



Assessment of Technological Set-up for Teaching Real-time and Recorded Laboratories for Online Learning: Implications for the Return to In-person Instruction

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Chemistry at Quest University Canada

General Chemistry
1: Atomic Structure
and Bonding

General Chemistry
2: Chemical Kinetics
and
Thermodynamics

Inorganic Chemistry:
Molecular Design

Organic Chemistry 1

Forensic
Geochemistry

Biochemistry A:
Macromolecules

Organic Chemistry 2

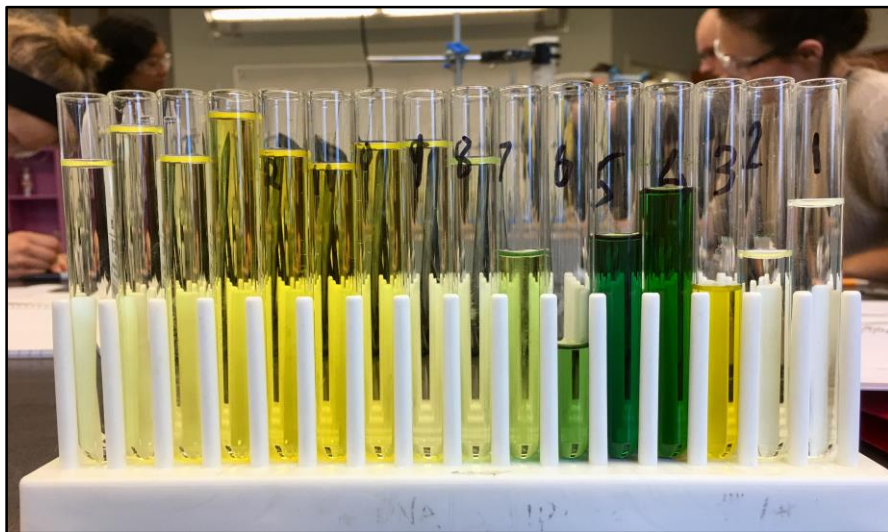
Organic Chemistry 3:
Advanced Synthesis

Biochemistry B:
Metabolism

Chemistry also serves the earth
sciences, physics, and molecular
biology

Learning Outcomes for Labs

- (1) A laddered approach to new lab-based techniques both within courses and across the curriculum
- (2) To enhance classroom understanding through a “macro” approach to chemistry
- (3) To make observations, collect data, interpret results, learn good lab practices, and learn good notebook practices
- (4) To engage in critical thinking about chemistry topics in two ways: direct experience in the lab and how those experiments connect to specific topics in the course



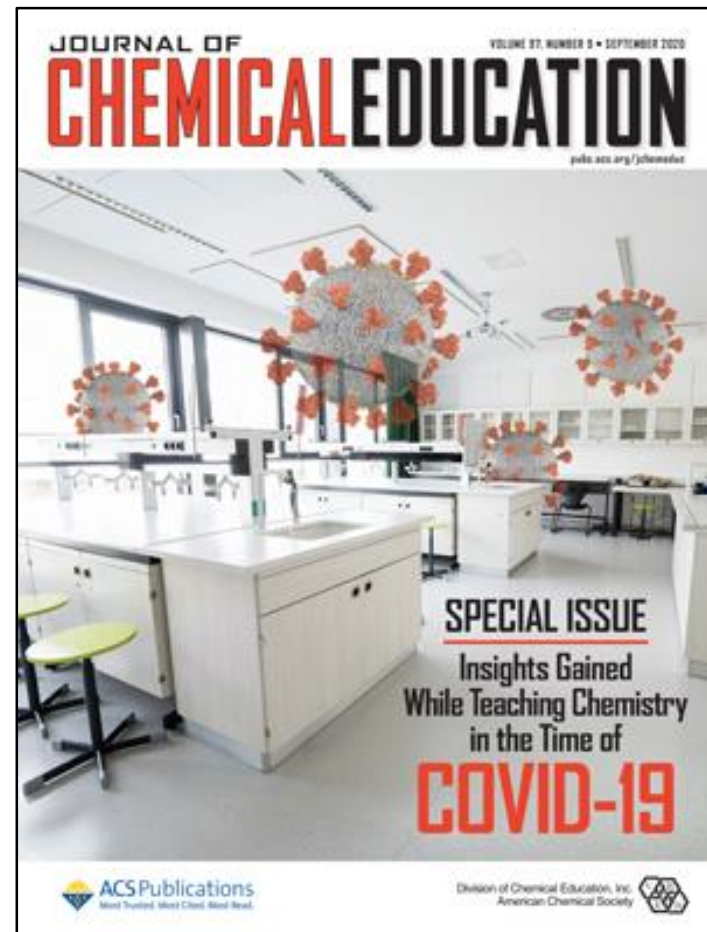
The Problem: Rapid Shift to Remote Teaching and Learning

