Class: 9th

Subject: Chemistry

Chapter 3: Chemical Bonding

Exercise MCQs:

i. When molten copper and molten zinc are mixed together, they give rise to a new substance called brass. Predict what type of bond is formed between copper and zinc.

(a) Coordinate covalent bond

(b) Ionic bond

(c) Metallic bond ✅

(d) Covalent bond

ii. Which element is capable of forming all the three types of bonds; covalent, coordinate covalent and ionic?

(a) Carbon ✅

(b) Oxygen

(c) Magnesium

(d) Silicon

iii. Why is H_2O a liquid while H_2S is a gas?

(a) Because in water, the atomic size of oxygen is smaller than that of sulphur

(**b**) Because water is a polar compound and there exists strong forces of attraction between its molecules ✅

(c) Because H_2O molecule is lighter than H_2S

(d) Because water can easily freeze into ice

iv. Which of the following bonds is expected to be the weakest?

(a) C-C

(b) Cl-Cl

(c) O-O

(**d**) F-F ✅

v. Which form of carbon is used as a lubricant?

(a) Coal

(b) Diamond

(c) Graphite ✅

(d) Charcoal

vi. Keeping in view the intermolecular forces of attraction, indicate which compound has the highest boiling point.

(a) H_2O ✅

(b) H_2S

(c) HF

(d) NH_3

vii. Which metal has the lowest melting point?

(a) Li

(b) Na

(c) K ✅

(d) Rb

viii. Which ionic compound has the highest melting point?

(a) NaCl

(b) KCl

(c) LiCl ✅

(d) RbCl

ix. Which compound contains both covalent and ionic bonds?

(a) $MgCl_2$

(b) NH_4Cl ✅

(c) CaO

(d) PCl_3

x. Which among the following has a double covalent bond?

(a) Ethane

(b) Methane

(c) Ethylene ✅

(d) Acetylene

Important MCQs:

