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VC210

Mid 1 review

Part 3: Molecule and exercise

UM-SJTU Joint Institute

Wang Yisen

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Contents

Ionic bond

Definition:

- If electrons transfer from one or more atoms, the entire compound is held together by electrostatic attractions between all the ions.

- This attraction is called an ionic bond.

Ionic bond

How to compare the bond strength between 2 ionic compounds?

1. Compare the electric charge

2. Compare the radius of atom

Ionic bond

The charges and sizes of the ions in an ionic compound affect the strength of the electrostatic attraction holding that compound together.

Based on ion charges and relative ion sizes, rank these ionic compounds by their expected melting points.

Highest melting point

CaO

CaF_2

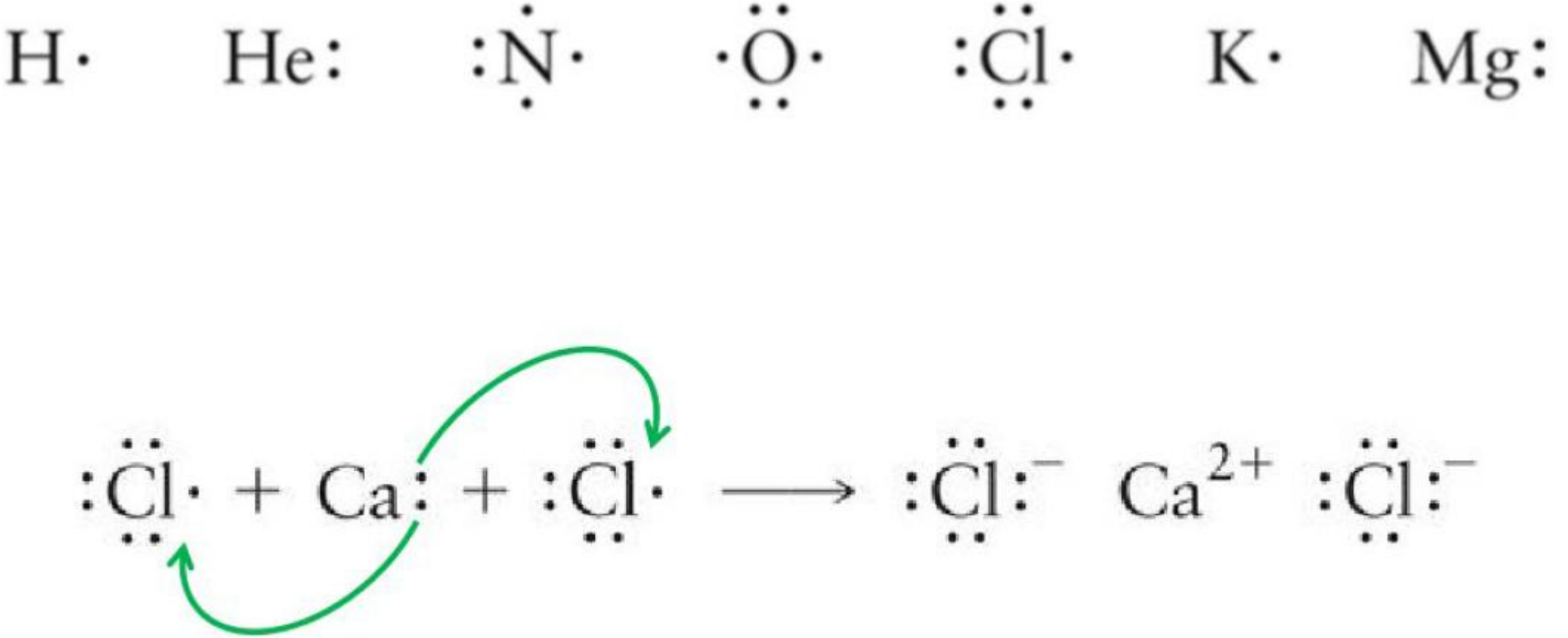
KF

RbBr

Lowest melting point

KF CaF_2 CaO RbBr

Lewis notation



Covalent bonds

- Covalent Bonds form between two nonmetals that do not form into ions.
- Covalent bonds form by atoms sharing electrons until they reach a noble-gas configuration.
- Octet rule: noble-gas configuration

Covalent bonds - Resonance Structures

Definition:

Delocalized electrons hop from one atom to another; no discretion as long as it's the same atom pair.

