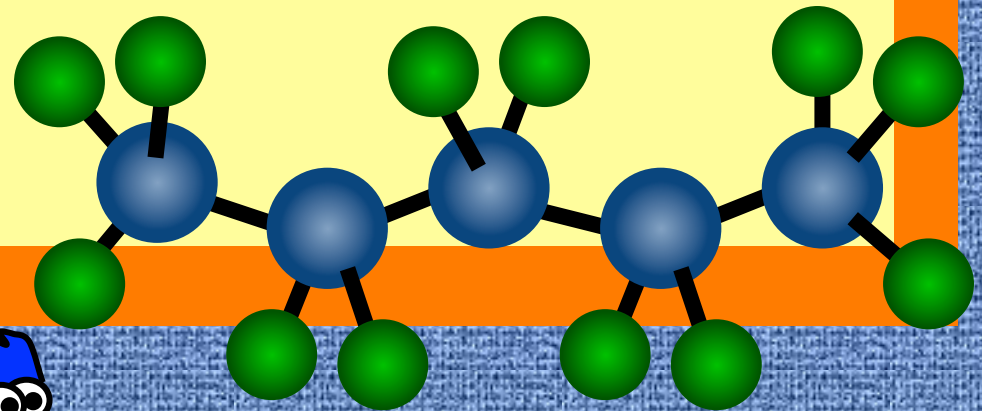


Experiment 10

9 November 2017

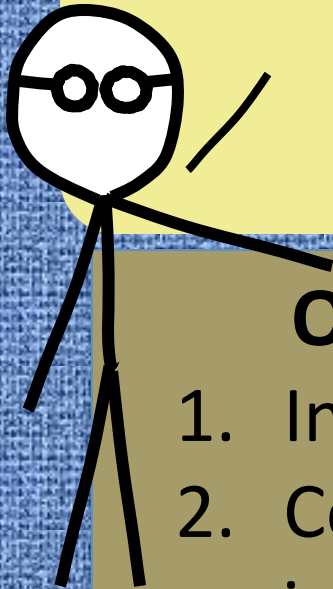
Intermolecular Forces

Today we will ask that age-old question: Why do molecules do that?




And here is one of our contestants...

Objective: To see how intermolecular forces affect rates of evaporation.



Today we will be gathering qualitative, empirical information about intermolecular forces.



*Molecules with weak intermolecular forces tend to evaporate faster...
...as we shall see.*

Overview:

1. Intermolecular forces
2. Connecting rate of evaporation with intermolecular forces
3. Procedure: Using LoggerPro
4. Procedure: What to do today
5. Your lab report

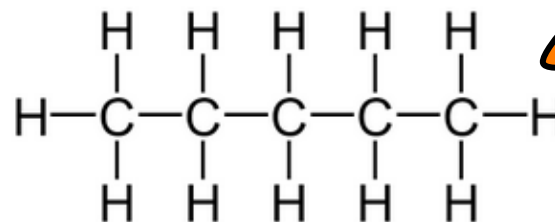
1. Intermolecular forces

This is pentane, C_5H_{12} . It can be drawn three different ways.

This is the "space-filling" model and is the most accurate of the them all – but Its hard to see every atom.

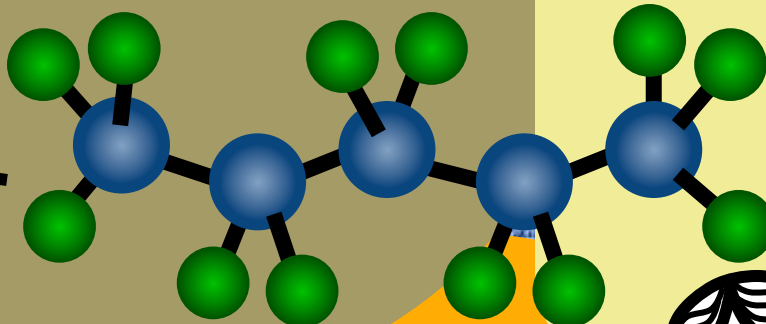
Here is the ball-and-stick model. It shows each atom and the bond angles.

And this one I call the "road-kill" model.



