

## Chapter-2 Chemical Bonding

### Text Questions 1

#### Question 1

How do atoms attain noble gas configuration?

#### Answer

Atoms attain noble gas configuration by losing, gaining or sharing of electrons present in their outermost shell.

#### Question 2

Define:

- A chemical bond,
- An electrovalent bond,
- A covalent bond.

#### Answer

(a) **Chemical Bond** — A chemical bond may be defined as the force of attraction between any two atoms, in a molecule, to maintain stability.

(b) **Electrovalent (or ionic) Bond** — The chemical bond formed between two atoms by transfer of one or more electrons from the atom of a metallic (electropositive) element to an atom of a non-metallic (electronegative) element is called an electrovalent (or ionic) bond.

(c) **Covalent Bond** — The chemical bond that is formed between two combining atoms by mutual sharing of one or more pair of electrons is called a covalent bond.

#### Question 3

What are the conditions for the formation of an electrovalent bond?

#### Answer

The conditions for the formation of an electrovalent bond are:

- Low ionisation potential** — if the ionisation potential of a particular atom is low, it will lose electron(s) easily, i.e., a cation is formed easily.
- High electron affinity** — if the electron affinity value is high, anion will be formed easily.
- Large electronegativity difference** — if the difference in the electronegativities of two elements is higher, then the transfer of electrons will be easier.

#### Question 4

An atom X has three electrons more than the noble gas configuration. What type of ion will it form? Write the formula of its (i) sulphate (ii) nitrate (iii) phosphate (iv) carbonate (v) hydroxide.

#### Answer

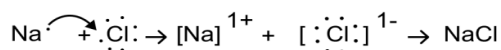
Since there are three electrons more than the noble gas configuration in the atom so the atom will try to lose three electron to gain noble gas configuration. Therefore, it will form a cation  $X^{3+}$ .

Formula of its:

- Sulphate —  $X_2(SO_4)_3$
- Nitrate —  $X(NO_3)_3$
- Phosphate —  $XPO_4$
- Carbonate —  $X_2(CO_3)_3$
- Hydroxide —  $X(OH)_3$

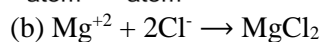




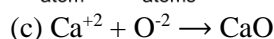
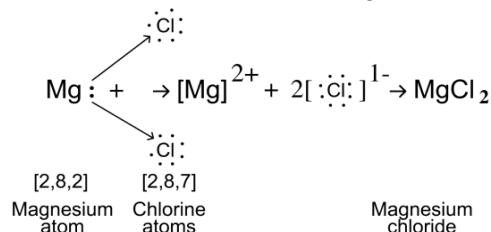


[2,8,1] [2,8,7]

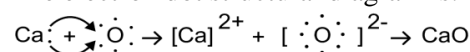
Sodium atom      Chlorine atom      Sodium chloride



The electron dot structural diagram is:



The electron dot structural diagram is:



[2,8,8,2] [2,6]

Calcium atom      Oxygen atom      Calcium oxide

### Question 10

Compare:

- (a) Sodium atom and sodium ion  
(b) Chlorine atom and chloride ion

With respect to

1. atomic structure
2. electrical state
3. chemical action
4. toxicity

**Answer**

(a) Comparison between sodium atom and sodium ion:

Property	Sodium Atom	Sodium Ion
Atomic Structure	It has one electron in M shell.	It has 8 electrons in L shell.
Electrical State	It is neutral.	It is positively charged.
Chemical Action	It is very Active.	It is inactive.
Toxicity	It is poisonous.	It is non-poisonous.

(b) Comparison between chlorine atom and chloride ion:

Property	Chlorine Atom	Chloride Ion
Atomic Structure	It has 7 electrons in M shell.	It has 8 electrons in M shell.
Electrical State	It is neutral.	It is negatively charged.
Chemical Action	It is very Active.	It is inactive.
Toxicity	It is poisonous.	It is non-poisonous.

### Question 11

The electronic configuration of Fluoride ion is the same as that of a neon atom. What is the difference between the two?

**Answer**



The electronic configuration of Fluoride ion is the same as that of a neon atom i.e., both have 8 electrons in their valence shell but Fluoride attain that configuration by gaining an electron so it is negatively charged but neon atom have its own 8 valence electrons so it is neutral i.e., it have no charge on it.

### Question 12

State which of the following are reduction reaction and which are oxidation

- (i)  $\text{Pb} \rightarrow \text{Pb}^{2+} + 2\text{e}^-$
- (ii)  $\text{Fe}^{2+} - \text{e}^- \rightarrow \text{Fe}^{3+}$
- (iii)  $\text{A}^{3+} + \text{e}^- \rightarrow \text{A}^{2+}$
- (iv)  $\text{Cu} \rightarrow \text{Cu}^{2+} + 2\text{e}^-$

### Answer

- (i) Oxidation, since there is a loss of 2 electrons by Lead (Pb).
- (ii) Oxidation, since there is a loss of an electron by Iron (Fe).
- (iii) Reduction, since there is a gain of an electron by A.
- (iv) Oxidation, since there is a loss of 2 electrons by Copper (Cu).

### Question 13

What do you understand by redox reactions?

### Answer

A reaction in which oxidation and reduction occur simultaneously is called an oxidation-reduction reaction or redox reaction. It involves transfer of electrons between two atoms.

### Question 14(i)

Explain oxidation and reduction in terms of loss or gain of electrons.

### Answer

The reaction in which electron(s) is gained is called a **reduction reaction** and the reaction in which there is a loss of electron(s) is called an **oxidation reaction**.

### Question 14(ii)

Explain formation of electrovalent compound is a redox reaction.

