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VCE Chemistry ½
Covalent Molecules [1.6]
Homework Solutions

Homework Outline:

Section A: Compulsory Questions (47 Marks)

Sub-Section: Draw Lewis Structures of Atoms & Covalent Molecules

Question 1 (6 marks)

a. Draw the Lewis Structure for each of the following atoms:

i. Sulphur. (1 mark)

ii. Boron. (1 mark)

b. Define what a covalent bond is and why atoms go through covalent bonding. (2 marks)

A covalent bond is comprised of an electron pair being shared between two atoms. Atoms go through covalent bonding with each other in order to fulfil Octet Rule and obtain a full valence shell.

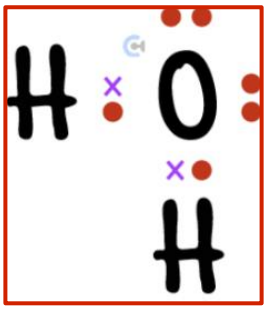
c. What is the maximum number of covalent bonds an atom of carbon will form? Explain your answer. (2 marks)

4 because carbon contains 4 valence electrons, requiring 4 more to reach Octet rule and hence it can make a maximum of 4 bonds to fulfill this requirement.

Question 2 (8 marks)

Draw the Lewis Structure for each of the following molecules:

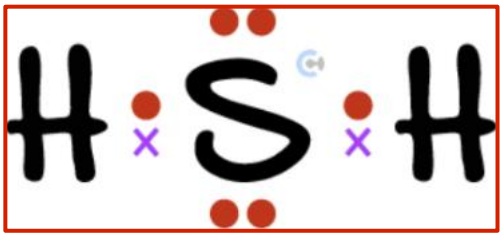
a. Water, H_2O. (2 marks)



b. Carbon Dioxide, CO_2. (2 marks)

c. Cl_2. (2 marks)

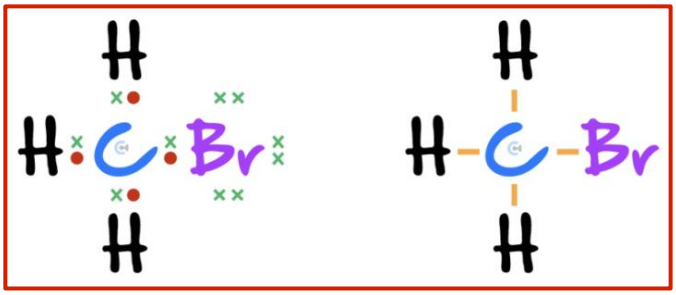
d. H_2S. (2 marks)



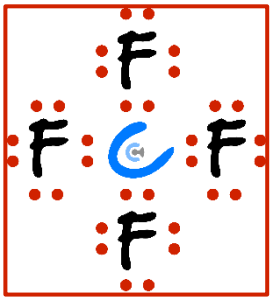
Question 3 (8 marks)

For the following, draw their Lewis Structures.

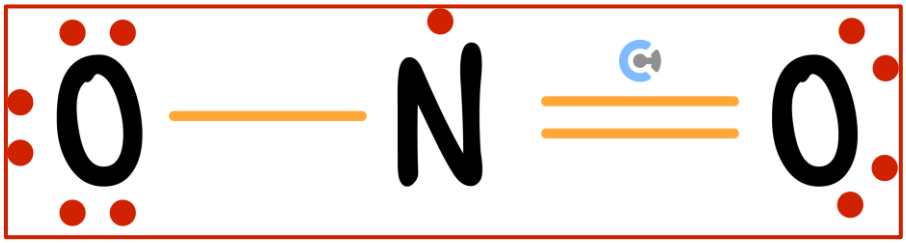
a. CH_3Br. (2 marks)



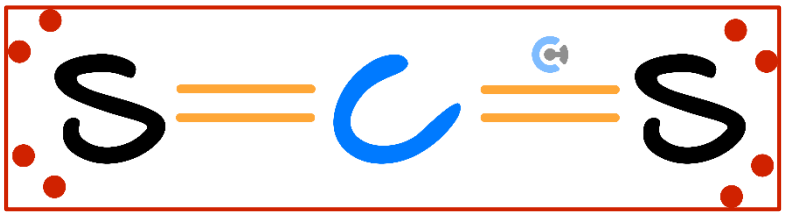
b. CF_4. (2 marks)



c. NO_2. (2 marks)



d. CS_2. (2 marks)



Sub-Section: Identify The Geometries (Parent & Molecular) of Molecules, With Reference To VSEPR Theory

Question 4 (4 marks)

For the following, state their molecular geometry.

a. CH_4. (1 mark)

Tetrahedral

b. H_2O. (1 mark)

V-Shaped/Bent

c. HCl. (1 mark)

