

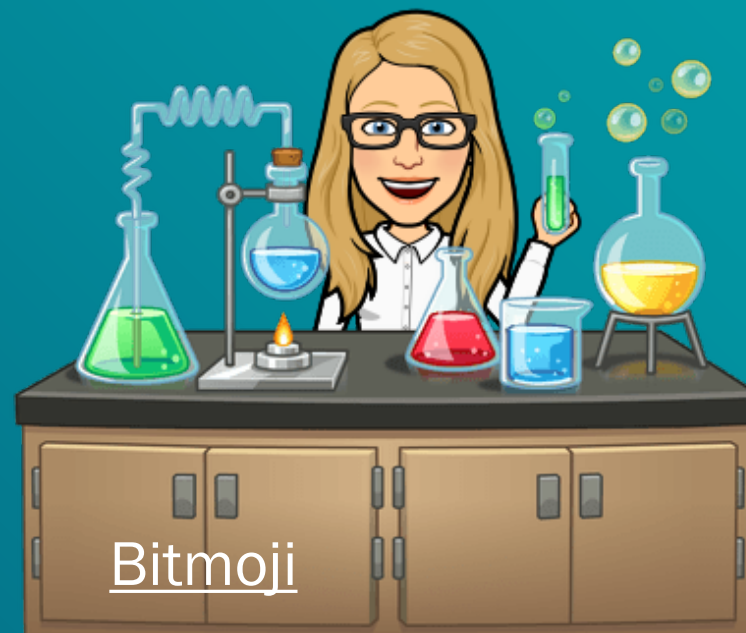
# Teaching Online Organic Chemistry “Labs” and Lectures: Moving beyond Survival Mode



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WILEY

# Ten Weeks in: Lessons Learned

- Invest in an iPad (Apple Pencil, Paperlike screen protector)
- Gradescope to manage student work
- Genius Scan to make PDF w/phone
- Use a headset (good mic, mute button)
- Get a good snipping tool (Snagit)
- Create a YouTube channel



# PLANNING for Remote/Hybrid Teaching

## ACS Guidelines

- Goal: be flexible and enable majors to graduate on time
- Proficiency with hands-on lab skills can be addressed in creative ways (*e.g.*, immersive face-to-face short course)
- Exceptions can be made to certification requirements

## Focus on Student Learning Objectives (SLOs)

- All planning, all activities, all assessments guided by SLOs

## Keeping students motivated (Motivate Lab training/resources)

- Growth Mindset – Purpose & Relevance – Sense of Belonging

# Building Community

## Introduction video

- Introduce yourself, share your passion

## Course Padlet

- Students can introduce themselves

## Encourage study groups

- Organic Learning Community (OLC)
- Offer credit for weekly report w/selfie pic

## Foster communication

- Discussion boards, Discord, Google Voice

<https://discord.gg/m6gQWE>





# Online Lecture Pros & Cons:

## Synchronous

## VS.

## Asynchronous

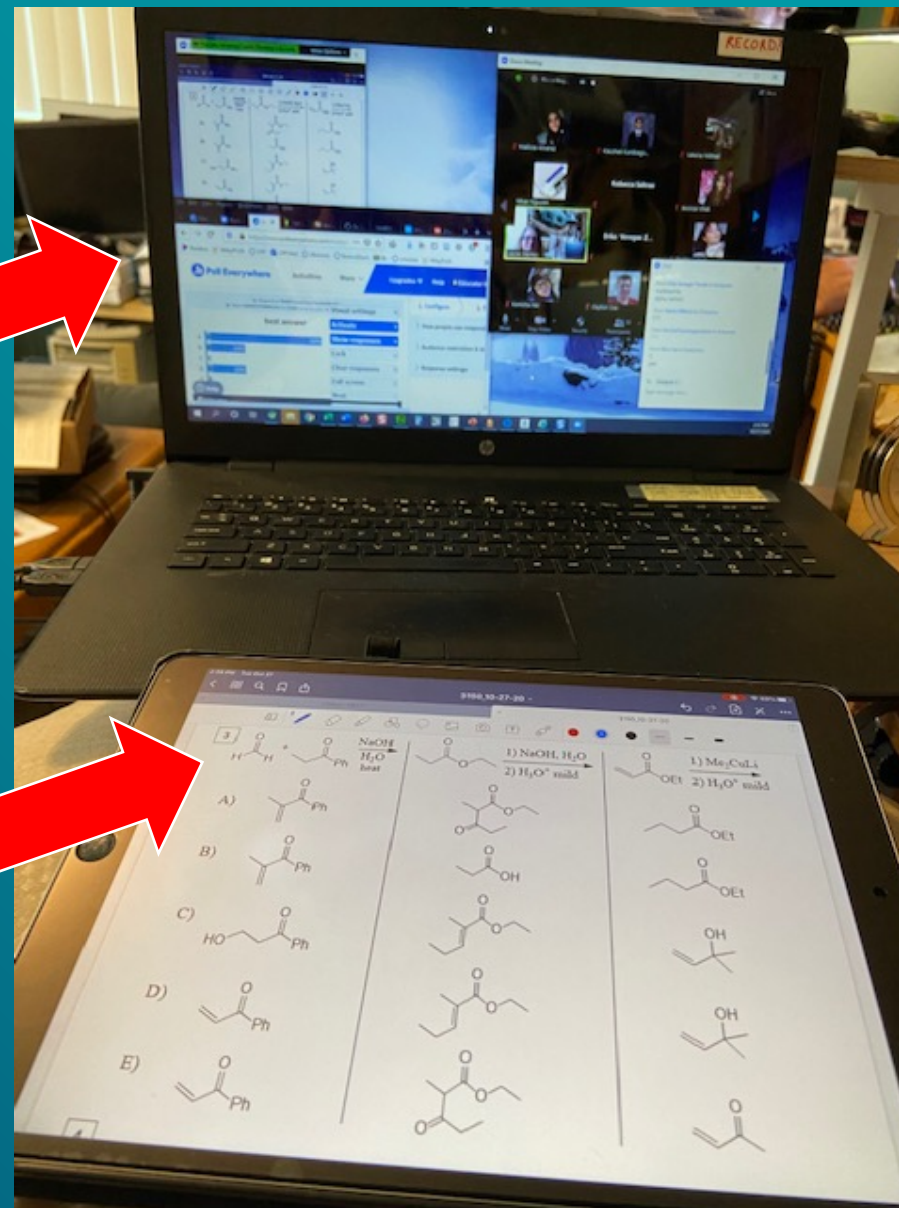
# Synchronous Lecture Delivery (aka Live Show)

