

2.6 Resonance and Formal Charge

Name: _____ Class: _____ Date: _____

Total: 10 marks

KEY WORDS formal charge 形式电荷 • resonance 共振 • lewis diagram 路易斯结构

Objective

Build the skills to answer exam questions on **resonance and formal charge**.

You must be able to:

- draw **resonance** 共振 structures when more than one valid Lewis diagram exists
- calculate **formal charge** 形式电荷 = (valence e^-) - (lone e^-) - $\frac{1}{2}$ (bonding e^-)
- use formal charge to choose the best structure

1 Worked examples

Study these first. Each one shows the method for a question type used later — follow the steps and you can do the Practice and Exam-style questions yourself.

■ Resonance

When electrons could be placed in more than one equally valid way, the molecule is a **blend** (resonance hybrid) of those structures. In O_3 (ozone) the double bond is shared between both O–O positions, so both bonds are identical.

■ Formal charge

For each atom,

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

■ A worked formal charge

In CO_2 , the carbon: valence 4, lone 0, bonding 8 (two double bonds): $FC = 4 - 0 - 4 = 0$. Each oxygen: $6 - 4 - 2 = 0$. All zero — a good structure.

■ Choosing the best structure

The **best** Lewis structure has formal charges **closest to zero**, and any negative formal charge on the **most electronegative** atom. Use this to pick between candidates.

2 Practice

Now apply the methods above.

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]

3 Exam-style questions

3.1 The preferred Lewis structure has formal charges that are

[1]

A	B
C	D

A as large as possible

B as close to zero as possible

C all positive

D all on carbon

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]

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

[1]

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