1. Intermolecular forces

Pentane, C_5H_{12} has only hydrogen and carbon atoms and is a member of the hydrocarbon family.



Carbon's electronegativity is 2.5 and hydrogen's is 2.1. They are so close in value that C-H bonds are relatively non-polar. The pentane molecule is functionally non-polar.

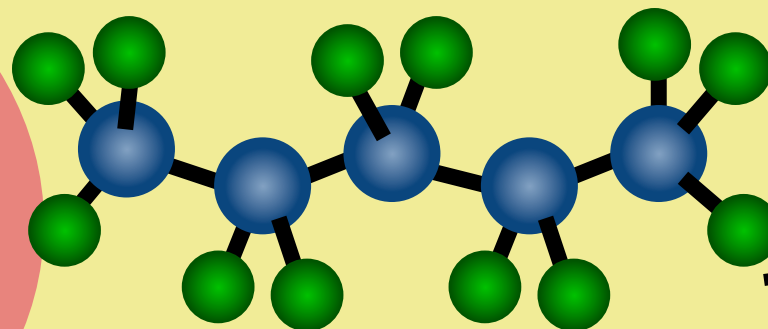
That means the pentane has only London dispersion intermolecular forces.

Ooo! Ooo! London forces are proportional to MM. This may be good-to-know!

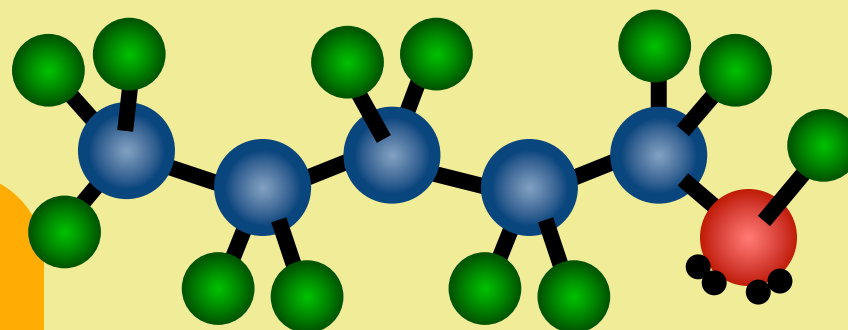
1. Intermolecular forces

The other type of molecule we will be studying today is an alcohol. Here is pentane and 1-pentanol – they look rather similar except for an importance difference!

The hydrocarbon end of 1-pentanol is non-polar, but the end with the –OH group is a completely different story!



pentane

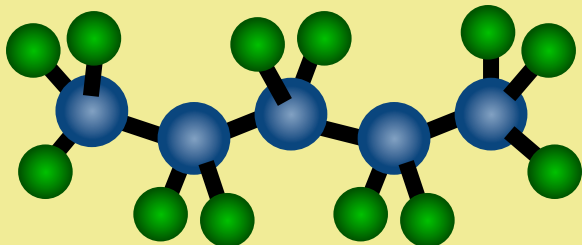


1-pentanol

O-H as in oxygen-hydrogen!
Electron pairs! Oh boy! Hydrogen bonding!

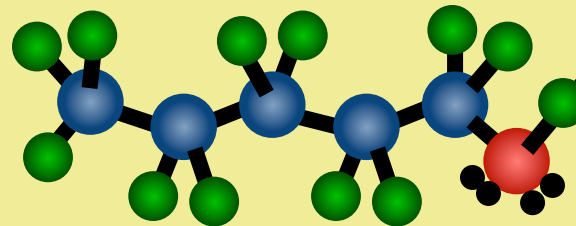


2. Connecting rate of evaporation with intermolecular forces



pentane

London dispersion forces



1-pentanol

London dispersion forces
and H-bonding



1-Pentanol should have larger intermolecular forces due to H-bonding, meaning the molecules are more attracted to each other than in pentane.

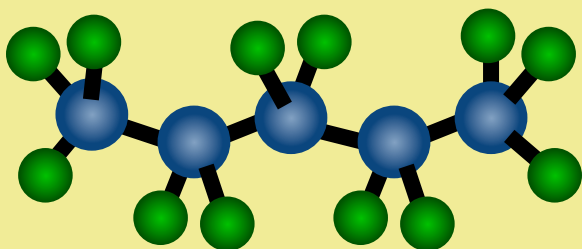


I feel like I can read her mind!

