# Unit 1, Lesson 11: Answers to Homework on Polarity of Molecules

Complete the first three columns of the chart below after the lesson on Polarity of Covalent Molecules. Complete the second two columns after the lesson on Intra- and Inter-molecular Attraction.

Lewis Structure	General Formula (AX <sub>n</sub> E <sub>m</sub> ) and	Determine the Polarity of the	Type and Strength of Inter-	Predicted Physical
	Name of Shape	Molecule	molecular forces	Properties
NH <sub>3</sub>		Is the molecule	H – bonding	Medium
••	$AX_3E_1$	symmetrical in all	(which is a	melting point
H - N - H	<b>T</b> · 1	planes? <u>No</u>	strong dipole-	(higher than
	Trigonal	Does the molecule	dipole) and	for small non-
Н	pyrannuar	contain any polar	LDFS	polai molecules)
		bonds: <u>Its</u>	Quite strong	and very
		Polarity: <b>very polar</b>	IMFs	water soluble
CF <sub>4</sub>		Is the molecule	non-polar	Low melting
: F:	$AX_4E_0$	symmetrical in all	molecule so only	point, gas at
•• •	<b>T 1 1 1</b>	planes? <u>Yes</u>	LDFs present	SATP
$: \mathbf{F} - \mathbf{C} - \mathbf{F}:$	Tetrahedral	Does the molecule	Ouita waal	Deletively
•• •		contain any polar	Quite weak	insoluble in
F:		bolids? <u>Tes</u>	forces (IMFs)	water
		Polarity: <u>non-polar</u>		water
CH <sub>3</sub> Br		Is the molecule	Polar molecule	Medium
:Br:	$AX_4E_0$	symmetrical in all	so there are	melting point,
	T ( 1 1 1	planes? <u>No</u>	dipole – dipole	01. 1.4
H - C - H	Tetranedral	Does the molecule	I DEc but the	Slightly
		bonds? No	bonds are non-	water (is only
Н			polar, so the	slightly polar)
		Polarity: <u>slightly polar</u>	IMFs are very	singing point)
<u>SO3</u>		Is the molecule	non-polar	Low melting
	$AX_3E_0$	symmetrical in all	molecule so only	point and gas
		planes? Yes	LDFs present	at SATP
	Trigonal planar	Does the molecule		
: 0 - s - 0:		contain any polar	Quite weak	Poorly soluble
••		bonds? <u>Yes</u>	inter-molecular	in water (but
(will have 3 reconcises forms)		Polarity: <u>non-polar</u>	forces (INIFS)	reacts with
(will have 5 resonance forms)				chemically)
SO <sub>2</sub>		Is the molecule	Polar molecule	Medium
	$AX_2E_1$	symmetrical in all	so there are	melting point
••••		planes? <u>No</u>	dipole – dipole	
	V-shaped or bent	Does the molecule	attractions and	Soluble in
: o - s:		contain any polar	LDFs. The bonds	water
		bonds? <u>Yes</u>	are polar, so the	
(will have 2 resonance forms)		Polarity: <u>very polar</u>	IMFs are quite strong.	

\*Melting points vary with both polarity and molecular size, so the trends in melting point are only general.

## Homework:

- 1. Read pages 187 to 189.
- 2. On page 188: Q 23 26.
- 3. On page 189: Q 1 3 & 5 7.

### Page 189, question 1:



**Page 189, question 2**: Discuss the validity of the statement: "All polar molecules must have polar bonds and all non-polar molecules must have non-polar bonds."

Both parts of this statement are untrue.

• Molecules are polar when they are asymmetrical. If a central atom has different types of atoms bonded to it, or if the arrangement of lone pairs around the central atom is asymmetrical, then the molecule is polar, regardless of whether or not it contains any polar bonds.

eg. AsH<sub>3</sub> is a polar molecule because it is asymmetrical, even though H - As - Hthe  $\Delta EN$  between As and H is only 0.02

• Molecules are non-polar when they are symmetrical. Even if a molecule contains polar bonds, the dipoles will cancel out if the molecule is symmetrical.

eg.  $CO_2$  contains polar bonds, but it is non-polar because the molecule is symmetrical in all planes, so the dipoles cancel out



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**Page 189, question 3**: What similarities and what differences would you expect in the molecular shape and the polarity of  $CH_4$  and  $CH_3OH$ ? Explain your answer.



 $CH_4$  is a tetrahedral, non-polar molecule. Because it is non-polar, it is a gas at SATP.  $CH_3OH$  is tetrahedral around the carbon atom, but bent around the oxygen atom.  $CH_3OH$  is a polar molecule and this substance (methanol) is a liquid at SATP.

#### Page 189, question 5:

The shape of  $SF_2$  is bent or V-shaped. Because it is asymmetrical, it is a polar molecule.

#### Page 189, question 6:

The  $PC\ell_4^+$  ion is a tetrahedral shape. It is a non-polar molecule, although it does carry an ionic charge.





#### Page 189, question 7:

The factors that determine the structure and polarity of molecules are the number and arrangement of bonded pairs and lone pairs around the central atom:

• each number of bonded pairs and lone pairs is associated with a different molecular shape (structure).

eg.  $AX_2E_2$  is bent

 $AX_3E_0$  is trigonal pyramid  $AX_5E_1$  is square based pyramid.

• the polarity of a molecule depends on its symmetry. If a molecule is symmetrical in all planes, it will be non-polar. If a molecule is asymmetrical (due to arrangement of lone pairs or atoms), then it will be polar.