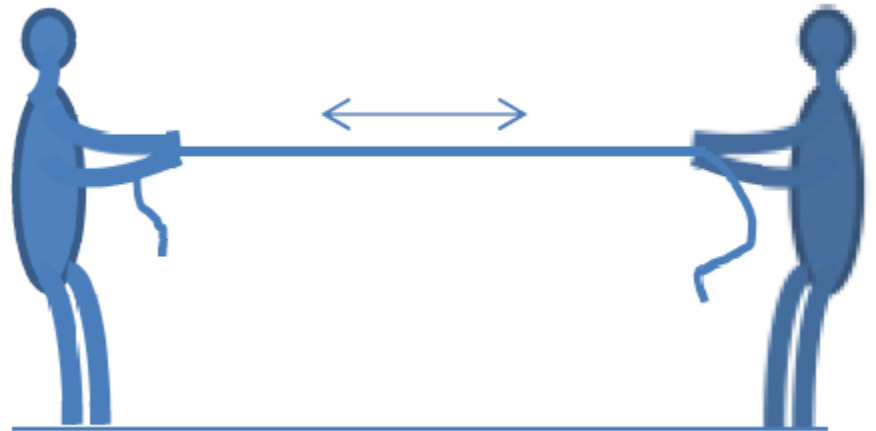


Chapter 7 Part 3

Dr. Turner

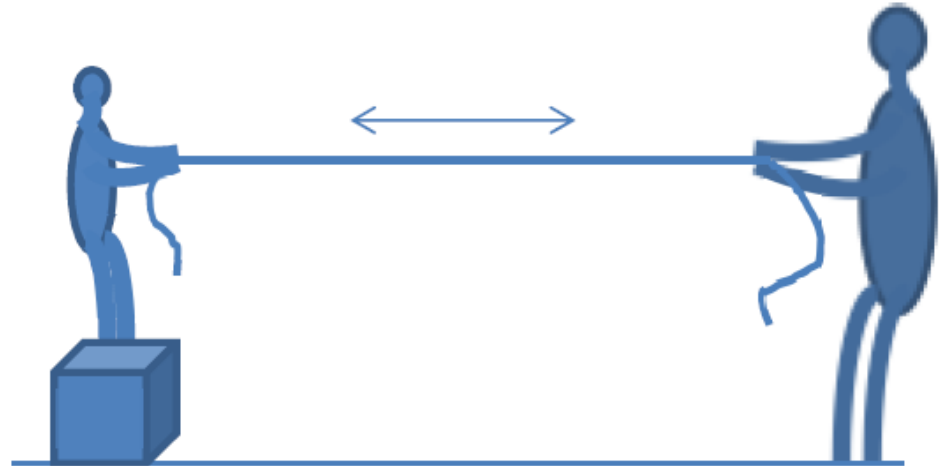
Tug of war

- Imagine a tug of war game played by two people of equal strength. If they pull against each other neither will win the game because neither has an advantage.
- Equal and opposite force is being asserted and there is no net gain.



Tug of war

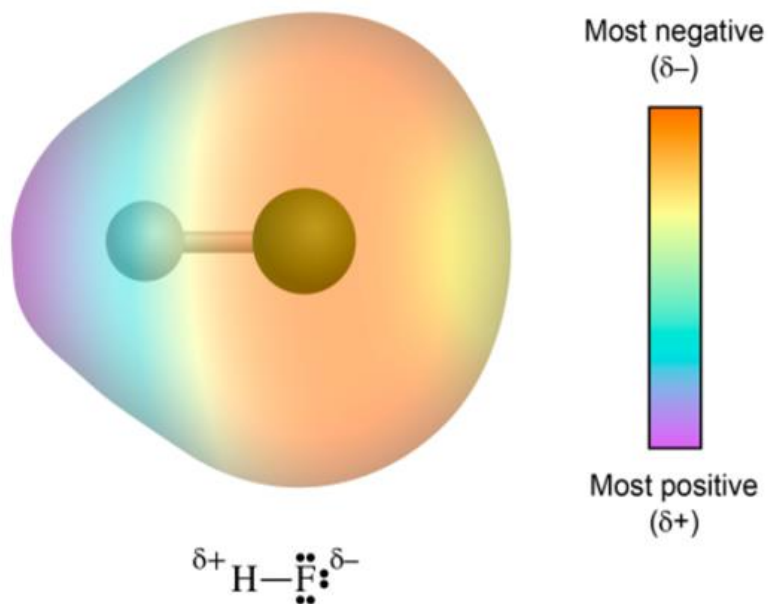
- Now, imagine two people of unequal strength play the game.
- Which will win?
- Why did you choose this one?