### Answer

In the formation of electrovalent compounds, the transfer of electrons is involved. The electropositive atom loses electrons and undergoes oxidation while the electronegative atom gains electrons and undergoes reduction. Hence, formation of electrovalent compound is a redox reaction.

### Question 15

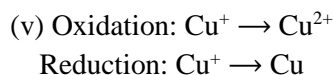
Divide the following redox reactions into oxidation and reduction half reactions.

- (i)  $\text{Zn} + \text{Pb}^{2+} \rightarrow \text{Zn}^{2+} + \text{Pb}$
- (ii)  $\text{Zn} + \text{Cu}^{2+} \rightarrow \text{Zn}^{2+} + \text{Cu}$
- (iii)  $\text{Cl}_2 + 2\text{Br}^- \rightarrow \text{Br}_2 + 2\text{Cl}^-$
- (iv)  $\text{Sn}^{2+} + 2\text{Hg}^{2+} \rightarrow \text{Sn}^{4+} + \text{Hg}_2^{2+}$
- (v)  $2\text{Cu}^+ \rightarrow \text{Cu} + \text{Cu}^{2+}$

### Answer

- (i) Oxidation:  $\text{Zn} \rightarrow \text{Zn}^{2+}$   
Reduction:  $\text{Pb}^{2+} \rightarrow \text{Pb}$
- (ii) Oxidation:  $\text{Zn} \rightarrow \text{Zn}^{2+}$   
Reduction:  $\text{Cu}^{2+} \rightarrow \text{Cu}$
- (iii) Oxidation:  $2\text{Br}^- \rightarrow \text{Br}_2$   
Reduction:  $\text{Cl}_2 \rightarrow 2\text{Cl}^-$
- (iv) Oxidation:  $\text{Sn}^{2+} \rightarrow \text{Sn}^{4+}$   
Reduction:  $2\text{Hg}^{2+} \rightarrow \text{Hg}_2^{2+}$





### Question 16

Potassium (at No. 19) and chlorine (at No.17) react to form a compound. Explain on the basis of electronic concept:

- (i) Oxidation
- (ii) Reduction
- (iii) Oxidising agent
- (iv) Reducing agent.

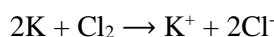
#### Answer

The electronic configuration of:

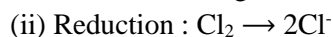
Potassium (19) = 2, 8, 8, 1

Chlorine (17) = 2, 8, 7

The reaction is :



Potassium undergoes oxidation reaction as it loses an electron.



Chlorine undergoes reduction reaction as it gains an electron.

(iii) Chlorine acts as an oxidising agent and gets reduced.

(iv) Potassium acts as a reducing agent and gets oxidised.

## Text Questions 2

### Question 1

What are the conditions necessary for the formation of covalent molecules?

#### Answer

The necessary conditions for the formation of covalent molecules are:

1. Both atoms should have four or more electrons in their outermost shells, i.e., non-metals (exceptions are H, Be, B, Al, etc).
2. Both the atoms should have high electronegativity.
3. Both the atoms should have high electron affinity.
4. Both the atoms should have high ionization energy.
5. The electronegativity difference between the combining atoms should either be zero or negligible.

### Question 2

Elements A, B and C have atomic numbers 17, 19 and 10 respectively.

- (a) State which one is: (i) a non-metal (ii) metal (iii) chemically inert?
- (b) Write down the formula of the compound formed by two of the above elements.

#### Answer

The electronic configuration of:

A (17) = 2, 8, 7

B (19) = 2, 8, 8, 1

C (10) = 2, 8

- (a) (i) A is a non-metal because there are 7 valence electrons in A.
- (a) (ii) B is a metal because there is only 1 valence electron in B.





They are made up of ions and are hard solids.	They are made up of molecules and are gases or liquids or soft solids.
They have high melting and boiling point.	They have low melting and boiling points.
They are soluble in water but insoluble in organic solvents.	

(c) Difference between a polar covalent compound and a non-polar covalent compound

<b>Polar Covalent Compound</b>	<b>Non-Polar Covalent Compound</b>
The covalent compounds are said to be polar when the shared pair of electrons are not at equal distance between the two atoms.	Covalent compounds are non-polar when the shared pair of electron(s) are equally distributed between the two atoms.
They have fractional positive and negative charges on them.	No charge separation takes place.
They ionise in water.	They don't ionise in water.

**Question 5**

A solid is crystalline, has a high melting point and is water soluble. Describe the nature of the solid.

**Answer**

The given properties of the solid indicates that the solid is an ionic compound consisting of oppositely charged ions held tightly together by strong electrostatic forces of attraction of an ionic bond.

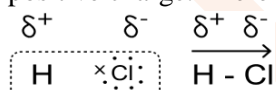
**Question 6**

What do you understand by dipole (polar) molecule? Explain it by taking hydrogen chloride as an example.

**Answer**

A molecule that has both, slight positive and slight negative charge is called a **dipole molecule**.

**For example** - In hydrogen chloride, the strong nuclear charge of the chlorine atom (the electronegativity of chlorine is 3) attracts the shared electron pair towards itself due to which a slight negative charge develops on the chlorine atom. The hydrogen atom (electronegativity 2.1) develops a slight positive charge. Therefore, a polar covalent bond is formed.



**Question 7(a)**

Explain the bonding in methane molecule using electron dot structure.

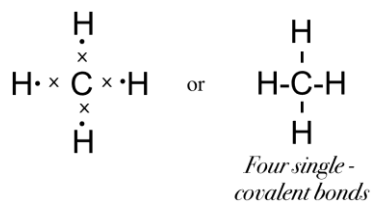
**Answer**

The valency of hydrogen element is 1 and that of carbon is 4. Hydrogen needs one electron to attain stable duplet structure of nearest noble gas - He [2] and carbon needs four electrons to attain stable octet structure of nearest noble gas - Ne [2,8]

One carbon atom shares four electron pairs one with each of the four atoms of hydrogen such that hydrogen acquires a duplet configuration and carbon an octet configuration resulting in the formation of four single covalent bonds.

