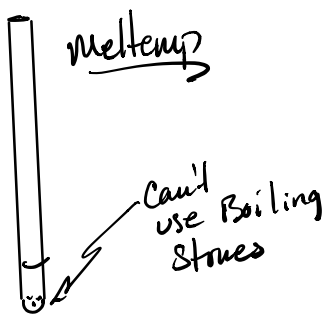
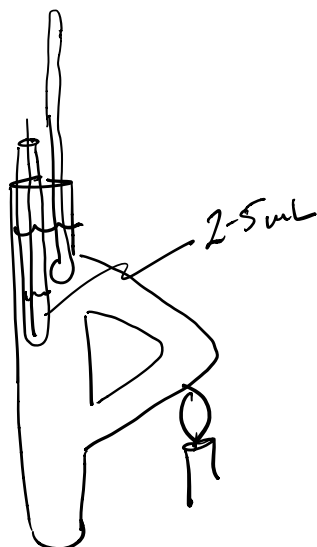
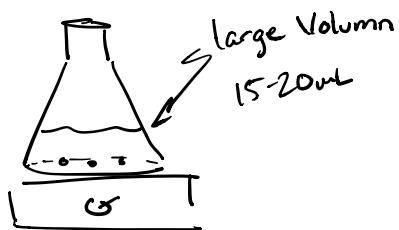


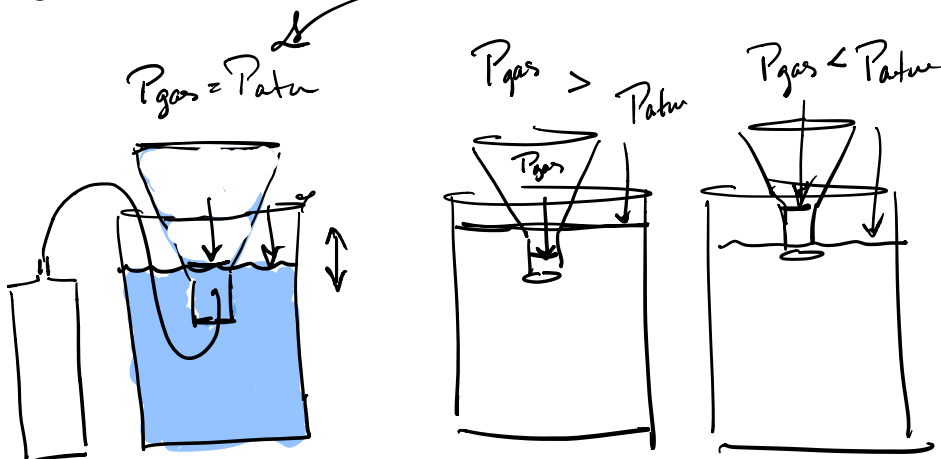
Experiment 8 Boiling Point & Infrared Spectroscopy