Bond polarity

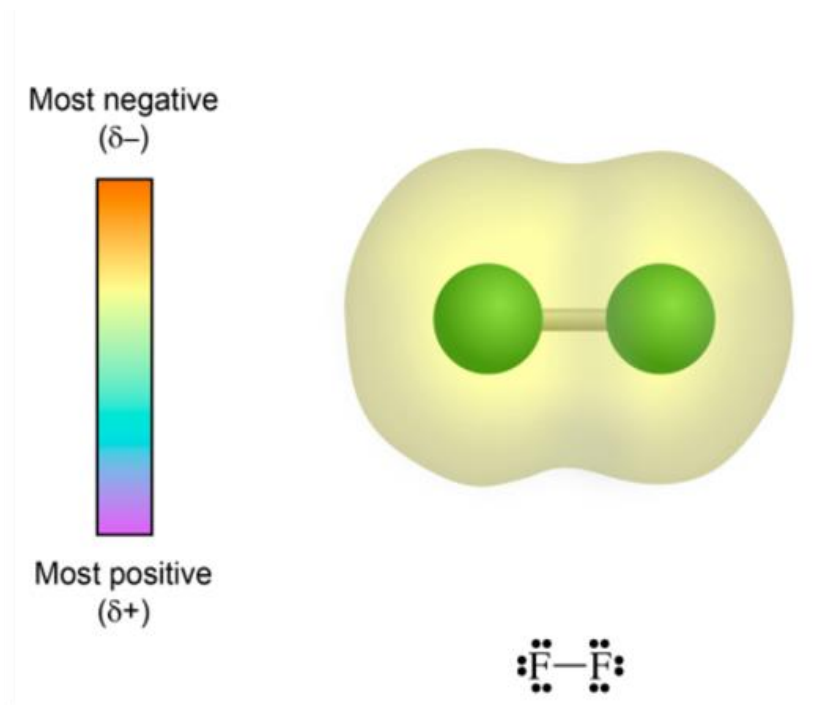
- Electronegativity is the ability of an atom to attract electrons to itself within a bond.
- We can think about the atoms on either side of a bond as pulling on the electrons located in the bond.
- The strength of an atom's pull on the electrons in the bond is determined by its electronegativity.
- This ultimately results in the electron density in the bond being pulled towards one of atoms in the bond.

Polar Bonds



- Two different atoms generally share electrons unevenly because they have different electronegativities
- This causes electron density in the electron cloud to shift to one side of the bond
- This type of uneven sharing of electrons is called polar covalent bonding