Electron Dot Structure:





**Question 7(b)**

Methane molecule is non-polar molecule. Explain.

**Answer**

The bond formed between dissimilar atoms can be non-polar if their electronegativity difference is little and their structure permits the shared pair of electrons to attract equally the linked atoms and thus the molecule becomes symmetrical.

The shared electron pairs in Methane are at an equal distance from the Carbon and the Hydrogen atoms because the two have nearly equal electronegativities (carbon = 2.5, hydrogen = 2.1).

**Question 8**

Give the characteristic properties of:

- (a) Electrovalent compounds,
- (b) Covalent compounds.

**Answer**

(a) The characteristic properties of electrovalent compounds are:

1. They are hard solids consisting of ions.
2. They are non-volatile with high melting and boiling points.
3. They do not conduct electricity in solid state but are good conductors of electricity in the fused or in aqueous state.
4. They are good conductors of heat.
5. They are soluble in water but insoluble in organic solvents.
6. They show rapid speed of chemical reactions in aqueous solutions.

(b) The characteristic properties of covalent compounds are:

1. Their constituent particles are molecules. They are gases or liquids or soft solids.
2. They are volatile with low melting and boiling points.
3. They are non-conductors of electricity in solid, molten or aqueous state.
4. They are poor conductors of heat.
5. They are insoluble in water but dissolve in organic solvents.
6. They show slow speed of chemical reactions in aqueous solutions.

**Question 9(a)**

State the type of bond formed, when the combining atoms have:

- (i) zero E.N. difference
- (ii) Small E.N. difference
- (iii) Large E.N. difference

**Answer**

- (i) Non-polar covalent bond.
- (ii) Polar covalent bond.
- (iii) Ionic or Electrovalent bond.

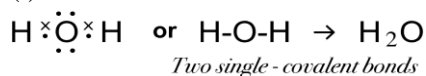
**Question 9(b)**

State the type of bond formed, and draw Lewis structure of

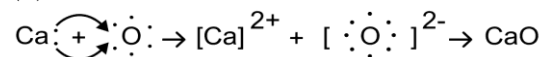
- (i) Water  
(ii) Calcium oxide

**Answer**

(i) In water covalent bond is formed.



(ii) In calcium oxide ionic bond is formed.



[2,8,8,2] [2,6]

Calcium atom      Oxygen atom

Calcium oxide

**Question 10(a)**

Explain the following:

Electrovalent compounds conduct electricity.

**Answer**

Electrovalent compounds consists of ions but the strong electrostatic force keeps ions in fixed position in the solid state. The force is weakened in the molten state and disappears in aqueous solution state, hence free ions formed help in the conduction of electricity.

**Question 10(b)**

Explain the following:

Electrovalent compounds have a high melting point and boiling point while covalent compounds have low melting and boiling points.

**Answer**

Electrovalent compounds have a high melting point and boiling point because there exists a strong force of attraction between the oppositely charged ions, so a large amount of energy is required to break the strong bonding force between ions. While covalent compounds have low melting and boiling points because they have weak forces of attraction between the binding molecules, thus less energy is required to break the force of bonding.

**Question 10(c)**

Explain the following:

Electrovalent compounds dissolve in water whereas covalent compounds do not.

**Answer**

Electrovalent compounds dissolve in water because water is a polar compound, it decreases the electrostatic forces of attraction, resulting in free ions in aqueous solution. Hence they dissolve. Whereas covalent compounds do not dissolve in water because covalent compounds are made up of molecules, they do not ionize in water and hence do not dissolve.

**Question 10(d)**

Explain the following:

Electrovalent compounds are usually hard crystals.

**Answer**

Electrovalent compounds are usually hard crystals because they have strong electrostatic forces of attraction between their ions, which cannot be separated easily.

**Question 10(e)**

Explain the following:

Polar covalent compounds conduct electricity.



**Answer**

Polar covalent compounds have fractional positive and negative charges on them. In aqueous solution state, they undergo ionisation converting the fractional charges to complete charges and ions are produced. These ions help in the conduction of electricity.

**Question 10(f)**

Explain the following:

Water is a polar covalent molecule?

**Answer**

Water is a polar covalent molecule because the shared pair of electrons between hydrogen and oxygen are not at equal distance. There is a slight difference in electronegativities of Oxygen (3.5) and Hydrogen (2.1) due to which the shared pair of electrons is shifted towards Oxygen creating a slight negative charge on it while a slight positive charge is developed on the two Hydrogen atoms making Water a polar covalent molecule.

**Question 11**

Elements X, Y and Z have atomic numbers 6, 9 and 12 respectively. Which one:

- (a) Forms an anion,
- (b) forms a cation,
- (c) State type of bond between Y and Z and give its molecular formula.

**Answer**

The electronic configuration of:

X (6) = 2, 4

Y (9) = 2, 7

Z (12) = 2, 8, 2

- (a) Y forms an anion as it needs just one more electron to complete its octet.
- (b) Z forms a cation. It will lose its 2 electrons to achieve a stable electronic configuration thus forming a cation.
- (c) Ionic bond is formed between Y and Z and its molecular formula is  $ZY_2$ .

**Question 12**

Taking  $MgCl_2$  as an electrovalent compound,  $CCl_4$  as a covalent compound, give four differences between electrovalent and covalent compounds.

