CBSE Class 11 Chemistry

Sample Paper 10 (2020-21)

Maximum Marks: 70

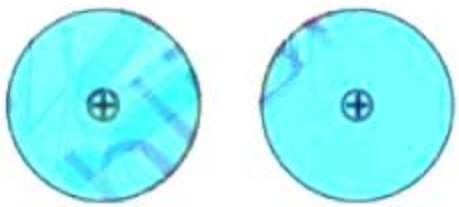
Time Allowed: 3 hours

General Instructions:

i. There are 33 questions in this question paper. All questions are compulsory.
ii. Section A: Q. No. 1 to 16 are objective type questions. Q. No. 1 and 2 are passage based questions carrying 4 marks each while Q. No. 3 to 16 carry 1 mark each.
iii. Section B: Q. No. 17 to 25 are short answer questions and carry 2 marks each.
iv. Section C: Q. No. 26 to 30 are short answer questions and carry 3 marks each.
v. Section D: Q. No. 31 to 33 are long answer questions carrying 5 marks each.
vi. There is no overall choice. However, internal choices have been provided.
vii. Use of calculators and log tables is not permitted.

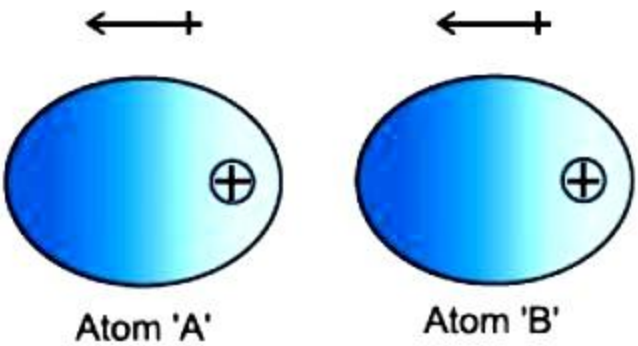
Section A

1. **Read the passage given below and answer the following questions:**
   Intermolecular forces are the forces of attraction and repulsion between interacting particles (atoms and molecules). Attractive intermolecular forces are known as van der Waals forces. Van der Waals forces vary considerably in magnitude and include dispersion forces or London forces, dipole-dipole forces, and dipole-induced dipole forces. Atoms and nonpolar molecules are electrically symmetrical and have no dipole moment because their electronic charge cloud is symmetrically distributed.



   Dipole-dipole forces act between the molecules possessing permanent dipole. Ends of the dipoles possess "partial charges" and these charges are shown by Greek letter delta (δ).

The dipole-dipole interaction energy between stationary polar molecules (as in solids) is proportional to $1/r^3$.



i. Who explains the dimension of real gas from the ideal behaviour?
   a. Jones van der waal
   b. Jahannes van der waal
   c. Fritz london
   d. Augustin

ii. The London force is always attractive and interactive energy is inversely proportional to
   a. sixth power of distance between 2 interacting particle
   b. fouth power of distance between 2 interacting particle
   c. a fifth power of distance between 2 interacting particle
   d. third power of distance between 2 interacting particle

OR

Dipole-Dipole interaction is stronger than
   a. London force
   b. ion-ion interaction
   c. hydrogen interaction
   d. none of these

iii. Effect of high polarisability on strength of attraction
   a. zero strength
   b. decreases strength
   c. increases strength
   d. none of these

iv. Energy of hydrogen bond varies between _____ KJ mol^{-1}

a. 10 to 100
b. 10 to 10000
c. 10 to 25
d. none of these

2. **Read the passage given below and answer the following questions.**

IUPAC (International Union of Pure and Applied Chemistry) system of nomenclature. Common names are useful and in many cases indispensable, particularly when the alternative systematic names are lengthy and complicated. A systematic name of an organic compound is generally derived by identifying the parent hydrocarbon and the functional group(s) attached to it. By using prefixes and suffixes, the parent name can be modified to obtain the actual name. In a branched-chain compound, small chains of carbon atoms are attached at one or more carbon atoms of the parent chain. The small carbon chains (branches) are called alkyl groups. An alkyl group is derived from a saturated hydrocarbon by removing a hydrogen atom from carbon. Abbreviations are used for some alkyl groups. For example, methyl is abbreviated as Me, ethyl as Et, propyl as Pr and butyl as Bu.

In these questions, a statement of assertion followed by the statement of reason is given. Choose the correct answer out of the following choices

a. Assertion and reason both are correct statements and reason is the correct explanation for assertion.
b. Assertion and reason both are correct statements and reason is not the correct explanation for assertion.
c. Assertion is the correct statement but reason is wrong statement.
d. Assertion is the wrong statement but reason is correct statement.

i. **Assertion:** Acid found in red ant is named formic acid.
Reason: Buckminsterfullerene is a common name given to the newly discovered C_{60} cluster.

ii. **Assertion:** Compounds containing carbon and hydrogen only are called hydrocarbons.
Reason: Unsaturated hydrocarbons are those, which contain a single bonded carbon only.

iii. **Assertion:** C_7H_{14} is butane.
Reason: The alkanes differ from each other by merely the number of $-CH_2$ groups in

the chain.

iv. **Assertion:** As CH_4 becomes -CH_3 it is called a methyl group.

