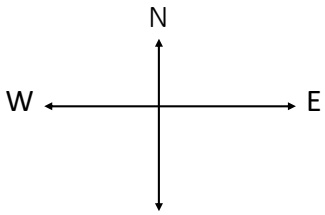
Background: vector addition

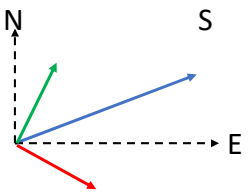
vector:

- has both direction and magnitude
- represented by an "arrow"



examples:

- velocity; e.g.
  - 50 mph east; 75 mph 20° north of east



- force; e.g.
  - 5 Newtons east; 25 Newtons 20° south of east
- displacement (of an object) = "distance that an object moves"; e.g.
  - walk 10 steps north; walk 25 steps 20° east of north
- https://phet.colorado.edu/sims/html/vector-addition/latest/vector-addition_en.html

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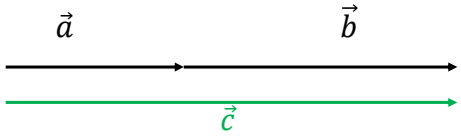
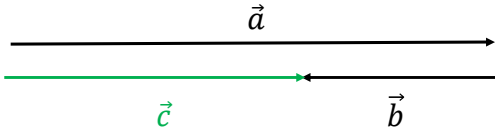
Properties of vector addition; let vector = displacement

1. vectors point in the same direction



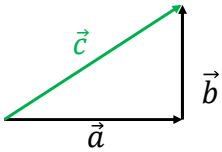
$\vec{a} + \vec{b} = \vec{c}$

2. vectors point in opposite directions



$\vec{a} + \vec{b} = \vec{c}$

3. vectors perpendicular to each other



$\vec{a} + \vec{b} = \vec{c}$

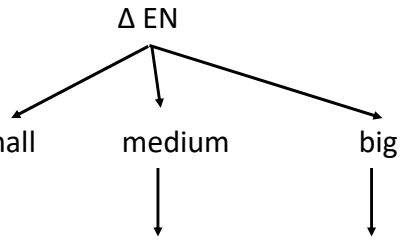
2

2

Bond polarity

review:

Electronegativity (EN) = how much an atom "wants" another atom's electrons



type of bond: nonpolar covalent | polar covalent | ionic

i.e. same atom or C & H

3

3

Bond dipole

- is a vector
- example: $C - O$ bond

$\overrightarrow{C - O}$ electronegativity: O > C

δ^+ δ^- δ = "slightly"

- arrow head: points to the more electronegative atom in the bond
- https://phet.colorado.edu/en/simulation/molecule-polarity

4

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molecular polarity -- in covalent compounds

- polar compounds: have polar (covalent) bonds
- nonpolar compounds: have nonpolar (covalent) bonds or polar (covalent) bonds

to differentiate between polar versus nonpolar compounds, evaluate a molecule's dipole moment,

$\sum \overrightarrow{bond\ dipole}$

zero → nonpolar compound

non-zero → polar compound

5

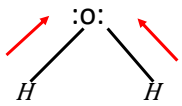
5

"steps" to determine if a compound is polar or nonpolar

1. sketch its Lewis structure
2. apply VSEPR to get its shape
3. evaluate the molecule's dipole moment = $\sum \overrightarrow{bond\ dipole}$

examples: CO_2 versus H_2O

: Ö = C = Ö :



as the dipole moment $= 0$, it's a nonpolar compound

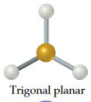
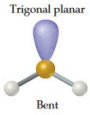
as the dipole moment $\neq 0$, it's a polar compound

6

6

more examples

TABLE 9.2 • Electron-Domain and Molecular Geometries for Two, Three, and Four Electron Domains around a Central Atom

Number of Electron Domains	Electron-Domain Geometry	Bonding Domains	Nonbonding Domains	Molecular Geometry	Example	polar / nonpolar?
2	 Linear	2	0	 Linear		NP
3	 Trigonal planar	3	0	 Trigonal planar		NP
		2	1	 Bent		polar
4	 Tetrahedral	4	0	 Tetrahedral		NP
		3	1	 Trigonal pyramidal		polar
		2	2	 Bent		polar

source:
https://sites.lps.org/sputnam/LHS_IB/IBChemistry/Chemistry_Brown_12th.pdf

7

7

continue

TABLE 9.3 • Electron-Domain and Molecular Geometries for Five and Six Electron Domains around a Central Atom

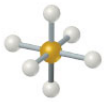
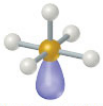
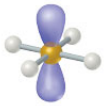
Number of Electron Domains	Electron-Domain Geometry	Bonding Domains	Nonbonding Domains	Molecular Geometry	Example	polar / nonpolar ?
5	 Trigonal bipyramidal	5	0	 Trigonal bipyramidal	PCl_5	NP
		4	1	 Seesaw	SF_4	polar
		3	2	 T-shaped	ClF_3	polar
		2	3	 Linear	XeF_2	NP

8

8

continue

TABLE 9.3 • Electron-Domain and Molecular Geometries for Five and Six Electron Domains around a Central Atom

Number of Electron Domains	Electron-Domain Geometry	Bonding Domains	Nonbonding Domains	Molecular Geometry	Example	polar / nonpolar ?
6	 Octahedral	6	0	 Octahedral	SF_6	NP
		5	1	 Square pyramidal	BrF_5	polar
		4	2	 Square planar	XeF_4	NP

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9