Evaporation requires the breaking of all intermolecular forces. It would take more energy to break the intermolecular forces in 1-pentanol.

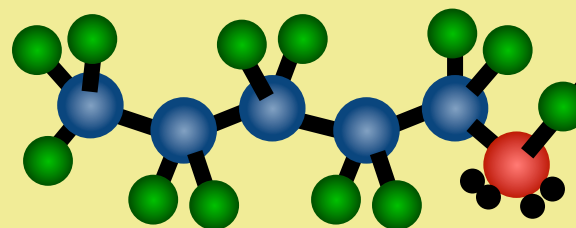
When evaporation takes place, the heat comes from the surroundings.

2. Connecting rate of evaporation with intermolecular forces



pentane

London dispersion forces



1-pentanol

London dispersion forces
and H-bonding

At the temperature of the lab, fewer molecules of 1-pentanol would have enough energy to evaporate.

So 1-pentanol is slower to evaporate and the surroundings don't get quite as cold.

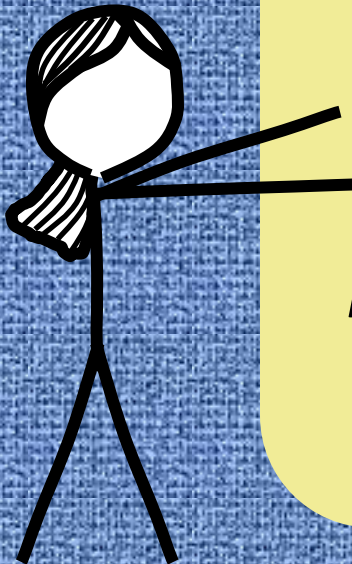
So the wimpier the intermolecular forces, the cooler it gets due to evaporation

I know it seems backwards...

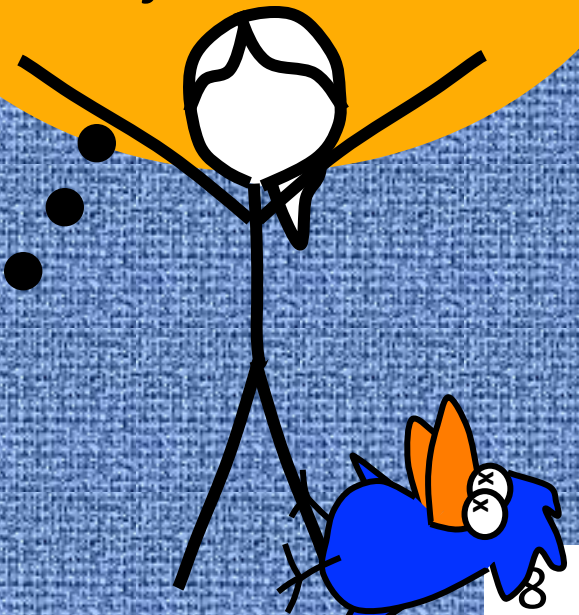
2. Connecting rate of evaporation with intermolecular forces



Soooo, large ΔT means fast evaporation



... and fast evaporation means a lot of molecules have sufficient kinetic energy to escape the liquid which means the liquid has a high vapor pressure



...and high vapor pressure means weak intermolecular forces!

2. Connecting rate of evaporation with intermolecular forces

Here are the molecules we are studying today.