- Students can ask questions, provide feedback
- YOU can ask questions
- Breakout sessions for discussion, problem-solving
- Builds community
- Preferred by students: online overload, getting what you pay for
- ***Disadvantages...***
  - *Minimal student participation (Is anyone laughing at my jokes?)*
  - *Students are reluctant to use video*
  - *Can be exhausting*
  - ***Equity concerns (Always make recordings available!)***

# My Online Classroom

Laptop  
(Zoom &  
Webcam)

iPad (Zoom  
& GoodNotes)



Clock!

# How to: Teach Synchronously & DRAW Using Zoom

The screenshot shows a Zoom meeting window with several features highlighted:

- Shared iPad screen:** A red box highlights the top of the Zoom window where the shared screen is indicated.
- Chat Q/A:** A red box highlights the chat window on the right side of the screen.
- Zoom Attendees:** A red box highlights the grid of participant video feeds in the center.
- Anonymous Polling:** A red box highlights the bottom toolbar where the 'Poll' icon is located.
- My Webcam:** A red box highlights the bottom right corner of the Zoom window.

The shared screen displays a chemical reaction scheme and a poll results page.

**Chemical Reaction Scheme:**

Reaction 1: Cyclopentanone  $\xrightarrow{\text{Step 1}}$  1-cyclopentanol  $\xrightarrow{\text{Step 2}}$  1-acetylcyclopentane

Reaction 2: Cyclopentanone  $\xrightarrow{\text{Step 1}}$  1-cyclopentanol  $\xrightarrow{\text{Step 2}}$  1-acetylcyclopentane

Reaction 3: Cyclopentanone  $\xrightarrow{\text{Step 1}}$  1-cyclopentanol  $\xrightarrow{\text{Step 2}}$  1-acetylcyclopentane

**Poll Results:**

Option	Percentage
A	11%
B	11%
C	56%
D	11%
E	22%

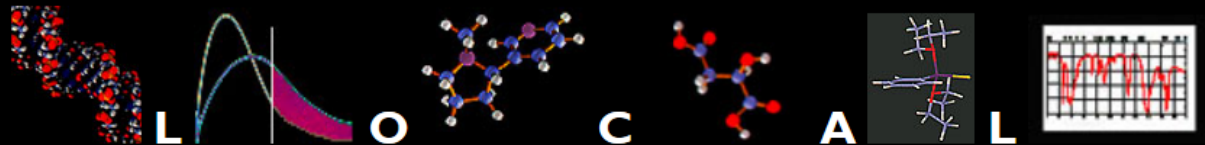


# How to: Teach Synchronously & DRAW Using Zoom

- Provide worksheet or skeleton notes as PDF
  - ChemDraw, PowerPoint, Word
  - Hand-written notes captured with **Genius Scan**
- Start Zoom session on laptop for best functionality
  - Webcam for video of me
  - Full keyboard for chat
  - presenter tools easy to find/use
  - can share screen to show LMS/websites/VitalSource text
- Join Zoom session with my iPad or phone and share screen
  - Phone camera can capture you writing on paper
  - iPad apps enable marking up PDF to work, annotate notes

# Active Learning: Worksheets, Clicker Questions...

<https://www.cpp.edu/~lsstarkey/local>



**Library for Organic Chemistry Active Learning**

Created by [Laurie Starkey](#), Professor of Organic Chemistry at [Cal Poly Pomona](#)  
To contribute materials, please contact Laurie (and thank you!) [lsstarkey@cpp.edu](mailto:lsstarkey@cpp.edu)

**\*\*\*\*COVID-19 & Remote Teaching Resources\*\*\*\***

Active-Learning Resources can also be found here: [organicERs.org](http://organicERs.org) | [MERLOT.org](http://MERLOT.org)

Clicker Questions:

Bonding/Structure, Acid-Base, Nomenclature	Stereochem, Radicals, Study of Reactions	Substitution & Elimination Alkene/Alkyne Reactions	Alcohols, Ethers & Epoxides
<a href="#">Lewis Structures &amp; Line Drawings</a> <a href="#">Resonance &amp; Hybridization/3-D</a> <a href="#">Acid-Base</a> <a href="#">MO Theory</a> <a href="#">Physical Properties</a> <a href="#">Nomenclature</a> <a href="#">Sites of Unsaturation (DU)</a> <a href="#">Conformations of Alkanes &amp; Cyclohexanes</a>	<a href="#">Chirality &amp; Optical Activity</a> <a href="#">R/S, E/Z Nomenclature</a> <a href="#">Stereochemical Relationships</a> <a href="#">Radical Reactions</a>  <a href="#">Thermodynamics, Kinetics &amp; Reaction Coordinate Diagrams</a>	<a href="#">Substitution Reactions (S<sub>N</sub>1/S<sub>N</sub>2)</a> <a href="#">Elimination Reactions (E1/E2)</a> <a href="#">Substitution vs. Elimination</a> <a href="#">Dehydration of Alcohols</a> <a href="#">Alkene Additions and Oxidation</a> <a href="#">Alkyne Reactions</a> <a href="#">Synthesis Strategies (Klein Ch. 11)</a> <b>**NEW**</b>	<a href="#">Alcohol Reactions</a> <a href="#">Grignard &amp; Hydride Reagents</a> <a href="#">Epoxide &amp; Ether Reactions</a> <a href="#">Alkoxides &amp; Thiols</a>  <a href="#">Syntheses Involving Alcohols</a>
Carbonyl Chemistry	Alpha-Carbon Chemistry	Conj. Systems, Aromaticity	Additional Topics

# Why use video to supplement Lecture and Textbook?

A great lecture can be great, but it cannot be...