**Answer**

Taking  $MgCl_2$  as an electrovalent compound,  $CCl_4$  as a covalent compound, give four differences between electrovalent and covalent compounds.

<b>Electrovalent Compound (<math>MgCl_2</math>)</b>	<b>Covalent Compound (<math>CCl_4</math>)</b>
$MgCl_2$ is formed by transfer of electrons from Magnesium to Chlorine so it consists of ionic bonds.	$CCl_4$ is formed by sharing of electrons between Carbon and Chlorine so it is made up of covalent bonds.
$MgCl_2$ consists of ions $Mg^{2+}$ & $Cl^-$ .	$CCl_4$ consists of molecules — 1 Carbon and 4 Chlorine atoms form a molecule of $CCl_4$ .
$MgCl_2$ has higher melting and boiling point.	$CCl_4$ has lower melting and boiling point.
An aqueous solution of $MgCl_2$ functions as an electrolyte and conducts electricity.	$CCl_4$ does not conduct electricity in solid, liquid or molten state.
$MgCl_2$ is easily soluble in water but insoluble in organic solvents.	$CCl_4$ is insoluble in water but soluble in organic solvents.

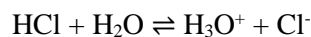
**Question 13**

Potassium chloride is an electrovalent compound, while hydrogen chloride is a covalent compound. But, both conduct electricity in their aqueous solutions. Explain.



**Answer**

Potassium chloride being an electrovalent compound consists of ions. In aqueous solution state, the electrostatic forces between them weaken and the ions become mobile conducting electricity. On the other hand, hydrogen chloride is a polar covalent compound. The shared electron pair is shifted towards Chlorine thereby developing a slight negative charge on it and a slight positive charge on hydrogen atom. In its aqueous solution state, hydrogen chloride ionises into Hydronium and Chloride ions as shown in the equation below. These ions help in conducting electricity.

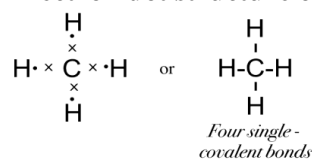


**Question 14(a)**

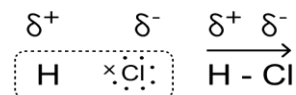
Draw the electron dot structure of covalent compound methane (non-polar) and HCl (polar) and give two difference between them.

**Answer**

**Electron dot structure of methane:**



**Electron dot structure of HCl:**



Methane (CH <sub>4</sub> )	Hydrogen Chloride (HCl)
No charge separation takes place.	Charge separation takes place.
The molecule is symmetrical and electrically neutral.	There is fractional positive and fractional negative charge on them.

**Question 14(b)**

Name two compounds that are covalent when taken pure but produce ions when dissolved in water.

**Answer**

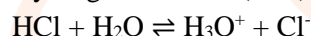
Hydrogen Chloride (HCl) & Ammonia (NH<sub>3</sub>).

**Question 14(c)**

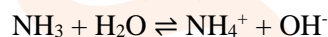
For each compound mentioned above give the formulae of ions formed in aqueous solution.

**Answer**

Hydrogen chloride (HCl)



Ammonia (NH<sub>3</sub>)



**Question 15**

An element M burns in oxygen to form an ionic bond MO. Write the formula of the compounds formed if this element is made to combine with chlorine and sulphur separately.

**Answer**

With Chlorine — MCl<sub>2</sub>

with Sulphur — MS

**Explanation:**

Given, M reacts with oxygen to form an ionic bond MO. Oxygen needs 2 electrons to complete its octet forming the anion O<sup>2-</sup>. As the compound formed is MO, it means that M has 2 electrons in its valence shell which it donates to Oxygen to attain a stable electronic configuration forming a cation M<sup>2+</sup>. Each Chlorine atom accepts 1 electron to complete its octet so 2 Chlorine atoms combine with 1 atom



of M to form  $MCl_2$ . Each Sulphur atom accepts 2 electrons to complete its Octet so 1 Sulphur atom combines with 1 atom of M to form MS.

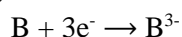
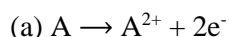
**Question 16**

Element A has 2 electrons in its M shell. Element B has atomic number 7.

- (a) Write equations to show how A and B form ions.
- (b) If B is a diatomic gas, write the equation for the direct combination of A and B to form a compound.
- (c) If the compound formed between A and B is melted and an electric current is passed through the molten compound, the element A will be obtained at the ..... and B at the ..... of the electrolytic cell.

**Answer**

A has two electrons in M shell i.e., A has valency 2 (metal), and the electronic configuration of B(7) is 2, 5 i.e., B has valency 3 (non-metal).



(c) Element A will be obtained at the **Cathode** and B at the **Anode** of the electrolytic cell.

**Reason** — As A is a cation, so it is attracted towards cathode as cathode is negatively charged. B is an anion so it is attracted towards anode as anode is positively charged.

**Question 17**

Element M forms a chloride with the formula  $MCl_2$  which is a solid with high melting point. M would most likely be in the group in which..... is placed.

- (a) Na
- (b) Mg
- (c) Al
- (d) Si

**Answer**

Magnesium (Mg).

**Reason** — since, element M forms a chloride with the formula  $MCl_2$  which is a solid with high melting point. So, M belongs to the group 2 because it has valency 2.

**Question 18**

Complete the following

	Sodium	Phosphorus	Carbon
Formula of chloride			
Nature of bonding			
Physical state of chloride			

**Answer**

	Sodium	Phosphorus	Carbon
Formula of chloride	NaCl	$PCl_3, PCl_5$	$CCl_4$
Nature of bonding	Ionic Bond	Covalent Bond	Covalent Bond
Physical state of chloride	Solid	Liquid, Solid	Liquid

**Question 19**

Compound X consists of molecules.