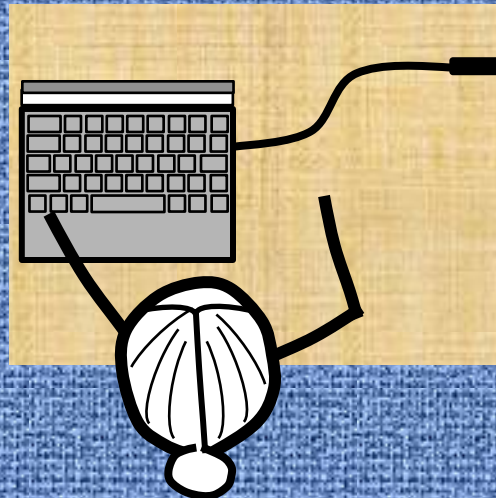
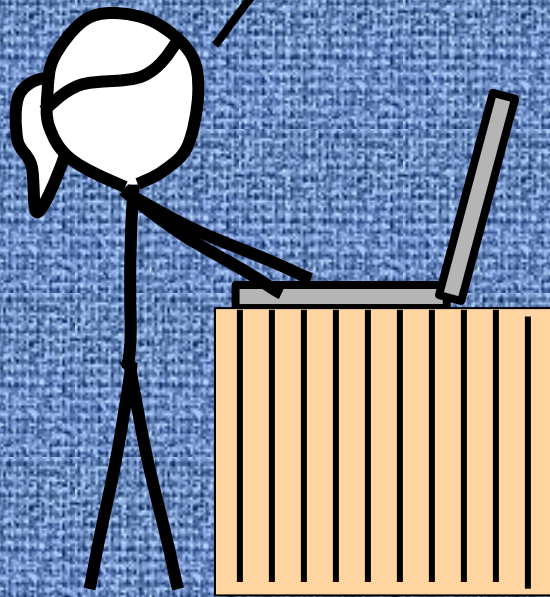
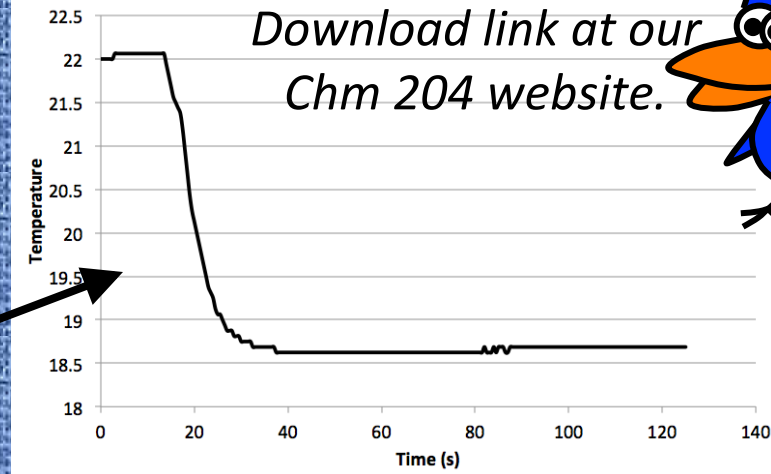
Soooo, let's complete this last column together...

Molecule	Formula	MM (g/mol)	IMF?
water	H_2O	18	LDF + H-bonding
ethanol	C_2H_5OH	46	
hexane	C_6H_{14}	86	
pentane	C_5H_{12}	72	
pentanol	$C_5H_{11}OH$	88	
methanol	CH_3OH	32	

Go!