Reason: An alkyl group is named by substituting 'yl' for 'ane' in the corresponding alkane.

OR

Assertion: The branched butyl groups are called sec-butyl, isobutyl and tert-butyl group.

Reason: Common branched groups have specific trivial names.

3. 20 grams is the same as:
   a. 1500 mg
   b. 20000 mg
   c. 200 mg
   d. 2000 mg
4. Spin quantum number with two spin states of the electron represented by two arrows, ↑ (spin up) and ↓ (spin down) was introduced to account for
   a. the splitting of emission lines in a Magnetic field
   b. the splitting of emission lines in an electric field
   c. to account for uncertainty in electron states
   d. the splitting of emission lines in a Vacuum

OR

If travelling at same speeds, which of the following matter waves have the shortest wavelength?

   a. Alpha particle (He^{2+})
   b. Proton
   c. Neutron
   d. Electron
5. Phenyl magnesium bromide reacts with methanol to give:
   a. a mixture of phenol and Mg(Me)Br.
   b. a mixture of anisole and Mg(OH)Br.

c. a mixture of toluene and Mg(OH)Br.
d. a mixture of benzene and Mg(OMe)Br.

6. For the process depicted by the equation:

H_2O (s) $\longrightarrow$ H_2O (l)

Δ H = + 1.43 kcal mol^{-1}. It represents:

a. Enthalpy of vaporization
b. Enthalpy of sublimation
c. Enthalpy of condensation
d. Enthalpy of fusion

OR

According to the first law of thermodynamics $\Delta U = q + w$, here what is a sign of q and w?

a. q is negative if heat is transferred into the system and w is negative if work is done on the system.
b. q is positive if heat is transferred into the system and w is positive if work is done by the system.
c. q is negative if heat is transferred from the system and w is negative if work is done by the system.
d. q is positive if heat is transferred into the system and w is positive if work is done on the system.

7. At a particular temperature and atmospheric pressure, the solid and liquid phases of a pure substance can exist in equilibrium. Which of the following term defines this temperature?

a. Boiling point
b. Phase change temperature
c. Normal melting point and Freezing point
d. Equilibrium temperature

OR

At a given temperature, equilibrium is possible only in a system which is a:

a. open system

b. partially open system
c. partially closed system
d. closed system

8. Arrange the following carbanions in order of their decreasing stability.

A. $H_3C - C \equiv C^-$

B. $H - C \equiv C^-$

C. $H_3C - \bar{C}H_2$

a. B > A > C
b. A > B > C
c. C > A > B
d. C > B > A

9. All alkali metal halides are soluble in water except:
a. Lithium
b. Rubidium
c. Francium
d. Caesium

10. The peroxide effect in anti-Markovnikov's addition of HBr to unsymmetrical alkenes involves
a. homolytic fission of the double bond
b. a free radical mechanism.
c. heterolytic fission of the double bond
d. an ionic mechanism

11. The octet of electrons represents a particularly stable electronic arrangement. Atoms achieve a stable octet when they are linked by chemical bonds. This rule is associated with which one of the following theories?
a. Valence Shell Electron Pair Repulsion VSEPR Theory
b. Lewis approach
c. Valence Bond (VB) Theory
d. Molecular Orbital (MO) Theory

12. **Assertion (A):** Combustion of 16 g of methane gives 18 g of water.
Reason (R): In the combustion of methane, water is one of the products.
a. Both A and R are true but R is not the correct explanation of A.

b. A is true but R is false.
c. A is false but R is true.
d. Both A and R are false.

13. **Assertion:** TICI is more stable than $TICI_3$.

Reason: + 1oxidation state of heaviest element is more stable than +3.

a. Both assertion and reason are CORRECT and reason is the CORRECT explanation of the assertion.
b. Both assertion and reason are CORRECT but, reason is NOT THE CORRECT explanation of the assertion.
c. Assertion is CORRECT but, reason is INCORRECT.
d. Assertion is INCORRECT but, reason is CORRECT.

14. **Assertion:** The value for van der Waal's constant 'a' is higher for ammonia than for nitrogen.

Reason: Intermolecular hydrogen bonding is present in ammonia.

a. Both assertion and reason are CORRECT and reason is the CORRECT explanation of the assertion.
b. Both assertion and reason are CORRECT but, reason is NOT THE CORRECT explanation of the assertion.
c. Assertion is CORRECT but, reason is INCORRECT.
d. Assertion is INCORRECT but, reason is CORRECT.

OR

Assertion: Liquefaction of H_2 and He are very difficult.

Reason: Critical temperature of H_2 and He gases are high.

a. Both assertion and reason are CORRECT and reason is the CORRECT explanation of the assertion.
b. Both assertion and reason are CORRECT but, reason is NOT THE CORRECT explanation of the assertion.
c. Assertion is CORRECT but, reason is INCORRECT.
d. Assertion is INCORRECT but, reason is CORRECT.