**PAUSED** if a student needs to think  
**REPLAYED** if not grasped immediately  
**REPEATED** for exam review  
**CAPTIONED** not just for the impaired!  
**TRANSLATED** into another language  
**DELIVERED** to a student who is absent

*(Fall 2020 update: to all students  
because campus is closed!)*

***Note: this slide is  
from March, 2020***

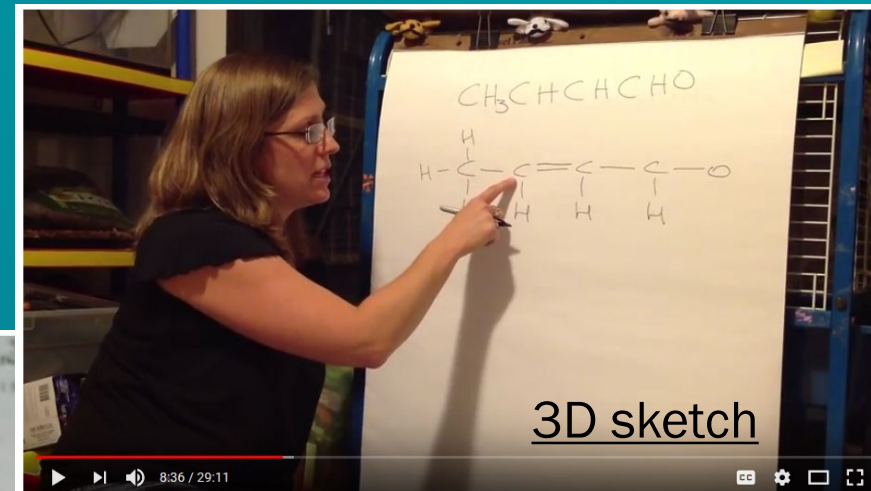
# Asynchronous Lecture Delivery (aka Videos)

- Works with student schedules
- More efficient use of faculty time
- Planned videos: professional, organized, good for future use
- “Flipped classroom” model – videos + problem-solving
- Asynchronous option must be available anyway (EQUITY)
- ***Disadvantages***
  - *no real-time interaction*
  - *Can't build relationships*  
*(faculty/student and student/student)*
  - *Lacking a sense of community*

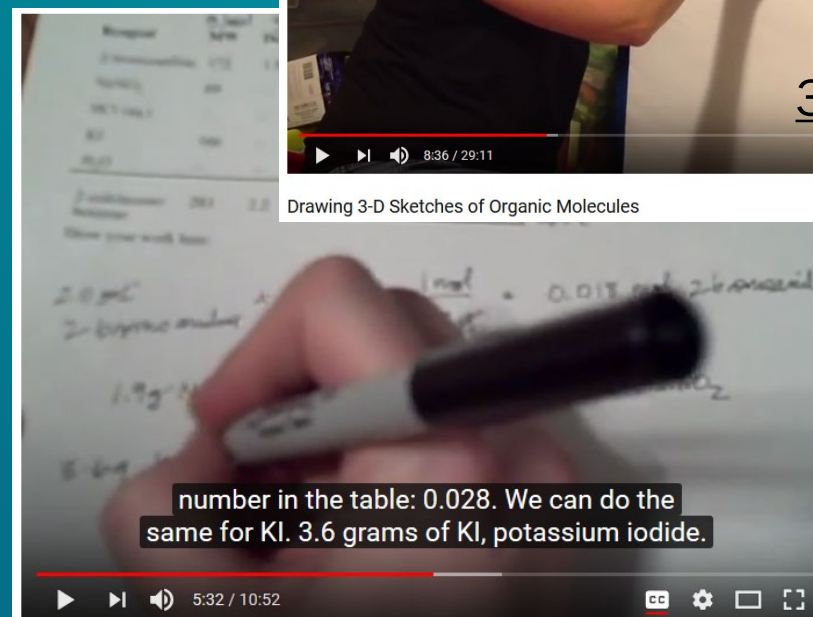


# Making videos the old -fashioned way

- Record a presentation with video camera
- Need tripod or videographer (studio at your institution?)
- Pros
  - quick & easy
  - instructor-student relationship
- Cons
  - Limited (or zero) editing options
  - Poor resolution



Drawing 3-D Sketches of Organic Molecules



number in the table: 0.028. We can do the same for KI. 3.6 grams of KI, potassium iodide.