1. Why do atoms form chemical bonds?

(a) To increase size

(**b**) To lower their energy and gain stability ✅

(c) To increase mass

(d) To form isotopes

2. What is the main reason for the stability of noble gases?

(a) They are radioactive

(**b**) They have complete duplet or octet ✅

(c) They have more protons

(d) They are heavy elements

3. Which noble gas has only two electrons in its outermost shell?

(a) Argon

(**b**) Helium ✅

(c) Neon

(d) Xenon

4. The Duplet Rule is applicable to which of the following?

(a) Neon and Argon

(b) Helium and Hydrogen ✅

(c) Sodium and Chlorine

(d) Fluorine and Bromine

5. Which of the following follows the Octet Rule for stability?

(a) Hydrogen

(b) Helium

(c) Neon ✅

(d) Lithium

6. Sodium forms a bond by:

(a) Gaining 1 electron

(b) Sharing 1 electron

(c) Losing 1 electron ✅

(d) Gaining 7 electrons

7. Which element is electropositive and tends to lose electrons?

(a) Oxygen

(b) Chlorine

(c) Sodium ✅

(d) Fluorine

8. Why is the Octet Rule considered less important in modern chemistry?

(a) It is difficult to understand

(b) It does not apply to noble gases

(c) Further investigations found exceptions ✅

(d) It applies only to metals

9. What is a chemical bond?

(a) A repulsive force between protons

(b) A force of attraction between nuclei

(c) A force that holds atoms together in molecules or compounds ✅

(d) A magnetic field around atoms

10. What happens if repulsion is stronger than attraction between atoms?

(a) A molecule is formed

(b) They become stable

(c) Atoms combine

(**d**) Atoms move away from each other ✅

11. What type of bond involves the complete transfer of electrons?

(a) Covalent bond

(**b**) Ionic bond ✅

(c) Coordinate bond

(d) Metallic bond

12. In an ionic bond, electrons are transferred:

(a) From one nucleus to another

(b) Between inner shells

(**c**) From one atom to another atom ✅

(d) Within the same atom

13. What are formed when sodium reacts with chlorine?

(a) Molecules only

(b) Ions only

(c) Positively charged sodium and negatively charged chloride ions ✅

(d) Uncharged atoms

14. Calcium chloride ($CaCl_2$) is formed when calcium:

(a) Shares two electrons

(b) Gains two electrons

(c) Loses one electron

(d) Loses two electrons ✅

15. What type of elements form ionic bonds with electronegative elements?

(a) Noble gases

(b) Electropositive metals ✅

(c) Non-metals

(d) Radioactive elements

16. A covalent bond is formed by:

(a) Transfer of electrons

(b) Sharing of electron pair between atoms ✅

(c) Attraction between nuclei

(d) Loss of protons

17. What happens when atoms approach each other to form a covalent bond?

(a) Only repulsion occurs

(b) Energy increases

(c) Attractive forces dominate repulsive forces ✅

(d) Electrons are removed

18. A single covalent bond is represented by:

(a) =

(b) ⇒

(c) - ✅ (single Line)

(d) :::

19. When atoms share two electrons each, the bond formed is:

(a) Single

(b) Triple

(c) Double ✅

(d) Ionic

20. A triple covalent bond involves:

(a) One shared electron pair

(b) Two shared electron pairs

(c) Three shared electron pairs ✅

(d) No shared electrons

21. In a water molecule, how many hydrogen atoms share electrons with oxygen?

(a) 1

(b) 2 ✅

(c) 3

(d) 4

22. What type of bond is formed in a hydrogen molecule (H_2)?

(a) Polar covalent

(b) Ionic

(c) Non-polar covalent ✅

(d) Metallic

23. A polar covalent bond is formed when:

(a) Electrons are equally shared

(b) Atoms are identical

(c) One atom is more electronegative than the other ✅

(d) Electrons are not shared

24. In HCl molecule, the shared pair of electrons bends towards:

(a) Hydrogen atom

(b) Oxygen atom

(c) Chlorine atom ✅

(d) Nitrogen atom

25. Which of the following contains a polar covalent bond?

(a) H_2

(b) Cl_2

(c) HCl ✅

(d) O_2

26.. What is a coordinate covalent bond?

(a) Mutual sharing from both atoms

(b) Complete transfer of electrons

(c) Shared pair donated by one atom only ✅

(d) Bond between metals only

27. In a coordinate bond, the atom donating the electron pair is called:

(a) Acceptor

(b) Donor ✅

(c) Neutral

(d) Receptor

28. Which symbol represents a coordinate covalent bond?

(a) –

(b) =

(c) (⇒) ✅

(d) ::

