.3 g of $H_2C_2O_4.2H_2O$ in 500 ml of solutions.
7. Give two chemical equilibrium reactions for which $K_p > K_c$
8. What is allotropy? Give the crystalline allotropes of carbon.
9. What is synthesis gas?How it is prepared?
10. Write the IUPAC names of

(a)  (b) 

SECTION-B

II. Answer any SIX of the following Questions. **6 × 4 = 24**

11. Define dipole moment. Write its applications.
12. Explain the hybridisation involved in PCl_5 molecule.
13. Deduce (a) Graham's law and (b) Dalton's law of partial pressures from kinetic gas equation.
14. Balance the following redox reaction by ion -electron method in basic medium

$$MnO^-_{4(aq)} + Br^-_{(aq)} \rightarrow MnO_{2(s)} + BrO^-_{3(aq)}$$

15. State and explain the Hess's law of constant Heat summation.
16. Write the conjugate acid and conjugate base of each of the following:

a) OH^- b) H_2O c) HCO^-_3 d) H_2O_2.

17. Discuss the position of hydrogen in the periodic table on the basis of its electronic configuration.
18. Explain Borax bead test with a suitable examples.

SECTION-C

III. Answer any TWO of the following Questions. **2 × 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. Write an essay on s,p,d and f block elements.
21. Give two methods of preparation of acetylene. How does it react with water and ozone?

IPE AP MARCH-2020
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. Green house effect is caused by .....and.....gases.

A: **1) Greenhouse effect:** It is the 'progressive warming up of the earth's surface' due to 'blanketing effect' of CO_2 and water vapour in the atmosphere .

2) 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.

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3. Why does the solubility of alkaline earth metal hydroxides in water increases down the group?

A: The lattice enthalpy decreases much more than the hydration enthalpy, with increasing ionic size down the group. So the solubility increases as we go down the group.

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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. On a ship sailing in pacific ocean where temperature is 23.4°C , a balloon is filled with 2 L air. What will be the volume of the balloon when the ship reaches Indian ocean. Where temperature is 26.1°C?

A: Initial Temperature T_1=(23.4+ 273)K= 296.4 K

Initial volume V_1 = 2 L

Final Temperature T_2= (26.1+273)K =299.1 K

Final volume V_2 = ?

From Charles law, $\frac{V_1}{T_1}=\frac{V_2}{T_2} \Rightarrow V_2=\frac{V_1T_2}{T_1}=\frac{2\times 299.1}{296.4}=2.018L$

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6. Calculate the normality of oxalic acid solutions containing 6.3 g of $H_2C_2O_4.2H_2O$ in 500 ml of solutions. [AP 20][TS 15]

A: Weight of solute = 6.3g

Gram Equivalent weight of solute $=\frac{126}{2}=63$

$\therefore$ Normality (N) = $\frac{w}{GEW}\times\frac{1000}{V(mL)}$ Normality (N) $=\frac{6.3}{63}\times\frac{1000}{500}=0.2\,N$

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7. Give two chemical equilibrium reactions for which $K_p > K_c$

A: 1) $PCl_{5(g)} \rightleftharpoons PCl_{3(g)} + Cl_{2(g)}$ $\Delta n = 2-1=+1$

2) $N_2O_4(g) \rightleftharpoons 2NO_{2(g)}$ $\Delta n = 2-1=+1$

$K_p = K_c(RT)^{+1} = K_c(RT)$ $\therefore K_p > K_c$

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8. What is allotropy? Give the crystalline allotropes of carbon.

A: The phenomenon of existence of an element in different physical forms having same chemical properties is called allotropy.

Crystalline allotropes of carbon are a) Diamond b) Graphite.

9. What is synthesis gas?How it is prepared?

A: 1) The mixture of CO and H_2 is called 'Synthesisgas (Water gas)'.

2) It is prepared by passing steam over hot coke.

3) It is used for the synthesis of methanol and a number of hydrocarbons.

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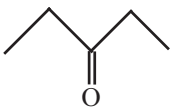
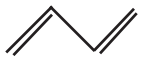
10. Write the IUPAC names of

a) 

b) 

A: a) 3- Pentanone b) 1, 3 - Butadiene

SECTION-B

11. Define dipole moment. Write its applications.

A: Dipole moment(μ): The product of the magnitude of the charge(Q) on either of the poles and the distance(r) between the centres of positive and negative charges is called dipole moment.

Mathematically, $\mu = Q \times r$

Where μ = Dipole moment; Q= charge;

r = distance between the charges.

Units: D (Debye units).