15. **Assertion:** $PbCl_2$ is more stable than $PbCl_4$.

Reason: $PbCl_4$ is a powerful oxidising agent.

a. Both assertion and reason are CORRECT and reason is the CORRECT explanation of the assertion.
b. Both assertion and reason are CORRECT but, reason is NOT THE CORRECT explanation of the assertion.
c. Assertion is CORRECT but, reason is INCORRECT.
d. Assertion is INCORRECT but, reason is CORRECT.

16. **Assertion:** Addition of Br_2 to but-1-ene gives two optical isomers.

    Reason: The product contains one asymmetric carbon atom.

    a. Both assertion and reason are CORRECT and reason is the CORRECT explanation of the assertion.
    b. Both assertion and reason are CORRECT but, reason is NOT THE CORRECT explanation of the assertion.
    c. Assertion is CORRECT but, reason is INCORRECT.
    d. Assertion is INCORRECT but, reason is CORRECT.

Section B

17. Among the elements B, Al, C and Si (a) Which has the highest first ionization enthalpy? (b) Which has the largest atomic radius?

    OR

    Describe the main features of Mendeleev's periodic table.

18. Using curved-arrow notation, show the formation of reactive intermediates when the following covalent bonds undergo heterolytic cleavage.
    a. $CH_3–SCH_3$
    b. $CH_3–CN$
    c. CH3–Cu
19. Calculate the pH of a buffer solution containing 0.1 mole of acetic acid and 0.15 mole of sodium acetate. Ionisation constant for acetic acid is 1.75×10^{-5}.

    OR

    Name the three groups that may classify the state of a chemical equilibrium.

20. Discuss the general characteristics and gradation in properties of alkaline earth metals.

OR

The second ionization enthalpy of calcium is more than the first. How is that calcium forms $CaCl_2$ and not CaCl?

21. Explain the following: Temporary hardness can be removed by boiling
22. A colorless liquid **A** contains H and O elements only. It decomposes slowly on exposure to light. It is stabilized by mixing urea to store in the presence of light.
    i. Suggest a possible structure of A.
    ii. Write chemical equations for its decomposition reaction in light.
23. Explain why the system are not aromatic.

24. Which of the following species will have the largest and the smallest size? Mg, Mg^{2+}, Al, Al^{3+}.
25. MnO_4^{2-} undergoes disproportionation reaction in acidic medium but MnO_4^- does not. Give reason.

Section C

26. Hydrogen gas is obtained from the natural gas by partial oxidation with steam as per following endothermic reaction:

$$CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$$

Write the expression for K_p for the above reaction.

How will the value of K_p and composition of equilibrium mixture be affected by:

i. increasing the pressure.
ii. increasing the temperature,
iii. using a catalyst?

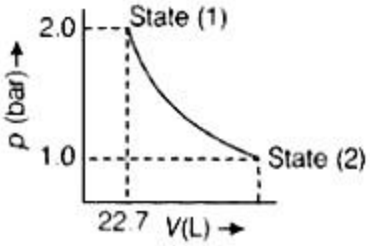
OR

An equilibrium mixture at 300 K contains N_2O_4 and NO_2 at 0.28 and 1.1 atm pressure respectively. If the volume of the container is doubled, calculate the new equilibrium pressure of two gases.

27. Give main differences between a reversible process and an irreversible process.

OR

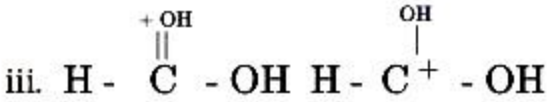
1.0 mole of a monoatomic ideal gas is expanded from the state (1) to state (2) as shown in figure. Calculate the work done for the expansion of gas from the state (1) to state (2) at 298 K.



28. An alkane has a molecular mass of 72. Give all the possible structural isomers along with their IUPAC names.
29. What is the relationship between the members of following pairs of structures? Are they structural or geometrical isomers or resonance contributors?

i. 

ii. 

iii. 

30. i. Calculate the gram molecular mass of sugar having molecular formula $C_{12}H_{22}O_{11}$.
    ii. Calculate
        a. The mass of 0.5 g molecule of sugar and
        b. Gram molecule of sugar in 547.2 g.

Section D

31. What is meant by the term bond order? Calculate the bond order of: N_2, O_2, O_2^+, O_2^-

OR

Discuss the orbital structures of the following molecules on the basis of hybridization.

i. BH_3

ii. C_2H_2

iii. BeF_2

32. Why was a change in the Bohr Model of atom required? Due to which important development (s), concept of movement of an electron in an orbit was replaced by, the concept of probability of finding electron in an orbital? What is the name given to the changed model of atom?

OR

Using Aufbau principle, write the ground state electronic configuration of following atoms.

i. Boron (Z = 5)
ii. Neon (Z = 10),
iii. Aluminium (Z = 13)
iv. Chlorine (Z = 17),
v. Calcium (Z = 20)
vi. Rubidium (Z = 37)

33. What are allotropes? Sketch the structure of two allotropes of carbon namely diamond and graphite. What is the impact of structure on physical properties of two allotropes?