Covalent bonds - Resonance Structures

How to find resonance structures?

1. Observe to find which bond can be moved.
2. Move the electron pairs correspondingly.
3. Do not change the location of the atoms.

Covalent bonds - Resonance Structures

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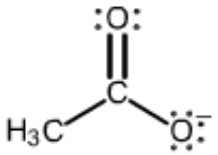
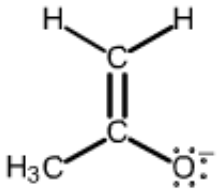
Ex. Sapling 20 (chemical bong)

Draw the other possible resonance structure of each organic ion in the spaces below. In each case, draw the structure that minimizes formal charges. Be sure to include all appropriate nonbonding electrons and charges.



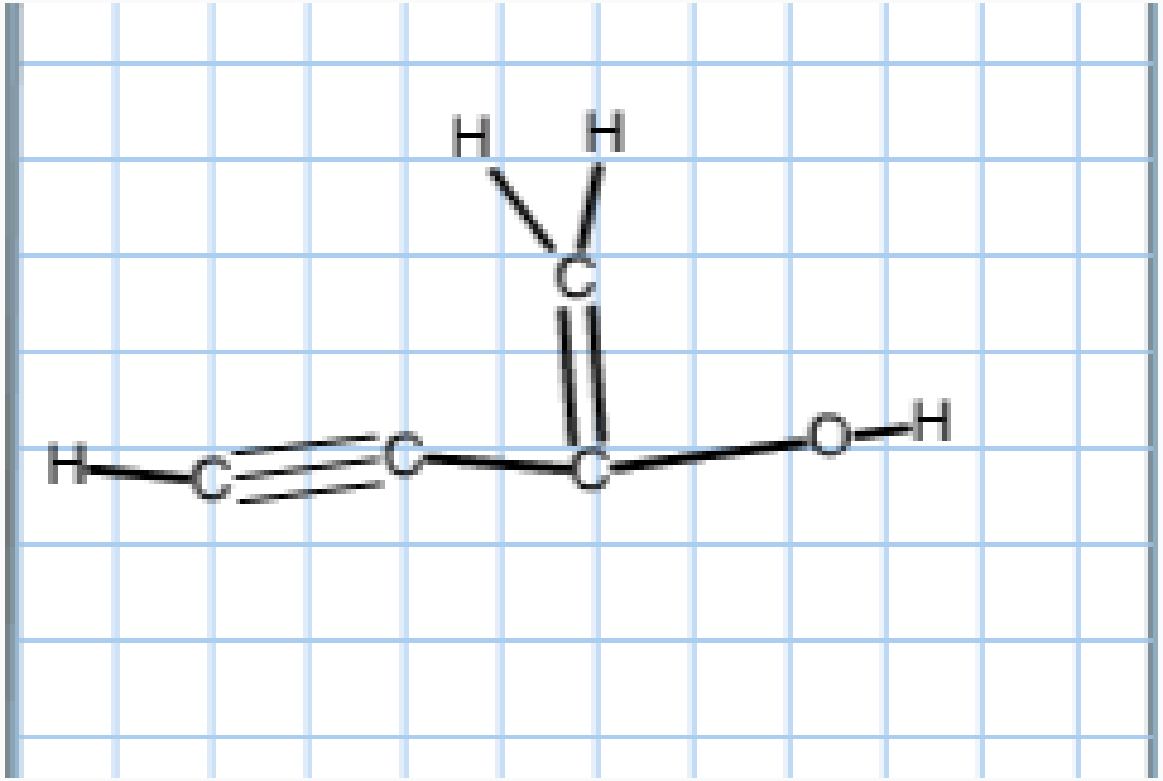
acetate ion ↔



an enolate ion ↔

Formal charge

Ex. Draw all resonance structures.