29. In the formation of hydroxonium ion (H_3O^+), who donates the electron pair?

(a) Hydrogen

(b) Water (oxygen atom) ✅

(c) Chlorine

(d) Nitrogen

30. During the reaction of ammonia (NH_3) with boron trifluoride (BF_3), which atom acts as the donor?

(a) Boron

(b) Hydrogen

(c) Nitrogen ✅

(d) Fluorine

31. A metallic bond is formed by:

(a) Mutual sharing of electrons

(b) Transfer of electrons

(c) Mobile electrons surrounding positive ions ✅

(d) Nuclei attracting nuclei

32. In a metallic bond, the positively charged ions are bound together by:

(a) Neutrons

(b) Protons

(c) Mobile electrons ✅

(d) Covalent forces

33. The 'sea of electrons' model explains which type of bond?

(a) Covalent bond

(b) Ionic bond

(c) Metallic bond ✅

(d) Hydrogen bond

34. Metals are good conductors of electricity because:

(a) Their electrons are tightly bound

(b) Their nuclei are strong

(c) They have freely moving electrons ✅

(d) They have more protons

35. In sodium metal, how many electrons does each atom set free?

(a) Two

(b) One ✅

(c) Three

(d) Four

36. The metallic bond in magnesium is stronger than sodium because:

(a) Magnesium has more neutrons

(b) Magnesium sets free two electrons ✅

(c) Magnesium atoms are smaller

(d) Sodium is radioactive

37. Which property of metals is explained by the sliding of atomic rows?

(a) High melting point

(b) Hardness

(c) Ductility and malleability ✅

(d) Luster

38. Which of the following is a property of metals?

(a) Low melting point

(b) Poor conductor of electricity

(c) Metallic luster ✅

(d) Fragile and brittle

39. The strength of a metallic bond depends on:

(a) Atomic size

(b) Number of neutrons

(c) Number of positive charges and mobile electrons ✅

(d) Number of shells

40. Electropositive character means:

(a) Tendency to gain electrons

(b) Tendency to share electrons

(c) Tendency to lose electrons and form cations ✅

(d) Neutral behavior

41. Alkali metals are highly electropositive because:

(a) They do not react

(b) They gain electrons easily

(c) They lose electrons easily ✅

(d) They are radioactive

42. Which metal reacts vigorously with water and halogens?

(a) Aluminum

(b) Magnesium

(c) Sodium ✅

(d) Copper

43. Compared to alkali metals, alkaline earth metals are:

(a) More electropositive

(b) Less electropositive ✅

(c) Equally reactive

(d) Non-reactive

44. Which of the following is a highly electropositive metal?

(a) Carbon

(b) Aluminum ✅

(c) Fluorine

(d) Oxygen

45. Non-metals tend to:

(a) Lose electrons

(b) Share electrons

(c) Gain electrons to form anions ✅

(d) Remain neutral

46. Intermolecular forces of attraction are:

(a) Stronger than chemical bonds

(b) Present within atoms

(c) Weak forces between molecules ✅

(d) Found only in gases

47. In which state of matter are intermolecular forces the weakest?

(a) Solid

(b) Liquid

(c) Gas ✅

(d) Plasma

48. Stronger the intermolecular forces, the:

(a) Lower the melting point

(b) Higher the boiling point ✅

(c) Lower the density

(d) Weaker the chemical bond

49. Dipole-dipole forces exist between:

(a) Non-polar molecules

(b) Ionic compounds

(c) Polar molecules ✅

(d) Atoms of noble gases

50. Dipole-dipole forces are due to:

(a) Complete transfer of electrons

(b) Presence of partial positive and negative charges ✅

(c) Shared neutrons

(d) Presence of lone pairs

51. Hydrogen bonding occurs when hydrogen bonds with:

(a) Metals

(b) Halogens only

(c) Highly electronegative atoms like F, O, N ✅

(d) Any atom

52. Which compound shows hydrogen bonding?

(a) CH_4

(b) NH_3

(c) H_2O ✅

(d) H_2S

53. The high boiling point of water is due to:

(a) Ionic bonds

(b) Weak van der Waals forces

(c) Hydrogen bonding ✅

(d) Metallic bonding

54. Ionic compounds exist in:

(a) Gaseous form

(b) Crystalline solid form ✅

(c) Liquid form

(d) Amorphous structure

55. In solid state, ionic compounds:

(a) Conduct electricity

(b) Are flexible

(c) Are hard and brittle ✅

(d) Are liquids

56. Ionic compounds conduct electricity in:

(a) Solid state only

(b) Molten and aqueous state ✅

(c) All states

(d) None of the above

57. Ionic compounds dissolve in water because:

(a) Water boils easily

(b) Water molecules break and hydrate the ions ✅

(c) Water is neutral

(d) Water is non-polar

58. Diamond is the hardest substance because:

(a) It has ionic bonds

(b) It is metallic

(c) Each carbon atom is covalently bonded to four others ✅

(d) It has a liquid core

59. Graphite conducts electricity due to:

(a) Covalent bonds only

(b) Free electrons between layers ✅

(c) Ionic bonds

(d) Polar nature

60. Methane, ammonia, and hydrogen sulphide are examples of:

(a) Ionic solids

(b) Polar ionic compounds

(c) Binary covalent compounds ✅

(d) Hydrogen bonded crystals

Exercise Short Questions:

i. What type of elements lose their outer electron easily and what type of elements gain electron easily?