Choose the letter corresponding to the correct answer from the options A, B, C and D given below:

- (i) The type of bonding in X will be:
  - A. ionic
  - B. electrovalent



- C. covalent  
D. molecular
- (ii) X is likely to have a:
- A. low melting point and high boiling point.  
B. high melting point and low boiling point.  
C. low melting point and low boiling point.  
D. high melting point and high boiling point.
- (iii) In the liquid state, X will:
- A. become ionic,  
B. be an electrolyte,  
C. conduct electricity,  
D. not conduct electricity.

**Answer**

(i) C → covalent

**Reason:** Since, X consists of molecules. Therefore, covalent bond is present.

(ii) C → Low melting point and low boiling point.

**Reason:** Covalent compounds have low melting and boiling points.

(iii) D → not conduct electricity.

**Reason:** Covalent compounds are non-conductor of electricity in solid, molten or aqueous state.

## Exercise 2 — Multiple Choice Type

### Question 1

The property which is characteristic of an electrovalent compound is that:

- a) it is easily vaporized  
b) it has a high melting point  
c) it is a weak electrolyte  
d) it often exists as a liquid

**Answer**

b) it has a high melting point

**Reason** — Electrovalent compounds have a high melting point because there exists a strong force of attraction between the oppositely charged ions, so a large amount of energy is required to break the strong bonding force between ions.

### Question 2

When a metal atom becomes an ion:

- a) it loses electrons and is oxidized  
b) it gains electrons and is reduced  
c) it gains electrons and is oxidized  
d) it loses electrons and is reduced

**Answer**

a) It loses electrons and is oxidized

**Reason** — Metals readily give the valence electron during reactions and are hence oxidised.

### Question 3

Which of the following compounds has all three bonds — ionic, covalent and coordinate bonds ?

- a) Ammonia  
b) Ammonium chloride



- c) Sodium hydroxide
- d) Calcium chloride

**Answer**

Ammonium chloride

**Reason** — when ammonium chloride  $\text{NH}_4\text{Cl}$  is formed cation  $\text{NH}_4^+$  (having 3 covalent and one coordinate bond) and anion  $\text{Cl}^-$  are attracted towards each other, due to electrical charge existing between them and ionic bond is formed. Thus, ammonium chloride is a good example of compound having all three types of bonds i.e., covalent, coordinate and ionic bond.

**Question 4**

Which of the following is not a typical property of an ionic compound?

- a) High melting point
- b) Conduction of electricity in molten and aqueous states
- c) Insolubility in water
- d) Existence as oppositely charged ions even in the solid state.

**Answer**

Insolubility in water

**Reason** — Ionic compounds are soluble in water. They are insoluble in organic solvents. Water [polar solvent] has a high dielectric constant i.e., capacity to weaken the force of attraction, thus resulting in free ions. Organic solvents [non-polar] have low dielectric constants and do not cause dissolution.

**Question 5**

Metals lose electrons during ionization. This change is called:

- a) Oxidation
- b) Reduction
- c) Redox reaction
- d) Displacement

**Answer**

Oxidation

**Reason** — Oxidation is the process when an atom or ion loses electrons in order to attain a stable state.

**Question 6**

Compound 'X' consists of only molecules. 'X' will have:

- a) A crystalline hard structure
- b) Low melting and low boiling point
- c) An ionic bond
- d) A strong force of attraction between its molecules

**Answer**

Low melting and low boiling point

**Reason** — there are weak Vander Waals forces of attraction between molecules. Thus, less amount of energy is required to break these forces of attraction.

**Question 7**

The molecule which contains a triple covalent bond is:

- a) ammonia
- b) methane
- c) water
- d) nitrogen



**Answer**

- a) nitrogen

**Reason** — the valency of nitrogen element is 3. Nitrogen needs three electrons to attain stable octet structure of nearest noble gas - Ne [2, 8]. Each of the two N atoms contributes three electron so as to have three shared pair of electrons between them. Both atoms attain stable – octet structure, resulting in the – formation of a – triple covalent bond  $[N \equiv N]$  between them.

**Question 8**

The formation of a covalent bond between two atoms is favoured when:

**P.** both the atoms have a large difference in electronegativity

**Q.** both the atoms have high electron affinity

**R.** both the atoms have high electronegativity

- a) Only P  
b) Only Q  
c) Both P and Q  
d) Both Q and R

**Answer**

d) Both Q and R

**Reason** — covalent bond between two atoms is favoured when

1. The electronegativity difference between the combining atoms should either be zero or negligible.
2. Both the atoms should have high electron affinity.
3. Both the atoms should have high electronegativity.

Hence both Q and R are correct.

**Question 9**

**Assertion (A):** If the electron affinity value is high, anions are formed easily.

**Reason (R):** Ionic bonding is favoured by high electron affinity.

- a) Both A and R are true and R is the correct explanation of A.  
b) Both A and R are true but R is not the correct explanation of A.  
c) A is true but R is false.  
d) A is false but R is true.

**Answer**

Both A and R are true and R is the correct explanation of A.

**Explanation** — the anion is formed easily if the electron affinity value is high. A high (more negative) electron affinity means an atom releases a significant amount of energy when it gains an electron indicating it strongly attracts electrons. This makes it easier for the atom to accept an electron and form a negative ion (anion). Hence the Assertion (A) is true.

Electron affinity encourages electron acceptance, which is a step in ionic bond formation. Hence Reason (R) is also true and it correctly explains Assertion (A).

**Question 10**

**Assertion (A):** Atoms can combine either by the transfer of valence electrons from one atom to another or by sharing of valence electrons.