Applications:

1) Dipole moment predicts the polarity of molecules.
   a) Molecules with dipole moment greater than zero are polar.
   b) Molecules with dipole moment is equal to zero are non polar.
2) It predicts the shape of the molecules.
3) It predicts the % ionic character of covalent bonds.

$$\%\text{ ionic character of a covalent bond} = \frac{\mu_{experimental}}{\mu_{calculated}} \times 100$$

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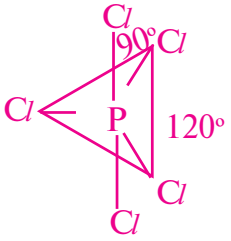
12. Explain the hybridisation involved in PCl_5 molecule.

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 Cl atoms to form five σ bonds.
6) Shape of PCl_5 is Trigonal bipyramid and the bond angles are 120°,90°.

13. Deduce (a) Graham's law and (b) Dalton's law of partial pressures from kinetic gas equation. [☞P 91(52)]

A: 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.

1) **Dalton's law of partial pressures**: "The total pressure(P) exerted by a mixture of non - reacting gaseous mixture is equal to the sum of the partial pressures of all component gases at constant temperature and volume".

2) Consider a gas in a vessel of volume V. Let m_1, n_1, u_{1rms} denote the mass, number of moles and RMS velocity of molecules.

   From the kinetic gas equation,the pressure of the gas $p_1 = \frac{1}{3}\frac{m_1 n_1 u_{1rms}^2}{V}$

3) If the gas is replaced by another gas in the same vessel, with m_2, n_2, u_{2rms} as mass, number of moles and RMS velocity of molecules, then its pressure $p_2 = \frac{1}{3}\frac{m_2 n_2 u_{2rms}^2}{V}$

4) Now $P = \frac{1}{3}\frac{m_1 n_1 u_{1rms}^2}{V} + \frac{1}{3}\frac{m_2 n_2 u_{2rms}^2}{V}$

   $\therefore P = p_1 + p_2$

   Hence Dalton's law is derived.

14. Balance the following redox reaction by ion -electron method in basic medium

$MnO^-_{4(aq)} + Br^-_{(aq)} \rightarrow MnO_{2(s)} + BrO^-_{3(aq)}$

A: 1) Skeleton ionic equation: $MnO_4^- + Br^- \rightarrow MnO_2 + BrO_3^-$

	Oxidation half reaction	**Reduction half reaction**
	$Br^- \rightarrow BrO_3^-$	$MnO_4^- \rightarrow MnO_2$
3)	Balance the atoms other than O and H	Balance the atoms other than O and H
	$Br^- \rightarrow BrO_3^-$	$MnO_4^- \rightarrow MnO_2$
4)	Balance of oxygen atoms	Balance of oxygen atoms
	$Br^- + 3H_2O \rightarrow BrO_3^-$	$MnO_4^- \rightarrow MnO_2 + 2H_2O$
5)	Balance of hydrogen atoms	Balance of hydrogen atoms
	$Br^- + 6OH^- + 3H_2O \rightarrow BrO_3^- + 6H_2O$	$MnO_4^- + 4H_2O \rightarrow MnO_2 + 2H_2O + 4OH^-$
6)	Balance of charges	Balance of charges
	$Br^- + 6OH^- \rightarrow BrO_3^- + 3H_2O + 5e^-$	$MnO_4^- + 2H_2O + 3e^- \rightarrow MnO_2 + 4OH^-$
7)	Equalizing of electrons	Equalizing of electrons
	$3Br^- + 18OH^- \rightarrow 3BrO_3^- + 9H_2O + 15e^-$	$5MnO_4^- + 10H_2O + 15e^- \rightarrow 5MnO_2 + 20OH^-$

8) Adding the two half reactions

$3Br^- + 18OH^- \rightarrow 3BrO_3^- + 9H_2O + 15e^-$

$5MnO_4^- + 10H_2O + 15e^- \rightarrow 5MnO_2 + 20OH^-$

$3Br^- + 5MnO_4^- + H_2O \rightarrow 3BrO_3^- + 5MnO_2 + 2OH^-$ This is the balanced equation.

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15. 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 = ΔH

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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16. Write the conjugate acid and conjugate base of each of the following:

a) OH^- **b) H_2O** **c) HCO_3^-** **d) H_2O_2.**

A:

Species	Conjugate acid	Conjugate base
OH^-	H_2O	O^{2-}.
H_2O	H_3O^+	OH^-.
HCO_3^-	H_2CO_3	CO_3^{2-}
H_2O_2	$H_3O_2^+$	HO_2^-

17. Discuss the position of hydrogen in the periodic table on the basis of its electronic configuration.

A: Electronic configuration of H is $1s^1$. This configuration is responsible for its dual nature. It behaves like both Alkali metals and Halogens.

Points in support of placing H in IA group:

a) Just like alkali metals, Hydrogen has one electron in its outer shell ($1s^1$).

b) Just like alkali metals, Hydrogen forms unipositive ion, $H^+(aq)$.

c) Just like alkali metals, Hydrogen shows valency 1 in its compounds.