Metals lose their outer electrons easily and are called electropositive elements. Non-metals gain electrons easily and are called electronegative elements.

ii. Why do lower molecular mass covalent compounds exist as gases or low boiling liquids?

Because they have weak intermolecular forces of attraction, so less energy is required to separate

their molecules, resulting in low boiling points and gaseous or liquid state at room temperature.

iii. Give one example of an element which exists as a crystalline solid and it has covalent bonds between its atoms.

Diamond is an example of a crystalline solid with covalent bonds between its carbon atoms.

iv. Which property of metals makes them malleable and ductile?

The presence of a "sea of free electrons" allows metal atoms to slide over each other without breaking the metallic bond, making metals malleable and ductile.

v. Is coordinate covalent bond a strong bond?

Yes, coordinate covalent bonds are strong bonds because the shared pair of electrons is held tightly by both atoms.

vi. Write down dot and cross formula of HNO3.

The dot and cross formula shows hydrogen (H) with one electron (dot), nitrogen (N) with five valence

electrons (dots and crosses), and oxygen (O) atoms with six valence electrons each. The bonds are shown by shared pairs between N and O atoms and between H and O.

(Since this is a text format, here is a simplified description:

- H is bonded to one O atom with a single bond.
- N is bonded to three O atoms: one with a double bond, two with single bonds (one of these O has H attached).

Electron pairs are represented by dots and crosses on respective atoms.)

Important Short Questions:

1. Why do atoms form chemical bonds?

Atoms form chemical bonds to lower their energy and increase their stability by achieving a duplet or octet configuration in their outermost shell.

2. What is the Duplet and Octet Rule?

The Duplet Rule states that atoms like hydrogen and helium are stable with two electrons in their outermost shell. The Octet Rule states that atoms are stable when they have eight electrons in their outermost shell, like noble gases.

3. How does a sodium atom achieve stability?

A sodium atom achieves stability by losing one electron from its outermost shell, forming a positive ion (Na^+), and attaining the electronic configuration of neon, a noble gas.

4. What is a chemical bond?

A chemical bond is a force of attraction between atoms that holds them together in a molecule or compound.

5. When two atoms come close, what are the two possible interactions between them?

The atoms may either attract or repel each other. If attraction dominates, they form a bond; if repulsion dominates, they move away from each other.

6. How is an ionic bond formed?

An ionic bond is formed when one atom loses electrons and another gains them, resulting in positively and negatively charged ions which attract each other.

7. How do the electronic configurations of sodium and chlorine change in sodium chloride?

Sodium loses one electron to become Na^+ (2,8) and chlorine gains that electron to become Cl^- (2,8,8), both achieving stable electronic configurations.

8. What force holds ionic compounds together?

Ionic compounds are held together by the electrostatic force of attraction between positively and negatively charged ions.

9. How many electrons does a calcium atom lose to form calcium chloride?

A calcium atom loses two electrons to form a Ca^{2+} ion in calcium chloride ($CaCl_2$).

10. Give examples of electropositive and electronegative elements.

- **Electropositive**: Sodium (Na), Calcium (Ca)

- **Electronegative**: Chlorine (Cl), Oxygen (O)

11. What is a covalent bond?

A covalent bond is a type of chemical bond formed by the mutual sharing of electron pairs between atoms.

12. How is energy lowered during the formation of a covalent bond?

Energy is lowered when the attractive forces between the atoms dominate the repulsive forces, resulting in a stable molecule with minimum energy.

13. What is meant by a single covalent bond?

A single covalent bond is formed when one electron pair is mutually shared between two atoms.

14. How is a double covalent bond different from a triple covalent bond?

In a double covalent bond, two electron pairs are shared, while in a triple covalent bond, three electron pairs are shared between atoms.

15. How are covalent bonds represented in structural formulas?

A single covalent bond is shown by a single line (–), a double bond by two lines (=), and a triple bond by three lines (≡) between atoms.