Linear

d. O_2. (1 mark)

Linear

Question 5 (4 marks)

For the following, state their molecular geometry.

a. CH_2BrCl. (1 mark)

Tetrahedral

b. HOBr. (1 mark)

V-Shaped/Bent

c. Draw the Lewis Structure for CO_2, state its parent geometry and molecular geometry. (2 marks)

Parent: Linear, Molecular: Linear

Question 6 (6 marks)

Classify the parent and molecular geometry of the following molecules.

a. OCSe. (2 marks)

Parent: Linear, Molecular: Linear

b. NOBr. (2 marks)

Parent: Trigonal Planar, Molecular: V-Shaped/Bent

c. CH_2O. (2 marks)

Parent: Trigonal Planar, Molecular: Trigonal Planar

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Sub-Section: The 'Final Boss'

Question 7 (11 marks)

Certain molecules are similar to each other in formula but can be very different in real life.

a. For the following molecules, draw their Lewis Structures.

i. SO_2. (2 marks)

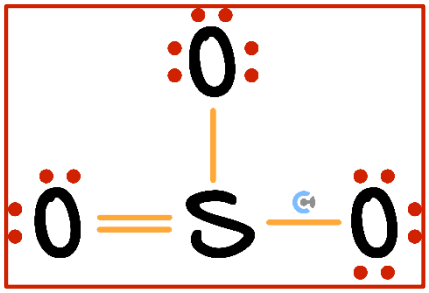
ii. SiO_2. (2 marks)

b. Now, compare their molecular geometries with each other. (3 marks)

Both of them are similar as each of the oxygens are doubly bonded to the central atom, however, the SO_2 has a lone pair whereas SiO_2 does not, due to the extra valence electrons S has. Thus, SO_2 has a trigonal planar geometry whereas SiO_2 is linear.

c. In real life, there are molecules of SO, SO_2 that exist. Explain whether SO_3 exist as a compound, and if so draw its Lewis Structure and state its geometry around the sulphur. (4 marks)

SO_3 does exist as a compound as one oxygen is doubly bonded and the other two are singly bonded.



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Section B: Supplementary Questions (50 Marks)

Sub-Section: Draw Lewis Structures of Atoms & Covalent Molecules

Question 8 (4 marks)

State how many covalent bonds the following molecules can form.

a. Silicon. (1 mark)

4

b. Iodine. (1 mark)

1

c. Phosphorus. (1 mark)

3

d. Krypton. (1 mark)

0

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Question 9 (5 marks)

a. Draw the Lewis Structure for the following.

i. Selenium. (1 mark)

ii. Fluorine. (1 mark)

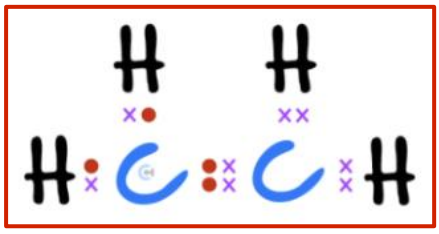
b. What is the likely formula of the molecule formed between Carbon and Sulphur? Explain. (3 marks)

CS_2. This forms due to Carbon needing to gain 4 electrons but each S needs 2 electrons, hence 2 sulphurs will doubly bond to the carbon to ensure all atoms gain a full outer shell.

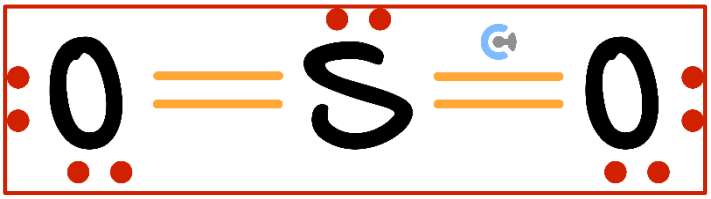
Question 10 (6 marks)

For the following, draw their Lewis Structures.

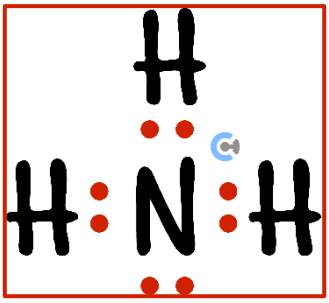
a. C_2H_4. (2 marks)



b. Sulphur Dioxide, SO_2. (2 marks)



c. NH_3. (2 marks)



Question 11 (7 marks)

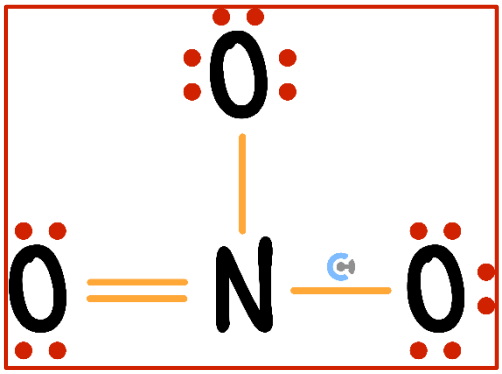
Consider the atom of Nitrogen.

