CH-110 Advanced General Chemistry I

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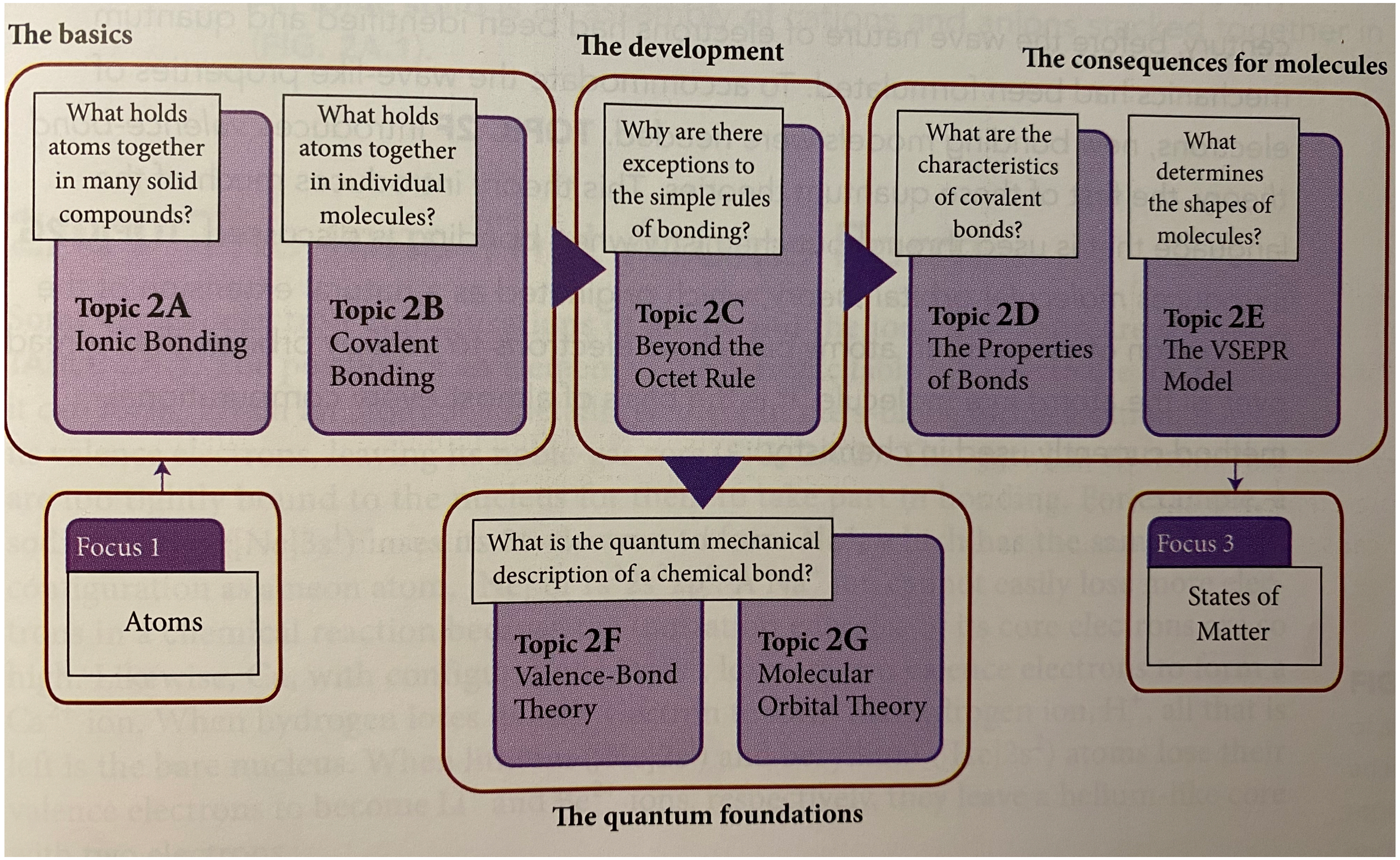
Overview Chapter 2 (Focus 2: Bonds Between Atoms)



The VSEPR Model

Topic 2E

2E The VSEPR model

Lead-in

Lewis structures vs. the VSEPR model

Lewis structure	The VSEPR model
Shows **distribution** of valence electrons in bonding pairs (bonds) and lone pairs or unpaired electrons.	The valence electrons about a central atom control the **shape** of a molecule
Shows how atoms are **connected**.	

