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VCE Chemistry ½
Covalent Molecules [0.5]
Workshop

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Section A: Recap

Learning Objective: [1.6.1] – Draw Lewis Structures Of Atoms & Covalent Molecules

- The Lewis Structure shows the _____ **electrons** in an atom, typically depicted by _____.
- A _____ bond is a chemical bond where two or more atoms [share] / [transfer] electrons.
- [Bonding] / [Non-bonding] electrons are valence electrons directly involved in a covalent bond.
- [Bonding] / [Non-bonding] electrons are electrons **not** directly involved in a covalent bond.
- Covalent bonding occurs between [metals] / [non-metals], as they [gain] / [lose] electrons!
- The _____ formula lists the amount of each atom in a **molecule**.
- Many elements exist in their _____ form, as the atoms have **full** outer shells.
- List the diatomic elements using the mnemonic. *(Label Below)*

- The element that can form the [most] / [least] covalent bonds is usually in the **middle** of the molecule.

Learning Objective: [1.6.2] – Identify The Geometries (Parent & Molecular) Of Molecules, With Reference To VSEPR Theory

- As electron pairs [attract] / [repel] each other, they will be located as [close] / [far] as possible from each other.
- The _____ **theory** (_____) is used to predict the **shapes** that covalent molecules will take based on valence **electron repulsion** for molecules!

Number of Bonding Sites	Molecular Geometry	Bond Angle
1		
2		
3		
4		

- An _____ is merely a **pair** of electrons, which may or may not be bonding.
- In double and triple covalent bonds, all electrons associated in those bonds are _____ electron group.
- A _____ can be thought of as an **electron group** if the group of electrons is **part of a bond!**
- The non-bonding electron pair is also known as the _____ pair as it is the pair of electrons.

Parent/Electron Geometry	Molecular Geometry
The shape that the arrangement of [electrons] / [atoms] in a molecule takes.	The shape that the arrangement of [electrons] / [atoms] in a molecule takes.
Considers **both** the **bonding electron pairs** and the **non-bonding electron pairs** (lone pairs).	Only considers the **atoms**, excluding lone pairs.

Total Number of electron groups	0 non-bonding pairs	1 non-bonding pair	2 non-bonding pairs	3 non-bonding pairs
4				
3				N/A
2			N/A	N/A

Question 1 (2 marks) **Walkthrough.**

Sophie decides to investigate the structure of Sulphur Iodide (SI_2).

a. Draw the structure of this molecule. (1 mark)

b. State the parent and molecular geometries. (1 mark)

Parent Geometry	Molecular Geometry

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Section B: Warm Up (16 Marks)

INSTRUCTION: 16 Marks. 11 Minutes Writing.

Question 2 (1 mark)

What is the approximate bond angle in a molecule with a tetrahedral molecule geometry?

A. 120°.

B. 105.9°.

C. 109.5°.

D. 90°.

Question 3 (6 marks)

a. Draw the Lewis structure for Hydrogen molecules (H_2). How many bonding electrons are present? (1.5 marks)

b. Draw the Lewis structure for Oxygen molecules (O_2). How many bonding electrons are present? (1.5 marks)

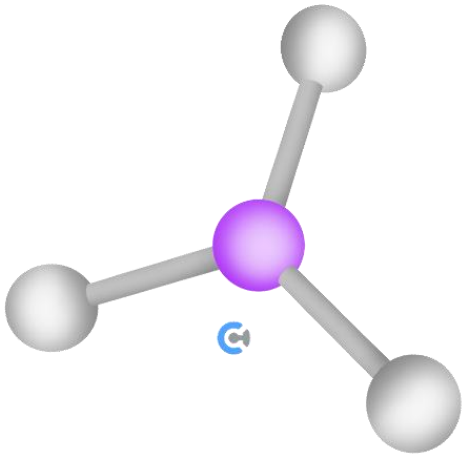
c. Draw Chlorine (Cl_2). Indicate any lone pairs of electrons. (1.5 marks)

d. Draw the Lewis structure of Nitrogen gas (N_2). (1.5 marks)