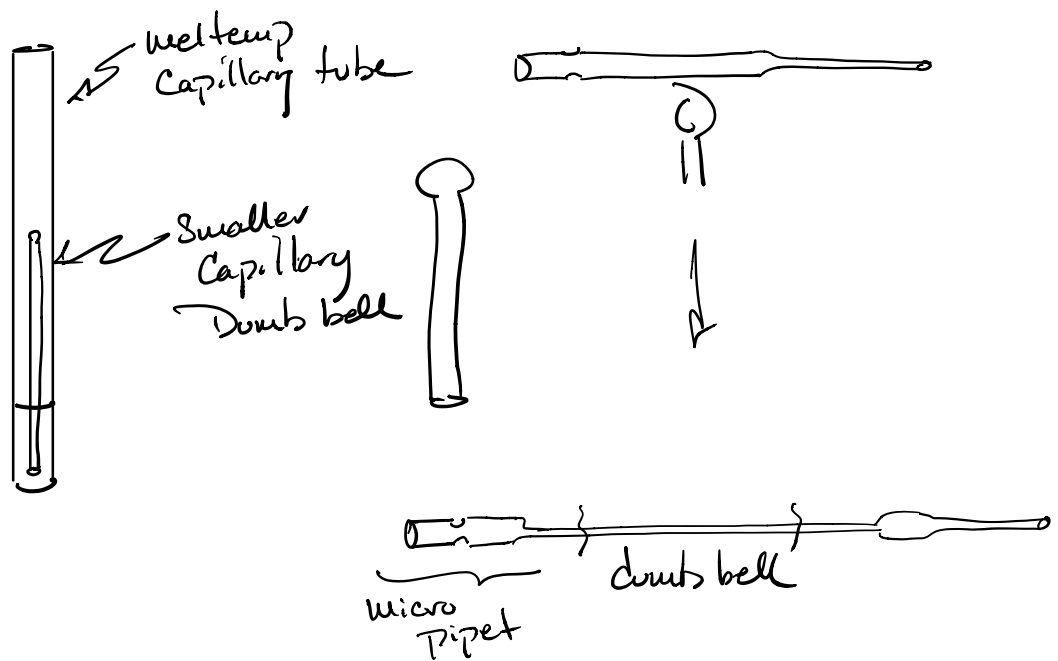
Boiling Points



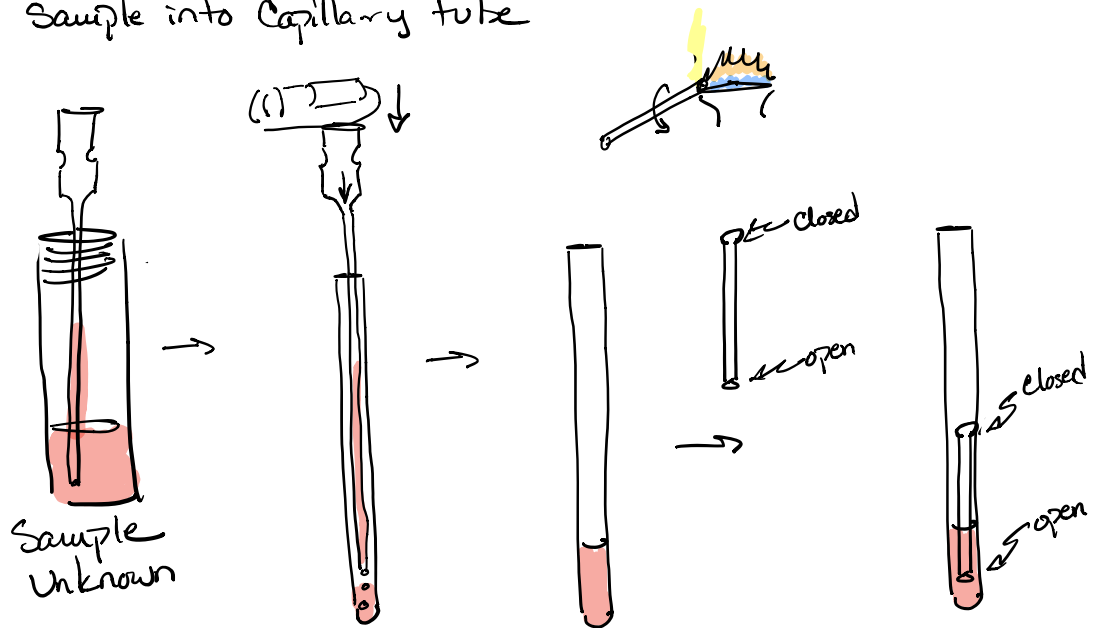
Meltemp

$$\text{Boiling Point} = P_{\text{vap}} = P_{\text{atm}}$$





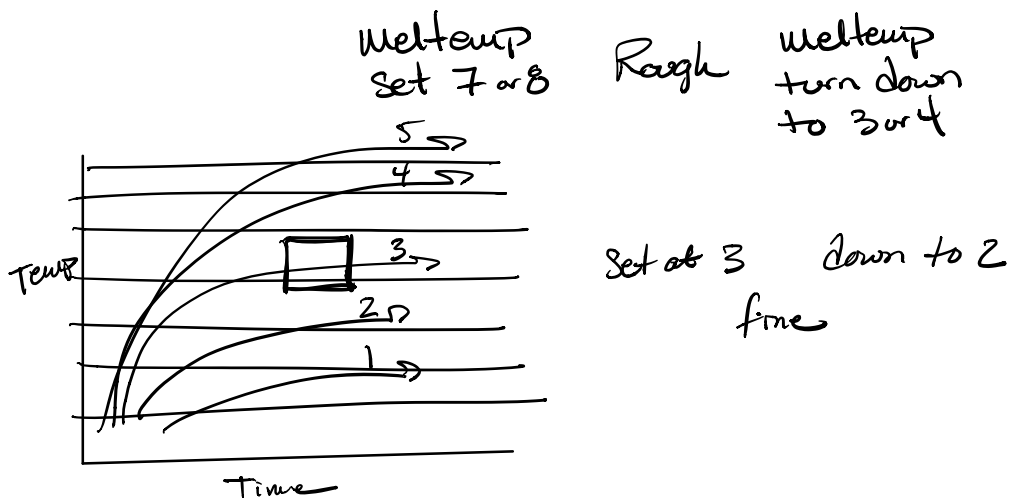
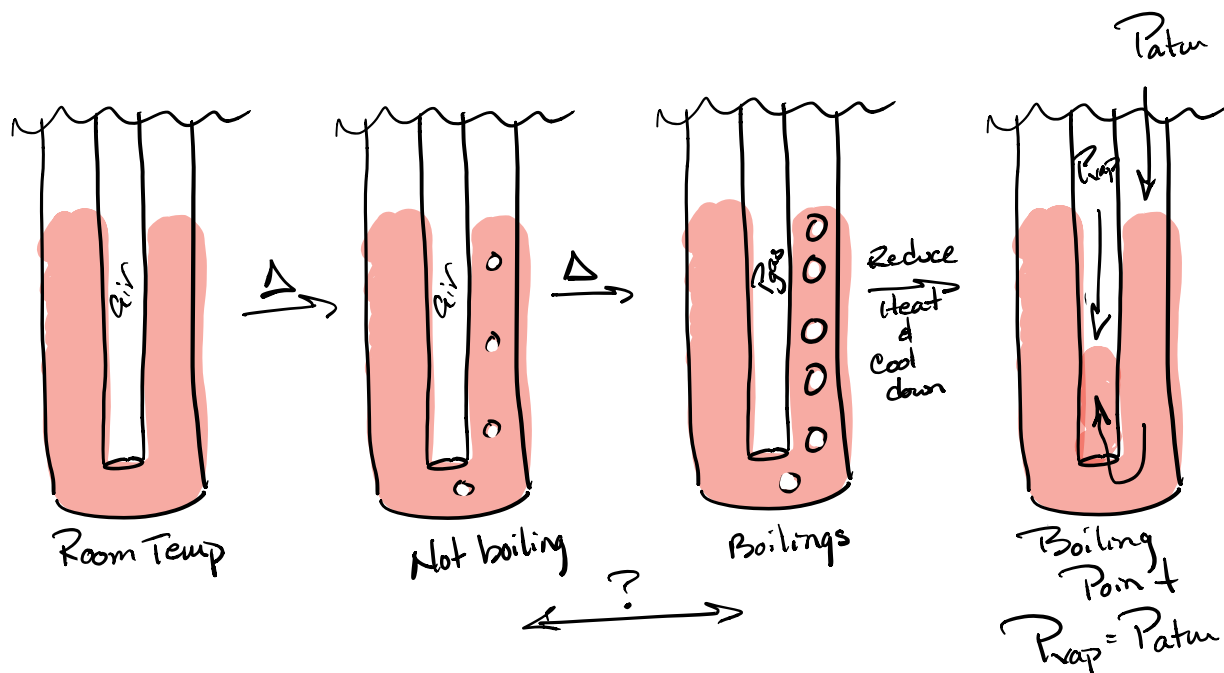
① Add Sample into Capillary tube



