Unit 5 · Chemical Bonding and Shapes of Molecules

WORKSHEET

Full marks 33

Name _____ Class _____ Roll no. _____ Date _____ Marks _____ / 33

1 Key words [4]

Write True or False after each sentence. Correct the false ones. Each carries 0.5 mark.

i. In an ionic bond, electrons are transferred from one atom to another, and the ions attract in every direction. ☐

ii. In a coordinate covalent bond, each atom gives one electron to the shared pair. ☐

iii. A molecule with polar bonds can still be non-polar, if its bond dipoles cancel. ☐

iv. A pi bond is formed by the head-on overlap of two orbitals. ☐

v. By VSEPR theory, lone pair–lone pair repulsion is greater than bond pair–bond pair repulsion. ☐

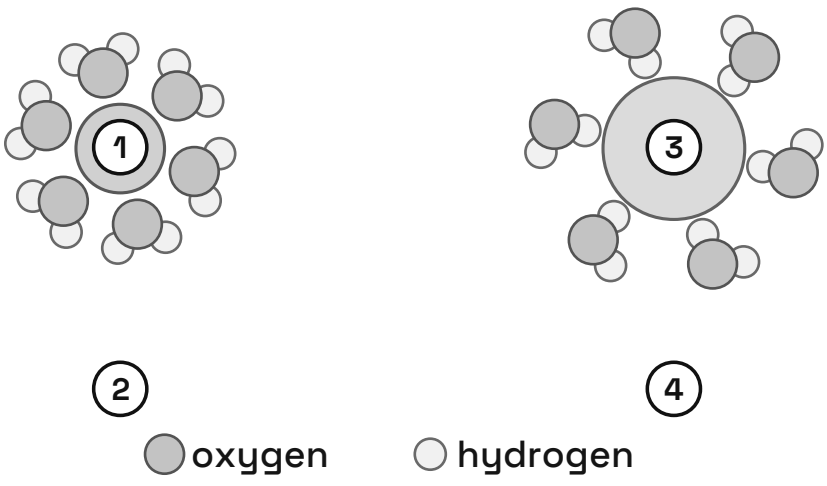
vi. The sp^3 hybrid orbitals of an atom point to the corners of a triangle, 120° apart. ☐

vii. A hydrogen bond forms between a hydrogen atom bonded to carbon and a lone pair on another atom. ☐

viii. In a metal, positive ions sit in a sea of delocalized electrons. ☐

2 Label the diagram [2]

The diagram shows water molecules round the ions of salt as it dissolves. Write the labels that belong in place of 1 to 4. Each carries 0.5 mark.



1. _____ 2. _____

3. _____ 4. _____

3 Multiple choice [5]

Choose the correct option for each of the following questions.

i. Which of these molecules has an expanded octet round its central atom? [1]

a. BF_3 **b.** PCl_5
c. NH_3 **d.** H_2O

ii. Which of these is an odd-electron molecule? [1]

a. NO **b.** CO
c. CO_2 **d.** N_2

iii. What is the hybridization of boron in BF_3, and the F–B–F angle? [1]

a. sp, 180° **b.** sp^2, 120°
c. sp^3, 109.5° **d.** sp^3, 107°

iv. Which molecule is non-polar, although every one of its bonds is polar? [1]

a. CH_3Cl **b.** NH_3
c. H_2O **d.** CCl_4

v. How many sigma and pi bonds are there in a molecule of carbon dioxide, O=C=O? [1]

a. 4 sigma, 0 pi **b.** 1 sigma, 3 pi
c. 2 sigma, 2 pi **d.** 3 sigma, 1 pi

4 Short answers [7]

Write short answers to the following questions.

a. The H–O–H angle in water is 104.5°, less than the tetrahedral angle of 109.5°. Why? [2]

b. Ethanol, C_2H_5OH, mixes with water in any amount, but ethane, C_2H_6, hardly dissolves. Why? [2]

c. Draw the Lewis structure of the hydronium ion, H_3O^+. Which of its bonds is a coordinate bond? Find the formal charge on its oxygen atom. [3]

5 Long answer [4]

Write a long answer to the following question.

What is hybridization? Explain the sp^3 hybridization of carbon in methane, CH_4, using orbital boxes, and say how it accounts for methane's shape and bond angle.

6 Numerical problems [8]

Solve the following problems. Show your working. Take the electronic charge $e = 1.602 \times 10^{-19}$ C and $1\ D = 3.336 \times 10^{-30}$ C m.

a. Hydrogen fluoride has a dipole moment of 1.82 D and a bond length of 92 pm; hydrogen bromide has 0.80 D and 141 pm. [4]

i. Find the dipole moment each would have if its bond were completely ionic, in debye.

ii. Find the percentage ionic character of each bond.

iii. Which bond is more ionic? How does this fit the electronegativities (H 2.2, F 4.0, Br 3.0)?

Answer:

b. i. Propenenitrile (acrylonitrile), used to make acrylic fibers, is CH_2=CH–C≡N. How many sigma and how many pi bonds does a molecule have? Give the hybridization of each of its three carbon atoms. **[4]**

ii. Carbon monoxide is drawn as :C≡O: with a triple bond and a lone pair on each atom. Find the formal charge on carbon and on oxygen.

Answer: _____

7 Think **[3]**

Fluorine and chlorine are gases at room temperature, bromine is a liquid and iodine a solid, though all four are non-polar X_2 molecules. Anish says, "The heavier halogens must have stronger covalent bonds." Is he right? Explain.

8 Activity: Balloon shapes (not marked)

Blow up nine balloons of the same size, about as big as a fist. Tie two of them together at their necks, then three, then four (two pairs twisted together). Let each bunch settle by itself and look at how the balloons spread.

Balloons tied together	Shape they make	Angle between them (roughly)	A molecule with this shape
2			
3			
4			

Why do the balloons take these shapes by themselves? How is this like the electron pairs round a central atom?