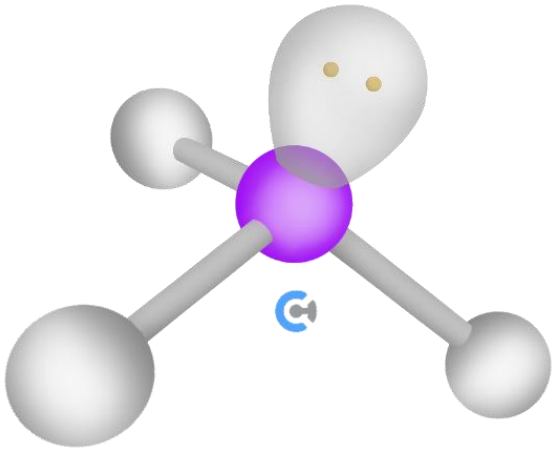
Question 4 (3 marks)

What is the name of the molecular geometry for each of the following?

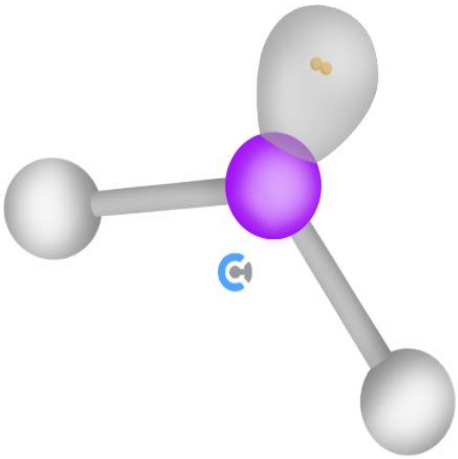
a. (1 mark)



b. (1 mark)



c. (1 mark)



Question 5 (4 marks)

Draw the Lewis structure of each of the following atoms/molecules.

a. Nitrogen Atom. (1 mark)

b. CH_4. (1 mark)

c. Cl_2. (1 mark)

d. SiO_2. (1 mark)

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Question 6 (2 marks)

For each of the following, name the most likely molecular formula that will be formed between the atoms.

a. Sulphur and Fluorine. (1 mark)

_____

b. Hydrogen and Selenium. (1 mark)

_____

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Section C: Ramping Up (19 Marks)

INSTRUCTION: 19 Marks. 14 Minutes Writing.

Question 7 (1 mark)

How many electrons are being shared in a triple bond?

A. 6.

B. 8.

C. 4.

D. 3.

Question 8 (6 marks)

Consider two molecules CF_4 and HCl.

a. Draw the Lewis structure for CF_4 and state its molecular geometry. (2 marks)

b. Draw the Lewis structure for HCl and state its molecular geometry. (2 marks)

c. Briefly explain why the two molecules have the same parent geometry but we observe their molecular geometries to be different. (2 marks)

_____

_____

_____

_____

Question 9 (10 marks)

For each of the following molecules, draw their Lewis structure and determine their molecular geometries.

a. Hydrogen Sulphide, H_2S. (2 marks)

b. Chlorine gas, Cl_2. (2 marks)

c. Oxygen Difluoride, OF_2. (2 marks)

d. Ethyne, C_2H_2. (2 marks)

e. CHN. (2 marks)

Question 10 (2 marks)

Ryan, having just failed his chemistry exam, is thinking about everything he has learnt in regard to covalent bonding. However, despite looking through his notes, he cannot figure out why chlorine gas is diatomic, whereas argon gas is monoatomic. With reference to covalent bonding, explain why this is the case.

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Section D: Getting Trickier I (15 Marks)

INSTRUCTION: 15 Marks. 12 Minutes Writing.

Question 11 (3 marks)

Tiffany is curious, and wants to find out more about Ammonia (NH_3).

a. Draw the Lewis structure of Ammonia. (1 mark)

b. Explain the difference between molecular geometry and electron geometry with reference to an Ammonia molecule. (2 marks)

_____

_____

_____

_____

_____

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Question 12 (3 marks)

Draw the Lewis structure for NF_3. Identify its parent and molecular geometry and state the bond angles that we expect to observe.