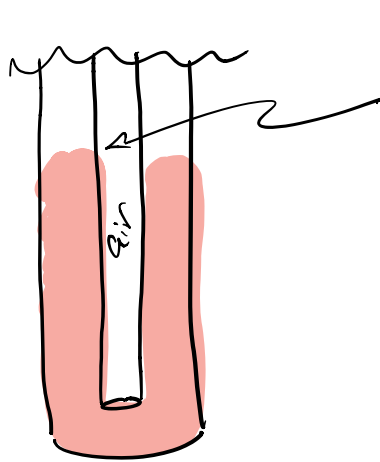
② make dumb bell

③ Add dumb bell to capillary

Taking the boiling Point

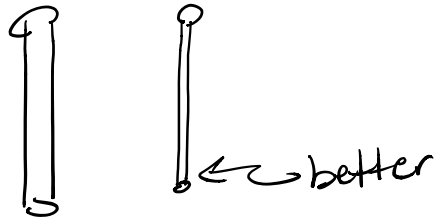


Goal Boiling Pt within $\pm 5^\circ\text{C}$ of actual

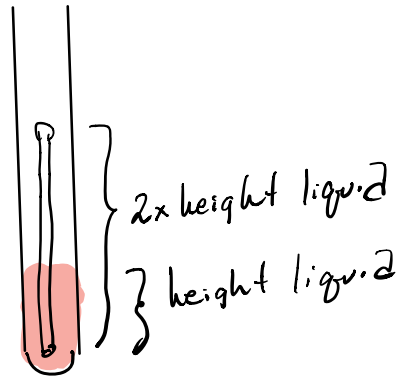


2 keys to success

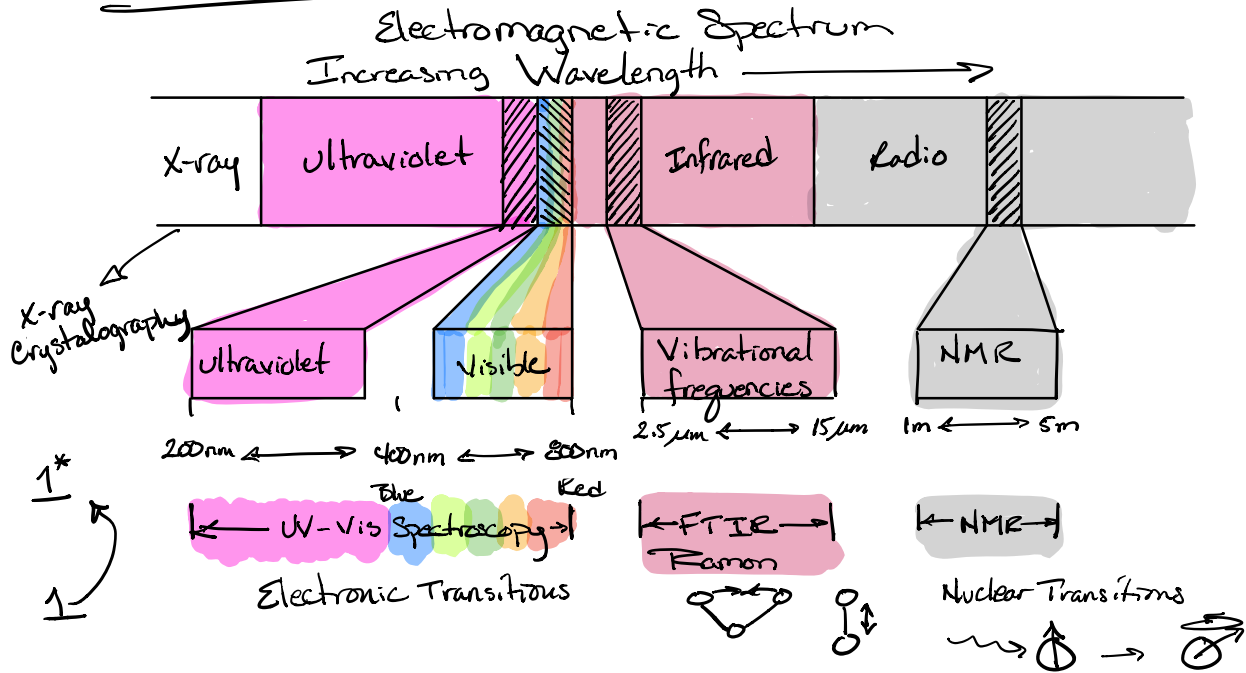
① Make capillary as thin as possible while still being a tube