Topic 2E.1 The basic VSEPR model
Topic 2E.2 Molecules with lone pairs on the central atom
Topic 2E.3 Polar molecules

WHY DO YOU NEED TO KNOW THIS MATERIAL?

- Molecular shape is essential to understand reactivity

WHAT DO YOU NEED TO KNOW ALREADY?

- Lewis structures (Topic 2B)
- Polar molecules and polar bonds (Topic 2D)

The Basic VSEPR Model

Topic 2E.1

What is the 3D shape of a molecule?

2E.1 The basic VSEPR model

Valence-shell electron-pair repulsion (VSEPR) model

- Focused on understanding of **molecular shape.**
- VSEPR model extends Lewis's theory of bonding by adding rules that account for **bond angles** and **molecular shapes** in terms of **regions of high electron concentration**.

2E.1 The basic VSEPR model

Valence-shell electron-pair repulsion (VSEPR) model

Figure 2E.2

2E.1 The basic VSEPR model

Valence-shell electron-pair repulsion (VSEPR) model

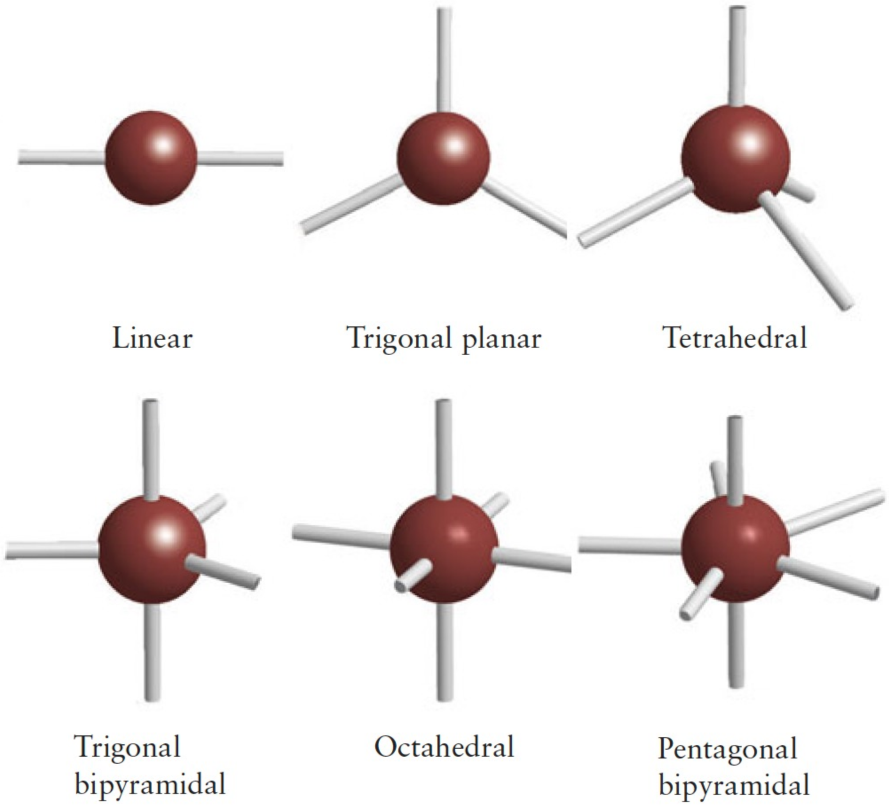


Figure 2E.2

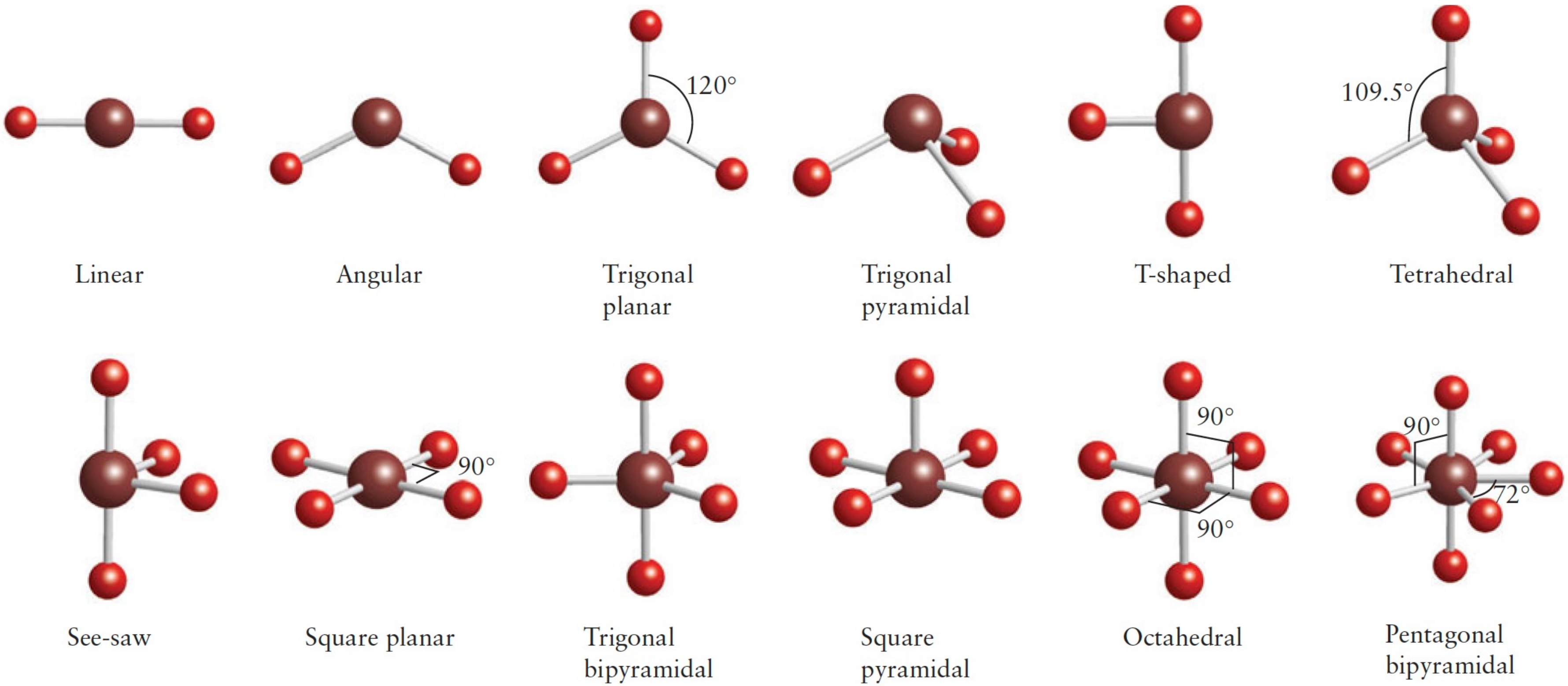
- The positions that two to seven regions of high electron concentration (atoms and lone pairs) take around a central atom.
- **Regions**: straight lines sticking out from the **central atom (red)**.
- Use this diagram to identify the **electron arrangement of a molecule** and then use Fig. 2E.1 to identify the shape of the molecule from the locations of its atoms.