Question 13 (4 marks)

After playing around with molecular models in the lab, Jeff takes notes in his chemistry book in order to study for his upcoming test. Jeff wonders what the difference is between a molecule that has a trigonal planar shape and one with a pyramidal shape.

a. With reference to bond angles and lone pairs, explain the difference between these two structures. (2 marks)

_____

_____

_____

_____

b. Draw examples for each. (2 marks)

Question 14 (5 marks)

Formaldehyde, or Methanal, is a compound with the molecular formula of CH_2O.

a. Draw the Lewis Structure of Methanal. (2 marks)

b. Determine the molecular geometry of Methanal. (1 mark)

_____

_____

c. Briefly explain why the Oxygen molecule is not the central atom in this molecule but the Carbon atom is. (2 marks)

_____

_____

_____

_____

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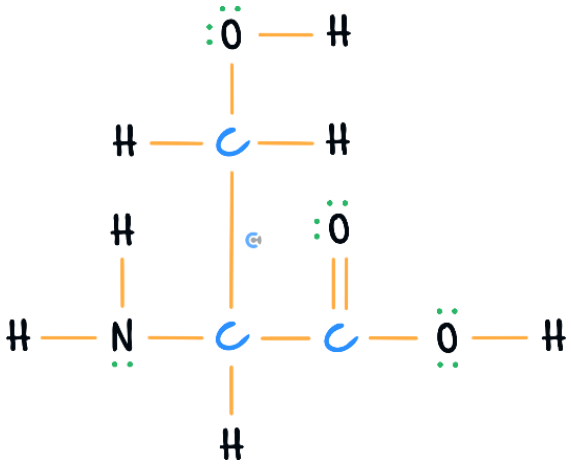
Section E: Getting Trickier II (14 Marks)

INSTRUCTION: 14 Marks. 13 Minutes Writing.

Question 15 (5 marks)

Consider the following amino acid which is commonly found in proteins consumed by humans.



a. What is represented by the double dashed line? (1 mark)

_____

_____

b. Circle one part of the molecule that is not represented properly. Explain what it should look like in reality. (2 marks)

_____

_____

_____

_____

c. Where is the most polar bond located in this molecule? (1 mark)

_____

_____

d. Where is the least polar bond located in this molecule? (1 mark)

_____

_____

Question 16 (6 marks)

Sulphur hexafluoride (SF_6) is a molecule which is being investigated by Angel.

a. Draw the Lewis structure of the molecule, and state its parent geometry. (2 marks)

b. How many shared electrons does each Fluorine have? Is it stable? (2 marks)

_____

_____

_____

_____

c. How many shared electrons does the Sulphur have? Is it stable? (2 marks)

_____

_____

_____

_____

_____

_____

Question 17 (3 marks)

Draw the structure of Nitrogen dioxide (NO_2).

Let's take a BREAK!

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Section F: VCAA-Level Questions I (16 Marks)

INSTRUCTION: 16 Marks. 30 Seconds Reading. 15 Minutes Writing.

Question 18 (9 marks)

Consider an environment where a Hydrogen atom is next to a Fluorine atom.

a. Define electronegativity and compare the electronegativities of the two atoms. (2 marks)

_____

_____

_____

_____

b. State the most likely molecular formula that would be formed from these two atoms. (1 mark)

_____

_____

c. Draw its Lewis structure and state its molecular geometry. (2 marks)

d. Based on your answer to **part a.**, explain which atom the electrons involved in the bond would be more attracted towards. (2 marks)

e. Hence or otherwise, would you expect the ends of the molecule to be charged? Briefly justify your answer. (2 marks)

Question 19 (7 marks)

Nitrogen trifluoride is a chemical that is used to remove silicon particles from many computer chips. Despite not being commonly used commercially, its characteristics and shape are well known.

a. Draw the structure of a molecule of nitrogen trifluoride. (1 mark)

b. What is the molecular geometry of nitrogen trifluoride? Explain why this is the case. (2 marks)

c. What is the parent geometry of nitrogen trifluoride? (1 mark)

_____

d. Explain why only a single covalent bond forms between the nitrogen atom and fluorine atom, with reference to the octet rule. (2 marks)

_____

_____

_____

e. What type of intermolecular bond would be present in NF_3? (1 mark)

_____

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Section G: Multiple Choice Questions (7 Marks)

INSTRUCTION: 7 Marks. 7 Minutes Writing.

Question 20 (1 mark)

Which of the following statements below about covalent molecules is false?