Completing the Reagent Table for Organic Chemistry Lab Notebook

reagent  
table

# 21<sup>st</sup> Century lecture: transparent lightboard

- Present a lecture with a “Learning Glass” or lightboard!
- Neon writing + maintaining eye contact = captivating lecture!
- Inexpensive to build (how it works)

HYBRIDIZATION + GEOMETRY

Laurie Starkey  
Cal Poly Pomona

Result + Geometry (VSEPR)

four "sp<sup>3</sup>" hybrid orbitals (tetrahedral)

three "sp<sup>2</sup>" hybrid orbitals + one p orbital (trigonal planar)

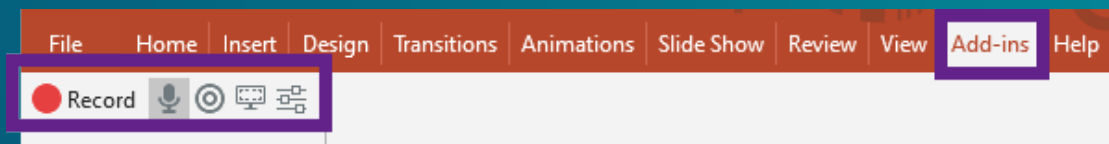
two "sp" hybrid orbitals + two p orbitals

draw this is if we took a different point of view of this same 3-D molecule and said,

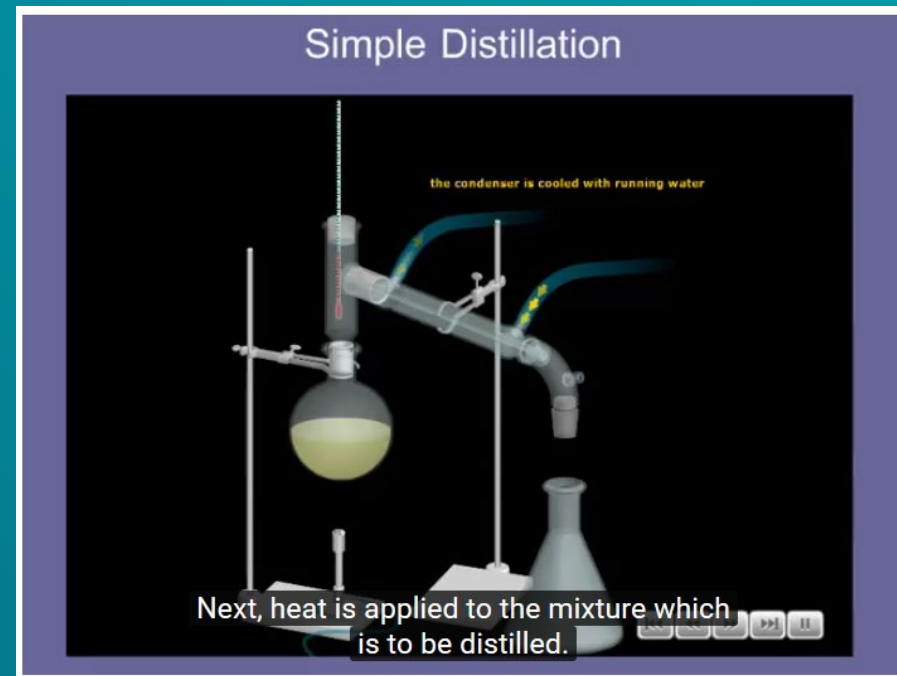
Example Molecule	Regions e-density	Hybridization	SPPP
	4	sp <sup>3</sup>	✓✓✓✓
	3	sp <sup>2</sup>	✓✓✓□
	2	sp	✓✓□□

# Camtasia: screen capture & video editing

- Uses screen capture (while recording voice) to make videos
- Great for demonstrating software
- PowerPoint integration



- Advanced editing tools (learning curve)
- Tutorials: <http://tiny.cc/CreatingPedagogicalVideos>
- Examples: [tutorial](#) and [solved problem](#)



Distillation Tutorial



# iPad/Tablet Screen Capture

- Screencasting = records voice + writing
- Import slides/graphs/images for markup
- Export videos to camera roll
- Best stylus = Apple pencil
- Can be used during f2f lecture (Airplay to project on screen) and during Zoom meeting





# Apps for Screen Capture

Lecture-capture w/iPad apps - can export videos to YouTube

Explain Everything   Cyclohexane   and Doceri   Reagent Table

Also:

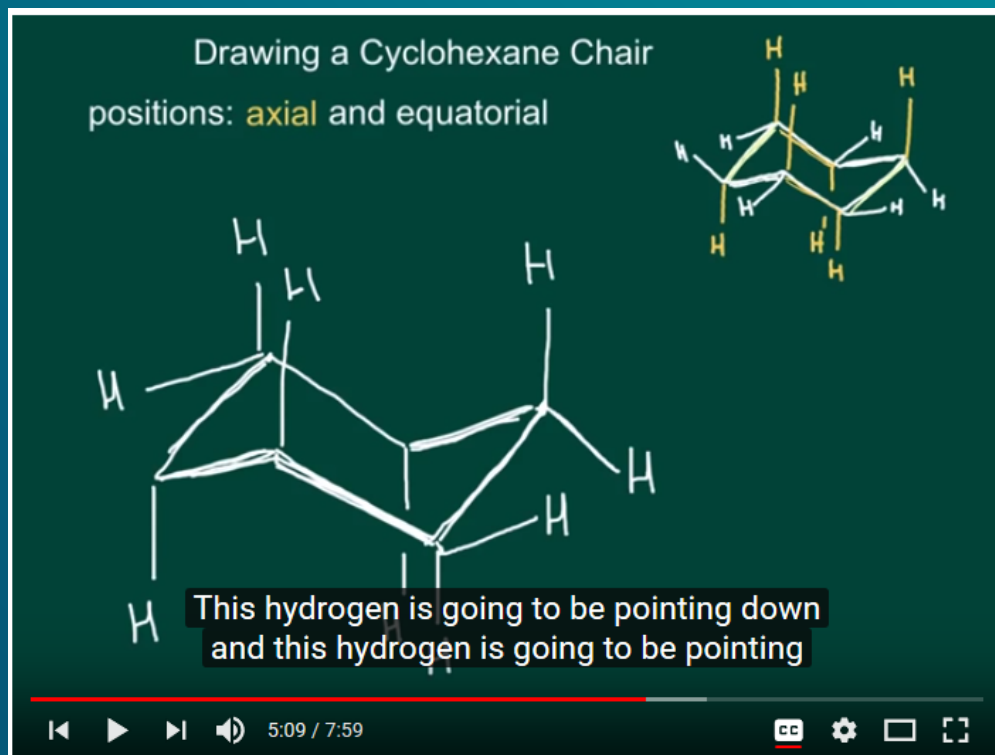
GoodNotes

Sketchbook Pro

Screencast-  
O-Matic

TouchCast

And many more



Completing the Reagent Table for Prelab

Nc1ccccc1Br  $\xrightarrow[2) \text{KI}]{1) \text{NaNO}_2, \text{HCl}}$  Ic1ccccc1Br

