How many pairs of electrons are shared by each O and the C of formate, \( \text{HC(O)O}^- \)?

- 20% 1. 1 pair (2 electrons)
- 20% 2. 1 ½ pair (3 electrons)
- 20% 3. 2 pair (4 electrons)
- 20% 4. Something else
- 20% 5. The answer is different for the two O-C bonds

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**HC(O)O\(^-\) sp\(^2\) \(\sigma\) framework**

9 pairs in Lewis structure, 7 pairs in \(\sigma\) framework, and so 2 pairs in (delocalized) \(\pi\) framework.

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**HC(O)O\(^-\) \(\pi\) framework**

2 pairs in (delocalized) \(\pi\) framework

1 pair in \(\pi\) (bonding) and 1 pair in \(\pi^*\) (nonbonding);

bond order 1

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Lecture 5 CH102 A1 (MWF 9:05 am) Monday, January 30, 2017

- Complete: Polyatomic MO recipe: Formate, \( \text{HC(O)O}^- \) (delocalized \(\pi\) bonds)
- Begin Mahaffy et al., Chapter 11: States of Matter
- Behavior of gases: Macroscopic versus microscopic understanding
- Kinetic molecular theory, PDF: http://goo.gl/njf3em
- Next: Continue ch11: Molecular speeds and their distribution; real gases (attraction and size)
How many pairs of electrons are shared by each O and the C of formate, HC(O)O⁻?

- 1 pair (2 electrons)
- 1 ½ pair (3 electrons)
- 2 pair (4 electrons)
- 4. Something else
- 5. The answer is different for the two O–C bonds

A container of volume V is filled with a gas at 20 °C. If V is decreased (while keeping T constant), pressure P exerted by the gas on the walls of the container must ...

- go down
- stay the same
- go up
- Further information needed

Behavior of gases
Macroscopic behavior

Very likely you know and have a lot of experience working with the ideal gas equation relating $P$, $T$, $V$, and $n$, ...

$$PV = R n T$$

The constant of proportionality is the gas constant ...

$$R = 8.314 \text{ J/(K mol)}$$

From

$$PV = R n T$$

we know that if $V$ is decreased (while keeping $T$ constant), the pressure $P$ exerted by the gas on the walls of the container must go up, since the left-hand side of the equation is unchanged.

This is an example of macroscopic understanding.

Our goal is to understand this kind of behavior at a microscopic level.

That is, at the level of the individual particles of the gas.

Our method is called the kinetic molecular theory of gases.

Microscopic behavior

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Our method is called the kinetic molecular theory of gases.

Kinetic-molecular theory of gases

Goal: Get microscopic expression for pressure $P$

Key idea 1: Pressure is due to force exerted by particles during collisions with the container walls

Key idea 2: Force is due to momentum change in collision with the container walls.

Note: Here upper-case $P$ is used for pressure and lower-case $p$ is used for momentum.
Kinetic-molecular theory of gases

1. We have not one particle, but a lot.
2. Particles move at different speed.

\[ P_1 = \frac{m_1 u_1^2}{V}, \quad P_2 = \frac{m_2 u_2^2}{V} \]

\[ P = \frac{m}{V} \left( u_1^2 + u_2^2 + \ldots + u_n^2 \right) \]

\[ P = \frac{m}{V} \left( u_1^2 + u_2^2 + \ldots + u_n^2 \right) \sqrt{N} - \frac{m}{V} N u_{avg}^2 \]

\[ P = \frac{m}{V} \left( u_1^2 + u_2^2 + \ldots + u_n^2 \right) \sqrt{N} - \frac{m}{V} N u_{avg}^2 \]

\[ PV = \frac{m}{V} N u_{avg}^2 \]

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