Class :- IX

Chemical Bonding

Covalent bond Formation and Properties

Teaching Task

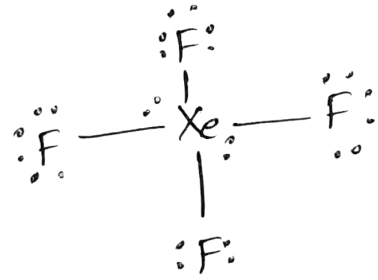
JEE Main level Questions

Q1) Ans :- 2

Solution :- Be has a higher tendency to form covalent compounds due to its small size, it has high ionization energy and hence prefers covalent bond rather than ionic bond.

Q2). Ans :- 3

Solution :-

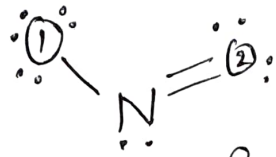


Formal charge = No. of valence electrons - no. of dots - no. of lines.

$= 7 - 6 - 1 = \underline{0}$

Q3) Ans :- 1

Solution :-



For 1 oxygen formal charge = No. of valence electrons - no. of dots - no. of lines.

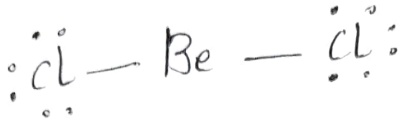
$= 6 - 6 - 1$

$= -1$

Q4) Ans:- 3.

Solution:- Be has 2 electrons in th valence shell. Now both electrons are involved in bond formation with both the Cl atoms. It comprises only bonded pair of electrons.

So, there is no lone pairs in Be.



Q5) Ans:- 4.

Solution:- HCN contains 4 bonds

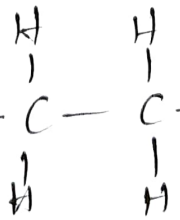
1 → H – C bond

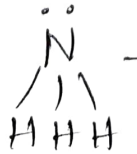
3 → C ≡ N bonds (triple bond)

H – C ≡ N.

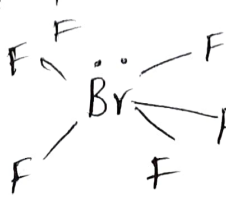
Total bond pairs are 4.

Q6) Ans:- 1

Solution:- 1) Ethane (C_2H_6) →  → 7 bonds.

2) Ammonia (NH_3) →  → 3 bonds.

3) Sulphur hexafluoride (SF_6) →  → 6 bonds.

4) Bromine pentafluoride (BrF_5) →  → 5 bonds.

Q7) Ans:- 2

Solution:- 1 Electron pair for each bond & there are 6 S-F bonds in the given molecule.

Q8) Ans:- 2

Solution:-

1) PH_3 → In 'P' 5 valence electrons are there. 3 electrons forms bonds with 3 hydrogens. Remaining 2 electrons — 1 Lone pair

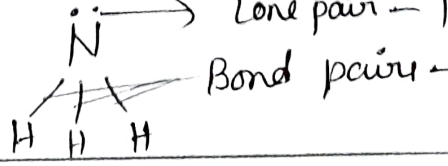
2) H_2S → In 'S' 6 valence electrons. 2 forms bond with hydrogen. Remaining 4 electrons → 2 lone pairs.

3) CH_4 → In 'C', 4 valence electrons forms bonds with hydrogen. So there is no lone pairs.

4) BrF_5 → In Br, 7 valence electrons are there. 5 forms bonds with fluorine, remaining 2 electrons form 1 lone pair.

Q9) Ans:- 1

Solution:- In ammonia (NH_3) central atom is nitrogen. There are 5 valence electrons in Nitrogen. 3 formds bond pairs. Remaing 2 forms 1 lone pair.



JEE Advanced Level Questions

(Q10) Ans:- 1, 4.

Solution:-

→ Covalent bond is formed by sharing of the electrons.

→ Covalent bond is formed blw two non-metals.

→ Covalent bonds are not necessarily stronger than ionic bonds, the strength depends on the specific atoms and context.

→ The study of covalent bonds is more associated by Gilbert N. Lewis.

(Q11) Ans:- 1, 3.

Solution:-

→ The bond formed blw two non-metallic elements is covalent bond.