Reagent	MW	Density	Amount	Mole	Equiv.	Remarks
2-bromoaniline	172	1.56	2.0 mL	0.018	1.0	bp 229 °C
NaNO <sub>2</sub>	69	--	1.9 g	0.028	1.6	--
HCl (aq.)	--	--	5.0 mL	--	excess	Corrosive!
KI	166	--	3.6 g	0.022	1.2	--
H <sub>2</sub> O	--	--	10 mL	--	--	--
2-iodobromo-benzene	283	2.2		0.018	1.0	bp 240 °C, mp 9 °C

Limiting reagent = smallest # moles  
↳ determines # moles product  
Theoretical 0.018 mol  
Yield (TY) 2-iodobromo benzene

# Thinking Beyond Fall 2020 - Sharing Your Work

- Private (LMS) or Public (webpage link, MERLOT)
- Maximum exposure: make a YouTube channel!
  - Include captioning for accessibility (Hablas Español? Si!)
- ChemistryConnected, created in 2012, has over 730,000 views and over 1,500 subscribers
  - Pre-lab tutorials, solved problems, demos of hands-on elementary school science activities
  - Over half the views have come from outside the U.S. (200 different countries)

<http://www.youtube.com/user/ChemistryConnected>

# Create a YouTube Channel

EDU Educator.com online organic

Not buried in LMS,  
so videos can be  
accessed by your  
students after  
current  
semester...  
and by other  
students around  
the world!  
**FACULTY** can  
provide quality  
content on  
YouTube.

**ChemistryConnected**  
1.34K subscribers

[CUSTOMIZE CHANNEL](#) [YOUTUBE STUDIO](#)

HOME VIDEOS **PLAYLISTS** COMMUNITY CHANNELS ABOUT

Created playlists SORT BY







Thumbnail	Playlist Title	Number of Videos
	Lab Notebook	2
	Drawing 3-D Sketches of Organic Molecules	6
	Distillation Tutorial	20
	TLC (Thin Layer Chromatography) Tutorial	19
	Extraction Tutorial	15
	Resonance problems - set 1	5
	Hands-on Experiments for Kids	7
	Melting Point Tutorial	9
	Drawing Cyclohexane Chair Conformations	3
	Recrystallization Tutorial	11



# Teaching Remote/Hybrid “Labs”

Focus on SLO to plan activities

- Basic techniques
- Writing/Notebook skills
- Safety
- Advanced techniques
- Spectroscopy
- Working as a Scientist

HCS Pictograms and Hazards		
<b>Health Hazard</b>  <ul style="list-style-type: none"><li>• Carcinogen</li><li>• Mutagenicity</li><li>• Reproductive Toxicity</li><li>• Respiratory Sensitizer</li><li>• Target Organ Toxicity</li><li>• Aspiration Toxicity</li></ul>	<b>Flame</b>  <ul style="list-style-type: none"><li>• Flammables</li><li>• Pyrophorics</li><li>• Self-Heating</li><li>• Emits Flammable Gas</li><li>• Self-Reactives</li><li>• Organic Peroxides</li></ul>	<b>Exclamation Mark</b>  <ul style="list-style-type: none"><li>• Irritant (skin and eye)</li><li>• Skin Sensitizer</li><li>• Acute Toxicity (harmful)</li><li>• Narcotic Effects</li><li>• Respiratory Tract Irritant</li><li>• Hazardous to Ozone Layer (Non-Mandatory)</li></ul>
<b>Gas Cylinder</b> 	<b>Corrosion</b> 	<b>Exploding Bomb</b> 



# Student Learning Objectives

## O-Chem Lab

Basic Techniques	performing a distillation
	running a TLC
	follow rxn progress by TLC
	exploring TLC solvent combos
	performing an extraction
	acid-base extractions
	doing a recrystallization
	choosing a solvent for recrystallization
	taking a melting point
	taking a mixed melting point
	refluxing a reaction
	running a flash column
	choosing a solvent for flash column
Writing	using a rotovap
	using a GC
	writing a scientific paper
	writing an introduction/summary
Safety	maintaining a lab notebook
	completing a reagent table
	gathering SDS safety data
	identifying/recognizing hazards
	responding to hazards
	minimizing hazards
	operating safely in a lab

Adv. Techniques	running a multistep synthesis
	statistical analysis of experimental data
	experience with computational methods
	polymer synthesis, characterization
	dry ice/acetone bath
	working with a solvent still
	air-sensitive reaction/syringe
Spectroscopy	vacuum distillation
	natural product isolation
	running an IR spectrometer
	interpreting IR spectra
	preparing an NMR sample
	taking an NMR (60 MHz)
	interpreting NMR spectra
	processing of NMR data
	interpreting 2D NMR
	NMR with impurities/solvents
	NMR of mixtures
	C-13 and DEPT NMR
	interpreting Mass spectra

Working as a Scientist	working with lab partner
	working independently
	performing variations of exp. (e.g. kinetics)
	modifying a given procedure
	using a literature procedure
	designing an experiment
	determining a suitable rxn workup
	planning a multistep synthesis
	identification of an unknown
	decision-making during procedure
	dealing with unexpected outcomes
	searching the literature