2E.1 The basic VSEPR model

Valence-shell electron-pair repulsion (VSEPR) model

2E.1 The basic VSEPR model

Valence-shell electron-pair repulsion (VSEPR) model



Note: lone pairs are **not** shown in these figures, only atoms.

Figure 2E.1

2E.1 The basic VSEPR model

The method

2E.2 Molecules with lone pairs on the central atom

The generic VSEPR formula AX_nE_m

A = central atom

X_n = *n* attached atoms

(E_m = *m* lone pairs: see Friday)

Molecules with the same VSEPR formula have the same electron arrangement and the same shape.

E.g. BF_3 and NO_3^- are examples of AX_3 species.

2E.1 The basic VSEPR model

Some examples: predict the shape of these molecules.

- Beryllium chloride, $BeCl_2$
- Boron trifluoride, BF_3
- Methane, CH_4
- Phosphorous pentachloride, PCl_5
- Sulfur hexafluoride, SF_6
- Carbon dioxide, CO_2
- Carbonate ion, CO_3^{2-}
- Nitrate ion, NO_3^-
- Ethene, C_2H_4

2E.1 The basic VSEPR model

Example 2E.1

Predict the shape of a methanal molecule (formaldehyde, $H_2C{=}O$).

2E.1 The basic VSEPR model

Summary

According to the VSEPR model, regions of high electron concentration take up positions that maximize their separations; electron pairs in a multiple bond are treated as a single unit. The shape of the molecule is then identified from the relative locations of its atoms.