Formal charge

$$Formal\ Charge = V - \left(L + \frac{1}{2}B\right)$$

Number of valence electrons of the neutral atom

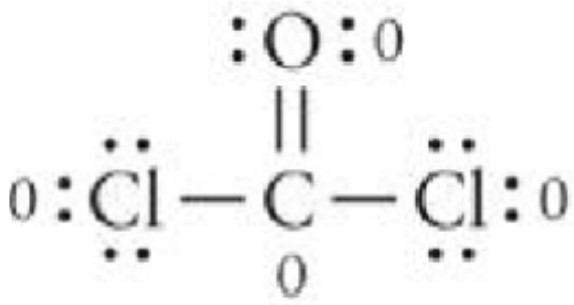
number of non-bonding valence electrons on this atom

total number of electrons shared in bonds with other atoms

O 6 - (4 + ½ 4) = 0

Cl 7 - (6 + ½ 2) = 0

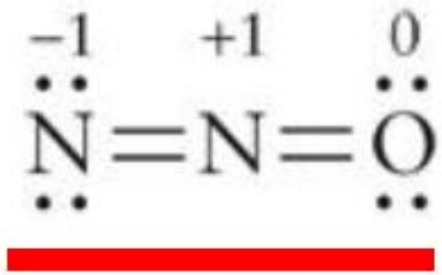
C 4 - (0 + ½ 8) = 0

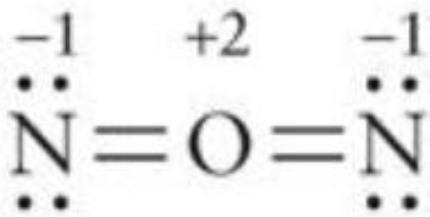


Formal charge

Formal charges can predict the most *favorable Lewis structure:*

NNO





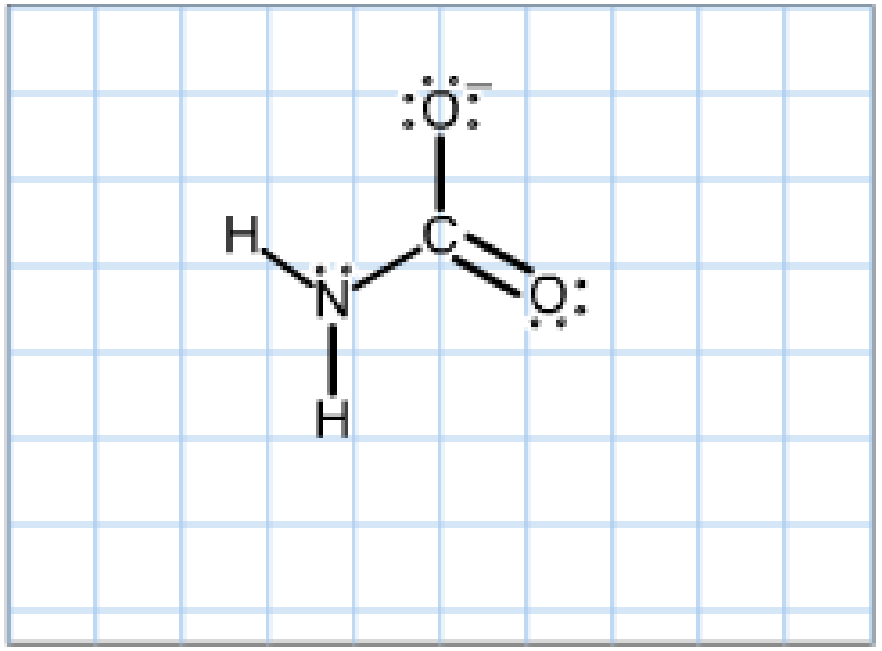
The structure with the lowest formal charges on each atom is the most plausible (lowest energy) structure.