# Opportunities to Meet Neglected SLOs

## Organic Chem Lab Learning Objectives

	Fully met
	Partially met
	<b>SLO not achieved</b>

Basic Techniques	performing a distillation	
	running a TLC	
	follow rxn progress by TLC	
	exploring TLC solvent combos	
	performing an extraction	
	acid-base extractions	
	doing a recrystallization	
	choosing a solvent for recrystallization	
	taking a melting point	
	taking a mixed melting point	
	refluxing a reaction	
	running a flash column	
	choosing a solvent for flash column	
	using a rotovap	
	using a GC	
Writing	writing a scientific paper	
	writing an introduction/summary	
	maintaining a lab notebook	
	completing a reagent table	
Safety	gathering SDS safety data	
	identifying/recognizing hazards	
	responding to hazards	
	minimizing hazards	
	operating safely in a lab	

Adv. Techniques	running a multistep synthesis	
	statistical analysis of experimental data	
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	air-sensitive reaction/syringe	
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Spectroscopy	natural product isolation	
	running an IR spectrometer	
	interpreting IR spectra	
	preparing an NMR sample	
	taking an NMR (60 MHz)	
	interpreting NMR spectra	
	processing of NMR data	
	interpreting 2D NMR	
	NMR with impurities/solvents	
	NMR of mixtures	
	C-13 and DEPT NMR	
	interpreting Mass spectra	

Working as a Scientist	working with lab partner	
	working independently	
	performing variations of exp. (e.g. kinetics)	
	modifying a given procedure	
	using a literature procedure	
	designing an experiment	
	determining a suitable rxn workup	
	planning a multistep synthesis	
	identification of an unknown	
	decision-making during procedure	
	dealing with unexpected outcomes	
	searching the literature	

# Student Learning Objectives O-Chem Lab

- [OrganicERs.org](#) Organic Education Resources Community
- [Teaching Labs Remotely](#) blog by Cathy Welder
- [COVID-19 Resources](#) webpage by Laurie Starkey
- Facebook Groups
  - Strategies for Teaching Chemistry Online
  - OrganicERs

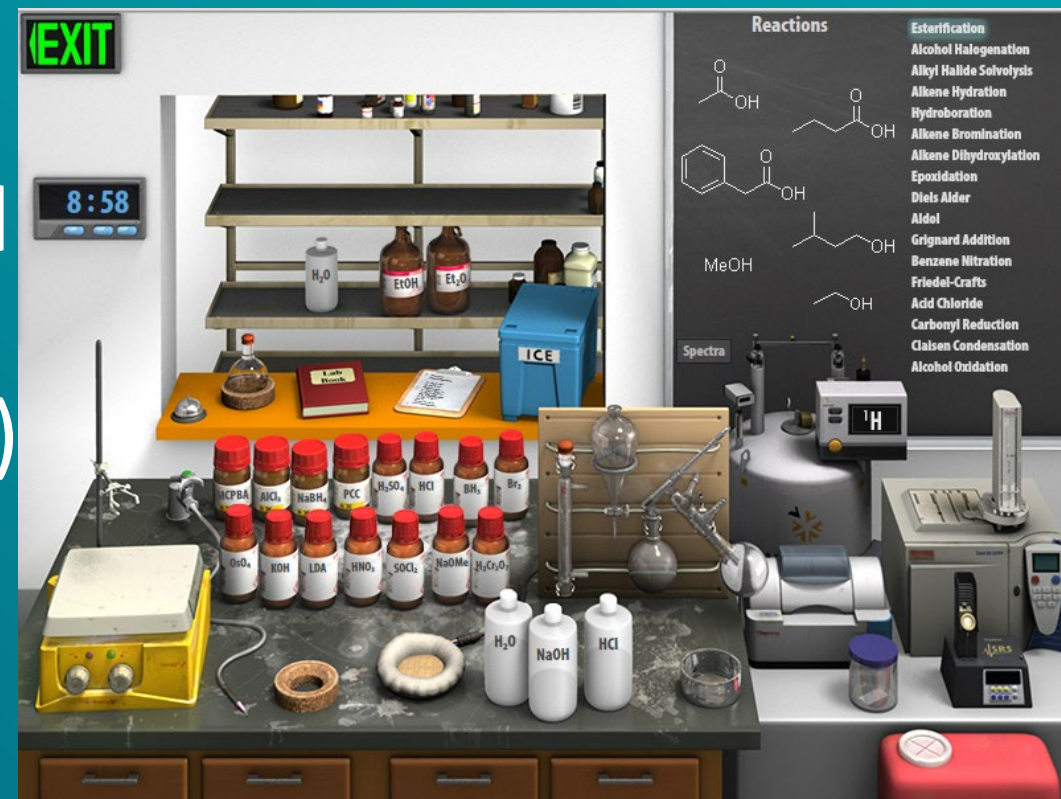
# Options for At -Home Lab Activities

- Commercial lab kits: Holscience, Carolina
- Recrystallization of brown sugar
- Extraction (Brewing coffee? Salting out isopropanol?)
- Paper chromatography
- Shoebox polarimeter (*JCE* 2018)
- Cabbage dye indicator



# Virtual “Lab” Options – Beyond Labz

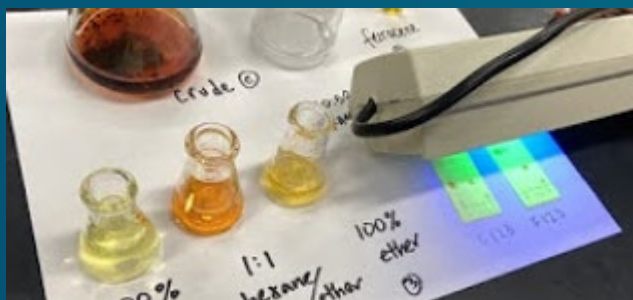
- Simulated lab experiments
- Enables multiple trials
  - Kinetic v. Thermodynamic control
  - Vary substrate, solvent
  - Mistakes allowed (forget N<sub>2</sub> line?)
- Follow reaction progress by TLC
- Simple extractive workup
  - Remove pyridine w/acid wash
- Analysis: IR, NMR, Mass Spec, M.P.
- \$25/year, better aligned with 2<sup>nd</sup> semester