→ The bond formed blw a metal & non-metal is called as ionic bond.

→ Inert gases typically do not form bonds, but weak vander waals forces can exist blw them.

→ The bond blw 2 metallic elements is a metallic bond.

(Q12) Ans:- 1.

Solution:- G.N. Lewis explained covalent bond by the electron dot. The covalent bond blw a pair of 2 atoms is represented by small line (—)

(Q13) Ans:- 3.

Solution:- BeF_2 is predominantly covalent compound, because of small size of Be, IE value is very high, so it is not able to form Be^{+2}. So it can form covalent compound.

→ Electronegative difference blw Be and F is very high.

(Q14) Ans:- 1

Solution:- Between 2 hydrogen atoms covalent bond is formed due to mutual sharing of electrons blw two hydrogen atoms. Each Hydrogen contributes 1 electron each and form a bond.

H—H

Matrix Matching

(Q17) Ans:- A) 2 B) 3 C) 4 D). 5.

Solution:-

a) Pure covalent bond → 2) H_2.

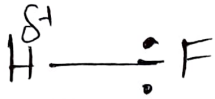
b) Polar covalent bond → 3) HCl.

c) multiple bonds → 4) Double or triple bonds

d) Co-ordinate covalent bond → 5) Lewis.

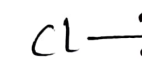
Q18). Ans:- 4.

Solution:- In polar covalent bond, the bonded electron pairs are unequally shared blw the two atoms.



Q19) Ans:- 1, 2.

Solution:- A covalent bond in which electron pairs are shared equally blw two bonded atom is called non-polar covalent bond.



→ BCl_3 has bond polarity but it is non polar molecule because it has a trigonal planar shape, hence the net dipole moment is cancelled.

Learner's Task

Conceptual Understanding Questions

Q1) Ans:-

Solution:- The anion chlorine is common in all molecules. Smaller the size of cation & greater the charge, more is the covalent character. NaCl & KCl have lesser charge, & among these K ions have greater ions than Na ions. So KCl is least covalent.

Q2) Ans:- 4

Solution:- LiI has the maximum covalent nature because covalent character is dependent on the size of cation and anion.

Smaller cation, Larger anion supports covalent character.

LiI has small cation Li^+ and large anion I^-.

Q3) Ans:- 1

Solution:- Nitrogen typically forms 3 covalent bonds due to its 5 valence electrons, but it can extended its covalency to 4 in certain compounds like ammonium ion (NH_4^+), wher it four covalent bonds. Hence, the maximum covalency is 4.

Q4) Ans:-

Solution:- $N_2 \longrightarrow N \equiv N$.

In N_2, there is a triple bond b/w 2 nitrogen atoms. The other compounds listed (N_2O, CO_2 & HCN) contain multiple types of bond single, double & both along with their triple bonds.

Q5) Ans:- 3.

Solution:- C – C

% Ionic = $16\Delta x + 3.5(\Delta x)^2$

Δx = difference in E.N.

% Covalent = 100% – % ionic

if same atoms are $\Delta x = 0$.

% ionic character = 0.

% Covalent character = 100%.

1) Acetylene (C_2H_2)

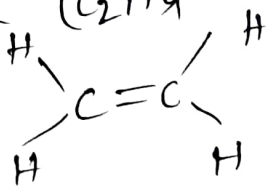
H – C ≡ C – H (there is no double bond)

2) Carbon dioxide (CO_2)

O = C = O.

The double bond b/w C=O, they have higher electronegativity difference.

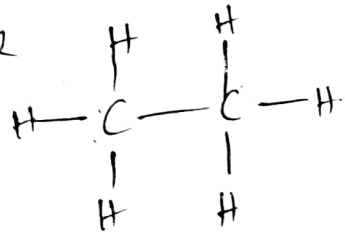
3) Ethylene (C_2H_4)



The double bond b/w C=C, so $\Delta x = 0$.

The % Covalent character = 100%.

4) Ethane



There is also no double bond.

Q6) Ans:- 3

Solution:-

1) NH_4OH

→ NH_4^+ has 4 covalent bonds

→ OH^- has 1 covalent bond.