Challenges for Educators:

- (1) Lack of graduate student/lab manager assistance; personnel time in set-up/take-down
 - (2) Associated start-up costs of remote instruction
 - (3) Adapting current experiments (or designing new ones)
 - (4) Steep learning curve of associated technological platforms (for all parties)
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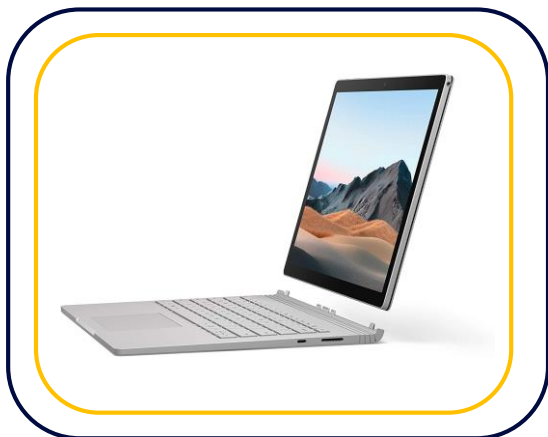
Challenges for Students:

- (1) Decreased engagement
- (2) Adverse learning experiences
- (3) Increased mental health concerns



Audio/Visual Equipment Selected

We wanted the equipment we selected to be **accessible**, **affordable**, and **easy to set-up**



Microsoft Surface Book 2



Logitech C525 HD Camera



Sony Alpha Mirrorless Camera



iPhone 8 Plus



Blue Snowball Microphone

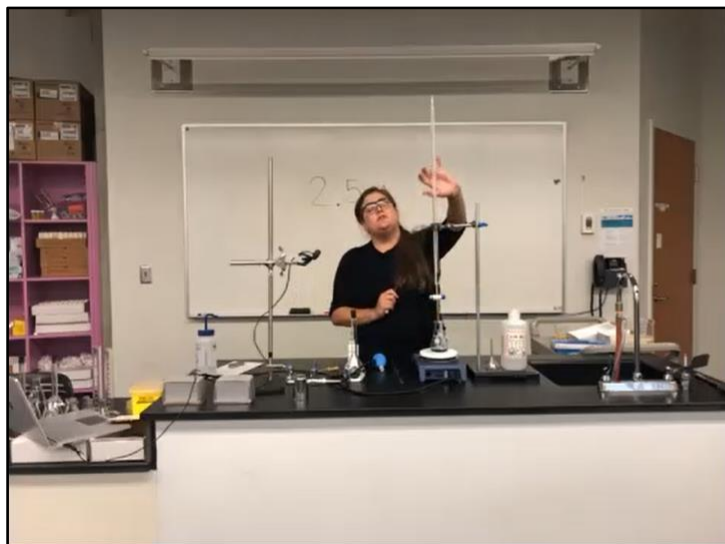
Recording Test Videos

Conducive to a single instructor

Benefits from a full shot of the equipment as well as a close-up view

All videos recorded were < 2 minutes

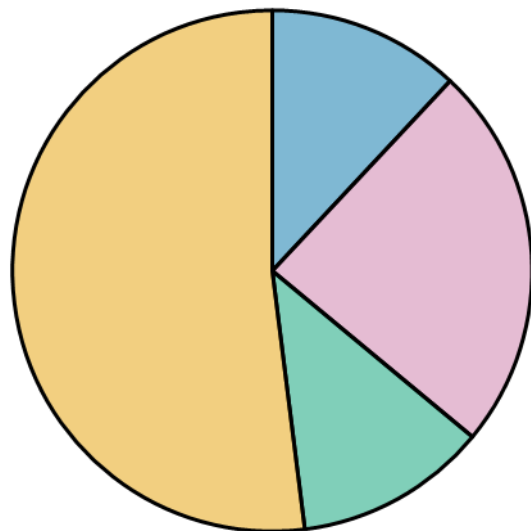
Acid/base titration with universal indicator



