Website: contoureducation.com.au | **Phone:** 1800 888 300
Email: hello@contoureducation.com.au

VCE Chemistry ½
Covalent Molecules [0.5]
Workshop

Error Logbook:

Mistake/Misconception #1		Mistake/Misconception #2	
Question #:	Page #:	Question #:	Page #:
Notes:		Notes:	
Mistake/Misconception #3		**Mistake/Misconception #4**	
Question #:	Page #:	Question #:	Page #:
Notes:		Notes:	

Section A: Recap

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

- The Lewis Structure shows the valence **electrons** in an atom, typically depicted by dots / crosses.
- A covalent 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 molecular formula lists the amount of each atom in a **molecule**.
- Many elements exist in their diatomic form, as the atoms have **full** outer shells.
- List the diatomic elements using the mnemonic. *(Label Below)*

H_2 N_2 F_2 O_2 I_2 Cl_2 Br_2

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

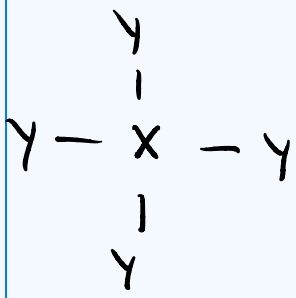
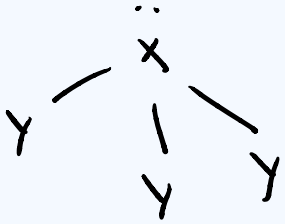
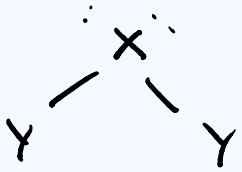
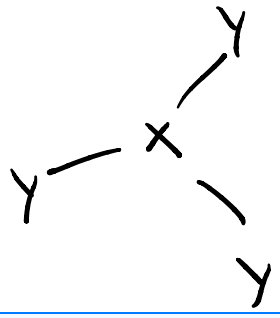
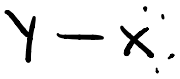
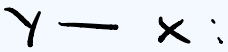
Learning Objective: [1.6.2] – Identify The Geometries (Parent & Molecular) Of Molecules, With Reference To VSEPR Theory

- As electron pairs [attract] / [repel] each other, they will be located as [close] / [far] as possible from each other.
- The valence shell electron pair repulsion **theory** (VSEPR) 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	linear	180°
2	linear	180°
3	trigonal planar	120°
4	tetrahedral	109.5°

- An electron group 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 one electron group.
- A bonding site 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 lone pair as it is the pair of electrons.

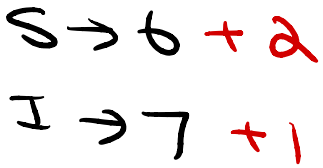
Parent/Electron Geometry	Molecular Geometry
The shape that the arrangement of [electrons] / [atoms] in a molecule takes.	The shape that the arrangement of [electrons] / [atoms] in a molecule takes.
Considers **both** the **bonding electron pairs** and the **non-bonding electron pairs** (lone pairs).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

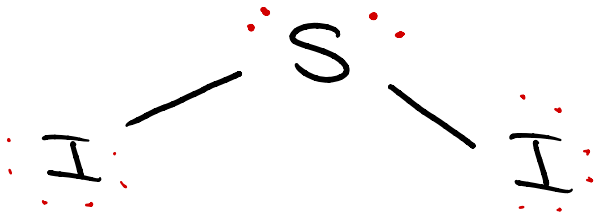
Total Number of electron groups	0 non-bonding pairs	1 non-bonding pair	2 non-bonding pairs	3 non-bonding pairs
4				
3				N/A
2			N/A	N/A

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
tetrahedral	V-shaped

Space for Personal Notes

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°.

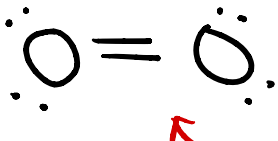
D. 90°.