Formal charge

But sometimes it does not work.

You should consider something else…

Ex. Which one is more stable?



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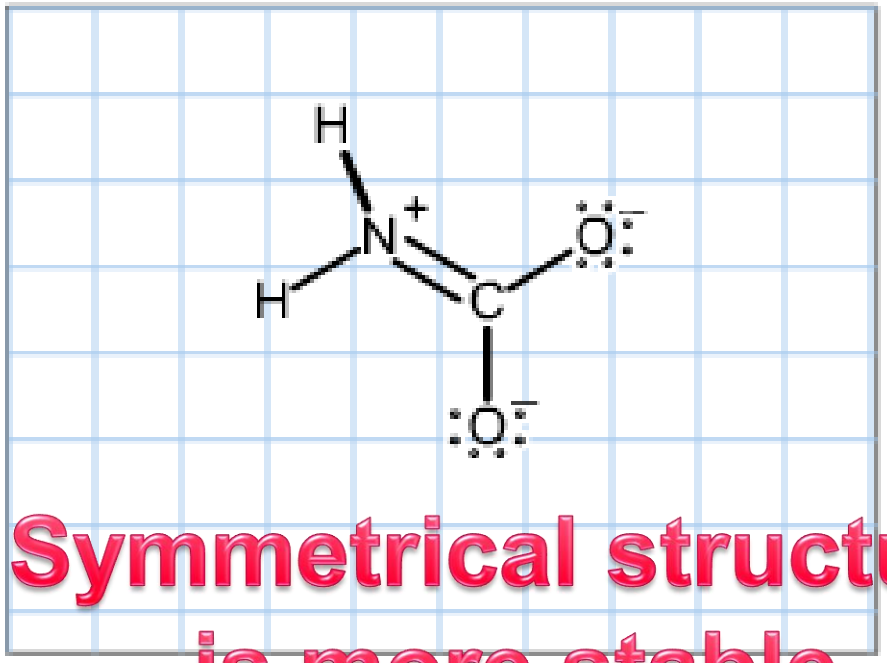

Symmetrical structure is more stable

Formal charge

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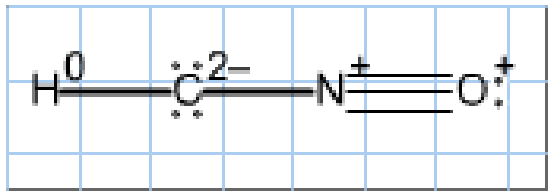
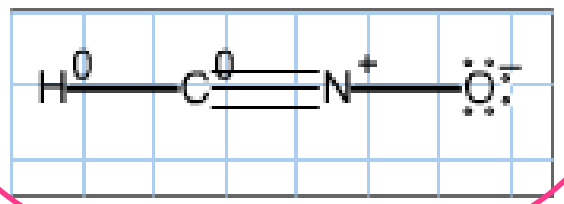
Ex. Which one is more stable?

Add formal charges to each resonance form of HCNO below.

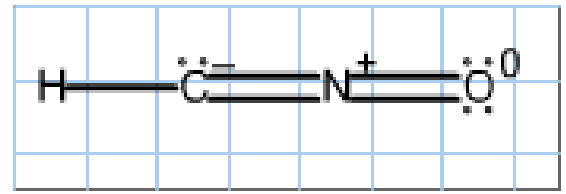
A.



B.



C.