② Height of capillary $2 \times$ height of liquid

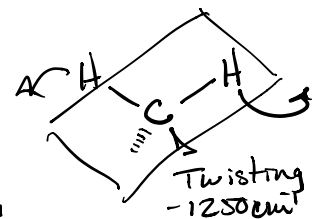
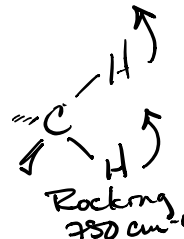
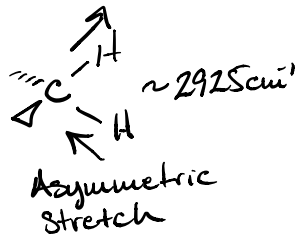
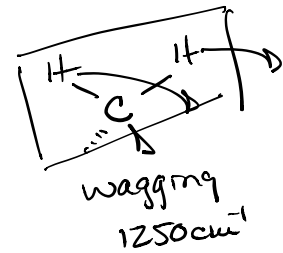
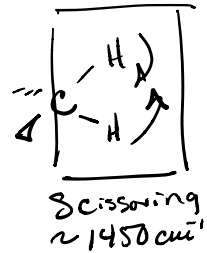
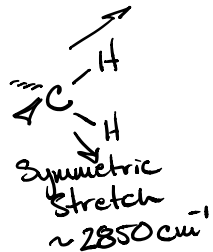
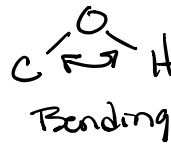
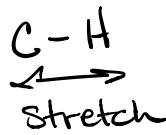
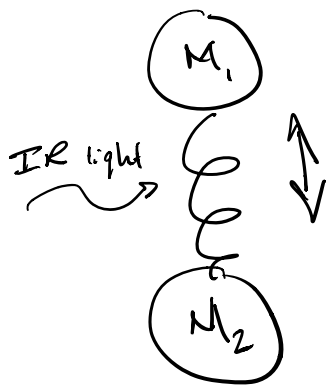


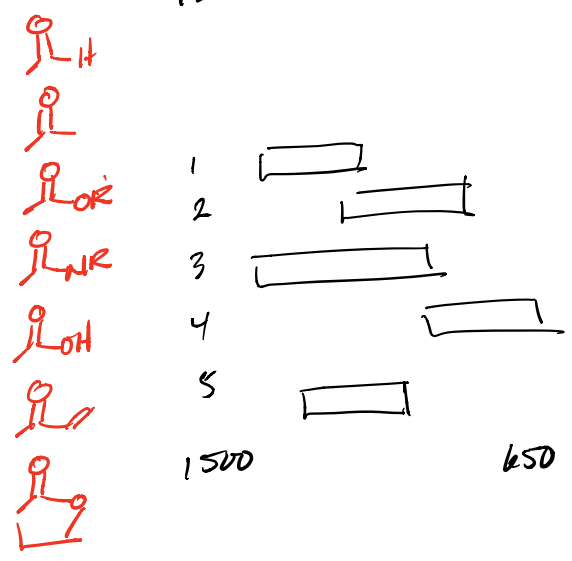
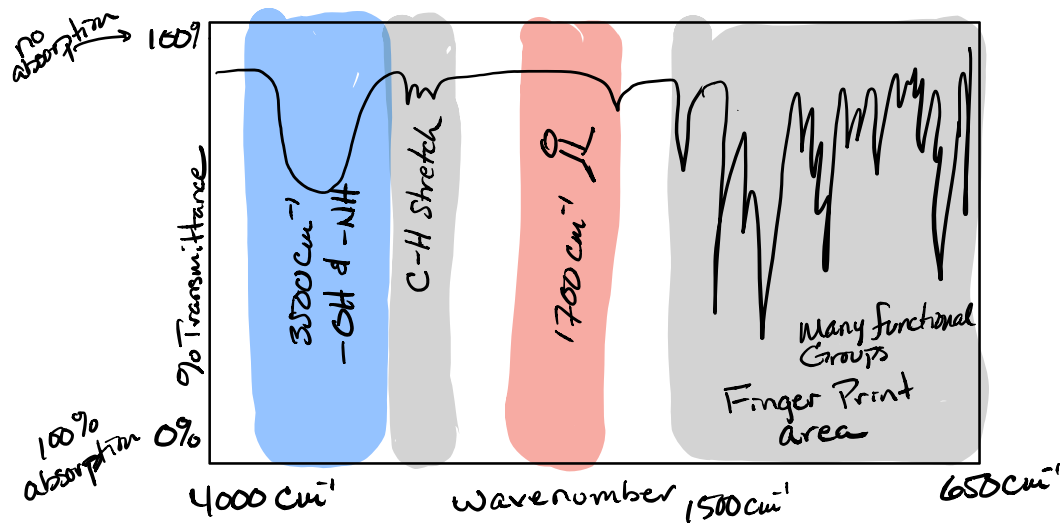
Infrared Spectroscopy