16. What is the difference between a polar and a non-polar covalent bond?

In a non-polar covalent bond, the shared electrons are equally distributed between identical atoms. In a polar covalent bond, the electrons are unequally shared, with the more electronegative atom gaining a partial negative charge.

17. Give one example of a non-polar covalent bond.

The bond in a hydrogen (H_2) molecule is a non-polar covalent bond.

18. Give one example of a polar covalent bond and explain why it is polar.

The bond in hydrogen chloride (HCl) is polar because chlorine is more electronegative, so the shared electrons are pulled more toward the chlorine atom.

19. What is a coordinate covalent bond?

It is a covalent bond in which both electrons in the shared pair are donated by only one atom.

20. How do we represent a coordinate covalent bond in a structural formula?

A coordinate covalent bond is represented by an arrow (⇒) pointing from the donor atom to the acceptor atom.

21. What is a Hydroxonium ion (H_3O^+)?

A Hydroxonium ion is formed when a proton (H^+) from an acid reacts with a water molecule, resulting in H_3O^+.

22. How is a Hydroxonium ion formed?

It is formed when a proton accepts an electron pair from the oxygen atom of a water molecule.

23. After formation, how do the bonds in Hydroxonium ion behave?

All three bonds around the oxygen atom in H_3O^+ behave exactly alike.

24. What is the difference between a covalent bond and a coordinate covalent bond?

The difference lies in the way they are formed; in coordinate bonds, both electrons come from one atom.

25. How is a coordinate covalent bond formed between NH_3 and BF_3?

Nitrogen in ammonia donates an electron pair to the empty shell of boron in BF_3, forming a coordinate covalent bond.

26. Why do all bonds in ammonium ion (NH_4^+) behave alike?

Because after bond formation, there is no distinction between coordinate and covalent bonds.

27. What is a metallic bond?

It is a chemical bond formed by the attraction between positively charged metal ions and a sea of mobile electrons.

28. Why is magnesium's metallic bond stronger than sodium's?

Because magnesium donates two electrons while sodium donates only one, increasing the strength of

the metallic bond.

29. Why are metals good conductors of electricity?

Due to the presence of freely moving electrons within the metallic structure.

30. What is meant by the electropositive character of metals?

Electropositive character is the tendency of metals to lose electrons and form positive ions (cations).

31. Why are alkali metals more reactive than alkaline earth metals?

Because alkali metals lose their outer electrons more easily, showing higher electropositive character and reactivity.

32. What is electronegativity?

Electronegativity is the tendency of an atom (especially non-metals) to attract shared electrons in a chemical bond.

33. What are dipole-dipole forces?

They are attractive forces between polar molecules

due to partial positive and negative charges, like in HCl.

34. What is hydrogen bonding?

Hydrogen bonding is a strong dipole-dipole attraction that occurs when hydrogen is bonded to highly electronegative atoms like F, O, or N.

35. Why does water have a higher boiling point than H_2S and NH_3?

Because strong hydrogen bonds are present between water molecules which require more energy to break.

36. What is a crystal lattice in ionic compounds?

It is a regular arrangement of oppositely charged ions held by strong electrostatic forces in a solid form.

37. Why are ionic solids brittle?

Because when an external force is applied, the crystal lattice breaks due to the rigid arrangement of ions.

38. Why does graphite conduct electricity while diamond does not?

Graphite has mobile electrons between its layers, while diamond has all electrons tightly bonded in a rigid structure.

39. Why are covalent compounds generally gases or liquids at room temperature?

Because they have weak intermolecular forces, resulting in low melting and boiling points.

Important Long Questions:

Q1: Why do atoms form chemical bonds? Explain Duplet and Octet Rule with examples.

Atoms form chemical bonds to attain a more stable electronic configuration by decreasing their energy. When atoms combine, they achieve the stable configuration of noble gases, which are known for their unreactivity due to full outermost shells.

Duplet Rule:

This rule applies mainly to hydrogen and helium. They require two electrons in their outermost shell to become stable. For example, hydrogen can gain one electron to become hydride ion (H^-) or lose one to become a proton (H^+).