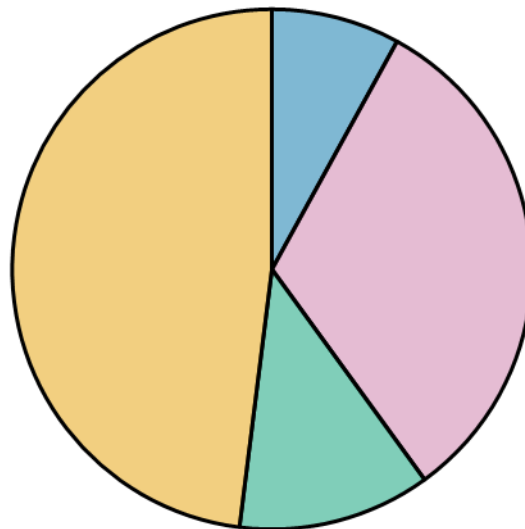
Recording Test Videos

Set-up Label	Video Equipment	Audio Equipment
A	iPhone	
B	Microsoft Surface Book 2	
C	Logitech Web Camera	
D	Microsoft Surface Book 2	Blue Snowball Microphone
E	Sony Mirrorless Camera	Microsoft Surface Book 2
F	Sony Mirrorless Camera	Blue Snowball Microphone
G	iPhone; Logitech Web Camera	Logitech Web Camera
H	iPhone; Mirrorless Camera	Blue Snowball Microphone

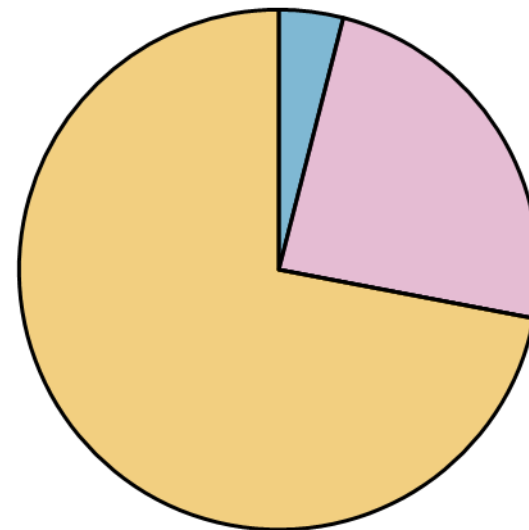
Student Survey and Results



overall video
quality



overall audio
quality



overall quality

	iPhone only		Sony Camera; Blue Snowball Microphone
	Web camera only		Dual Video: iPhone, web camera; web camera (audio)

Student Survey and Results

(1) Students prefer a two-camera set-up

(2) The inexpensive web camera performed the best for audio pick-up

(3) The resources we had at the ready (computer, phone, web camera) provided the best overall experience!

overall video
quality

overall audio
quality

overall quality

	iPhone only		Sony Camera; Blue Snowball Microphone
	Web camera only		Dual Video: iPhone, web camera; web camera (audio)

Experiments Run Using This Set-up

Synthesis

Ferrocene synthesis

Aspirin synthesis

Analysis

Titration (iron in soil; copper in ore; acid/base)

Purification

Recrystallization

Sublimation

Choose Your Own Adventure

Isolate benzoic acid from a mixture

Courses include: General Chemistry 1; Forensic Geochemistry, Inorganic Chemistry, Organic Chemistry 1, General Chemistry 2