Question 3 (6 marks)

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

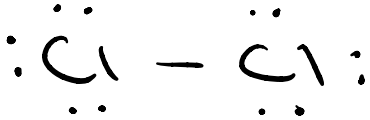
2

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



4

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

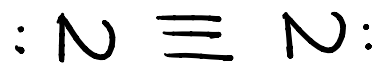


Cl → 17

7

+1

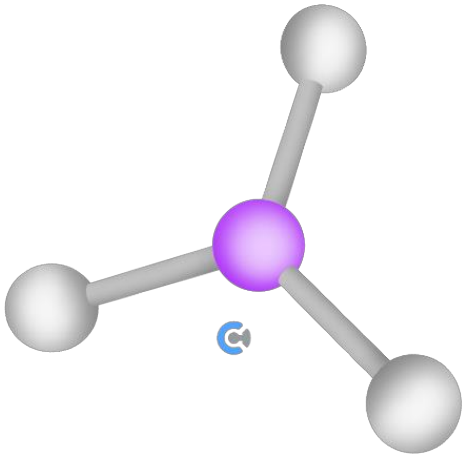
d. Draw the Lewis structure of Nitrogen gas (N_2). (1.5 marks)



Question 4 (3 marks)

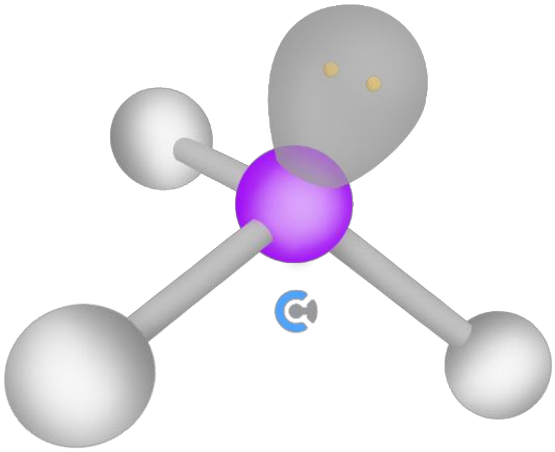
What is the name of the molecular geometry for each of the following?

a. (1 mark)



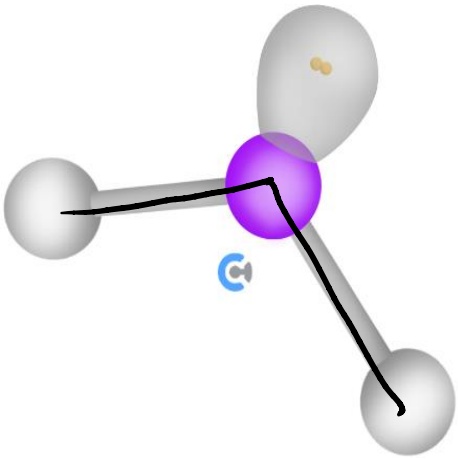
trigonal planar

b. (1 mark)



pyramidal

c. (1 mark)



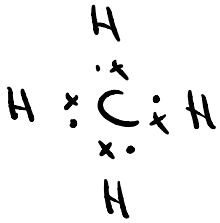
V - shaped

Question 5 (4 marks)

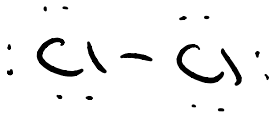
Draw the Lewis structure of each of the following atoms/molecules.

a. Nitrogen Atom (1 mark)

b. CH_4. (1 mark)



c. Cl_2. (1 mark)



d. SiO_2. (1 mark)

Si → 4
O → 2

Space for Personal Notes

Question 6 (2 marks) S → 2 F → 1

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

a. Sulphur and Fluorine. (1 mark)

SF_2

b. Hydrogen and Selenium. (1 mark) H → 1 Se → 2

H_2S

Space for Personal Notes

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.

