

Physical properties

Organic Chemistry
Chapter 2, part b

What holds stuff together?

What holds stuff together?

Opposites attract!
Electrostatic potential energy

$$|F| = k \frac{|q_1q_2|}{r^2}$$

- attraction depends on amount of charge, q
- distance between charges, r

Not all attractions are alike!

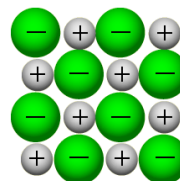
ion-ion: STRONG (large q)

What makes things melt?

And why?
A whole lotta shaking goin' on...

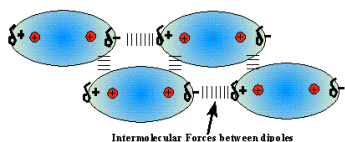
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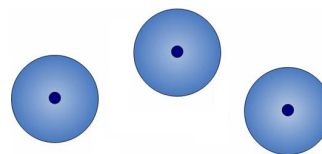
Not all attractions are alike!

ion-ion
dipole-dipole: moderate (smaller q)



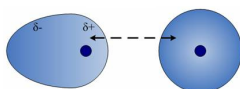
Not all attractions are alike!

ion-ion
dipole-dipole
van der Waals' attraction: weakest



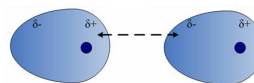
Not all attractions are alike!

ion-ion
dipole-dipole
van der Waals' attraction: weakest
instantaneous dipole (temporary)



Not all attractions are alike!

ion-ion
dipole-dipole
van der Waals' attraction: weakest
induced dipole

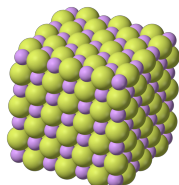


http://www.chemprofessor.com/inf_files/image003.jpg

Sodium fluoride

- Very strong attractions
- Electrostatic potential energy

$$|F| = k_e \frac{|q_1 q_2|}{r^2}$$



"Effective" charge of attraction

- Sodium fluoride - STRONG
- Sodium iodide - medium
- Sodium acetate - smaller

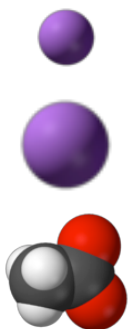
	mp (K)	bp ⁷⁶⁰ (K)
Na fluoride	1266	1977
Na iodide		
Na acetate		



“Effective” charge of attraction

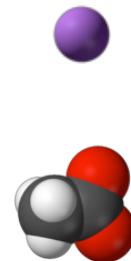
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	mp (K)	bp ⁷⁶⁰ (K)
Na fluoride	1266	1977
Na iodide	934	1577
Na acetate		



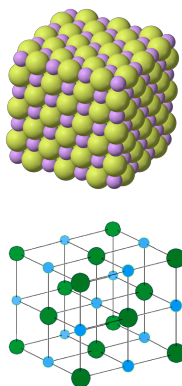
Sodium acetate

- Not like sodium fluoride
 - anion is much larger than cation; charge is “diluted”



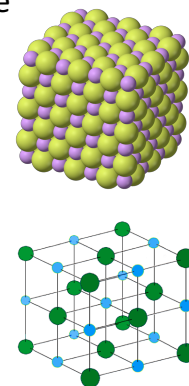
Sodium acetate

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 - anion is much larger than cation; charge is “diluted”
 - ionic structure can’t form as compactly now



Sodium acetate

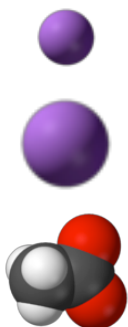
- Not like sodium fluoride
 - anion is much larger than cation; charge is “diluted”
 - ionic structure can’t form as compactly now
 - smaller q; easier to “shake” apart



“Effective” charge of attraction

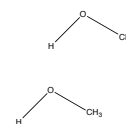
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	mp (K)	bp ⁷⁶⁰ (K)
Na fluoride	1266	1977
Na iodide	934	1577
Na acetate	597	1154



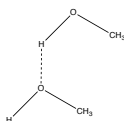
Attraction vs. property

- dipole-dipole
 - H-bonding; O-H or N-H in structure
- van der Waals



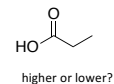
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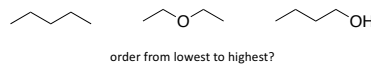
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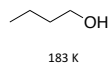
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Attraction vs. property

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Boiling vs. Melting

Same attractions

Temperature dependence

Different behavior

Pressure dependent

Boiling point of water...

Where?

Boston: 100 °C

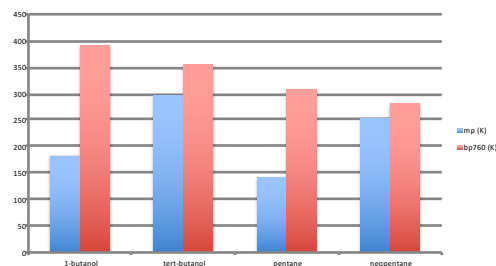
Denver: 95 °C

Size vs. property

van der Waals attractions are weak but they accumulate with size

	mp (K)	bp ⁷⁶⁰ (K)
C-C-C-C-C	143	309
C ₁₀	243	447
C ₁₅	286	540
C ₂₀	309	616
C ₃₀	339	723
C ₄₀	355	798

Shape vs. property vs. attraction



Solubility property

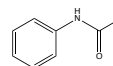
- “Like dissolves like”
 - Polar for polar; non-polar for non-polar
- Non-polar solvents:
 - Alkanes
 - Mineral oil
 - fats/oils
- Polar solvents:
 - water
 - alcohol
 - ether

Water Solubility – Rule of Five

Calculate #C / (#N + #O)

- If less than five, water soluble
- The lower, the more soluble

Example:



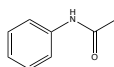
acetanilide

Water Solubility – Rule of Five

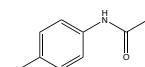
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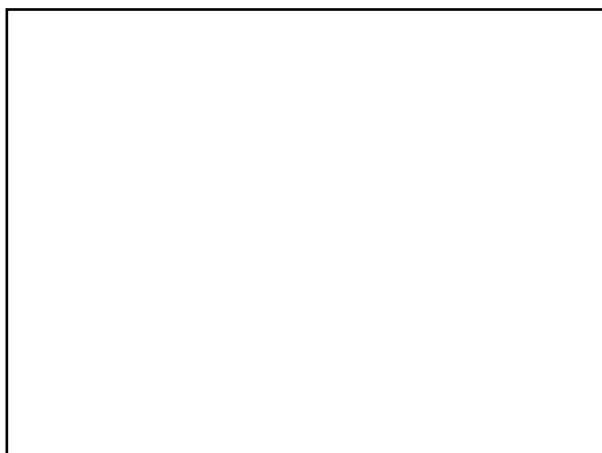
Example:



acetanilide



acetaminophen



extra data – not presented in class ...
Pentane vs. Neopentane

	mp (K)	bp ₃₀ (K)
Na fluoride	1266	1977
Na iodide	934	1577
Na acetate	597	1154
Et acetate	190	350
propanoic acid	252	414
1-butanol	183	391
diethyl ether	157	308
tert-butanol	298	355
propane	85	231
pentane	143	309
neopentane	254	282
heptane	182	371
nonane	220	423
C ₂₀	309	616