Octet Rule:

This rule states that atoms (other than hydrogen and helium) try to attain eight electrons in their outermost shell. For example, sodium (Na) has one electron in its outer shell. It loses one electron to attain the configuration of neon (Ne). Chlorine (Cl) has seven electrons in its outer shell and gains one electron to complete its octet, achieving the configuration of argon (Ar).

Q2: What is a chemical bond? Describe its types with explanation.

A chemical bond is a force of attraction that holds atoms together in a molecule or compound. Atoms form chemical bonds when the attractive forces between them are stronger than the repulsive

forces, resulting in lower energy and increased stability.

Types of Chemical Bonds:

1. Ionic Bond:

Formed when one atom loses electrons and another gains electrons, resulting in positive and negative ions held together by electrostatic force.

Example: Sodium (Na) and Chlorine (Cl) form NaCl.

2. Covalent Bond:

Formed when atoms share electrons to complete their outer shells.

Example: Two hydrogen atoms (H) each share one electron with an oxygen atom (O) to form H_2O (water).

3. Coordinate Covalent Bond:

A covalent bond where both shared electrons come from one atom.

Example: In the ammonium ion (NH_4^+), the nitrogen atom donates a lone pair to a hydrogen ion.

Q3: What is an Ionic Bond? Explain with the formation of sodium chloride.

An ionic bond is a type of chemical bond formed between two atoms when one atom donates electron(s) and the other atom accepts them, resulting in oppositely charged ions that attract each other.

Formation of Sodium Chloride (NaCl):

- **Sodium** (Na) has 1 electron in its outer shell. It loses this electron to achieve the configuration of Neon (Ne) and becomes a positive ion (Na^+).
- **Chlorine** (Cl) has 7 electrons in its outer shell. It gains 1 electron to complete its octet, becoming a negative ion (Cl^-).

These oppositely charged ions (Na^+ and Cl^-) attract each other through electrostatic force, forming an ionic bond and producing sodium chloride (NaCl).

Q4: Differentiate between single, double, and triple covalent bonds with suitable examples.

A covalent bond is formed when two atoms share

one or more pairs of electrons to achieve stability by completing their outer shells.

Single covalent bond: This bond involves the sharing of one pair of electrons (two electrons) between two atoms. It is represented by a single line (-).

Example: In a hydrogen molecule (H_2), each hydrogen atom shares one electron to form a single covalent bond.

Double covalent bond: This bond involves the sharing of two pairs of electrons (four electrons) between two atoms. It is represented by two lines (=).

Example: In an oxygen molecule (O_2), each oxygen atom shares two electrons, forming a double covalent bond.

Triple covalent bond: This bond involves the sharing of three pairs of electrons (six electrons) between two atoms. It is represented by three lines (≡).

Example: In a nitrogen molecule (N_2), each nitrogen atom shares three electrons, forming a triple covalent bond.

Q5: Describe the formation of a water molecule and a carbon dioxide molecule by covalent bonding.

Water (H_2O) molecule formation:

1. **Oxygen** atom has 6 electrons in its outer shell, needing 2 more to complete its octet.
2. Each **hydrogen** atom has 1 electron and needs 1 more to complete its duplet.
3. **Oxygen** shares one electron with each hydrogen atom.
4. **Two single covalent** bonds are formed between oxygen and two hydrogen atoms.
5. Each **hydrogen** completes its duplet; oxygen completes its octet.
6. Resulting **molecule** is stable and formed by mutual sharing of electrons.

Carbon dioxide (CO_2) molecule formation:

1. Carbon atom has 4 electrons in its outer shell and needs 4 more to complete its octet.

2. Each oxygen atom has 6 electrons in its outer shell, needing 2 more to complete its octet.

3. Carbon shares two electrons with each oxygen atom.

4. Two double covalent bonds are formed between carbon and the two oxygen atoms.

5. Carbon completes its octet by sharing 4 electrons; each oxygen completes its octet.

6. The molecule is linear and stable due to covalent bonding.

Q6:What are polar and non-polar covalent bonds? Explain with examples.