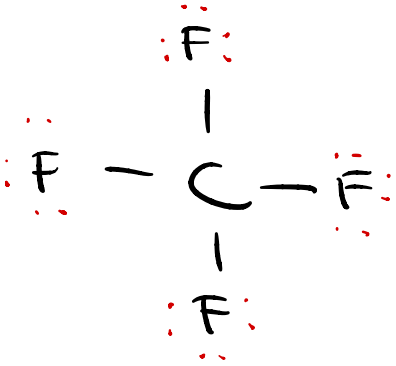
C. 4.

D. 3.

Question 8 (6 marks)

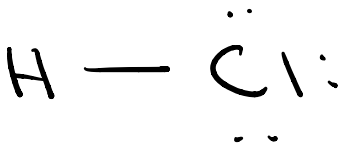
Consider two molecules CF_4 and HCl.

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



tetrahedral

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



linear

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

- Both have 4 e⁻ groups ∴ same geometry → tetrahedral
- CH_4 → all bonding [tetrahedral]
  HCl → one is bonding [linear]

Question 9 (10 marks)

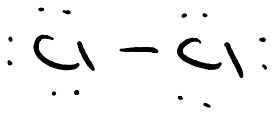
For each of the following molecules, draw their Lewis structure and determine their molecular geometries.

a. Hydrogen Sulphide, H_2S. (2 marks)

S → 6 +2
H → 1 +1

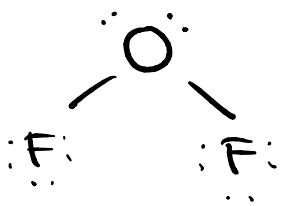
V-shaped

b. Chlorine gas, Cl_2. (2 marks)



linear

c. Oxygen Difluoride, OF_2. (2 marks)



O → 2
F → 1

d. Ethyne, C_2H_2. (2 marks)

e. CHN. (2 marks)

C → 4
H → 1
N → 3

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.

- Ar gas is noble → 8e⁻ in outer shell its stable in a monoatomic form
- Cl has 7e⁻ ∴ unstable & needs to pair to have a full outer shell via covalent bond

Space for Personal Notes

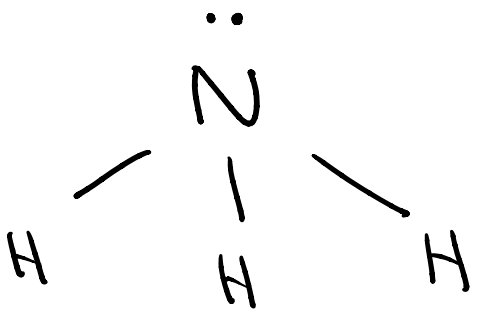
Section D: Getting Trickier I (15 Marks)

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)

- molecular geometry ⇒ pyramidal
  this is the shape of atoms
- electron geometry ⇒ tetrahedral
  this is the shape of e⁻ groups

Space for Personal Notes

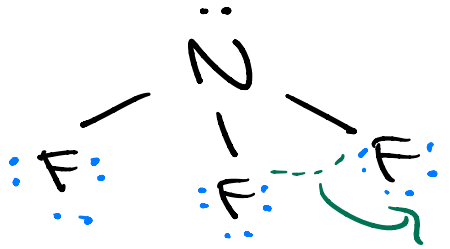
Question 12 (3 marks)

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

tetrahedral

N → +3 → pyramidal

F → +1



109.5°

~ 107

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)

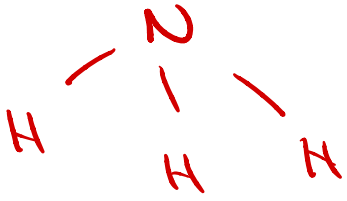
- Pyramidal ⇒ 1 lone pair will exist

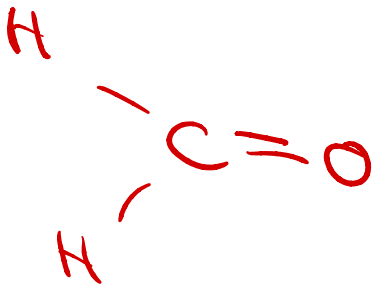
109.5 → 107

- Trigonal planar ⇒ no lone pairs

120°

b. Draw examples for each. (2 marks)