Nonpolar bonds

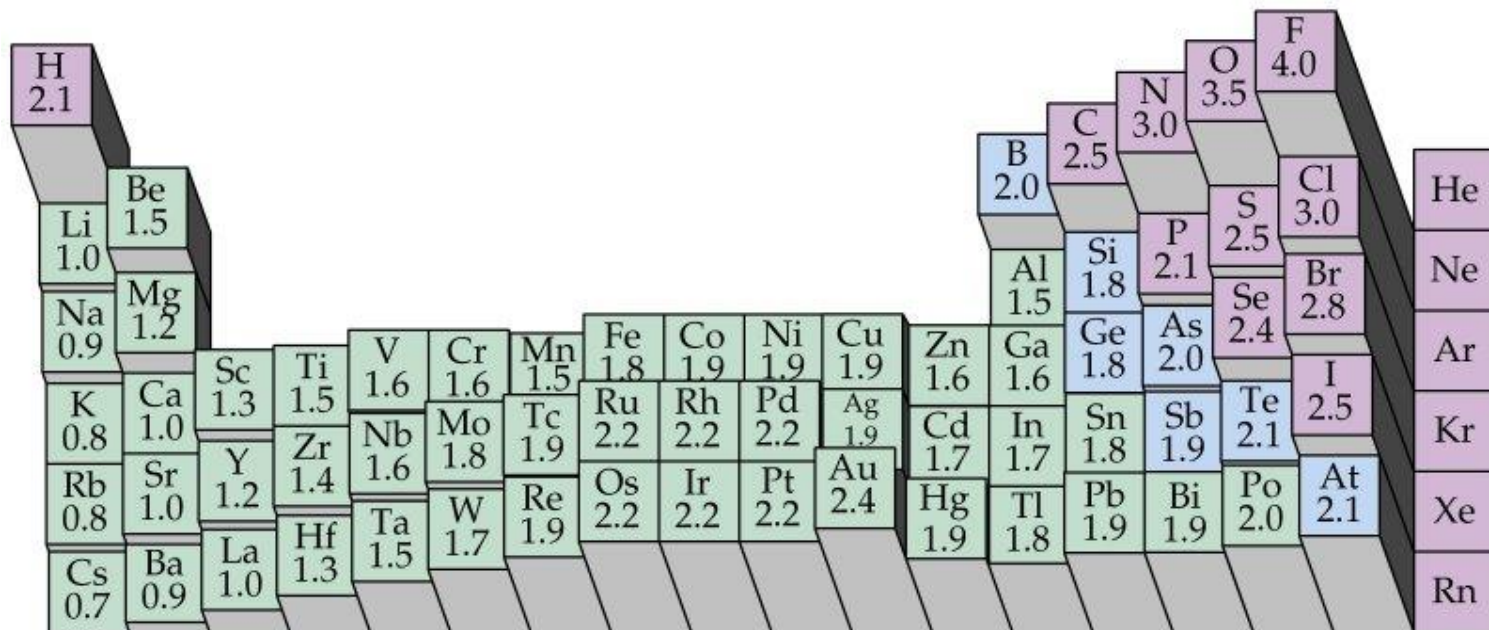


- Two identical atoms generally share electrons evenly because they have identical electronegativities
- This causes electron density in the electron cloud to be spread evenly across the bond
- This type of even sharing of electrons is called nonpolar covalent bonding

Comparison of Bonding in HF and F₂

- The difference in charge density results in a partial negative charge, δ^- , on the F atom and a partial positive charge, δ^+ , on the H atom.
- These positive and negative poles in HF indicate a charge separation and creates a polar bond.
- The completely evenly shared bonding electrons in F₂ creates a nonpolar bond.

Electronegativity



Differences in Electronegativity

- Larger differences in electronegativity between bonded atoms lead to larger bond polarities
- The only truly nonpolar bond exists when the two atoms have exactly the same electronegativity.
- However, electronegativity difference between carbon and hydrogen is so small that C-H bonds are generally considered nonpolar



Most Polar

Less Polar

Nonpolar

Bond Polarity

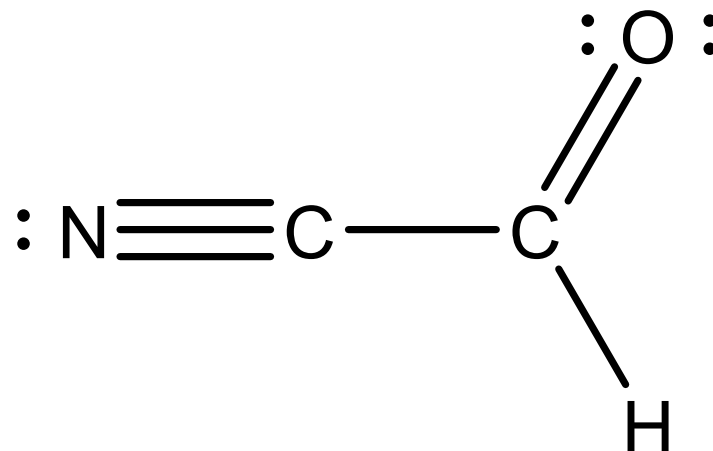
Which bond is the most polar?