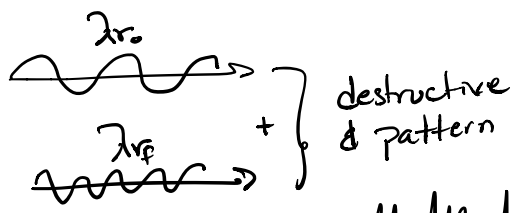
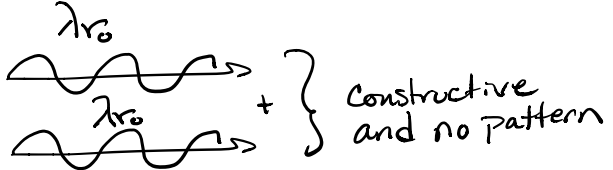
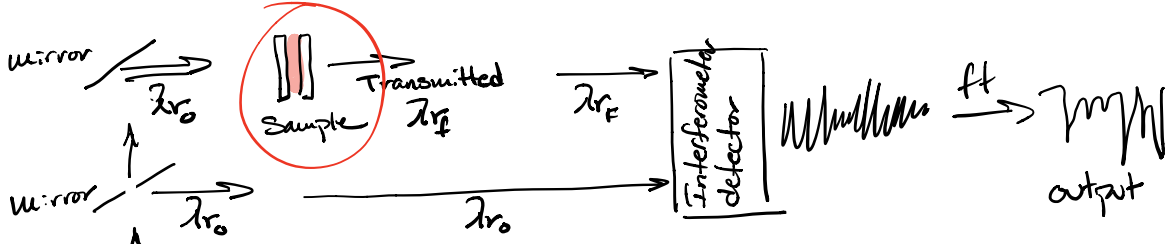


$$\text{Wavelength} = \mu\text{m} = 1 \times 10^{-6} \text{ m} = 1 \times 10^5 \text{ cm}$$

$$\text{Wavenumber} = \text{cm}^{-1} = \frac{1}{\mu\text{m}} \times \frac{10,000 \mu\text{m}}{1 \text{ cm}} = \frac{1}{\mu\text{m}} \times 10,000$$