OR

BCl_3 is trigonal planar while ACl_3 is tetrahedral in a dimeric state. Explain.

CBSE Class 11 Chemistry

Sample Paper 10 (2020-21)

Solution

Section A

1. i. (b) Jahannes van der wall

   ii. (a) sixth power of the distance between 2 interacting particle

   OR

   (a) London force

   iii. (c) increases strength

   iv. (a) 10 to 100

2. i. (b) Assertion and reason both are correct statements and reason is not the correct explanation for assertion.

   ii. (c) Assertion is the correct statement but reason is wrong statement.

   iii. (d) Assertion is the wrong statement but reason is correct statement.

   iv. (a) Assertion and reason both are correct statements and reason is the correct explanation for assertion.

   OR

   (a) Assertion and reason both are correct statements and reason is the correct explanation for assertion.

3. (b) 20000 mg

   Explanation: Since, 1 g

   = 1000 mg

   $\therefore$ 20 g

   = (20 $\times$ 1000) mg

   = 20,000 mg

4. (d) the splitting of emission lines in a Vacuum

   OR

   (a) Alpha particle (He^{2+})

Explanation: $\lambda = \frac{h}{mv} = \frac{h}{p}$

The higher the mass, the shortest is the wavelength. since alpha particles have the highest mass ($6.68*10^{-24}$g), they have the shortest wavelength.

5. (d) a mixture of benzene and Mg(OMe)Br.

   Explanation: This is because Grignard reagents react with proton from methanol to give benzene and Mg(OMe)Br.

6. (d) Enthalpy of fusion

   Explanation: In this process 1 mole of solid water is converted to liquid state. Fusion or melting is endothermic, so all enthalpies of fusion are positive.

OR

(d) q is positive if heat is transferred into the system and w is positive if work is done on the system.

Explanation: The first law is simply the conservation of energy equation. q is positive if heat is added to the system, and negative if heat is removed; w is positive if work is done on the system, and negative if work is done by the system.

7. (c) Normal melting point and Freezing point

   Explanation: These are normal melting point and freezing point since they are measured at atmospheric pressure.

OR

(d) closed system

Explanation: Equilibrium is possible only in a closed system at a given temperature for physical processes. When equilibrium is attained for a physical process, it is characterized by the constant value of one of its parameters at a given temperature.

8. (a) B > A > C

   Explanation: In B, the '-' charge is on sp hybridized C atom so the negative charge is stabilised. In A, there is an alkyl group attached to sp hybridised carbon which destabilizes the negative charge. In C, the '-' charge is on a sp^3 hybridised carbon and is hence the least stable.

9. (a) Lithium

   Explanation: Greater the lattice energy, the higher is the melting point of the MX (metal halide) and the lower is its solubility.

10. (b) a free radical mechanism.

    Explanation: The mechanism involved along with the generation of a free radical [i.e. phenyl free radical ($C_6H_5\cdot$)] by the use of benzoyl peroxide, showing peroxide effect in given below,

$$CH_3 - CH = CH_2 \xrightarrow[\text{Peroxide}]{HBr} \underset{\text{Propyl bromide}}{CH_3CH_2 - CH_2Br}$$

(i) $C_6H_5-\overset{\overset{O}{\|}}{C}-O-O-\overset{\overset{O}{\|}}{C}-C_6H_5 \xrightarrow{\text{Homolysis}}$

Benzoyl peroxide

$$2C_6H_5-\overset{\overset{O}{\|}}{C}-\dot{\underset{\cdot\cdot}{O}}: \rightarrow 2\dot{C}_6H_5 + 2CO_2$$

(ii) $\dot{C}_6H_5 + H-Br \xrightarrow{\text{Homolysis}} C_6H_6 + \dot{Br}$

11. (b) Lewis approach

    Explanation: G.N.Lewis, proposed the octet rule to explain the valence electron sharing between atoms that resulted in a bonding type with the atoms attaining noble gas electronic configuration.

    The statement is: "a bond is formed between two atoms by mutual sharing of pairs of electrons to attain a stable outer-octet of electrons for each atom involved in bonding". This type of valence electron sharing between atoms is termed as covalent bonding.

12. (c) A is false but R is true.

    Explanation: $CH_4(g) + 2O_2(g) \rightarrow CO_2(g) + 2H_2O(g)$

    16g of CH_4 on complete combustion will give 36g of water.

13. (a) Both assertion and reason are CORRECT and reason is the CORRECT explanation of the assertion.

    Explanation: Both assertion and reason are CORRECT and reason is the CORRECT explanation of the assertion.

14. (a) Both assertion and reason are CORRECT and reason is the CORRECT explanation of the assertion.

    Explanation: Both assertion and reason are CORRECT and reason is the CORRECT explanation of the assertion.

OR

(c) Assertion is CORRECT but, reason is INCORRECT.