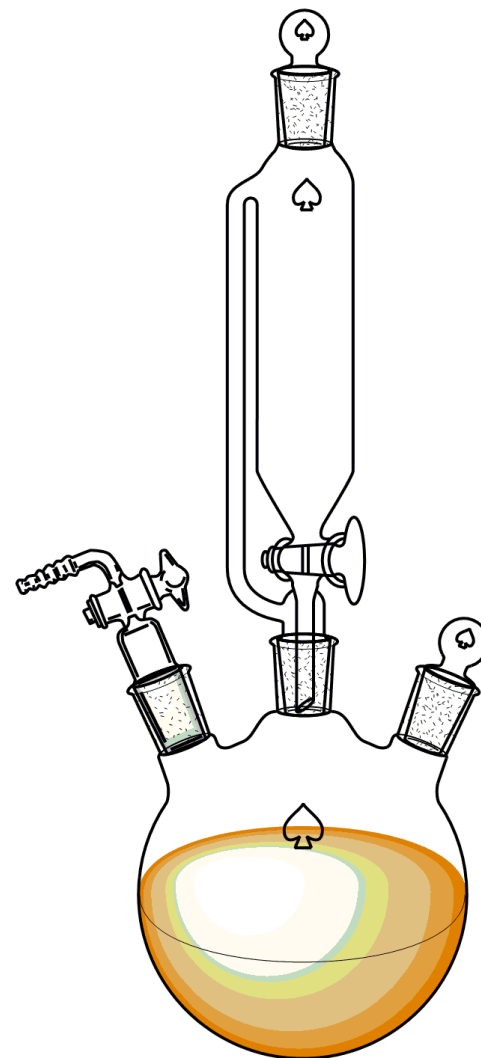
Ferrocene Synthesis and Purification: Learning Outcomes

Experiment: Synthesis and purification of ferrocene

Course: Inorganic Chemistry

When: Week 2

- (1) Experiencing an experiment from start to finish
- (2) Observing purity of sample
- (3) Analyzing bulk purity via melting point
- (4) Encountering air-sensitive techniques
- (5) Populating lab notebook in real time
- (6) Determining the metrics of synthesis



Assessment of Various Methods of Remote Delivery

Learning Outcome	Narrative Labs	3 rd Party Recordings	Real-time Delivery
Experiencing an experiment from start to finish			✓
Observing purity of the sample		✓ -	✓
Analyzing bulk purity via melting point		✓	✓
Encountering air sensitive techniques		✓ -	✓
Populating lab notebook in real time			✓
Determining the metrics of synthesis	✓	✓	✓