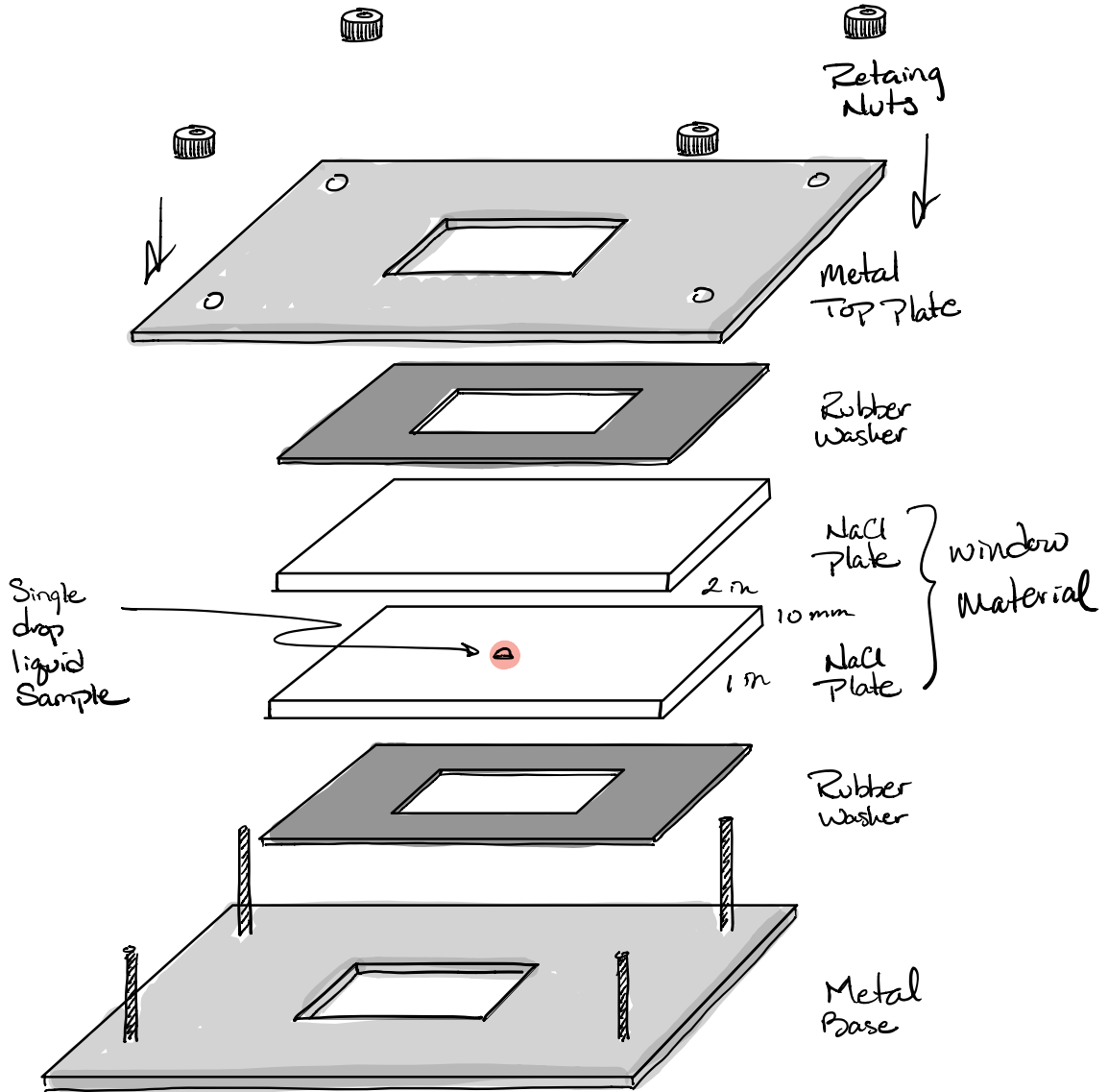


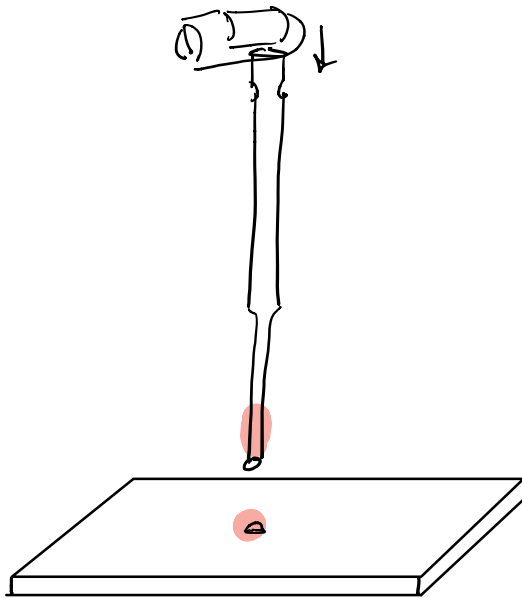
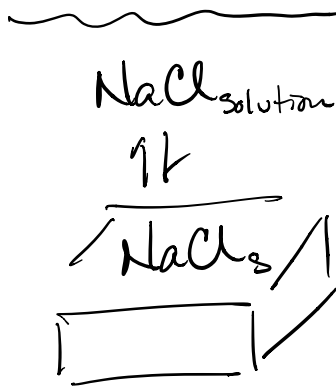
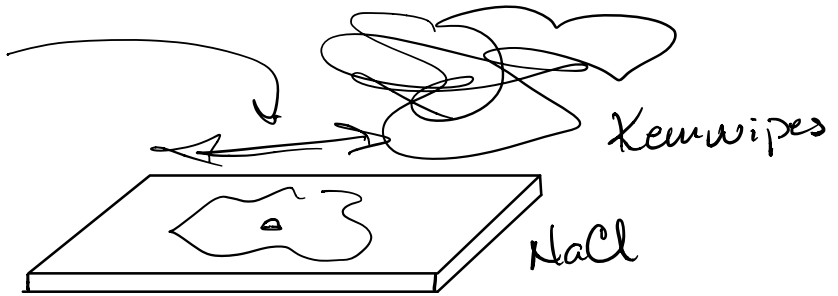
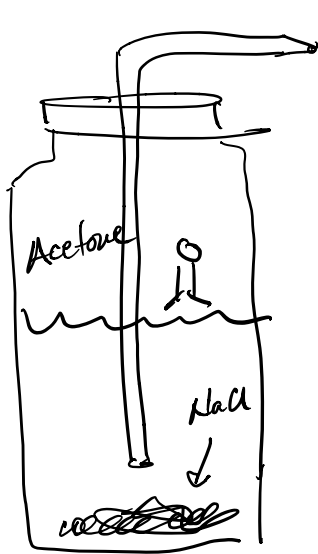




ft
fid

Sample Holder





OBSERVATION

PUDDLES AND WORMS...

IT MUST HAVE RAINED.

INFERENCE

AN IR BAND OF THIS SIZE AND SHAPE...

INFERENCE

PROBABLY THAT FUNCTIONAL GROUP.