**Reason (R):** Sharing and transfer of valence electrons is done by atoms to have an octet in their valence shell.

- a) Both A and R are true and R is the correct explanation of A.
- b) Both A and R are true but R is not the correct explanation of A.
- c) A is true but R is false.
- d) A is false but R is true.

**Answer**

- a) Both A and R are true and R is the correct explanation of A.

**Explanation** — By sharing the valence electron pair, atoms can combine to form Covalent bond and by transferring electron(s), atoms establish a strong electrostatic attraction to form an Ionic bond. Atoms always try to attain their stable electron configuration i.e., to have 8 electrons in their valence shell. So, both Assertion (A) and Reason (R) are true and Reason (R) correctly explains Assertion (A).

**Question 11**

**Assertion (A):** Ionic compounds conduct electricity in molten or aqueous state.

**Reason (R):** Ionic compounds consist of molecules.

- a) Both A and R are true and R is the correct explanation of A.
- b) Both A and R are true but R is not the correct explanation of A.
- c) A is true but R is false.
- d) A is false but R is true.

**Answer**

A is true but R is false.

**Explanation** — Ionic compounds when in molten or aqueous state dissociate into free moving ions, which carry electric current. That is why substances like NaCl conduct electricity when dissolved in water or melted. Hence Assertion (A) is true.

Reason (R) is false because ionic compounds consist of positive and negatively charged ions bound by strong electrostatic forces.

**Question 12**

**Assertion (A):** A pair of electrons not shared with any other atom is known as a lone pair.

**Reason (R):** Ammonium ion has a lone pair.

- a) Both A and R are true and R is the correct explanation of A.
- b) Both A and R are true but R is not the correct explanation of A.
- c) A is true but R is false.
- d) A is false but R is true.

**Answer**

A is true but R is false.

**Explanation** — the unshared pair of electrons is known as **lone pair** of electrons. Hence the Assertion (A) is true.

**Ammonium molecule** has lone pair of electrons NOT **ammonium ion**. Ammonium ion is formed when the lone pair of electron present on nitrogen atom in ammonium molecule is accepted by hydrogen ion and forms a coordinate bond. So, there are no lone pair of electrons left. Hence Reason (R) is false.

**Question 13**

**Assertion (A):** Electrovalent compounds conduct electricity even in solid state.

**Reason (R):** Electrovalent compounds are composed of ions.

- a) Both A and R are true and R is the correct explanation of A.
- b) Both A and R are true but R is not the correct explanation of A.
- c) A is true but R is false.



d) A is false but R is true.

**Answer**

A is false but R is true.

**Explanation** — Electrovalent compounds cannot dissociate into ions in solid state hence they do not conduct electricity but they are very good conductors of electricity in the molten or in aqueous state. Hence the Assertion (A) is false.

Electrovalent compounds are composed of ions that are held by strong electrostatic force of attraction, which cannot be separated easily. Hence Reason (R) is true.

## Exercise 2 — Very Short Answer Type

### Question 1

Fill in the blanks by selecting the correct word from the brackets:

- When the nuclei of two different reacting atoms are of ..... mass, then a bond so formed is called ..... covalent bond (equal, unequal, polar, non-polar).
- In case of non-polar covalent bond, the covalent bond is formed in the ..... of atoms and shared electrons are ..... distributed (corner, middle, equally, unequally).
- Ionic or electrovalent compounds do not conduct electricity in their ..... state (fused/solid).
- The ions in ..... compounds are held very strongly due to strong ..... forces (electrovalent, covalent, electromagnetic, electrostatic).
- In covalent compounds, the bond is formed due to..... [Sharing/transfer] of electrons.
- Electrovalent compounds have a..... [low/high] boiling point.

**Answer**

- Unequal, Polar
- Middle, Equally
- Solid
- Electrovalent, Electrostatic
- Sharing
- High

### Question 2

Give one word or phrase for the following:

- Formation of ions from molecules.
- A bond formed by a shared pair of electrons with both electrons coming from the same atom.
- A bond formed by a shared pair of electrons, each bonding atom contributing one electron to the pair.

**Answer**

- Ionisation
- Coordinate bond
- Covalent Bond

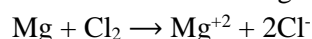
### Question 3

In the formation of magnesium chloride (by direct combination between magnesium and chlorine), name the substance that is oxidized and the substance that is reduced.

**Answer**

Magnesium is oxidized and Chlorine is reduced.

In the formation of magnesium chloride the reaction is:



**Oxidation:**  $\text{Mg} \rightarrow \text{Mg}^{+2}$



**Reduction:**  $\text{Cl}_2 \rightarrow 2\text{Cl}^-$

**Question 4**

Give an example in each of the following:

- (a) Co-ordinate bond compound,
- (b) Solid covalent compound,
- (c) Gaseous polar covalent compound,
- (d) Gaseous non polar covalent compound,
- (e) Liquid non polar covalent compound,
- (f) Compound with electrovalent and covalent bond,
- (g) Compound with all three types of bonds.

**Answer**

- (a) Ammonium ion ( $\text{NH}_4^+$ ) & Hydronium ion ( $\text{H}_3\text{O}^+$ ),
- (b) Phosphorus pentoxide ( $\text{P}_2\text{O}_5$ ) & Silicon dioxide or Silica ( $\text{SiO}_2$ ),
- (c) Hydrogen sulphide ( $\text{H}_2\text{S}$ ) & Ammonia ( $\text{NH}_3$ ),
- (d) Hydrogen ( $\text{H}_2$ ) & Oxygen ( $\text{O}_2$ ),
- (e) Toluene & Gasoline.
- (f) Calcium Carbonate ( $\text{CaCO}_3$ )
- (g) Ammonium chloride ( $\text{NH}_4\text{Cl}$ )

**Question 5**

Electrons are getting added to an element Y:

- (i) Is Y getting oxidized or reduced?
- (ii) Which electrode will Y migrate to during the process of electrolysis?

