

Physical Properties and Stability

Physical Properties

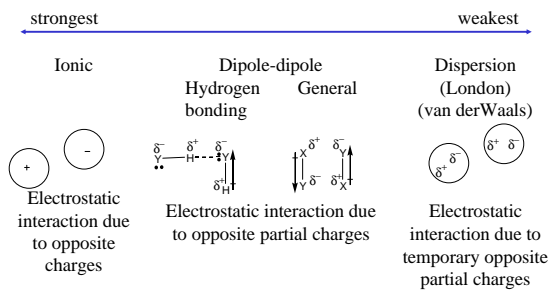
- Properties that can be measured or observed **WITHOUT** changing the chemical nature of the substance (in other words, **NO** reactions)
- Examples
 - Boiling point
 - Melting point
 - Solubility in water
 - Solubility in organic solvents

Influences on Physical Properties - I

- Velocity
 - Gas phase: Rapidly moving molecules
 - Liquid phase: Less rapidly moving molecules
 - Solid phase: Least rapidly moving molecules
 - $KE = 1/2 mv^2$ (proportional to temperature)
 - Therefore lighter molecules move faster at a given temperature than heavy molecules (all other influences being equal)

Influences on Physical Properties - II

- Interactions between molecules



Physical Property Activity – 15 min.

- Form teams of 4-6 people
- Select team member with most siblings – that person requests a card
- Given the molecule on the card:
 - What intermolecular interactions can occur between that molecule and other identical molecules?
 - Make a sketch demonstrating each type.
 - What intermolecular interactions can occur between that molecule and water molecules? (Sketch them)
 - Do you expect a high, moderate or low boiling point?
 - Do you expect high, moderate or low water solubility?
 - Do you expect high, moderate or low organic solubility?

Molecules Used in Exercise

- | | |
|---|--|
| 1. $\text{CH}_3\text{CHOHCH}_3$ | 9. $\text{CH}_3\text{C}\equiv\text{CCH}_3$ |
| 2. $\text{CH}_3\text{CH}_2\text{C}\equiv\text{N}$ | 10. $\text{CH}_3\text{CH}=\text{CHCH}_3$ |
| 3. $\text{CH}_3\text{CHNH}_2\text{CH}_3$ | 11. $\text{C}(\text{CH}_3)_4$ |
| 4. $\text{CH}_3\text{CH}_2\text{CH}_2\text{NH}_2$ | 12. CH_3CONH_2 |
| 5. $\text{CH}_3\text{CH}_2\text{CH}_2\text{F}$ | 13. HCO_2CH_3 |
| 6. $\text{CH}_3\text{CH}_2\text{CH}_2\text{OH}$ | 14. $\text{CH}_3\text{CO}_2\text{H}$ |
| 7. $\text{CH}_3\text{CH}_2\text{CHO}$ | 15. $\text{CH}_3\text{OCH}_2\text{CH}_3$ |
| 8. CH_3COCH_3 | 16. $\text{CH}_3\text{CH}_2\text{CH}_2\text{CH}_3$ |

Stability

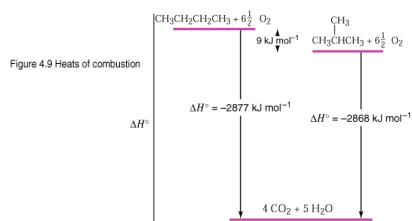
- Molecular energies include both kinetic and potential energy
- Relative potential energies of molecular systems are often used to describe stability

More potential energy = more reactive = less stable

Less potential energy = less reactive = more stable

Reflections of Stability

- Stability/Relative potential energy cannot be directly measured
- Heat given off during reactions producing identical products can be measured



Cycloalkane Stability

Ring Size	ΔH Combustion (kJ/mol)	ΔH per CH_2 group (kJ/mol)	Ring Strain (kJ/mol)
3	2091	697.0	115
4	2744	686.0	109
5	3320	664.0	27
6	3952	658.7	0
7	4637	662.4	27
*		658.6	0

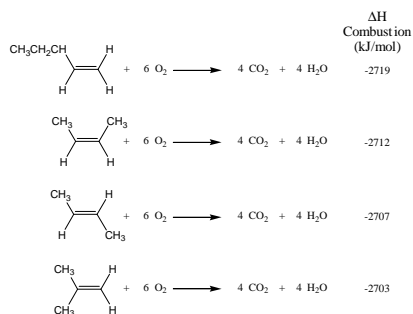
* Reference value for unbranched alkane

Data from Table 4.6

Sources of Ring Strain – 10 min.

- You may work alone or with a neighbor:
 - Draw a 3D representation (or build models) of rings with 3 and 4 carbons and also a 3 carbon chain
 - What bond angles do you expect for the 3 carbon chain?
 - What bond angles do the ring geometries allow?

Relative Alkene Stability



Relative Alkene Stability - II

- Construct a diagram representing the enthalpy changes during the combustion of the alkenes on the previous slide.
- Which alkene was most stable initially?
- Which alkene was least stable initially?
- Can you suggest reasons for any of the differences?

Relative Stability vs. Bond Types

Most covalent ←————→ Most ionic
Least reactive ←————→ Most reactive