Explanation: Assertion is CORRECT but, reason is INCORRECT.

15. (b) Both assertion and reason are CORRECT but, reason is NOT THE CORRECT explanation of the assertion.

    Explanation: Both assertion and reason are CORRECT but, reason is NOT THE CORRECT explanation of the assertion.

16. (a) Both assertion and reason are CORRECT and reason is the CORRECT explanation of the assertion.

    Explanation: Both assertion and reason are CORRECT and reason is the CORRECT explanation of the assertion.

Section B

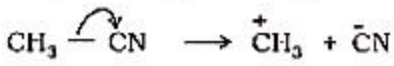
17. i. As we know, the ionization energy increases as we move from left to right in the periodic table while it decrease when we move from top to bottom in the periodic table. Therefore, Carbon has the highest first ionization enthalpy.
    ii. Aluminum has the largest atomic radius as atomic radius increases down the group and decreases along the period.

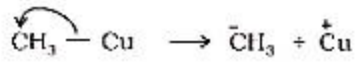
OR

i. In Mendeleev table, the elements were arranged in vertical columns, and horizontal rows. The vertical columns were called groups and the horizontal rows were called periods.
ii. There were in all eight groups. Group I to VIII. The group numbers were indicated by Roman numerals. Group VIII occupy three triads of the elements each i.e. in all nine elements.
iii. There were seven periods to accommodate more elements the period 4, 5, 6 and 7 were divided into two halves. The first half of the elements were placed in the upper left corner and the second half in the lower right corner of each box.

18. The formation of reactive intermediates is as follows:

    a. 

    b. 

    c. 

19. We have, Henderson's equation

$pH = pK_a + \log \frac{[Salt]}{[Acid]}$

$pH = -\log K_a + \log \frac{[Sodium\ acetate]}{[Acetic\ acid]}$

$pH = -\log (1.75 \times 10^{-5}) + \log \frac{0.15}{0.10}$

or, $pH = -\log 1.75 - \log 10^{-5} + \log 1.5$

$= -0.243 + 5 + 0.176 = 4.933$

OR

Based on the extent to which the reactions proceed, the state of chemical equilibrium in a chemical reaction may be classified into three groups:

1. The reactions that proceed nearly to completion and only negligible concentrations of the reactants are left.
2. Those reactions which tend to form a very small amount of product and most of the reactant remain unchanged at equilibrium state.
3. The reactions in which the concentrations of the reactant and product are almost the same when the reaction reaches the condition of equilibrium.

20. i. Atomic size goes on increasing down the group.
    ii. Ionisation energy goes on decreasing down the group.
    iii. They are harder than alkali metals.
    iv. They are less electropositive than alkali metals. Electropositive character increases on going down the group.

OR

When Ca^{2+} combines with 2 Cl^- ions,the lattice energy released is large enough to compensate the second and first ionisation energy of Ca. Moreover Ca^{2+} is having noble gas configuration, so it is much stable and stabilization energy also takes part. Therefore formation of $CaCl_2$ becomes more favorable than CaCl energetically.

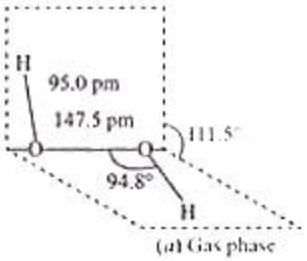
21. Upon boiling, the bicarbonates of calcium and magnesium decompose to insoluble carbonate which can be removed by filtration.

$$Ca(HCO_3)_2 \xrightarrow{Boil} CaCO_3 \downarrow + H_2O + CO_2 \uparrow$$

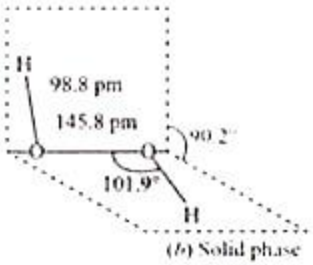
$$Mg(HCO_3)_2 \xrightarrow{Boil} MgCO_3 \downarrow + H_2O + CO_2 \uparrow$$

22. i. A is H_2O_2. The structure of H_2O_2 is given below.

Gas-phase



Solid-phase



ii. $2H_2O_2(l) \longrightarrow 2H_2O\ (l) + O_2(g)$

23. For the given compound, the number of π-electrons is 8.

By Huckel's rule,

$\Rightarrow 4n + 2 = 8$

$\Rightarrow 4n = 6$

$\Rightarrow n = 3/2$

For a compound to be aromatic, the value of n must be an integer (n = 0, 1, 2...).

This is not true for the given compound as it is a fraction. Hence, it is not aromatic in nature.

24. Atomic radii decrease across a period. Cations are smaller than their parent atoms. Among isoelectronic species, the one with the larger positive nuclear charge will have a smaller radius.

Hence the largest species is Mg; the smallest one is Al^{3+}.

25. Mn cannot exceed its oxidation state beyond 7. In MnO_4^-, the oxidation state of Mn is +7.

Thus, here manganese cannot undergo oxidation and it can undergo reduction only. That is why disproportionation is not possible whereas in MnO_4^{2-} manganese is in +6 oxidation state which can be oxidized as well as reduced.

