# WORKSHEET-14



#### Worksheet-14 (A. Physical Chemistry) **Chemical Bonding USE THIS SPACE FOR** Q.1 Which of the following molecules does not have planar SCRATCH WORK geometry? A) Benzene C) Ethene B) Boron trifluoride D) Phosphorous trichloride Q.2 Which one of the following pair of compounds contains one that is giant ionic and one that is simple molecule? C) SiO<sub>2</sub> and SiCl<sub>4</sub> A) $Al_2O_3$ and $Al_2Cl_6$ B) P<sub>4</sub>O<sub>10</sub> and PCl<sub>3</sub> D) HF and PbCl<sub>4</sub> Which of the following molecules has only non-coplaner Q.3 tetrahedral geometry? A) NF<sub>3</sub> C) C<sub>2</sub>Cl<sub>4</sub> B) $C_3H_8$ D) $C_3H_6$ **Q.4** Ionic compounds show all of the following properties **EXCEPT:** A) All are present in the solid state B) All conduct electricity in the molten state C) All show polymorphism and isomerism D) All have non-directional and non-rigid bond Q.5 MTBE (Methyl tertiary butyl ether) is a constituent of Petrol. Its structural formula is shown below. $\stackrel{\text{le P}}{\underset{H_3C-C-O-CH_3}{\leftarrow}} \stackrel{CH_3}{\underset{I}{\underset{H_3C-C-O-CH_3}{\leftarrow}}} angle Q}$ angle P $CH_{3}$ What are the values of angle P and angle Q in a molecule of MTBE?

Options	Angle P	Angle Q
A)	90°	105°
B)	90°	180°
C)	109°	105°
D)	90°	180°

Q.6	According to VSEPR theorethe basic condition for the	ry, which of the following is not regular geometry:	USE THIS SPACE FOR SCRATCH WORK
	A) Central atom is surround	ed by similar atoms	
	B) Central atom has no lone	e pair	
	C) Molecule has similar bor	nds	
	D) The electronegativity of	central or surrounding	
Q.7	atoms affect the bond ar <b>Majority of the compound</b>	ngle I <b>s in nature have:</b>	
	A) Electrovalent bond	C) Ordinary covalent bond	
Q.8	B) Dative covalent bond Which property is not sho	D) Hydrogen bond wn by covalent compounds?	
	A) They are present in the g	as, liquid or solid state	
	B) They are more reactive the	han ionic compounds	
	C) They show resonance an	d isomerism	
	D) They have low meltin compared to ionic compo	g points and boiling points as ounds	
Q.9	Which one of the follow geometry?	ing molecules shows a linear	
	A) $H_2O$	C) HCN	
<b>O.10</b>	B) Cl <sub>2</sub> O Second and higher electro	D) C <sub>2</sub> H <sub>4</sub> on affinity values are positive	
<b>C</b> <sup>1</sup>	because of:		
	A) Repulsion between electronic detection of the second se	rons and negatively charged ions	
	B) Attraction between electron	rons and positively charged ions	
	C) First repulsion between e	electrons and then attraction	
Q.11	D) Both A and B In which of the following atoms of elements?	ionic bond is formed between	
	A) Al and Cl	C) B and F	
Q.12	B) H and Cl Which of the following electrons?	D) Na and H molecules has six bonding	
	A) C <sub>2</sub> H <sub>4</sub>	C) CO <sub>2</sub>	
	B) H <sub>2</sub> S	D) NCl <sub>3</sub>	