Total = 4+1=5

2) NH_4Cl

→ NH_4^+ has 4 covalent bonds.

→ The bond blw NH_4^+ and Cl^- is ionic.

→ Total = 4 covalent bonds.

3) $CO(NH_2)_2$ (urea).

→ C=O (1 double bond = 2 covalent bonds)

→ C-N (2 single bonds)

→ Each NH_2 has 3 covalent bonds (2 N-H bonds, 1 N-C bond).

So 2 NH_2 group contribute 6 covalent bonds.

Total = 2+2+6=10

4) CH_3OH (Methanol)

→ C-H → 3 bonds

→ C-O → 1 bond.

→ O-H → 1 bond

Total = 3+1+1=5 covalent bonds.

So urea have more covalent bonds

Q7) Ans: 3

Solution:

1) $CH_4 = 6+(4\times1) = 10$ electrons

2) $CO_2 = 6+(2\times8) = 6+16 = 22$ electrons

3) $NO_2 = 7+2(8) = 7+16 = 23$ electrons. ✓

4) $N_2O = 2(7)+8 = 14+8 = 22$ electrons

Q8) Ans: 2

Solution:- Ionic bonds are non directional in nature.

RbCl is ionic bond, it is non-directional in nature.

Q9) Ans: 2

Solution:- Polarity in a molecule depends on electronegativity difference. If ΔEN is high then it is more polar.

EN of H = 2.1.
Cl = 3.

1) HCl, $\Delta EN = 0.9$.

2) HF, $\Delta EN = 4-2.1 = 1.9$.

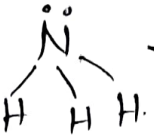
3) H_2S, $\Delta EN = 2.58-2.1 = 0.48$.

4) NH_3 $\Delta EN = 3-2.1 = 0.9$.

HF has more EN difference. So it is more polar.

Q10) Ans:- 2

Solution:-

1) Ammonia (NH_3)  → 1 lone pair.

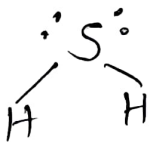
2) Xenon difluoride (XeF_2) → 

2 bond pairs & 3 lone pairs

3) Chlorine trifluoride (ClF_3)

 → 2 lone pairs.

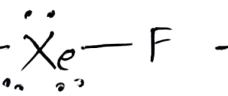
4) Hydrogen sulphide (H_2S)

 → 2 lone pairs.

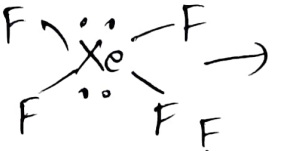
JEE Main level

Q11) Ans:- 3.

Solution:-

1) XeF_2 →  → 2 bond pairs, 3 lone pairs.

2) CO_2 → O=C=O → 4 bond pairs, '0' lone pairs.

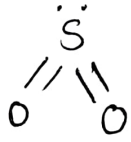
3) XeF_4 →  → 4 bond pairs, 2 lone pairs.

4) SF_6 →  → 6 bond pairs, '0' lone pairs.

(Q12). Ans:- 1, 2.

Solution:-  (PF_5) → More than 8 electrons (i.e. 10).

SF_6  → 12 electrons on central atom.

SO_2  → It has an expanded octet.

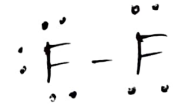
CO_2 O=C=O → 8 electrons obey octet rule.

(Q13) Ans:- 2, 3

Solution:- Non-polar covalent compounds are soluble in organic solvents like ether & benzene.

(Q14) Ans:- B.

Solution:- Lewis dot structure of F_2.



(Q15) Ans:- 1

Solution:- Double & triple bonds are called multiple bonds.

→ Lone pair doesn't involve in coordinate covalent bond.

→ Covalent bonds involve the sharing of electron pairs, not just unpaired electrons.

Q16) Ans:- 1,3

Solution:

→ In polar covalent bond, the bond formed b/w the two disimilar atoms, then the electron pairs are shared unequally b/w the two atoms.

→ As the covalent compounds are rigid & directional, covalent compounds exhibit stereo & space isomerism.

Q17) Ans:- 4.

Solution:-

→ The shape & structure of a molecule can affect intermolecular forces, so it will affect melting and boiling points.