a. Explain how a Nitrogen molecule will be formed using covalent bonds. (3 marks)

Each nitrogen atom will want to gain 3 electrons to fulfill Octet's rule. And thus, as each nitrogen requires three, each nitrogen will share 3 of its electrons with the other nitrogen, this results in a molecule of N_2 with a triple covalent bond (6 total electrons being shared).

b. Draw the Lewis Structure for Nitrogen. (1 mark)

c. Now, draw the Lewis Structure for the molecule that is likely to form between Nitrogen and Oxygen. (3 marks)



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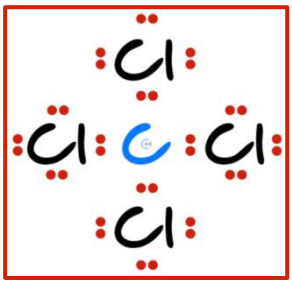
Sub-Section: Identify The Geometries (Parent & Molecular) of Molecules, With Reference To VSEPR Theory

Question 12 (8 marks)

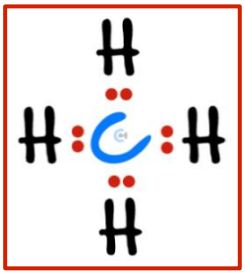
Draw the Lewis Structures of the following and state their molecular geometry.

a. CCl_4. (2 marks)



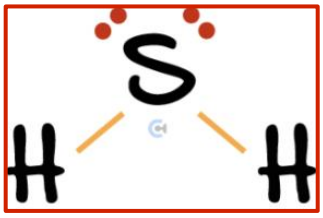
Tetrahedral

b. CH_4. (2 marks)



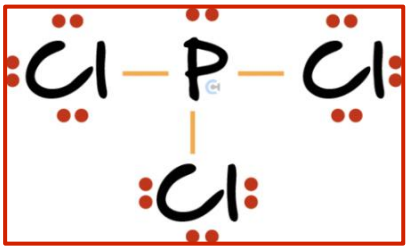
Tetrahedral

c. H_2S. (2 marks)



V-Shaped/Bent

d. PCl_3. (2 marks)



Pyramidal

Question 13 (4 marks)

a. For the following, state their molecular geometry.

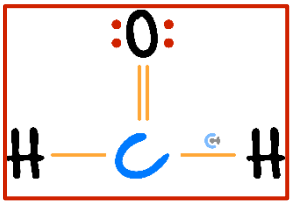
i. BF_3. (1 mark)

Trigonal Planar

ii. H_2Se. (1 mark)

V-Shaped/Bent

b. Draw the Lewis Structure for CH_2O and state its molecular and parent geometry. (2 marks)



Trigonal planar for both.

Question 14 (5 marks)

Answer the following questions regarding the VSEPR theory.

a. Briefly explain the VSEPR theory. (2 marks)

Valence Shell Electron Pair Repulsion Theory is a theory that states electron pairs want to be as far away from each other as possible, informing us on a molecule's geometry and 3D shape.

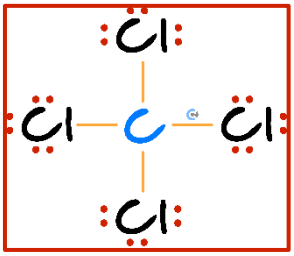
b. Explain why a trigonal planar molecular geometry for a molecule with 4 total electron pairs is not possible. (3 marks)

A trigonal planar geometry is dictated by having 3 total electron pairs in a molecule, so if a molecule has 4 total electron pairs, then the trigonal planar would not be possible. 4 total electron pairs but 3 bonding pairs will result in a pyramidal molecular geometry not a trigonal planar.

Question 15 (8 marks)

A chemist is designing new molecules for an environmentally friendly refrigerant.

a. One of the proposed compounds is CCl_4. Draw its Lewis Structure and state its molecular geometry. (2 marks)



Tetrahedral

b. Another molecule CH_3OH is also investigated. State its geometry around the carbon. (2 marks)

Tetrahedral

c. What is the main similarity between the two compounds? (1 mark)

They both have a tetrahedral geometry around the carbon.

d. Explain which molecule you would say has a more even distribution of valence electrons. (3 marks)

CCl_4 would have a more even distribution because around the oxygen in the CH_3OH we can see that it is actually V-shaped/bent because of the oxygen itself causing an uneven distribution due to the lone pairs that exist on the oxygen. Therefore, we can see from a molecule standpoint that CCl_4 is going to be more balanced.

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