Q.13	If two atoms ar of the covalently that are shared	e bonded y bonded , then wh	in such a molecule at is this t	way that one mo donates both ele ype of bond callo	ember ctrons ed?	<u>USE THIS SPACE FOR</u> <u>SCRATCH WORK</u>
	A) H-bonding		C) Coo	ordinate covalent	bond	
Q.14	B) Covalent bon Which of the geometry?	nd <b>following</b>	D) Ele g molecul	ctrovalent bond es shows tetral	hedral	
	A) $\overset{oo}{NH_3}$		C) SO	–2 4		
Q.15	B) SO3 Which type of I forces in liquid	bonding i CCl4?	D) SO <u>:</u> s responsi	<sup>2</sup> ble for intermol	ecular	
	A) Covalent bon	nding				
	B) Hydrogen bo	nding				
	C) Instantaneous	s dipole –	induced di	pole forces		
Q.16	D) Dipole – Dip The C <sub>2</sub> H <sub>2</sub> mole the numbers of	ole forces cule is lin $\sigma$ and $\pi$	ear which bonds pre	can be deduced sent in the mole	l from cule?	
	O	ptions	$\sigma$	π		
		A)	2	2		
		B)	2	3		
		C)	3	2		
Q.17	Which one of melting and b bonding?	D) the follo poiling po	3 wing gian bints on	it solids have g the basis of ty	reater pe of	
	A) Metallic solid	ds	C) Ion	ic solids		
Q.18	B) Covalent solids D) Molecular solids With the increase of which one of the following factors bond energy of a molecule decreases:					
	A) Electronegative difference					
	B) Bond order					
	C) s-character					
	D) Number of lo	one pair				

Q.19	Which of	the following mo	lecules has	greater	bond	USE THIS SPACE FOR
	energy?					SCRATCH WORK
	A) H - H	С	) 0-0			
Q.20	B) N - N Which of th	D e following has tri	) F - F igonal planar	geomet	ry?	
	A) SO <sub>2</sub>	С	) SO <sub>3</sub>			
Q.21	B) CCl <sub>4</sub> Mark the intermolecu	D incorrect staten llar forces present	) H <sub>2</sub> O nent about in the indica	the tyj ted mole	pe of cule:	
	Option	Molecule	Type of int for	ermolec ces	ular	
	A)	HC1	Debye force	S		
	B)	CHCl <sub>3</sub>	Dipole Dipo	le forces		
	C)	Halogens in liquid state	London Disj forces	persion		
	D)	Noble gases in liquid state	London Disj forces	persion		r
Q.22	All of the fol	llowing molecules	have H–bond	ing EXC	CEPT:	
	A) Ethanol	С	) Aminoethan	e		
	B) Ethanoic	acid D	) Propanone			
Q.23	Which of another of i	the following wil ts own molecule?	l not form	H-bond	with	
	A) CH <sub>3</sub> CHC	) (	) CH <sub>3</sub> OH			
	B) CH <sub>3</sub> NH <sub>2</sub>	D	) NH3			
Q.24	Solid carbon dioxide (dry ice) is used as a refrigerating agent because it readily changes directly from the solid into the vapor state at low temperature. What does this indicate the main intermolecular bonding / forces in CO <sub>2(s)</sub> to be?					
	A) Covalent	bonding C	) Hydrogen bo	onding		
	B) Ionic bon	ding D	) London disp	ersion fo	orces	
Q.25 Which of the following theories was put forward by Drude and extended by Loren (1923) to explain the properties of metallic solid?						
	A) Electron	gas theory C	) Band theory			
	B) Valance l	bond theory D	) Crystal field	theory		
		1 4 5 4 1		•		

Q.26 When heated solid iodine readily forms iodine vapors. What does this information suggest about the nature of particles in these two physical states of iodine?

Option	Solid	Vapor
A)	Ionic	Atomic
B)	Ionic	Molecular
C)	Molecular	Atomic
D)	Molecular	Molecular

- Q.27 Magnesium oxide is used to line industrial furnaces because it has a very high melting point. Which type of bond needs to be broken for magnesium oxide to melt?
  - A) Co-ordinate bond C) Covalent bond
  - B) Ionic bond D) Metallic bond
- Q.28 All of the following are correct statements regarding difference between polar and non-polar bonds EXCEPT:

Option	Non-Polar	Polar
A)	It is a covalent bond which exists between two similar atoms or those having negligible electronegativity difference	It is a covalent bond which exists between two dissimilar atoms or those having appreciable electronegativity difference but less than 1.7
B)	It is a weaker bond	It is a stronger bond
C)	It has no polarity	It has always polarity in the molecule
D)	It is more reactive	It is less reactive

USE THIS SPACE FOR SCRATCH WORK



## Q.29 All of the following are correct statements regarding difference between sigma bond and pi-bond EXCEPT:

Option	Sigma bond	Pi bond
A)	It is formed by linear overlapping of two half-filled atomic orbitals	It is formed by sidewise overlapping of two half-filled parallel atomic orbitals
B)	It has restricted rotation about the inter-nuclear axis	It has free rotation about the inter nuclear axis
C)	It has only lobe of electron density between the nuclei	It has two lobes of electron density on opposite sides of inter nuclear axis
D)	It has symmetrical charge density about the inter-nuclear axis	It has no symmetrical charge density about the inter-nuclear axis

Q.30 Which of the following molecules does not obey dot-andcross model diagram?



