

Exercise walk-through

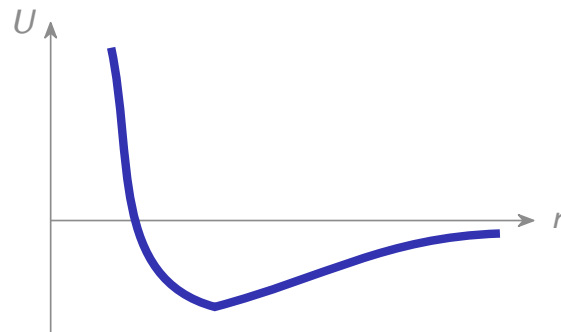
2.6

Resonance and Formal Charge

AP Chemistry

What we will cover

- 1 Types of chemical bonds
- 2 Bond energy and length
- 3 Ionic solids
- 4 Metals and alloys
- 5 Lewis diagrams and resonance
- 6 VSEPR and hybridization



Lewis diagrams and resonance

A **Lewis diagram** shows shared **bonds** (lines) and **lone pairs**, aiming for an **octet**.

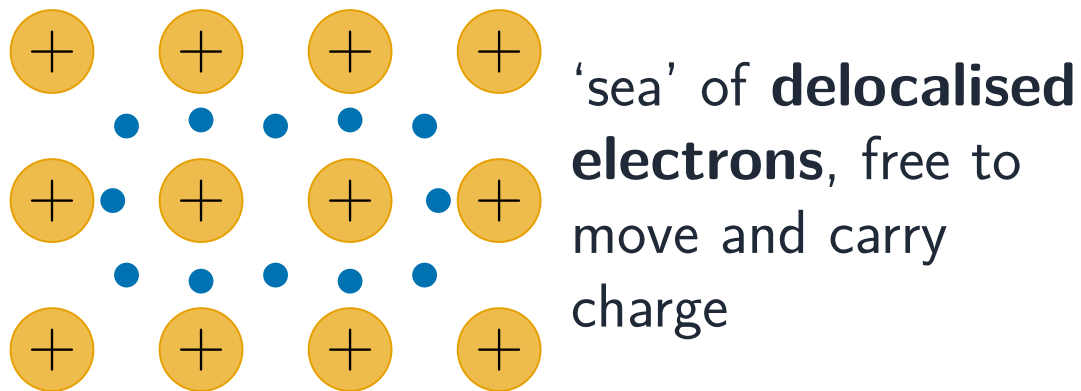
Formal charge picks the best

$$\text{FC} = V - (\text{lone}) - (\text{bonds})$$

Resonance : when several equal structures exist, the real bonds are an **average** (delocalized).



Structure of Metals and Alloys, continued



positive metal ions in a fixed lattice

Metallic bonding: positive ions in a sea of delocalised electrons

Exercises 2.1·2.3

2.1 Write the formula for formal charge.

[1]

2.2 Find the formal charge on N in NH_4^+ (valence 5, 0 lone electrons, 8 bonding electrons).

[2]

2.3 What does it mean that ozone O_3 has resonance structures?

[1]

Exercises 2.1·2.3

2.1 Write the formula for formal charge.

[1]

2.1

- $\text{FC} = (\text{valence } e^-) - (\text{nonbonding } e^-) - \frac{1}{2}(\text{bonding } e^-)$

2.2 Find the formal charge on N in NH_4^+ (valence 5, 0 lone electrons, 8 bonding electrons).

[2]

2.2

- $\text{FC} = 5 - 0 - \frac{1}{2}(8) = 5 - 4 = +1$

2.3 What does it mean that ozone O_3 has resonance structures?

[1]

2.3

- The molecule is a blend (hybrid) of the equivalent structures, not switching between them

Exercise 3.1

3.1 The preferred Lewis structure has formal charges that are

[1]

☐

A as large as possible

B as close to zero as possible

C all positive

D all on carbon

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3.1 B

- formal charges as close to zero as possible

Exercise 3.2 (a)

3.2 In one resonance structure of NO_3^- , an oxygen has 6 nonbonding electrons and 2 bonding electrons (a single bond).

(a) Find the formal charge on that oxygen.

[2]

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(a) Find the formal charge on that oxygen. [2]

(a)

- $$\text{FC} = 6 - 6 - \frac{1}{2}(2) = 6 - 6 - 1 = -1$$

Exercise 3.2 (b)

3.2 In one resonance structure of NO_3^- , an oxygen has 6 nonbonding electrons and 2 bonding electrons (a single bond).

(b) State what the true structure looks like given resonance.

[1]

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(b) State what the true structure looks like given resonance. [1]

(b)

- The real ion is a resonance hybrid – the extra bond and charge are spread equally over all three oxygens

Exercise 3.3

3.3 Explain why all three N–O bonds in NO_3^- have the same length, using the idea of resonance. [2]

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- Resonance spreads the double-bond character equally over all three N–O positions, so each bond is identical (an average of single and double), giving equal lengths