Non-polar covalent bonds:

1. Formed between two identical atoms or atoms with similar electronegativity.

2. Shared electron pair lies exactly between the two

atoms.

3. No partial charges develop; electron sharing is equal.

4. **Example**: H_2 molecule, Cl_2 molecule.

Polar covalent bonds:

1. Formed between two different atoms with different electronegativities.

2. Shared electron pair is pulled towards the more electronegative atom.

3. Partial negative charge forms on the more electronegative atom; partial positive on the other.

4. **Example**: HCl molecule (electrons pulled toward Cl), H_2O molecule (electrons pulled toward O).

Q7: What is a coordinate covalent bond? Describe its formation with the example of the hydroxonium ion (H_3O^+).

Coordinate covalent bond:

1. A covalent bond where both shared electrons come from the same atom.

2. One atom donates a lone pair of electrons; the other atom accepts it.

3. Represented by an arrow (⇒) pointing from donor to acceptor atom.

Formation of Hydroxonium ion (H_3O^+):

1. An acid releases a proton (H^+) when dissolved in water.

2. The proton (H^+) has no electrons and can accept a lone pair.

3. Oxygen in water (H_2O) has two lone pairs of electrons.

4. One lone pair from oxygen is donated to the proton (H^+).

5. A coordinate covalent bond forms between oxygen and the proton.

6. This results in the hydroxonium ion (H_3O^+), which carries a positive charge.

3. Constructed Response Questions:

i. Why HF is a liquid while HCl is a gas?

- HF molecules form strong hydrogen bonds due to the high electronegativity of fluorine.
- Hydrogen bonding causes HF molecules to stick together, increasing intermolecular forces.
- This results in a higher boiling point, making HF a liquid at room temperature.
- HCl molecules have weaker dipole-dipole forces and no hydrogen bonding.
- Hence, HCl has a lower boiling point and exists as a gas at room temperature.

ii. Why covalent compounds are generally not soluble in water?

Water is a polar solvent.

- **Covalent compounds** are often non-polar or have weak polarity.
- **Like dissolves like rule:** polar solvents dissolve polar substances.

- **Non-polar covalent** compounds do not interact well with polar water molecules.
- Therefore, **covalent compounds** usually do not dissolve in water.

iii. How do metals conduct heat?

- **Metals** have free-moving (delocalized) electrons.
- These electrons transfer **kinetic energy** quickly through the metal.
- Also, the closely packed metal atoms vibrate and transfer **heat energy**.
- The **combined movement** of free electrons and vibrating **atoms** allows metals to conduct heat **efficiently**.

iv. How many oxides does nitrogen form? Write down the formulae of oxides?

- Nitrogen forms eight common oxides.
- Their **formulas** are: N_2O, NO, N_2O_3, NO_2, N_2O_4, N_2O_5, NO_3 (nitrate radical in some compounds), and N_2O_6 (less common).

- **The important ones are**: Nitrous oxide (N_2O), Nitric oxide (NO), Nitrogen dioxide (NO_2), Dinitrogen tetroxide (N_2O_4), and Dinitrogen pentoxide (N_2O_5).

v. What will happen if NaBr is treated with $AgNO_3$ in water?

- A white precipitate of silver bromide (AgBr) will form.
- This is because Ag^+ ions from $AgNO_3$ react with Br^- ions from NaBr.
- **The reaction is**: $NaBr + AgNO_3 \Rightarrow AgBr$ (white precipitate) + $NaNO_3$ (in solution).

vi. Why does iodine exist as a solid while Cl_2 exists as a gas?

- Iodine molecules are larger and heavier than chlorine molecules.
- Iodine atoms have more electrons, resulting in stronger Van der Waals forces.
- Stronger intermolecular forces in iodine cause it to be solid at room temperature.

- Chlorine has weaker intermolecular forces, so it remains a gas at room temperature.