→ If molecular weight increases, strength increases leading to higher M.P & B.P.

→ Chemical formula explains the type of bonding & the presence of functional groups that affect intermolecular forces.

Q18) Ans:- 2

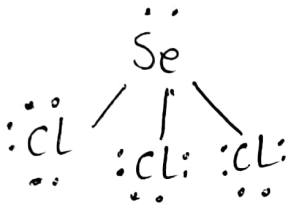
Solution:- Graphite does conduct electricity because it has delocalised electrons which move between the layers.

Q19) Ans:- 1

Solution:- In covalent compounds, entire molecules need to interact and react with each other, which often involves breaking and forming multiple bonds. So covalent compound reactions are slow.

Q20) Ans:- 1

Solution:-



Formal charge = No. of valence electrons − no. of dots − no. of lines.

= 6 − 2 − 3 = 1

Q21) Ans:- 1,2,3

Solution:- 1) $CO_2 \rightarrow O=C=O$

2) $O_2 \rightarrow O=O$

3) $N_2 \rightarrow N\equiv N$.

4) $HCN \rightarrow H-C\equiv N$.

In all compounds multiple bonds are present.

Q22) Ans:- 1,2.

Solution:- Diamond, Graphite are forms of carbon and are covalent network solids & covalent polymers.

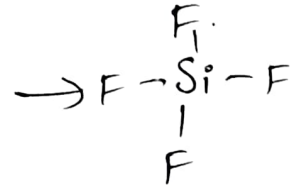
Q23) Ans:- 1.

Solution:-

→ Single bond is formed by mutual sharing of one pair of electrons blw two atoms.

→ Single bond is always ← bond.

Q24) Ans:- 1.

Solution:- SiF_4 → 

SiF_4 has octet configuration, because Silicon belongs 3 period in that vacant d-orbital is present, so it can involve in chemical bonding.

Q25) Matrix Matching

Ans:- A) 2 B) 4 C) 3 D) 1.

Solution:-

A) Ionic bond → 2) NaCl.

B) Covalent bond → 4) H_2O.

C) Valency → 3) No. of electrons in the outermost orbit.

D) Octet rule → 1) 8 Electrons in the outermost orbit.

Q26) Ans:- 3.

Solution:-

1) CH_4 → 4 electrons in Carbon, it forms 4 bonds with hydrogen. So total valence electrons is 8. So it follows octet.

2). CO_2 → 4 valence electrons in carbon.

2 O atoms bond 2 bonds with C.

$4+(2\times2)=8$

3). BF_3 → 3 for Boron & 3 from Fluorine.

So valence electrons are 6. So it doesn't obey octet.

4). OF_2 → 6 valence electrons in oxygen and 2 valence electrons from fluorine. So it obey octet.

Q27) Ans:- 2, 3.

Solution:-

1) PCl_3 → 5 valence electrons of P & 3 bonds. So 8 electrons are present on P. So there is no expansion.

2) PCl_5 → $5+5=10$, expansion occurs.

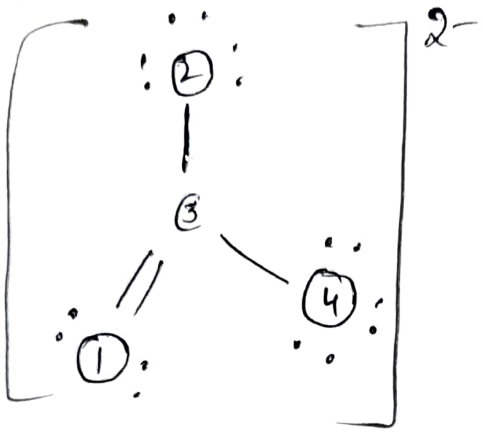
3). SO_3 → Sulphur $6+$ Oxygen $3(2)=6+6=12$, expansion occurs.

4). H_2S → $2(1)+6=8$; No expansion occurs.

Integer Type

(Q 28). Ans:- −1

Solution:-



Formal charge = No. of valence electrons − no. of dots − no. of lines.

For 2nd Oxygen,

Formal charge of ② = 6 − 6 − 1 = −1.

For 4th oxygen,

Formal charge of ④ = 6 − 6 − 1 = −1.