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Q.31 The distance between the nuclei of two atoms forming a covalent bond is called the bond length. All of the following statements are correctly matched EXCEPT:

Options	Compound	Hybridization	Bond	Bond Length (pm)
A)	SiH4 (Monosilane)	sp <sup>3</sup>	Si – H	148
B)	C <sub>2</sub> H <sub>4</sub> (Ethene)	sp <sup>2</sup>	C = C	154
C)	BF3 (Boron trichloride)	sp <sup>2</sup>	B – Cl	175
D)	C <sub>2</sub> H <sub>2</sub> (Ethyne)	sp	C ≡ C	120

<u>USE THIS SPACE FOR</u> <u>SCRATCH WORK</u>



Q.32 Observe the given dot and cross structures for the following molecules or ionic species:



#### The co-ordinate covalent bond exists between:

- A) N and C atoms in structure III and IV
- B) N and one H ion in all four structure
- C) N and Cl atom so structure II
- D) N and N atoms of structure I

### Q.33 All of the following statements are correctly matched for ionic and covalent bonds EXCEPT:

Opt.	Ionic bond (Electrovalent bond)	Covalent bond (Electron pair bond)
A)	It is formed by complete transfer of electron/ electrons from one atom of element to the other.	It is formed by mutual sharing of electrons between two atoms.
B)	The migrated electron/ electrons belongs to only one of the two bonded atoms.	The shared electrons pair belongs to both the bonded atoms.
C)	It is directional bond.	It is non-directional bond.
D)	It is shown by positive and negative charge on the bonded atoms $(+, -)$ .	It is shown by small line $(-)$ drawn between the two bonded atoms.

## Q.34 No electrovalent bond is 100% ionic in nature. This is because of:

A) When cations and anions approach each other, polarizability increases only

C) H<sub>2</sub>

D) KC1

- B) Sharing of electrons takes place to some extent only
- C) Highest ionic character is present in CsF only
- D) Both A and B
- Q.35 The compound which contains both ionic and covalent bond:
  - A)  $CH_4$
  - B) KCN



	ANS	WER	KEY	(Wor	kshee	et-14)	
1	D	11	D	21	Α	31	В
2	Α	12	D	22	D	32	В
3	В	13	С	23	Α	33	С
4	С	14	С	24	D	34	D
5	С	15	С	25	Α	35	В
6	D	16	С	26	D		
7	С	17	В	27	B		
8	B	18	D	28	D		
9	С	19	Α	29	B		
10	Α	20	С	30	B		

#### **ANSWERS EXPLAINED**

- Q.1 (D) PCl<sub>3</sub> is not planar structure due to the presence of lone pair on the central "P" atom of phosphorous. It is LAB<sub>3</sub> type molecule and shows pyramidal geometry (i.e. irregular geometry) while others are A, B and C have planar structure.
- Q.2 (A) Al<sub>2</sub>O<sub>3</sub> is giant ionic and Al<sub>2</sub>Cl<sub>6</sub> is simple molecule
  - (B) P<sub>4</sub>O<sub>10</sub> and PCl<sub>3</sub> are simple molecules
  - (C) SiO<sub>2</sub> and SiCl<sub>4</sub>. SiO<sub>2</sub> is a giant molecule while SiCl<sub>4</sub> is simple molecule
  - (D) HF and PbCl<sub>4</sub> both are simple molecules
- Q.3 (B) In C<sub>3</sub>H<sub>8</sub>(H<sub>3</sub>C-CH<sub>2</sub>-CH<sub>3</sub>), all the carbon atoms are sp<sup>3</sup> hybridized and show non-coplanar tetrahedral structure.
- Q.4 (C) All the ionic compounds show polymorphism and isomorphism but do not show isomerism. Isomerism is shown by covalent compounds.
- Q.5 (C) MTBE (Methyl tertiary butyl ether) is a constituent of petrol and it has following structure.