Section C

26. $CH_4(g) + H_2O(g) \rightleftharpoons CO(g) + 3H_2(g)$

The expression for K_p for the reaction is: $K_p = \frac{(P_{CO}) \cdot (P_{H2})^3}{(P_{CH_4}) \cdot (P_{H_2O})}$

i. By increasing the pressure, the number of moles per unit volume will increase. In order to decrease the same, the equilibrium gets shifted to the left or in the backward direction. As a result, more of reactants will be formed and the value of K_p will decrease.

ii. If the temperature is increased, according to Le chatelier's principle, the forward reaction will be favoured as it is endothermic. Therefore, the equilibrium gets shifted to the right and the value of K_p will increase.

iii. The addition of catalyst will not change the equilibrium since it influences both the forward and the backward reactions to the same extent. But it will be attained more quickly.

OR

According to the question, an equilibrium mixture at 300 K contains N_2O_4 and NO_2 at 0.28 and 1.1 atm pressure.

Reaction:

$N_2O_4 \rightleftharpoons 2NO_2$ (g)

Now, $K_p = \frac{p(NO_2)^2}{p(N_2O_4)} = \frac{(1.1)^2}{(0.28)} = 4.32$ atm

If volume of the container is doubled, the pressure will be reduced to half.

At new equilibrium,

Now, $K_p = \frac{\left(\frac{1.1}{2} + 2p\right)^2}{\left(\frac{0.28}{2} - p\right)} = 4.32$

On solving, we get

p = 0.045

$\therefore$ $p(N_2O_4) = 0.14 - 0.045 = 0.095$ atm

$p(NO_2) = 0.55 + 2 \times 0.045 = 0.64$ atm.

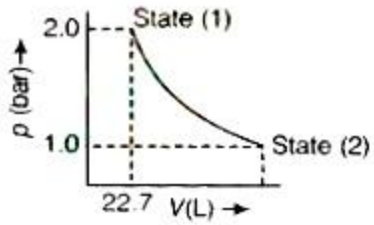
27.

S.no	Reversible Process	Irresversible Process
	It is very slow and takes an infinite time	It has appreciable speed and completes

i.	to complete.	soon.
ii.	Such a process is only a concept and does not exist in a true sense.	It is real. Thus, all processes which actually occur in nature are irreversible.
iii.	A reversible process is unreal as it assumes the presence of frictionless and weightless piston.	An irreversible process can be actually performed.
iv.	A reversible process can be made to go in either direction.	An irreversible process can proceed only in one direction.
v.	The work done by the reversible process is greater than the corresponding irreversible process between two states.	The work done is lesser than that of the reversible process.
vi.	A reversible process can be brought back to the initial state without producing any permanent effect on the adjacent surroundings.	An irreversible process cannot be brought back to the initial state without avoiding a permanent change in the surroundings.
vii.	A reversible process is in equilibrium state at all stages of the operation.	An irreversible process is in equilibrium state only at the initial and final stages of the operation.

OR

According to the question, 1.0 mole of a monoatomic ideal gas is expanded from the state (1) to state (2).



The given diagram represents that the process is carried out in infinite steps.
Therefore, it is an isothermal reversible expansion of the ideal gas from pressure 2.0 atm to 1.0 atm at 298 K.

We know that, $W = -2.303nRT \log \frac{p_1}{p_2}$

$W = -2.303 \times 1 \times 8.314 \times 298 \log 2$

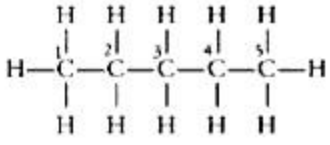
$\therefore W = -1717.46\ \text{J}$

28. The general Molecular formula of alkanes is C_nH_{2n+2}

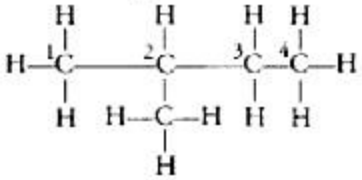
Molecular mass = 72

$\therefore 12 \times n + 1 \times (2n + 2) = 72$ or $12n + 2n + 2 = 72$ or $n = 5$

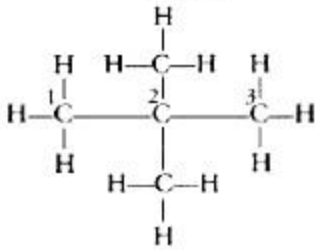
Thus, the molecular formula of the alkane is C_5H_{12}. The structural isomers and their IUPAC names are as follows.