Beyond Labz Worksheets

# Virtual “Lab” Options – Watch Videos

- Prepare notebook/procedure
- Record observations
- Spot mistakes/critique techniques in videos
- Embed questions!
- Watch together, discuss



acylation of  
ferrocene

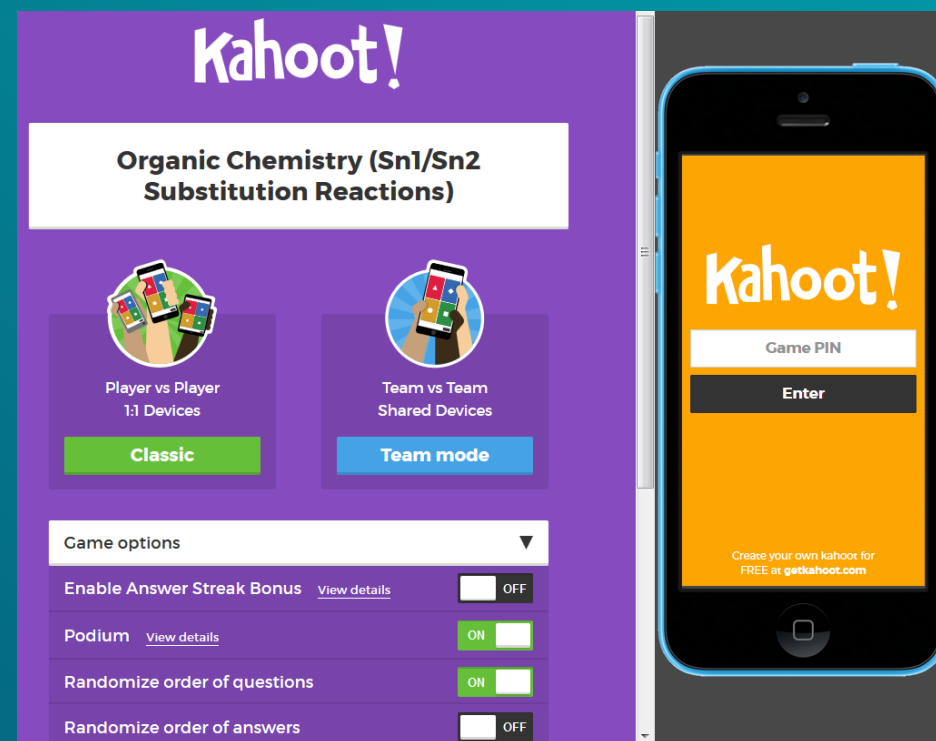
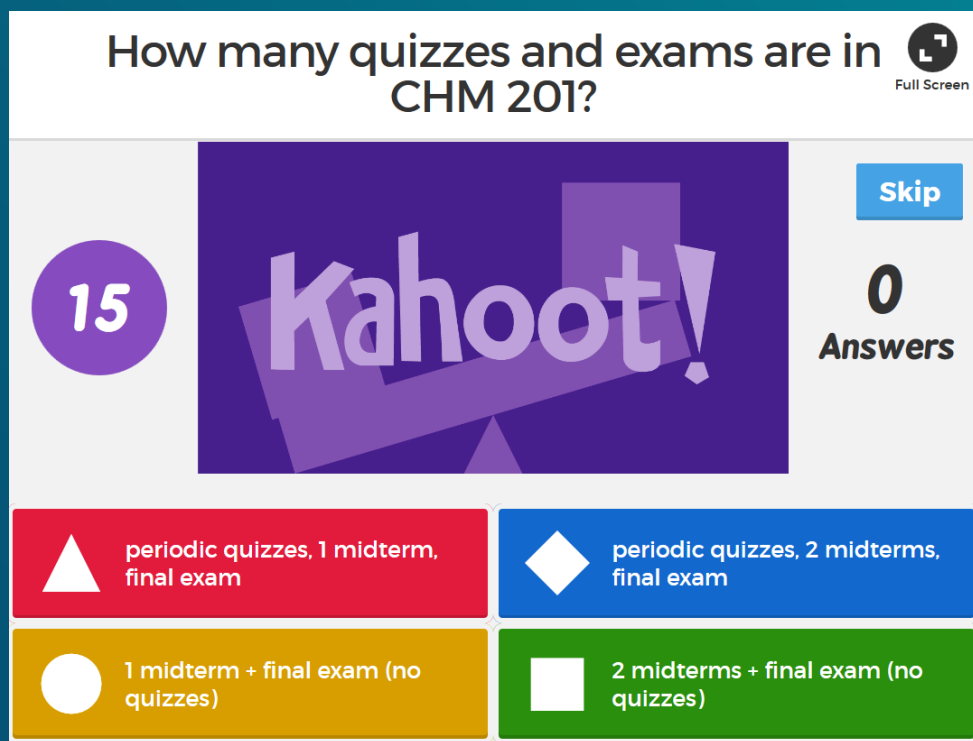
During this step, is the **eugenol** in the organic or aqueous layer?



“Inquisitive” eugenol lab demo  
>1,500 views since March!