**Answer**

- (i) Y is getting reduced as reduction is gain of electrons.
- (ii) Y migrates towards **anode**. Y is negatively charged as electrons are added to it. So, it migrates towards the positive terminal that is anode.

**Exercise 2 — Short Answer Type**

**Question 1**

What do you understand by lone pair of electrons.

**Answer**

A pair of electrons which is not shared with any other atom is known as the lone pair of electrons.

**Question 2**

State the type of bonding in the following molecules.

- (a) Water,
- (b) Calcium oxide,
- (c) Hydroxyl ion,
- (d) Methane,
- (e) Ammonium ion,
- (f) Ammonium chloride

**Answer**

- (a) Polar Covalent Bond,
- (b) Ionic Bond,
- (c) Polar Covalent Bond,
- (d) Non Polar Covalent Bond,
- (e) Coordinate & Covalent Bond,



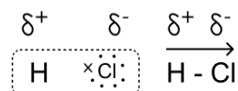
(f) Ionic, Covalent and Co-ordinate Bond.

**Question 3(a)**

Give reasons — Hydrogen chloride can be termed as a polar covalent compound.

**Answer**

In hydrogen chloride, the strong nuclear charge of the chlorine atom attracts the shared electron pair towards itself, i.e., negative charge shifts towards the chlorine atom thereby developing a slight negative charge on it. The hydrogen atom develops a slight positive charge. Therefore, a polar covalent bond is formed as shown below:



**Question 3(b)**

Give reasons — Covalent compounds can exist as gases, liquids or soft solids.

**Answer**

Covalent compounds exist as gases, liquids or soft solids as they have weak force of attraction between their molecules.

**Question 3(c)**

Give reasons — Carbon tetrachloride does not dissolve in water.

**Answer**

Carbon tetrachloride is a non-polar compound and water is a polar compound. Same kind of compounds dissolve in each other that's why carbon tetrachloride does not dissolve in water.

**Question 4**

There are three elements E, F, G with atomic numbers 19, 8 and 17 respectively. Give the molecular formula of the compound formed between E and G and state the type of chemical bond in this compound.

**Answer**

**EG** is the chemical formula.

The electronic configuration of E is (2, 8, 8, 1) and G is (2, 8, 7). We observe that E tends to donate one electron and G tends to gain one electron to attain a stable state. Hence, the two oppositely charged ions attract each other to form an ionic compound EG.

**Ionic bond** will be formed.

**Question 5**

A compound is formed between atoms A and B. The electronic configuration of A is 2, 8, 1 and B is 2, 6.

- Write the equation of the formation of ions of A and B.
- Why do A and B form ions?
- Which of the following can form a compound?
  - A and A
  - A and B
  - B and Balso state the type of bonding present in the compound
- If A and B combines, which of them will get oxidised?
- Draw an electron dot diagram of the ionic compound formed in part (c).
- Write the formula of the compound formed in part (c) which has a
  - high melting and boiling point
  - gaseous compound
  - good conductor of electricity in molten state.

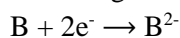


**Answer**

(a) Atom A loses one electron:



Atom B gains two electrons



(b) A and B form ions to achieve a stable noble gas configuration:

A loses 1 electron  $\rightarrow$  becomes  $A^+$  with a configuration of 2, 8 (like neon).

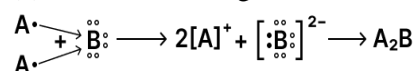
B gains 2 electrons  $\rightarrow$  becomes  $B^{2-}$  with a configuration of 2, 8 (also like neon).

(c) A and B can form a compound, electrovalent bonding will be present in it.

(d) Oxidation is the loss of electrons.

A (sodium) loses 1 electron to form  $Na^+$ . Hence A gets oxidised

(e) Electron dot diagram is shown below:



(f)

(i)  $A_2B$

(As  $A_2B$  is an ionic compound, hence, it will have high melting and boiling point)

(ii) A and B will not form a gaseous compound.

(iii)  $A_2B$

(As  $A_2B$  is an ionic compound, hence, ions will be free to move when in molten state)

## Exercise 2 — Long Answer Type

### Question 1

Define a coordinate bond and give the conditions for its formation.

**Answer**

The bond formed between two atoms by sharing a pair of electrons, provided entirely by one of the combining atoms but shared by both is called a coordinate bond.

**Conditions for the formation of coordinate bond are:**

(i) One of the two atoms must have at least one lone pair of electrons, e.g., ammonia ( $NH_3$ ), water ( $H_2O$ ).

(ii) Another atom should be short of at least a pair of electrons, e.g., Hydrogen ion ( $H^+$ ).

### Question 2

Draw an electron dot diagram for the formation of each of the following:

(i) Hydronium ion,

(ii) Ammonium ion,

(iii) Hydroxyl ion.

State the type of bonding present in them.

**Answer**

(i) **Hydronium ion**



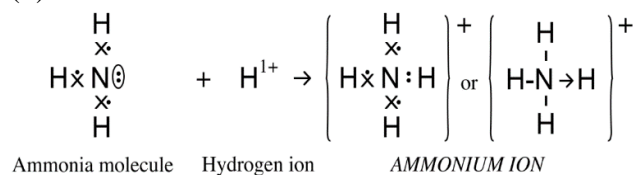
Water Molecule    Hydrogen ion

**HYDRONIUM ION**

Co-ordinate & Covalent Bond.