- A. C-H
- B. C-N
- C. C-O
- D. C-F

Bond Order

- Bond order is the number of bonding lines between two bonded atoms

- CN bond order is 3
- CC bond order is 1
- CH bond order is 1
- CO bond order is 2



Bond Order & Bond Length

- Bond length increases with increasing atomic radius

Shortest $\text{C} - \text{F} < \text{C} - \text{Cl} < \text{C} - \text{Br}$ Longest

- Bond length increases with decreasing bond order

Shortest $\text{C} \equiv \text{N} < \text{C} = \text{N} < \text{C} - \text{N}$ Longest

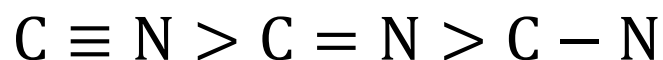
Bond Energy (Bond Enthalpy)

- Bond energy is the energy required to break a bond
- Bond strength increases with increasing bond energy
- Bond strength increases with increasing bond order

Strongest

Weakest

Highest bond
energy

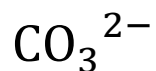


Lowest bond
energy

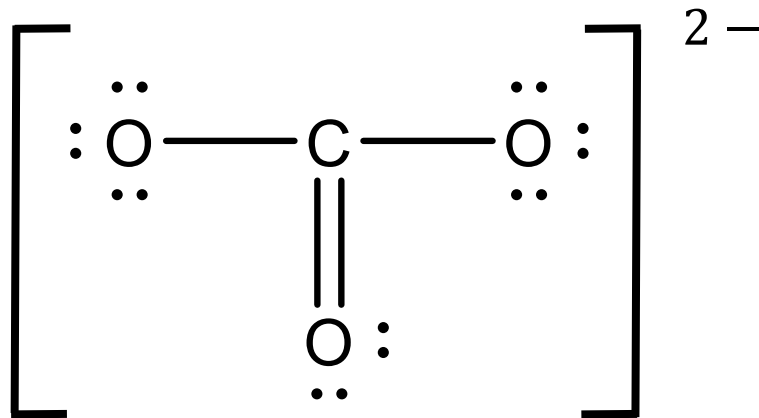
Shortest

Longest

Calculating Bond Order of a Resonance Structure



$$\text{bonding order of CO} = \left(\frac{\text{number of CO bonding lines}}{\text{number of CO bonding locations}} \right) = \frac{4}{3}$$



Bond order



Calculate the bond order of the chlorine-oxygen bond in perchlorate. Oxygen is more electronegative than chlorine.

Bond energy

Would it require more energy to break the carbon-oxygen bond in CO_2 or CO_3^{2-} ?

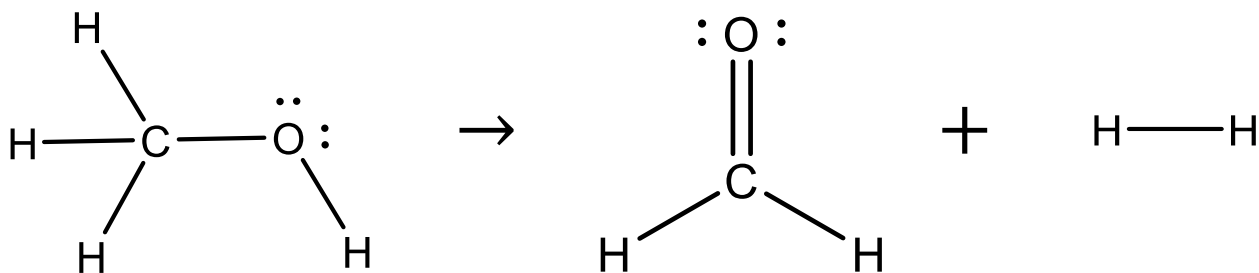
Enthalpy & Average Bond Energy

- Average bond energy values can be used to calculate the enthalpy of reaction for gas phase reactions

$$\Delta H^{\circ} = \sum (\text{Energies of bonds broken}) - \sum (\text{Energies of bonds formed})$$

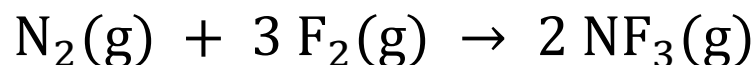
Enthalpy of Reaction from Bond Enthalpies

Find the enthalpy of reaction for the reaction below (C – H is 411 kJ/mol, C – O is 350 kJ/mol, O – H is 464 kJ/mol, H – H is 436 kJ/mol, and C = O is 741 kJ/mol).



Enthalpy of Reaction from Bond Enthalpies

Use bond enthalpies to calculate the ΔH_{rxn} (in kJ/mol) for the reaction below.



Bond	ΔH (kJ/mol)
N-N	240
N=N	418
N \equiv N	941
F-F	157
N-F	270