ALL IR BANDS ARE EQUAL, BUT SOME ARE MORE EQUAL THAN OTHERS.

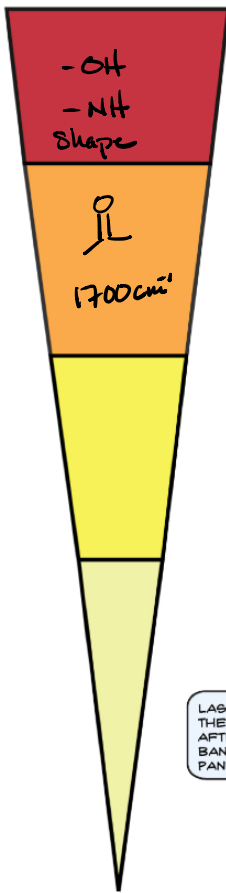
Alkyne (stretch)	ca. 3300	ca. 2100
Aldehyde	2900-2800	1700-1750
Alkyne	2900-2700	2100-2260
not interpretatively useful		
Alkene	1600-1660	3000-3100
Aromatic	1600 and 1475	3000-3100
Alkyne	2250-2100	1500-1600
Aldehyde	1740-1720	2800-3000
Ketone	1725-1705	2800-3000
Carboxylic Acid	1725-1700	2800-3000
Ester	1750-1730	2800-3000
Amide	1670-1640	2800-3000
Anhydride	1810 and 1760	2800-3000
Alcohol, Ethers, Esters, Carboxylic Acids, Anhydrides	1300-1000	2800-3000
Alcohol		2800-3000

MOVING DOWN THE CHART ONE AT A TIME, MATCHING BANDS AS YOU GO, IS NOT A USEFUL STRATEGY.

INSTEAD, LET'S ARRANGE THEM BY THEIR INTERPRETIVE POWER.

Alkyne (stretch)	ca. 3300
Aldehyde	2900-2800
	2800-2700
not interpretatively useful	
Alkene	1600-1660
Aromatic	1600 and 1475
Alkyne	2250-2100
Aldehyde	1740-1720
Ketone	1725-1705
Carboxylic Acid	1725-1700
Ester	1750-1730
Amide	1670-1640
Anhydride	1810 and 1760
Alcohol, Ethers, Esters, Carboxylic Acids, Anhydrides	1300-1000
Alcohol, Phenols	

GREAT INTERPRETIVE POWER



THIS IS THE FIRST REGION YOU SHOULD LOOK AT, AND THERE ARE 4 DIFFERENT SHAPES OF BANDS THAT YOU MAY SEE HERE.

Smooth & strong
Sharp weak
Sharp weak
Sharp strong

A SMOOTH TONGUE MEANS AN ALCOHOL... -O-H

VAMPIRE FANGS MEANS A PRIMARY AMINE... -N-H

ONE KNOCK-OUT FANG MEANS A 2° AMINE, OR A TERMINAL ALKYNE... -C≡C-H

HAIRY BEARD IS A SIGN FOR A CARBOXYLIC ACID... -COOH

IN THE C=O REGION, IT'S NOT THE SHAPE, BUT THE EXACT LOCATION THAT REVEALS THE IDENTITY OF THE FG.

NOTE THAT THE EXACT POSITION DEPENDS ON THE SURROUNDING ENVIRONMENT:

Table in Paris

STRAIN, OR CONJUGATED AT -O- (blue arrow, +30CM⁻¹)

CONJUGATED AT C=O (red arrow, -30CM⁻¹)

AT ~2200CM⁻¹, WE FIND TRIPLE BONDS: C≡C, AND C≡N

USUALLY SHARP (CAN BE SMALLISH)

HINT: USE 3300CM⁻¹ TO DISTINGUISH TERMINAL AND INTERNAL ALKYNES.

Interpreting IR spectra

JON - JKWCHUI@UVIC.CA

LASTLY, YOU SHOULD LOOK AT THESE FEATURES (BUT ONLY AFTER ANALYSING THE MAJOR BANDS IN THE PREVIOUS PANE(S))

UNSATURATED C-H STRETCH

SATURATED C-H STRETCH

3000CM⁻¹

ALKENE/AROMATIC SUBSTITUTION PATTERN CAN BE SEEN IN THE C-H BEND REGIONS.

MONO, GEM (1,1-) DI-SUBSTITUTED, CIS-, TRANS-

MONO: 1600, 1450, 900, 810

ORTHO: 750

META: 830, 780, 690

PARA: 830

STRONGS: 1610, 1510

~900 (STRONG)

~700 (WEAK)

~970 (STRONG)

LASTLY, A PEAK AT 2700CM⁻¹, TOGETHER WITH A C=O, IS INDICATIVE OF AN ALDEHYDE.

C-H STRETCH

2700cm⁻¹

1700cm⁻¹

C=O STRETCH

R-C-H

KETONES HAVE NO C-H IN THEM AND CAN HAVE NO 2700 C-H STRETCH PEAKS.