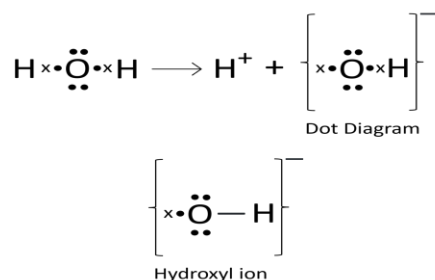


(ii) **Ammonium ion**



Co-ordinate & Covalent Bond.

(iii) **Hydroxyl ion**



Polar Covalent Bond.

**Question 3(a)**

How many atoms of each kind are present in the following molecules: calcium oxide, chlorine, water, carbon tetrachloride?

**Answer**

Calcium oxide (CaO) is formed by one calcium and one oxygen atom.

Chlorine (Cl<sub>2</sub>) molecule is formed by two chlorine atoms.

Water (H<sub>2</sub>O) is formed by two hydrogen and one oxygen atom.

Carbon Tetrachloride (CCl<sub>4</sub>) is formed by one carbon and four chlorine atoms.

**Question 3(b)**

How many electrons are required or released by each atom mentioned in (a) to attain the nearest noble gas configuration?

**Answer**

In Calcium oxide (CaO), Calcium needs to lose 2 electrons and Oxygen gains that 2 electrons to attain the nearest noble gas configuration.

In Chlorine (Cl<sub>2</sub>) molecule, each Chlorine atom needs an electron to complete its octet. So, two Chlorine atoms share a pair of electrons to attain the nearest noble gas configuration.

In Water (H<sub>2</sub>O), each Hydrogen atom needs one electron and one Oxygen atom needs two electrons to complete their duplet and octet respectively. So, each Hydrogen shares a pair of electrons with Oxygen to attain the nearest noble gas configuration.

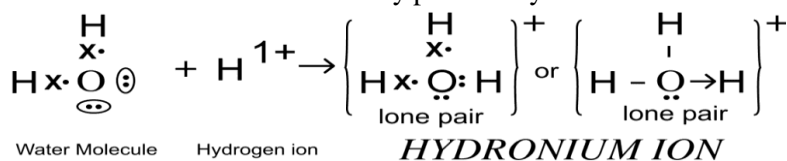
In Carbon Tetrachloride (CCl<sub>4</sub>), each Carbon atom needs 4 electrons and each Chlorine atom needs one electron to complete their octet. So, each Chlorine shares a pair of electrons with Carbon to attain the nearest noble gas configuration.

**Question 4**

Acids dissolve in water and produce positively charged ions. Draw the structure of these positive ions.

**Answer**

When acids dissolve in water they produce hydronium ion. Structure of hydronium ion is shown below:



**Question 5(a)**

Elements Q and S react together to form an ionic compound. Under normal conditions, which physical state will the compound QS exist in?

**Answer**

QS Exist in hard solid state.

**Reason** — As QS is an ionic compound, it consists of ions bond tightly together by strong electrostatic forces between them. Due to this it is a hard solid.

**Question 5(b)**

Elements Q and S react together to form an ionic compound. Can Q and S, both be metals? Justify your answer.

**Answer**

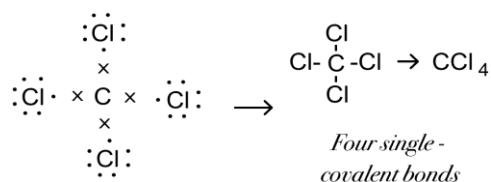
No, Q and S both can't be metals because Q and S react together to form an ionic compound. It is only possible when one of them is metal and the other one is non-metal.

**Question 6**

Draw the structural formula of carbon tetrachloride and state the type of bond present in it.

**Answer**

Structural formula of carbon tetrachloride is given below:



**Covalent** bond is present in carbon tetrachloride.

**Question 7**

Compare carbon tetrachloride and sodium chloride with regard to solubility in water and electrical conductivity.

**Answer**

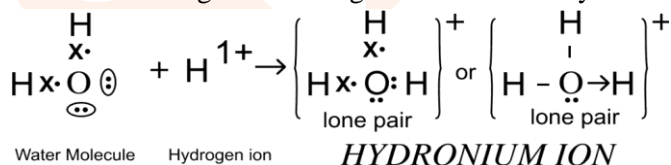
	<b>Carbon tetrachloride</b>	<b>Sodium chloride</b>
Solubility in water	Insoluble in water	Soluble in water
Electrical conductivity	Non Conductor	Good conductors in aqueous state or molten state

**Question 8**

Draw an electron dot diagram of hydronium ion. State the type of bonding present in it.

**Answer**

Electron dot diagram showing the structure of Hydronium ion is given below:



**Co-ordinate** bond is present in hydronium ion.

**Question 9**

By drawing an electron dot diagram, show the lone pair effect leading to the formation of — ammonium ion from ammonia gas and hydrogen ion.

**Answer**

Electron dot diagram showing the lone pair effect for formation of  $\text{NH}_4^{1+}$  ion from  $\text{NH}_3$  gas and  $\text{H}^{1+}$  is given below:





of nearest noble gas - He [2] and Y needs three electrons to attain stable octet structure of nearest noble gas - Ne [2, 8]

One Y atom shares three electron pairs one with each of the three atoms of Z such that Z acquires a duplet configuration and Y attain a stable octet configuration resulting in the formation of three single covalent bonds.

(ii) **Formula of the compound formed**

(a) X (2,8,7) and Z (1) — **XZ** as X needs one 1 electron to complete its octet and Z needs needs one electron to complete its duplet hence, they both share one electron pair and forms ZX compound.

(b) W (2, 8, 1) and X (2, 8, 7) — **WX** as W has the tendency to donate one electron and gain stability whereas X has the tendency to gain one electron to be stable. Hence, W donates one electron and X takes it and form WX compound.