Pentane (*n*-pentane)
(bp 309 K)



2-methylbutane (*iso*-pentane)
(bp 301 K)



2,2-dimethylpropane (*neo*-pentane)
(bp 282.5 K)

29. i. Structural isomers (actually position isomers as well as metamers)
    ii. Geometrical isomers
    iii. Resonance contributors because they differ in the position of electrons but not atoms

30. i. Molecular mass of sugar ($C_{12}H_{22}O_{11}$) = 12 × atomic mass of C + 22 × atomic mass of H + 11 × atomic mass of O = 12 × 12 + 22 ×1 + 11× 16 = 342 g

    ii. a. Since, 1 gram molecule of sugar = 342 g (Molecular Mass of Sugar,$C_{12}H_{22}O_{11}$=342 g)

    ∴ 0.5 gram molecule of sugar = 342× 0.5 = 171 g

    b. Since, 342 g of sugar = 1 gram molecule (Molecular Mass of sugar, $C_{12}H_{22}O_{11}$ =342 g)

547.2 g of sugar = $\frac{1}{342} \times 547.2 = 1.6$ gram molecule

Section D

31. Bond order is defined as half of the difference between the number of electrons present in bonding and antibonding molecular orbitals.

Bond order = $\frac{1}{2}(N_b - N_a)$

E.C. of $N_2 = 1s^2 2s^2 2p_x^1 2p_y^1 2p_z^1$

M.O. configuration of N_2= $[\sigma 1s]^2 [\sigma * 1s]^2 [\sigma 2s]^2 [\sigma^* 2s]^2 [\pi 2p_x]^2 [\pi 2p_y]^2 [\sigma 2p_z]^2$

Bond order (B.O) = $\frac{1}{2}(N_b - N_a)$

$= \frac{1}{2}[10 - 4] = 3$

B.O. of O_2

M.O. of configuration of O_2 = $(\sigma 1S)^2 (\sigma^* 1S)^2 (\sigma 2S)^2 (\sigma^* 2S)^2 (\pi 2p_z)^2$

$(\pi 2p_x)^2 (\pi 2p_y)^2 (\pi^* 2p_x)^2$

B.O. = $\frac{1}{2}(N_b - N_a)$

= = $\frac{1}{2}[10 - 6] = 2$

M.O. of the configuration of O_2^+ = $KK[\sigma 2s]^2\ [\sigma^* 2s]^2\ [\sigma 2p_z]^2\ [\pi 2p_x]^2\ [\pi 2p_y]^2$

$[\pi * 2p_x]^1$

= $\frac{1}{2}$ [8-3] = 2.5

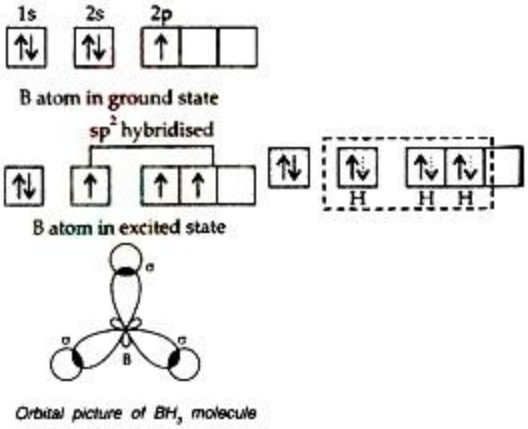
M.O. configuration of O_2^- = $KK[\sigma 2s]^2 [\sigma^* 2s]^2\ [\sigma 2p_z]^2\ [\pi 2p_x]^2\ [\pi 2p_y]^2\ [\pi^* 2p_x]^2$

$[\pi^* 2p_y]^1$

= $\frac{1}{2}$ [8-5] = 1.5

OR

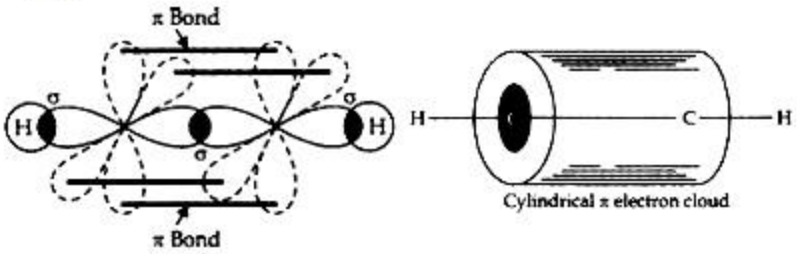
i. Formation of BH_3 (atomic no. of B is 5)



Orbital picture of BH_3 molecule

B atom gets hybridized to form three equivalent hybrid orbitals directed towards three corners of an equivalent triangle with B atoms in the center. Bond angle = 120°.

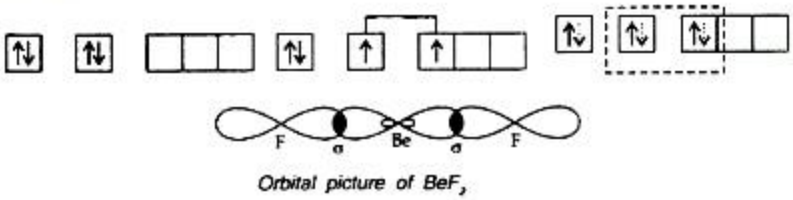
ii. C_2H_2



Orbitals picture of ethyne

Both the carbon atoms are sp hybridized. Both the carbon atoms have also two unhybridized orbitals which overlap sidewise with the similar orbitals of the other carbon atom to form two π bonds.

iii. BeF_2



Orbital picture of BeF_2

The orbital picture of BeF_2 molecule is Linear.