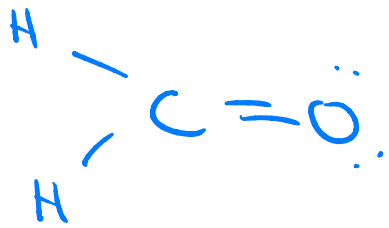




Question 14 (5 marks)

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)

Trigonal planar

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

- C has only 4 valence e⁻ whereas O has 6
- Because C atom needs more e⁻ → has to form more covalent bonds → being central allows for more bonds to be formed.

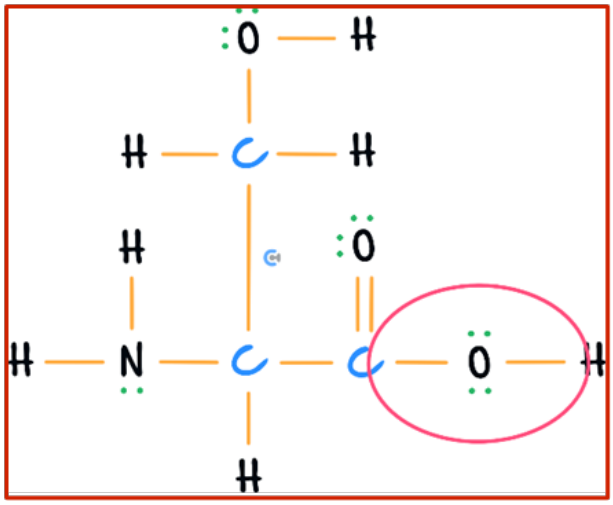
Space for Personal Notes

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)

Double covalent bond – 4 electrons being shared.

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

In reality, there would be a bent shape here due to the lone pairs of electrons pushing down on the covalent bond.

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

O-H

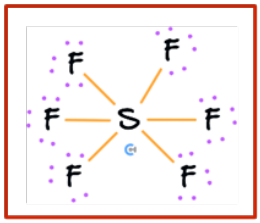
d. Where is the least polar bond located in this molecule? (1 mark)

C-C

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)



Octahedral

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

8 – it is stable and fulfils the octet rule.

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

12 electrons – it is stable.

Sulphur is an 'Octet Rule Exception', and can accommodate up to 6 bonds.
It is stable as each of its electrons are paired up! (This is not covered in the study design).

Question 17 (3 marks)

Draw the structure of Nitrogen dioxide (NO_2).

Let's take a BREAK!

Space for Personal Notes

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)

→ atoms e⁻ attracting ability

→ (F) is more e⁻ neg

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

HF

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)

- Fluorine
- more e⁻ neg, attract electrons more, pulled further towards fluorines side

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

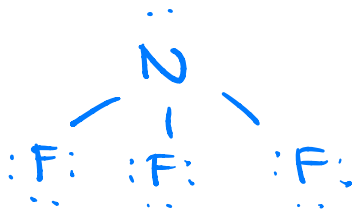
δ^+ H : F δ^-

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)

NF_3



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

- Pyramidal
- 3 bonding site & 1 lone
  - ↳ push bonding sites down (3D)

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

tetrahedral

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

• F has 7e⁻ in outer shell → needs 1 more

∴ it can only form one more covalent bond

e. ~~What type of intermolecular bond would be present in NF3? (1 mark)~~

Space for Personal Notes

Section G: Multiple Choice Questions (7 Marks)

Cl_2 H_2 F_2

INSTRUCTION: 7 Marks. 7 Minutes Writing.

Question 20 (1 mark)

diatomic HCl

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.

H–C≡N

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

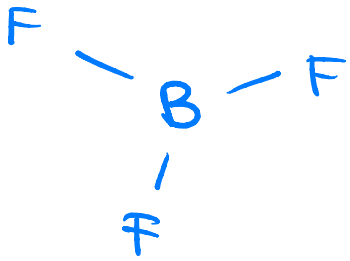
Question 21 (1 mark)

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

A. NH_3. → pyramidal

B. BeF_2. → X

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.