angle P 
$$CH_3$$
 angle Q  
 $H_3C - C - O - CH_3$   
 $|$   
 $CH_3$ 

From the structure it is clear that the value of **bond angle P** is 109° like alkane because the carbon atom is bonded with four other atoms while the value of **bond angle Q** is 105° just like water because oxygen is bonded with two atoms and has two lone pairs. The presence of two lone pair decreases the bond angle.

Options	Angle P	Angle Q
C)	109°	105°

- Q.6 (D) In fact, the electronegativity of central or surrounding atoms have no affect on the bond angle.
- Q.7 (C) Majority of the compound in nature are ordinary covalent compounds due to the following reason.
  - Carbon is tetravalent. It can form four covalent bonds at a time
  - It has unique property of catenation
  - It shows isomerism
  - It does not form ionic compound
- Q.8 (B) Covalent compound are less reactive than ionic compounds, because first old bonds are broken then new bonds are formed by covalent compounds.
- Q.9 (C) HCN molecule shows linear geometry like BeCl<sub>2</sub>, HgCl<sub>2</sub>, and CO<sub>2</sub>.
- Q.10 (A) Formation of uninegative ion is exothermic process while 2<sup>nd</sup>, 3<sup>rd</sup>, and so on are endothermic process. 2<sup>nd</sup> and higher electron affinities values are positive because when 2<sup>nd</sup> electron is added to uninegative ion the

incoming electron is repelled by the already present negative charge and thus energy has to supply to counter the effect of repulsion between incoming electron and negatively charged ion. This clearly explains that second and high electron affinity are positive.

- Q.11 (D) For the formation of ionic bond, there are two conditions.
  - One element should have low ionization energy
  - e.g first ionization energy of Na

= +496kJmol<sup>-1</sup>

- Other element should have high electron affinity. It has high first ionization energy (1313kJmol<sup>-1</sup>)
- e.g. electron affinity of H

 $= -73 k Jmol^{-1}$ 

- e.g Na and H form ionic bond and fulfill the above two conditions
- Q.12 (D) NCl<sub>3</sub> has six bonding electrons as shown in the structure.



**Q.13 (C)** It is coordinate covalent bond. A covalent bond in which shared electron pair is donated by only one atom is called coordinate covalent bond. It is shown by an arrow  $(\rightarrow)$ 

 $H_3N^+ \longrightarrow \overline{B}F_3$ 

Q.14 (C)  $SO_4^{-2}$  shows tetrahedral geometry as shows in diagram.



- Q.15 (C) CCl<sub>4</sub> is non-polar molecule and it shows tetrahedral geometry. It is in the liquid state because its molecules involve instantaneous dipole induced dipole forces (a type of intermolecular force).
- Q.16 (C) H-C≡C-H. From the structure it is clear that it has three sigma bonds and two pi bonds having linear structure.
- Q.17 (B) Covalent solids are giant molecules and have large number of covalent bonds. Due to their cumulative effect the strength of the bond is very high e.g. diamond (3550°C) graphite (3700°C) and silicon carbide SiC (2730°C) have high melting points.
- Q.18 (D) Bond energy of the molecule is greater if the bonded atoms have greater electronegative difference, high bond order and more s-character. But the presence of lone pair decreases bond energy because they produce repulsion.
- Q.19 (A) [H H (436kJmol<sup>-1</sup>)] H<sub>2</sub> molecule has greater bond energy because it have no lone pair and smaller atomic size.

Option	Bond	Bond energy (kJmol <sup>-1</sup> )
A)	H - H	436
<b>B</b> )	N - N	163
C)	0-0	146
D)	$\mathbf{F} - \mathbf{F}$	154.8

Q.20 (C) SO<sub>3</sub> shows trigonal planar geometry. It is AB<sub>3</sub> type molecule. It shows regular geometry. Double bond are treated as single bond like BF<sub>3</sub>, AlCl<sub>3</sub> as shown in structure.