Also, it is quite reasonable to start the periodic table with an element having the least atomic number (Z=1).

Points in support of placing H in VIIA group:

a) Just like Halogens, Hydrogen is a gaseous non-metal.

b) Just like Halogens, Hydrogen forms uninegative ion, H^-.

c) Just like Halogens (F_2,Cl_2....), Hydrogen is a diatomic molecule H_2.

Also, Hydrogen has a tendency of gaining one electron to attain stable electronic configuration of He.

Even though it resembles in many properties both with alkali and halogens, it differs from them as well. Hence, the position of hydrogen in the periodic table has become **a matter of choice**. It can be placed along with alkali metals in IA group (or) along with halogens in VIIA group.

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18. 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:

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

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

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

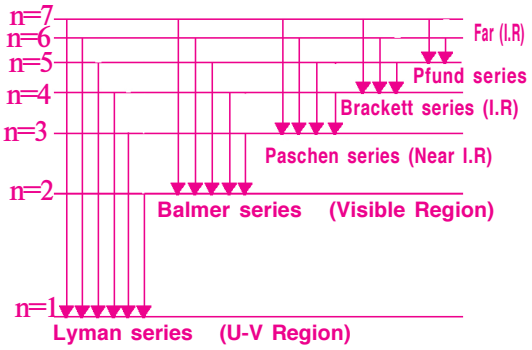
II) Hydrogen spectrum- Bohr's Explanation:

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

A: All the elements are classified into 4 blocks, depending on the entry of differentiating electron' into sub-shells. They are s-block, p-block, d-block, f-block.

I) s-block elements :

1) In s-block elements, the 'differentiating electron' enters into ns-subshells.
2) Their General Electronic Configuration(GEC) is ns^{1-2} .
3) They are arranged in two groups; group 1 & group 2 .
4) Group 1 elements are called Alkali metals. Their GEC is ns^1.
   Group 2 elements are called Alkaline earth metals. Their GEC is ns^2.
5) They are placed on the **left side** of the periodic table.

II) p-block elements :

1) In p- block elements, the 'differentiating electron' enters into np-subshells.
2) Their GEC is $ns^2\ np^{1-6}$.
3) They are arranged in 6 groups, from group 13 to group 18.
4) i) Group 13 is called **B**oron family. Its GEC is ns^2np^1
   ii) Group 14 is called **C**arbon family. Its GEC is ns^2np^2
   iii) Group 15 is called **N**itrogen family. Its GEC is ns^2np^3
   iv) Group 16 is called **C**halcogen family. Its GEC is ns^2np^4
   v) Group 17 is called **H**alogen family. Its GEC is ns^2np^5
   vi) Group 18 is called **N**oble gas family. Its GEC is ns^2np^6
5) They are placed on the **right side** of the periodic table.

III) d-block elements:

1) In d- block elements, the 'differentiating electron' enters into (n–1)d sub shells.
2) Their GEC is $(n-1)d^{1-10}\ ns^{1\text{ or }2}$.
3) They are arranged in 10 groups, from group 3 to group 12.
4) They are further classified into 3d series, 4d series, 5d series and 6d series.
5) They are placed at the **middle** of the periodic table.

IV) f-block elements :

1) In f- block elements the 'differentiating electron' enters into (n–2)f sub shells.
2) Their GEC is $(n-2)\ f^{1-14}\ (n-1)d^{0\text{ or }1}ns^2$.
3) They are classified into 2 series.
4) They are 4f series - known as **Lanthanide series**, 5f series - known as **Actinide series.**
5) They are placed separately at the **bottom** of the periodic table.

21. Give two methods of preparation of acetylene. How does it react with water and ozone?

A: I) 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

II) Properties of Acetylene:

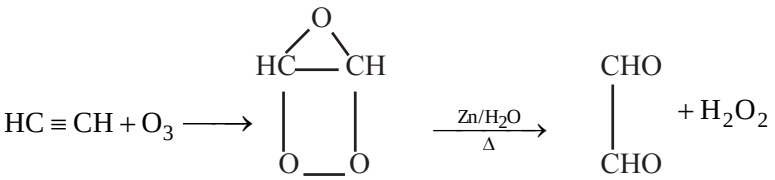
(i) Action with water: Acetylene reacts with water in the presence of 1% $HgSO_4$ and 30% H_2SO_4 to form Vinyl alcohol. This on rearrangement form acetaldehyde.

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

Acetylene Vinyl alcohol Acetaldehyde

(ii) Action with ozone: Acetylene reacts with ozone to form acetylene ozonide.

This on hydrolysis in the presence of Zn forms glyoxal.



Acetylene Acetylene ozonide Glyoxal