3. Procedure: Using LoggerPro

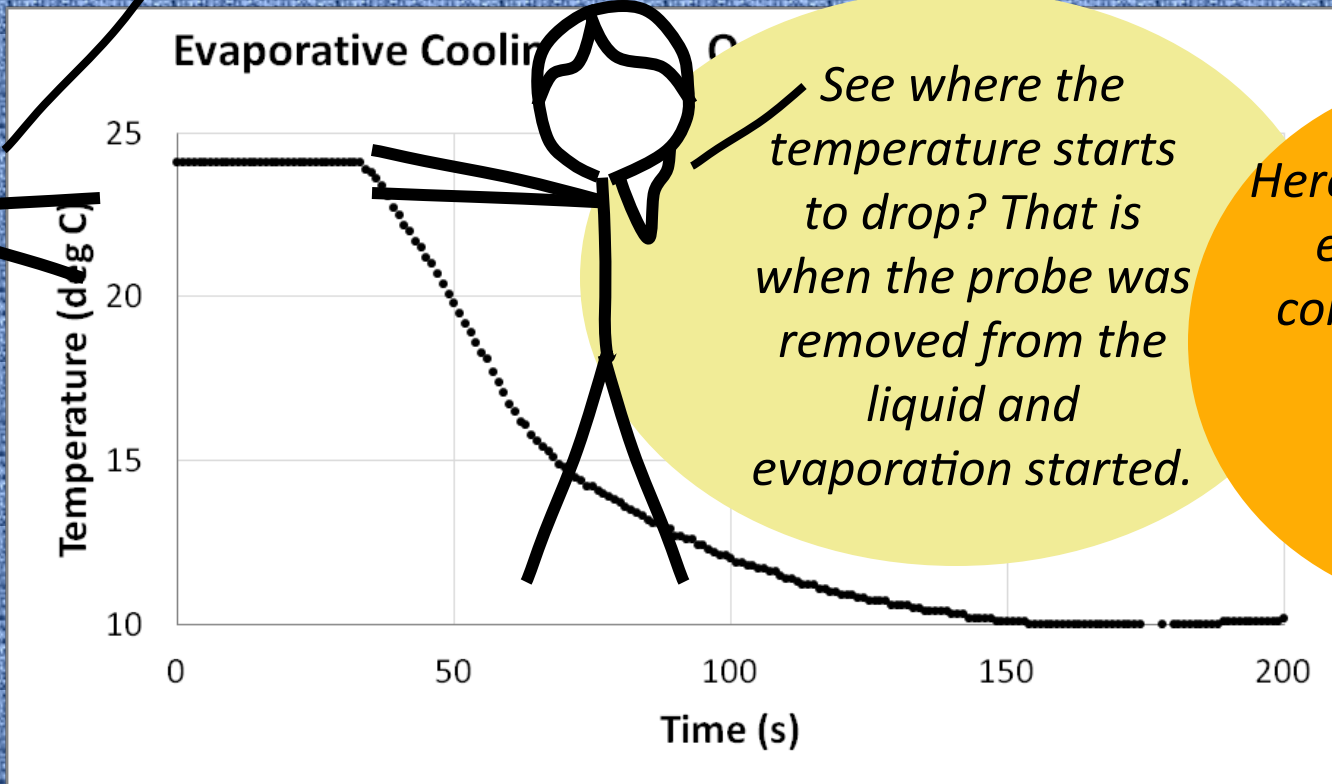
We'll use LoggerPro for the first time. Make sure it is downloaded onto your laptop.



See how the probe rests over the edge of the table?

3. Procedure: Using LoggerPro

This is a typical cooling curve. Evaporation is endothermic so the temperature drops.



See where the temperature starts to drop? That is when the probe was removed from the liquid and evaporation started.

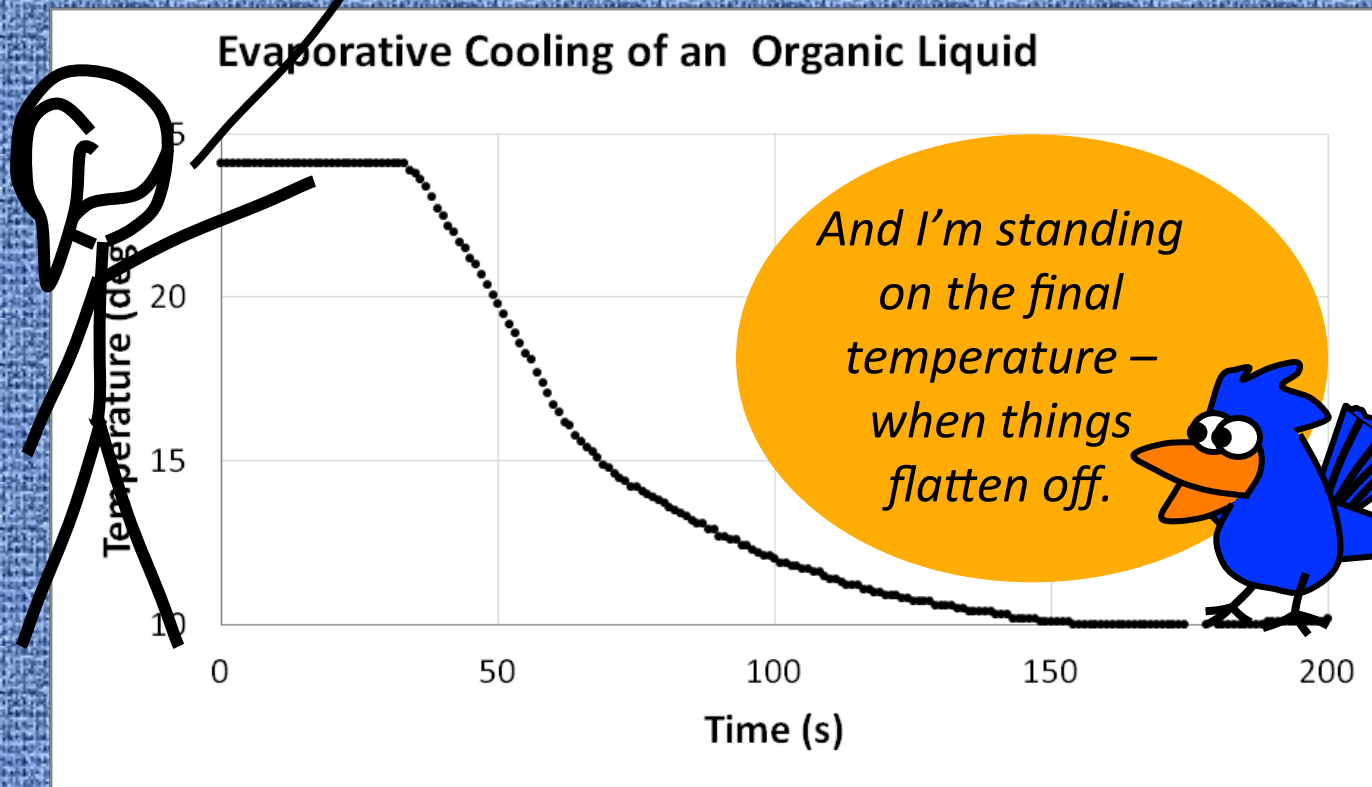
Here at about 200 s, evaporation is complete and you can stop.