- Q.21 (A) HCl is polar molecule and it has permanent dipoles. In HCl molecules there are dipole dipole forces. Debye forces are those forces which exist between polar and non-polar molecules e.g in HCl and Ar there are present debye forces which are also called dipole-induced dipole forces.
- Q.22 (D) In propanone (CH<sub>3</sub>COCH<sub>3</sub>) there is no hydrogen bonding because hydrogen bonding is the electrostatic force between a highly electronegative atom (N, O, F, and rarely Cl) and partial positively charged hydrogen atom.
  - In propanone there is no covalently bonded polarized hydrogen atom which is directly associated with more electronegative atoms such as N, O and F. That is why propanone does not show hydrogen bonding. It shows dipole dipole forces.
- Q.23 (A) In ethanal (CH<sub>3</sub>CHO), hydrogen atom is not covalently bonded with more electronegative atom such as N, O, F. That is why it does not show hydrogen bonding. It shows dipole dipole forces.

- **Q.24 (D)** CO<sub>2</sub> is non-polar molecule and its dipole moment value is zero ( $\mu = 0$ ). It has only London dispersion forces because in any non-polar molecule London dispersion forces are present which are the weakest and temporary forces.
- Q.25 (A) The force which binds a metal cation to a number of electrons within its sphere of influence is known as metallic bond (in term of lattice of positive ions surrounded by mobile electron). Electron gas theory was put forward by Drude and extended by Loren (1923). This theory is based on the following postulates:
  - Each atom in a metal crystal loses all of its valence electron
  - The valence electrons form a electron pool
  - Valence electrons are not attached to any individual ion in the sphere of crystal
  - Electrons are free to move within sphere of crystal
- **Q.26 (D)** Since the solid iodine (I<sub>2</sub>) readily sublimes when heated as shown below:

$$\mathbf{I}_{2(\text{solid})} \underbrace{\xrightarrow{\text{Heat}}}_{2(\text{vapours})} \mathbf{I}_{2(\text{vapours})}$$

This shows that the forces of attraction between the iodine molecules are very weak (London dispersion forces). As the sublimation process does not require a high temperature, the covalent bonds in the iodine molecules are not broken in the vapour states. Iodine vapours are still in the discrete simple molecular form (I<sub>2</sub>).

- Q.27 (B) The type of bond needs to be broken for magnesium oxide to melt is ionic bond. Ionic bond is comparatively stronger that covalent bond. That is why ionic compounds have higher melting points and boiling points. Magnesium oxide is used to line industrial furnaces because it has a very high melting point. Melting point of MgO is 2,852°C.
- Q.28 (D) In fact, polar bond is more reactive than non-polar bond. Greater is the electronegative difference between two covalently bonded atoms in a molecule, greater is the polarity, greater is the reactivity. That is why polar molecules are more reactive than non-polar molecule.
- Q.29 (B) Sigma bond has free rotation about the inter-nuclear axis but pi bond has restricted rotation about the inter-nuclear axis.
- Q.30 (B) Dot-and-cross model is not followed by water molecule as shown in the diagram in option B.
- Q.31 (B) In ethene C<sub>2</sub>H<sub>4</sub> there is  $sp^2$  orbital hybridization in the central carbon atom and C = C bond length is 133 pm and it is not 154 pm.
- Q.32 (B) The co-ordinate covalent bond exists between N and one H ion in all four structure as shown below.



Q.33 (C) It is incorrect statement. In fact, the correct statement about ionic and covalent bond is as given in the tabular form:



- Q.34 (D) No electrovalent bond is 100% ionic in nature. This is because of:
  - When cations and anions approach each other, polarizability increases only
  - Sharing of electrons takes place to some extent only
- Q.35 (B) In KCN there is ionic bond between potassium ion (K<sup>+</sup>) and cyanide ion (CN<sup>-</sup>). In cyanide ion there is covalent bond between carbon and nitrogen. So overall in KCN two bonds are involved i.e. ionic and covalent (K<sup>+</sup>C<sup>-</sup>≡N).



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