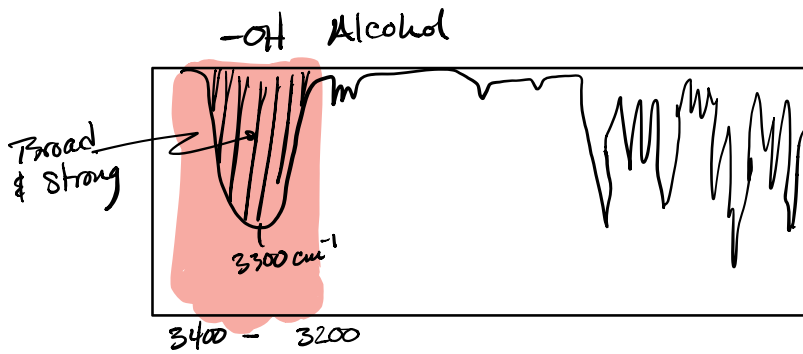
NOTES

** IF YOU'RE NOT SURE WHAT THE DIFFERENCE BETWEEN AN ACID AND AN ALCOHOL IS, DO THE QUICK "FUNCTIONAL GROUP IDENTIFICATION" EXERCISE.

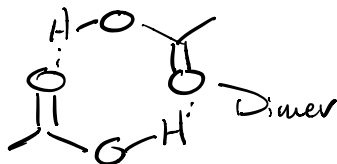
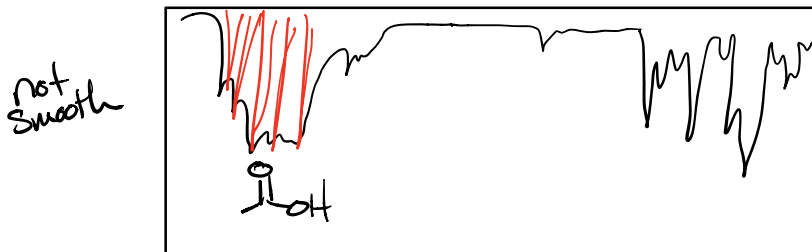
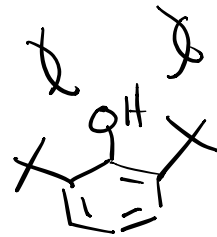
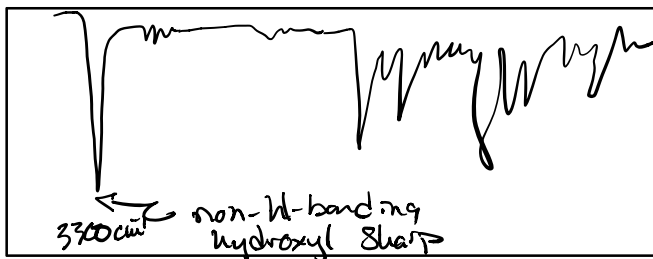
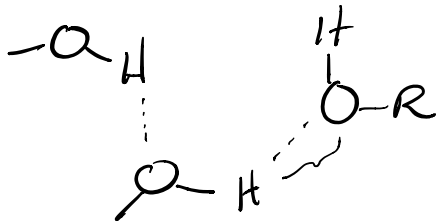
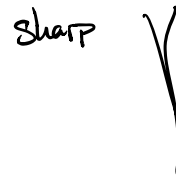
** ...IF YOU HAVE ONE FG. TWO 2° AMINE WOULD LOOK LIKE A 1 AMINE.

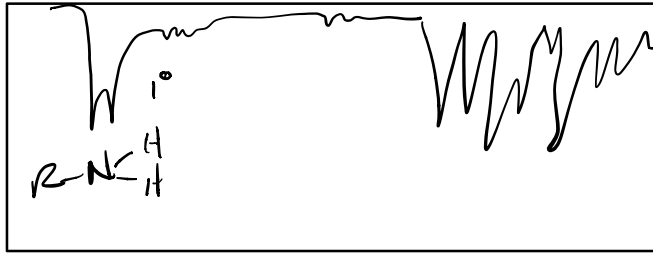
WE LOOKED AT THESE LAST BECAUSE THEY CAN BE AMBIGUOUS TO INTERPRET, OR THEY HAVE ONLY A NARROW NICHE OF USEFULNESS.

3400 cm^{-1} \rightarrow 3200 cm^{-1} OH & NH

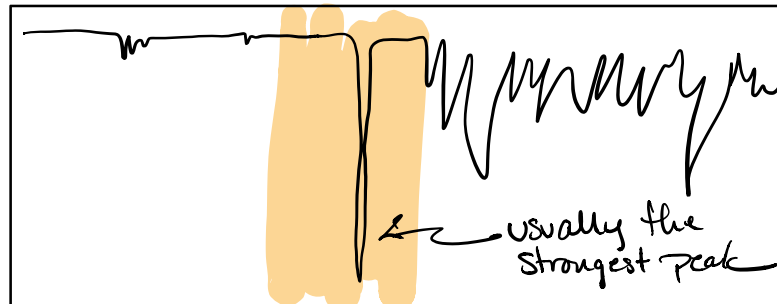


Strong 0-20% T
 Med 20-70% T
 Weak 70-95% T





Carbonyl



1720 - 1700 cm⁻¹ - 1650