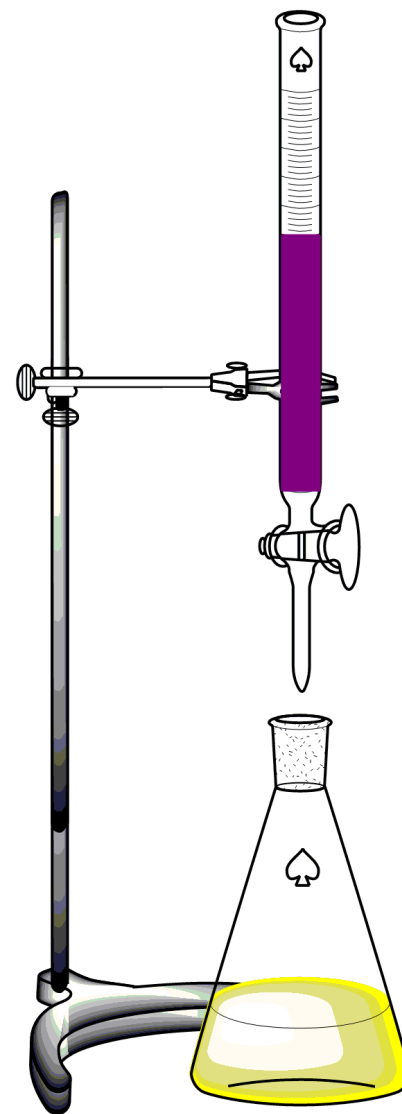
Titration: Learning Outcomes

Experiment: titration for Fe(II) in soil with KMnO_4

Course: Forensic Geochemistry

When: Week 3

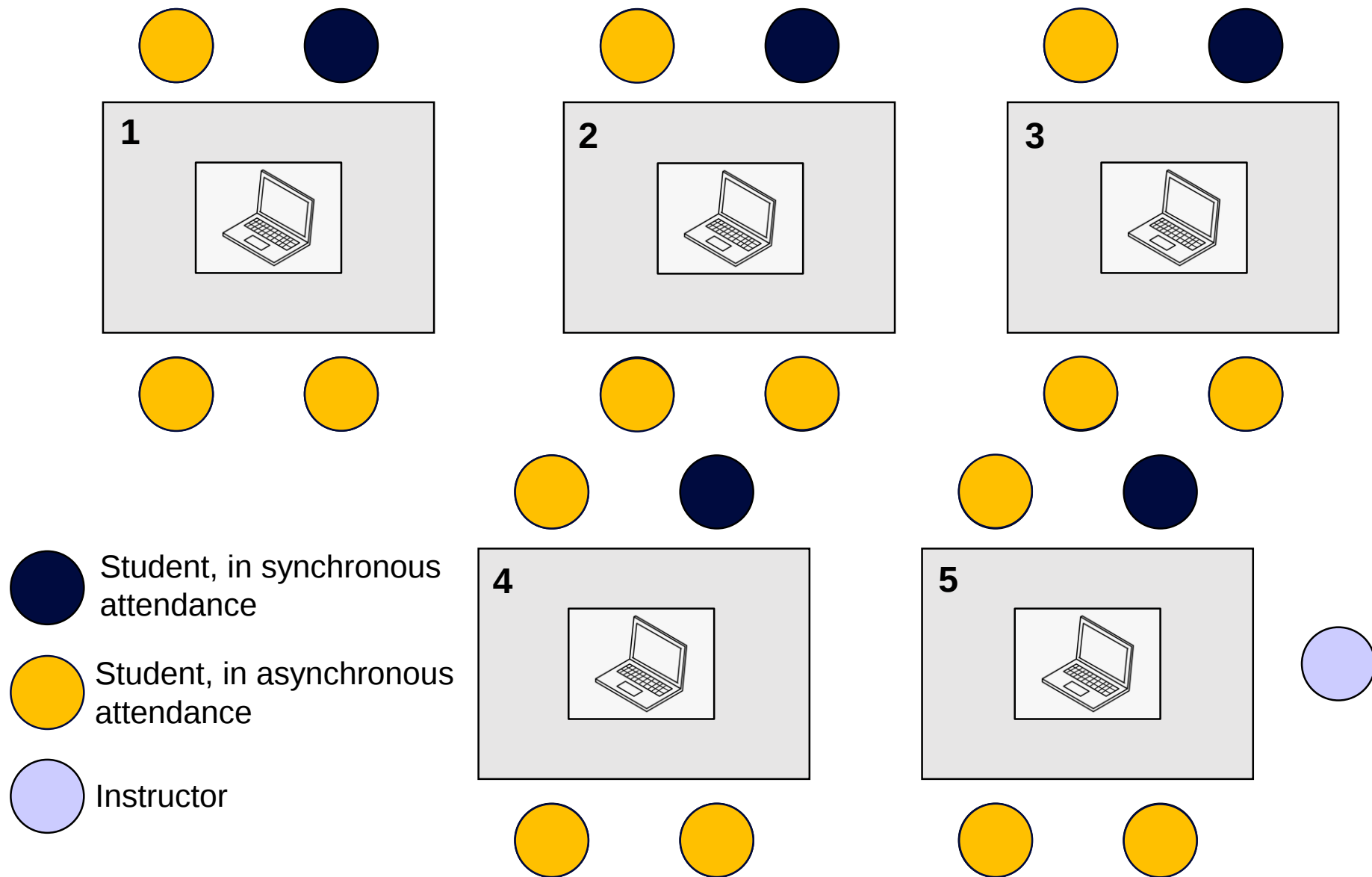
- (1) Making and recording observations
- (2) Performing relevant calculations
- (3) Making decisions about proper endpoint
- (4) Assessing the quality of the results
- (5) Deciding if the results are not adequate
- (6) Processing and analyze samples
- (7) Experiencing analysis of real-world samples



Assessment of Various Methods of Remote Delivery

Learning Outcome	Narrative Labs	3 rd Party Recordings	Real-time Delivery
Making and recording observations		✓	✓
Performing relevant calculations	✓	✓	✓
Making decisions about proper endpoint			✓
Assessing the quality of the results	✓	✓	✓
Deciding if the results are not adequate	✓	✓	✓
Processing and analyzing samples			
Experiencing analysis of real-world samples		✓ -	✓

Looking Beyond Covid-19: A Hybrid Approach



Looking Beyond Covid-19 and Conclusions



(1) Increased safety without full capacity in lab spaces

(2) Increased instructor attention without full capacity in lab spaces

(3) Reduced costs associated with reagents, chemical glassware needs, and waste management

(4) Students remain engaged in **decision making, critical thinking, observation making,** and **good notebook practices**