The atom with higher electronegativity should get a negative FC

Formal charge

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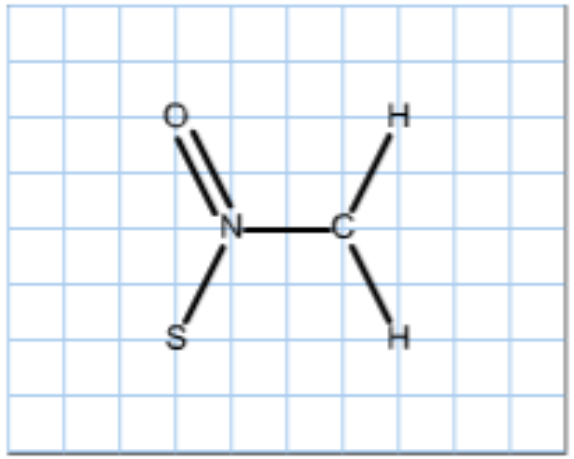
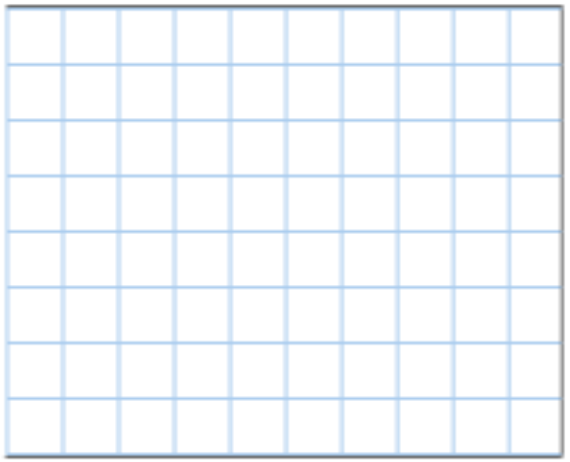
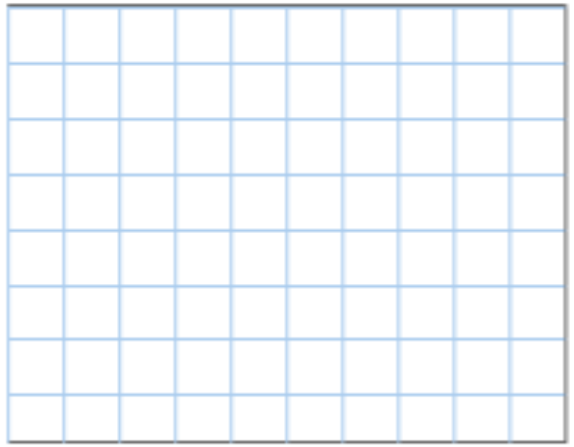
Ex. Draw all resonance structures. Which one is more stable?

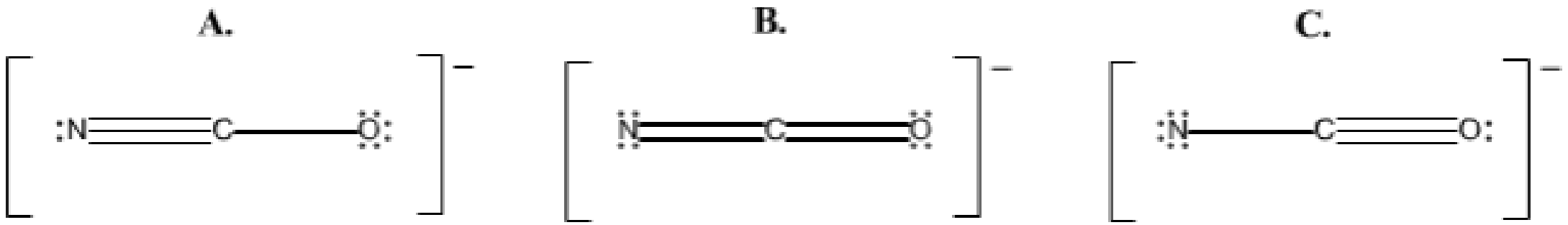
The following structure is an anion with three possible resonance contributors. One incomplete resonance form is shown below. Complete the given structure by adding nonbonding electrons and formal charges. Draw the two remaining resonance structures (in any order), including nonbonding electrons and formal charges.