N Br
↓ ↓
3 1

Question 24 (1 mark)

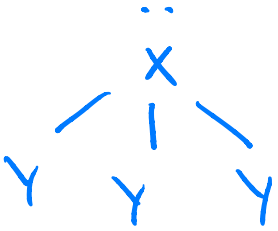
If a molecule has 3 total electron groups present, which one of these geometries is not possible?

A. Pyramidal.

B. Trigonal Planar.

C. V-shaped.

D. Linear.



Question 25 (1 mark)

4 e groups

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.

Space for Personal Notes

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.

Space for Personal Notes

S → 6 +2

F → 7 +1

NH_3

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)

V-shaped

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)

They will be the same because all group 16 elements have the same number of valence electrons and hence lone pairs, which will produce the same molecular geometry of V-shaped.

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

As you go down the group, the number of electron shells will increase and hence, the distance from the valence electron to nucleus will increase, hence the pull on electrons will be weaker. Thus as you go down the group, the electronegativity will be weaker.

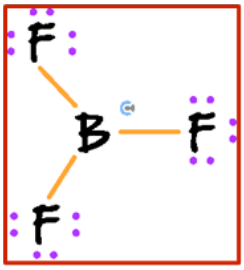
d. Explain the trend of electronegativity as you move down the group. (1 mark)

H_2O will have the most electronegative bond.

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)

Trigonal Planar

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

Tetrahedral

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)

No. This appears correct on paper since it can only be drawn in 2D.
However, in 3D, the bonds can move further away from each other, bringing the total bond angle to 109.5 degrees.

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

120°

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

For a pyramidal shape to be taken on, a lone pair of electrons needs to exist on the central atom.
However, boron does not have a lone pair of electrons, being stable with only 6 electrons in the outer shell.

Space for Personal Notes

Section I: Extension Questions (14 Marks)

Question 29 (5 marks)

State the molecular geometry of each of the following:

a. CO_2. (1 mark)

Linear

b. ClO_3^-. (1 mark)

Pyramid

c. CH_3Cl. (1 mark)

Tetrahedral

d. H_2O. (1 mark)

V-shape

e. HCN. (1 mark)

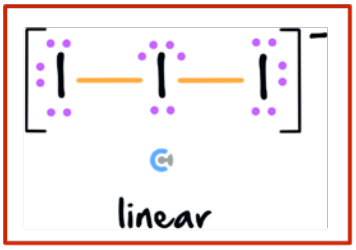
Linear

Question 30 (3 marks)

Draw the structure of Carbon monoxide (CO).

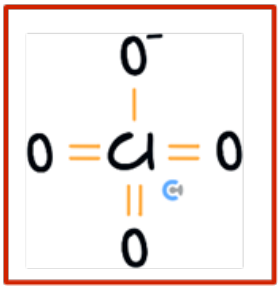
Question 31 (3 marks)

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



Question 32 (3 marks)

Draw the structure of Perchlorate (ClO_4^-).



Space for Personal Notes

CONTOUREDUCATION

Website: contoureducation.com.au | **Phone:** 1800 888 300 | **Email:** hello@contoureducation.com.au

VCE Chemistry ½

Free 1-on-1 Consults

What Are 1-on-1 Consults?

- **Who Runs Them?** Experienced Contour tutors (45 + raw scores and 99 + ATARs).
- **Who Can Join?** Fully enrolled Contour students.
- **When Are They?** 30-minute 1-on-1 help sessions, after-school weekdays, and all-day weekends.
- **What To Do?** Join on time, ask questions, re-learn concepts, or extend yourself!
- **Price?** Completely free!
- **One Active Booking Per Subject:** Must attend your current consultation before scheduling the next :)

SAVE THE LINK, AND MAKE THE MOST OF THIS (FREE) SERVICE!

Booking Link

bit.ly/contour-chemistry-consult-2025