4. Descriptive Questions:

i. Explain the formation of an ionic bond and a covalent bond.

Ionic Bond Formation:

- Formed between a metal and a non-metal.
- Metal atom loses electrons to form positive ions (cations).
- Non-metal atom gains electrons to form negative ions (anions).
- Electrostatic attraction between opposite charges holds ions together.
- **Example**: Na (metal) loses one electron $\Rightarrow$ Na^+, Cl (non-metal) gains one electron $\Rightarrow$ Cl^-, forming NaCl.

Covalent Bond Formation:

- Formed between two non-metal atoms.
- Atoms share pairs of electrons to achieve stability.
- Shared electrons count towards the outer shell of both atoms.
- Can be single, double, or triple bonds depending on number of shared pairs.
- **Example**: H_2 molecule where two hydrogen atoms share electrons.

ii. How do ions arrange themselves to form NaCl crystal?

- Na^+ and Cl^- ions arrange in a regular, repeating 3D pattern called a crystal lattice.
- Each Na^+ ion is surrounded by six Cl^- ions and vice versa.
- This arrangement maximizes attractive forces and minimizes repulsive forces.
- The strong electrostatic forces between oppositely charged ions hold the crystal firmly.

- This structure gives NaCl its high melting point and hardness.

iii. Explain the properties of metals keeping in view the nature of metallic bond.

- Metals have a "sea of electrons" where electrons move freely.
- Free electrons allow metals to conduct heat and electricity.
- Strong electrostatic attraction between positive metal ions and free electrons holds atoms together.
- This bonding gives metals their hardness and high melting points.
- Atoms arranged in layers can slide over each other, making metals malleable and ductile (can be shaped and drawn into wires).

iv. Compare the properties of ionic and covalent compounds.

1. Structure:

- **Ionic Compounds**: Made up of oppositely

charged ions arranged in a regular crystalline structure.

- **Covalent Compounds**: Composed of neutral molecules held together by weak forces.

2. Bond Strength and Forces:

- **Ionic Compounds:** Strong electrostatic forces of attraction between positive and negative ions.
- **Covalent Compounds**: Strong bonds within molecules, but weak intermolecular forces.

3. Physical State:

- **Ionic Compounds:** Usually solid at room temperature.
- **Covalent Compounds:** May exist as gases, liquids, or solids depending on molecular mass.

4. Melting and Boiling Points:

- **Ionic Compounds:** High melting and boiling points due to strong ionic bonds.
- **Covalent Compounds:** Usually have low

melting and boiling points, except for some giant covalent structures.

5. Solubility:

- **Ionic Compounds:** Soluble in polar solvents like water.
- **Covalent Compounds:** Soluble in non-polar solvents like benzene and ether.

6. Electrical Conductivity:

- **Ionic Compounds**: Conduct electricity in molten or aqueous form due to the presence of free ions.
- **Covalent Compounds**: Do not conduct electricity as they do not have free ions (except graphite).

7. Composition:

- **Ionic Compounds:** Formed between metals and non-metals.
- **Covalent Compounds**: Usually formed between non-metals.

v. How will you explain the electrical conductivity of graphite crystals?

- Graphite has layers of carbon atoms arranged in hexagonal rings.
- Each carbon atom is bonded to three others, with one electron free (delocalized).
- Delocalized electrons can move freely between layers.
- These free electrons allow graphite to conduct electricity.
- The layers can slide over each other, making graphite soft and slippery.

vi. Why are metals usually hard and heavy?

- Metals have closely packed atoms in a fixed arrangement.
- Strong metallic bonds between positive ions and free electrons hold atoms tightly.
- This dense packing results in metals having high density (heavy).

- Strong bonding also makes metals hard and gives them high melting points.

Note:

This chapter is designed to provide a solid foundation of knowledge, with the goal of deepening understanding and encouraging further exploration of the subject. The content has been

carefully selected to support effective learning and inspire students to engage with the topic more deeply.

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Purpose: To contribute to education by offering insightful, valuable content that enhances learning and understanding.

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