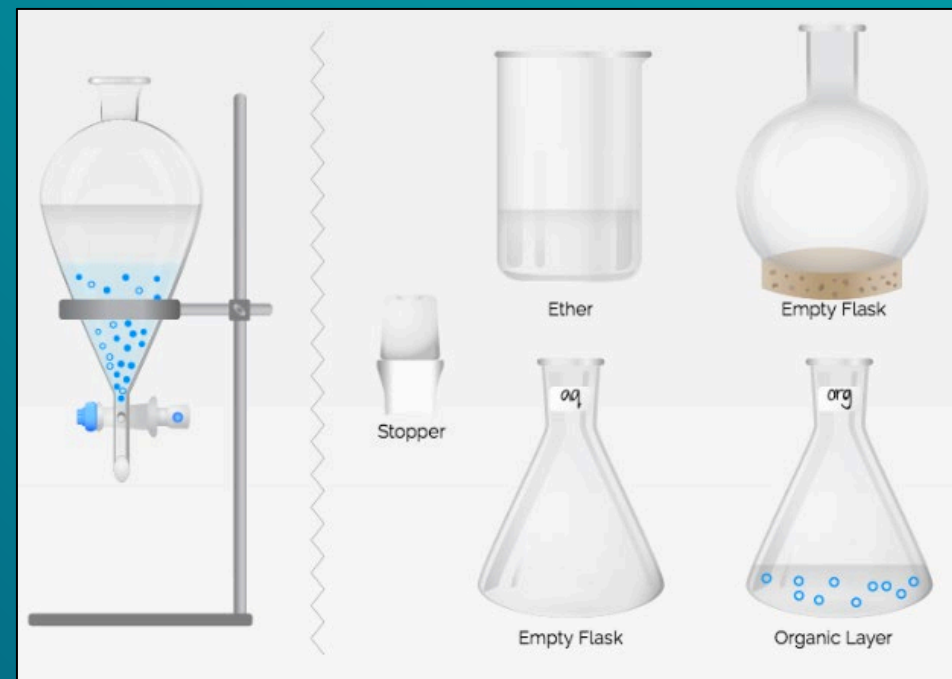
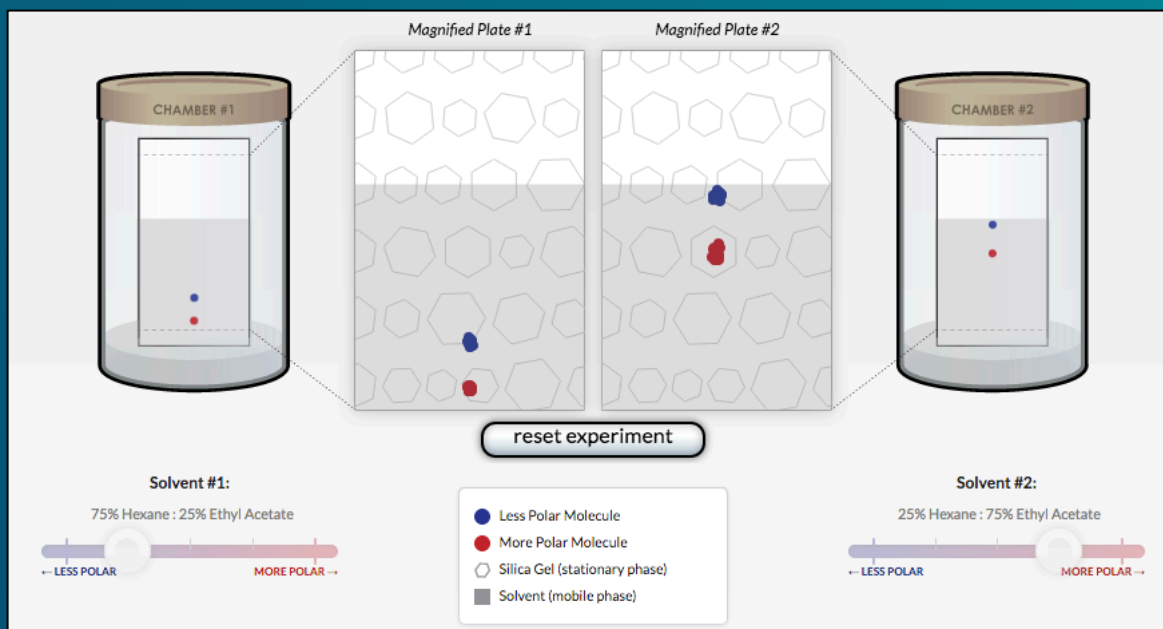
# Tech-Enabled ENGAGEMENT using Kahoot!

Clickers on steroids...fun, gameshow-style multiple-choice questions using mobile devices (good for syllabus “quiz,” exam review, “inquisitive” lab interactivity and more Kahoot)



# Utilize Existing Online Resources

- YouTube: Lab videos, technique tutorials...
- MERLOT.org multimedia repository
- **Animations** (with worksheets) TLC | Extraction





# Other Virtual “Lab” Options:

## Focus on Procedures/Planning

- Prepare procedure (costs, safety, rewriting)
- Design experiment, workup
- Modifying lab procedure  
(different substrate, calculations based on equivalents, etc.)
- Working with literature procedures



# Lab SLO DeepDiving Opportunity

- Spectroscopy (2D spectra, analysis of mixtures, spectral processing)
- Technique theory
- Safety/Hazardous training
- Green chemistry
- Optical activity (Tartaric acid data generator)
- Scientific writing (journal style, abstract, executive summary)
- Interdisciplinary or “Wicked” problems
  - global, ethics, chemistry & society

# Making it Work: Staying Happy, Healthy & Sane

Be Flexible

Be Open to Try  
New Things

Be Honest  
with Students

Be Patient

Don't Reinvent  
the Wheel

Don't Try to be  
a Superhero

Don't Obsess  
Over Cheating

Connect with  
Colleagues

**#AllInThisTogether**

Use Facebook  
Groups

Thank you for joining me!

Questions? Use chat or  
raise hand or email me...

[lsstarkey@cpp.edu](mailto:lsstarkey@cpp.edu)

<http://www.cpp.edu/~lsstarkey>



[COVID-19 remote  
teaching resources](#)

[Video resources](#)