Formal charge



Based on the formal charges you added above, which structure is favored?

- A
- B
- C

Formal charge

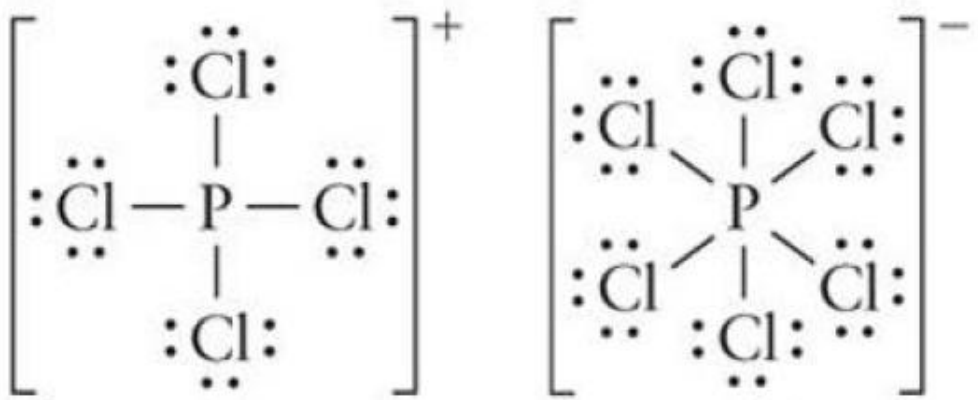
Summary:

The most stable structure has the following properties:

1. **Have lower FC.**
2. **Have symmetrical structure**
3. **Atom with higher electronegativity has negative FC**

Beyond octet-rule

Period 3 and subsequent periods can accommodate more than eight electrons by using d orbitals in its valence shell, up to 12 electrons.



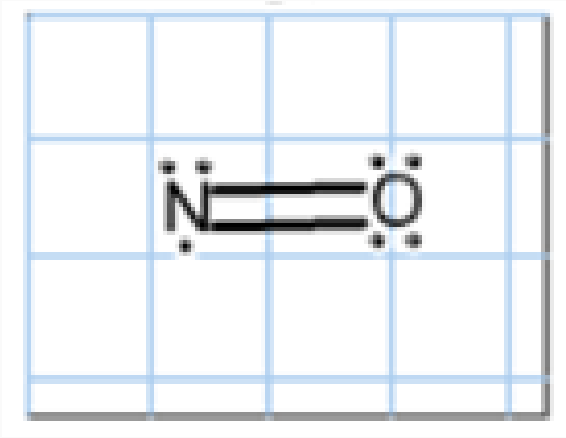
(a) PCl_4^+ (b) PCl_6^-

Another example: SO_2

Beyond octet-rule

- Some molecule cannot achieve 8 electrons for each atom.

e.g. NO, BF_3

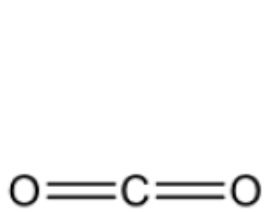


Under this circumstances, 7 or 6 electrons also work.

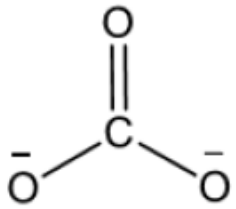
In our course, we do not consider delocalized pi bond。

Bond Order

$$\text{B.O.} = \frac{number\ of\ bonds}{number\ of\ bonding\ pairs}$$



1.



2.

3.

4.

BO=2

BO=1.33

BO=3

BO=1

Exercise on canvas…

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Reference

1. Chemical principal
2. Guo Linyun, VC210 FA2017 RC2
3. Guo Linyun, VC210 FA2017 RC3
4. Sapling learning

THANKΣ