32. In view of the shortcoming of the Bohr's model, attempts were made to develop a more suitable and general model for atoms. Two important developments which contributed significantly in the formulation of such a model were:
    i. Dual behaviour of matter
    ii. Heisenberg uncertainty principle.

Werner Heisenberg, a German physicist in 1927, stated the uncertainty principle which is the consequence of duel behaviour of matter and radiation. One of the important implication of the Heisenberg Uncertainty Principle is that it rules out the existence of definite paths or trajectories of electrons and other similar particles.
Quantum mechanics is the theoretical science that deals with the study of the motions of the microscopic objects that have both observable wave-like and particle-like properties. The name of the changed model of the atom is the Quantum Mechanical Model of the atom.

OR

i. Boron (Z = 5) $1s^2\ 2s^2\ 2p^1$
ii. Neon (Z = 10) $1s^2\ 2s^2\ 2p^6$

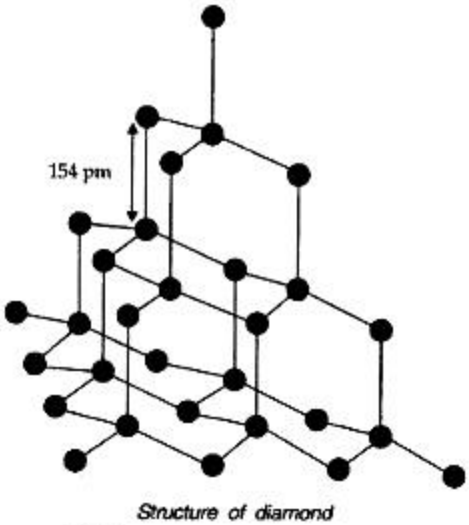
iii. Aluminium (Z = 13) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^1$

iv. Chlorine (Z = 17) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5$

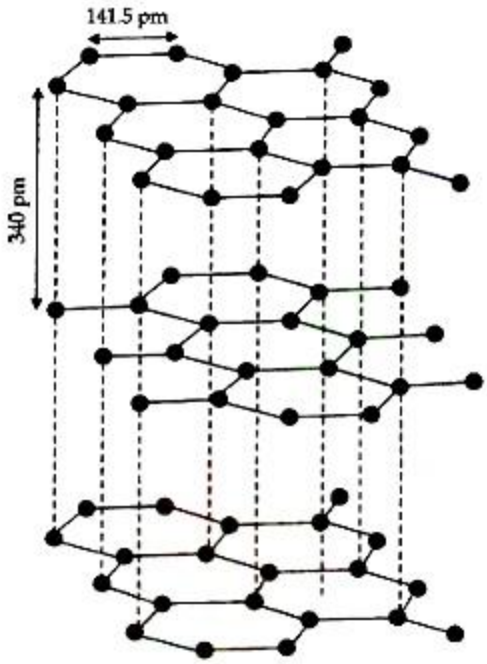
v. Calcium (Z = 20) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^2$

vi. Rubidium (Z = 37) $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^{10}\ 4s^2\ 4p^6\ 5s^1$

33. **Allotropes:** Allotropes are the different forms of an element which are having same chemical properties but different physical properties due to their structures.



Structure of diamond



Graphite

In diamond carbon is sp^3-hybridized. Since diamond has three dimensional network solid, it is hardest substance with high density whereas Graphite has a layered structure. The various layers are formed by Van der Waal forces of attraction that's why Graphite is soft and slippery.

OR

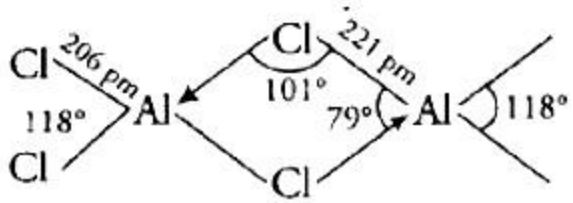
Both BCl_3 and $AlCl_3$ are electron deficient molecules having six electrons in the valence shell of their respective central atoms.

To complete their octets, the central atom in each case can accept a pair of electrons from the chlorine atom of another molecule forming dimeric structures.

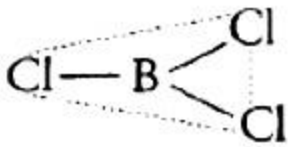
However, because of the small size of B, it cannot accommodate four big sized Cl atoms around it.

Al because of its bigger size can easily accommodate four Cl atoms around it.

As a result, $AlCl_3$ exists as a dimer. In this dimer, since the covalency of Al has increased to 4.



Therefore, BCl_3 prefers to exist as a monomeric planar molecule in which B atom is sp^2 - hybridised.



So, BCl_3 is trigonal planar while ACl_3 is tetrahedral in a dimeric state.