Temperature is a measure of energy...so when energy goes into making liquid evaporate, the surroundings cool down



3. Procedure: Using LoggerPro

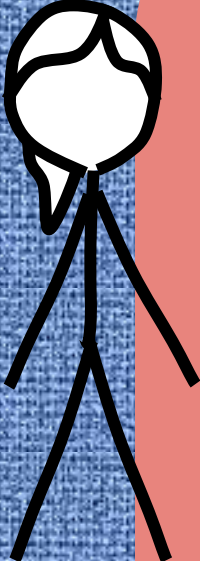
This is the initial temperature – anywhere along the flat line before the probe is removed from the liquid

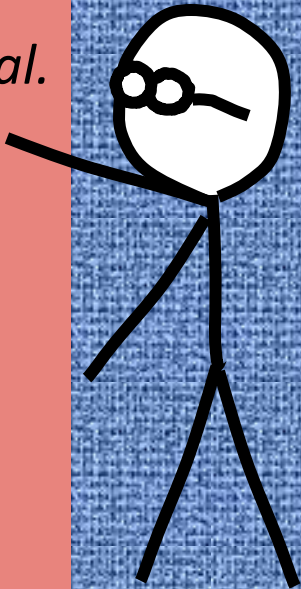


And I'm standing on the final temperature – when things flatten off.

$$\Delta T = T_{\text{final}} - T_{\text{initial}}$$

4. Procedure: What to do today

- 
- I. *Wear your safety glasses today.*
 - II. *We follow the manual carefully – except each pair of us will only do three and water is not listed in manual.*
 - III. *You and your partner will do three solvents and the other people at your station will do the other three.
The two sets are:*
 - Group A. Water, ethanol, hexane*
 - Group B. Pentane, pentanol, methanol*
 - IV. *Record observations and details as carefully as possible.*



If you are at Station 1A, 2A, etc., you do Group A solvents. Stations 1B, 2B and so on do Group B solvents.



5. Your lab report



- ① First, the cover page with TA initials.
- ② Next, the trimmed copy pages from your lab notebook stapled together.
- ③ **On-line results** due at the end of class today. . **Late submissions are not graded – see the syllabus.**
- ④ Turn in lab report **today** or **before** the start of class tomorrow. **Late labs may not be graded – see the syllabus.**

*LoggerPro will be used
for the last two labs.*

*Also, dress for a mess –
both weeks!*