A. Lone pairs in covalent molecules are electron pairs that do not participate in the bonds.

B. Covalent bonds mainly consist of electrons being shared between all the atoms present within the molecule itself.

C. Covalent molecules are in arrangements according to the VSEPR theory.

D. The molecule of HCl is considered to be a diatomic molecule.

Question 21 (1 mark)

Which of the following molecules have a trigonal planar molecular geometry?

A. NH_3.

B. BeF_2.

C. BF_3.

D. NO_2.

Question 22 (1 mark)

Which one of the following statements about molecular geometries is true?

A. Molecules with a tetrahedral parent geometry always have a tetrahedral molecular geometry.

B. All molecules with a trigonal planar electron geometry do not always have a trigonal planar molecular geometry.

C. The molecular geometry of NO_2 is linear.

D. Lone pairs on the central atom do not influence electron geometry.

Question 23 (1 mark)

If you wanted to form a molecule between atoms of Nitrogen and Bromine, how many Bromine atoms are required if you had one Nitrogen atom?

A. 1.

B. 2.

C. 3.

D. 4.

Question 24 (1 mark)

If a molecule has 3 total electron groups present, which one of these geometries is not possible?

A. Pyramidal.

B. Trigonal Planar.

C. V-shaped.

D. Linear.

Question 25 (1 mark)

If a given molecule has a tetrahedral parent geometry, which of these statements is true about the molecule?

A. The molecule should also have a tetrahedral molecular geometry.

B. The molecule has four bonding electron groups, but we do not know how many electron groups this molecule has in total.

C. The molecule has a central atom singly bonded to 4 other identical atoms.

D. The molecule has 4 total electron groups.

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Question 26 (1 mark)

Given that SF_6 has an octahedral molecular geometry, what do you think is happening in order to allow this to occur?

A. The Fluorine atoms all share electrons with each other, which allows 2 of the Fluorine to share a singular electron with the Sulphur atom.

B. Since Sulphur has 6 valence electrons, it will only bond with the Fluorine atoms if there is external energy put into the Sulphur and Fluorine system.

C. As Sulphur has 6 valence electrons, it shares each of these with a singular Fluorine atom, as Fluorine has a higher electronegativity.

D. As Sulphur has 6 valence electrons, it shares these 6 electrons with 3 Fluorine atoms, and the remaining Fluorine atoms bond to the other Fluorine atoms.

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Section H: VCAA-Level Questions II (15 Marks)

INSTRUCTION: 15 Marks. 30 Seconds Reading. 14 Minutes Writing.

Question 27 (7 marks)

Consider the group 16 elements.

a. Draw the Lewis structure of H_2Se and determine its molecular geometry. (2 marks)

b. Do you expect that for all group 16 elements, the molecular geometry of H_2X where X is the group 16 element will be the same? Justify your answer. (2 marks)

_____

_____

_____

_____

c. Explain the trend of electronegativity as you move down the group. (2 marks)

_____

_____

_____

_____

d. Explain the trend of electronegativity as you move down the group. (1 mark)

_____

_____

Question 28 (8 marks)

Daniel is researching two different molecules – BF_3 and CH_4. Despite both being organic molecules which undertake covalent bonds, Daniel notices discrepancies in their shape.

a. Draw the valence structure of BF_3. (1 mark)

b. What is the molecular geometry of BF_3? (1 mark)

_____

c. What is the molecular geometry of CH_4? (1 mark)

_____

d. When Daniel draws out a molecule of methane on paper, he labels the bond angles as being 90°. Is this correct? Why or why not? (2 marks)

_____

_____

_____

e. What is the bond angle for BF_3? (1 mark)

_____

f. Explain why BF_3 does not take on a pyramidal shape, like NH_3. (2 marks).

_____

_____

_____

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Section I: Extension Questions (14 Marks)

Question 29 (5 marks)

State the molecular geometry of each of the following:

a. CO_2. (1 mark)

_____

b. ClO_3^-. (1 mark)

_____

c. CH_3Cl. (1 mark)

_____

d. H_2O. (1 mark)

_____

e. HCN. (1 mark)

_____

Question 30 (3 marks)

Draw the structure of Carbon monoxide (CO).

Question 31 (3 marks)

Draw the structure of Triiodide (I_3^-). State its parent geometry.

Question 32 (3 marks)

Draw the structure of Perchlorate (ClO_4^-).

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