Course introduction

P. LeClair

PH 4/591 Fall 2022

Plan for today

- Course introduction / syllabus stuff
- Lab Safety
- Keeping records
- Finding information

- Contact: pleclair@ua.edu, 857-891-4267

Our goals

- Help you learn some of the fundamental principles for doing experimental work
- Help you develop some **transferrable** skills
- Help you learn the *process* of doing solid experimental work
- Learn all those little details that get left out of textbook problems and pre-arranged labs

Not our goals, so much

- You already have good physics content knowledge
  - we just want to apply it
- (you may need to learn a few things more deeply)
- Anyone can learn to operate a machine;
  - you need to know *why you're using it*
- Don't worry about novelty, first learn to do it the Right Way

Skills

- Knowing the difference between good & bad data
- Designing reliable experiments
- Making effective visualizations to display results.
- Expressing your ideas effectively.
- Working as part of a team.
- Relating your work to that of others.
- Recognizing the importance of a new discovery.

What will we do

- Mini-lectures with assignments
- Mini-experiments – specific techniques
- Longer experiments – 1 or 2 for most of term
- Midterm paper – design & progress
- Final paper – full writeup
- Undergrads – online participation
- Grads – final presentation

Tentative schedule

Date	Topic	Assignment given	Assignment due
18 Aug	Course intro, meet & greet.	inverse Occam's razor; finding info	
23 Aug	Case studies in experiment design	Paper critique/case study	
25 Aug	mini-experiments 1		Occam response + finding information
30 Aug	analysis & visualization of data	data visualization exercises	Paper critique
1 Sep	mini-experiments 2; discuss longer expts.		
6 Sep	writing a paper; pick longer expts.	paper outline for mini expt.	visualization exercises
8 Sep	first day with longer expts.		
13 Sep	curve fitting & analysis; longer expts.	curve fitting task	paper outline
15 Sep	continue with longer experiments		deliverable: preliminary data
20 Sep	electrical measurements & noise		curve fitting
22 Sep	continue with longer experiments		deliverable: initial analysis, supplies needed
27 Sep	feedback & control	(finish 1st round of expt. refinements	
29 Sep	continue with longer experiments		first paper due (expt. design & progress)
4 Oct	apparatus deep dive, discuss 1st paper	first paper feedback	
6 Oct	switch/continue longer experiments		deliverable: plan of work
11 Oct	discussion - status reports		
13 Oct	continue with experiments		
18 Oct	continue with experiments		deliverable: plan of work update
20 Oct	continue with experiments		first paper revisions due
25 Oct	continue with experiments		
27 Oct	continue with experiments		deliverable: data update/comparison
1 Nov	continue with experiments		
3 Nov	continue with experiments		final paper *outline* due
8 Nov	continue with experiments		
10 Nov	continue with experiments	feedback on final paper outline	
15 Nov	analysis & writing		
17 Nov	analysis & writing		final paper due
29 Nov	final presentations (grads)		
1 Dec	post mortem		

Grading

%	Item
20	first paper/proposal can revise for improved grade (last 10% is revision, have rubric) expt design and progress in standard format (proc/results/disc) + proposal for deep dive or what next expt is if not continuing
25	final paper 10% for outline/etc prior to due date as noted if going on with expt to do deep dive: all on one expt if switching expts: on second experiment only
10*	final presentation [GRAD only] as a group, 15 min or so
10*	PackBack [ask 1 answer 2 per week] [UGRAD only] draft slides in before thanksgiving
15	short assignments in first 4-6 weeks
20	lab deliverables - short memo style, fairly informal is fine 1: preliminary data 2: sketch of analysis, major sources of error, supplies needed 3: plan of work/timetable for 2nd phase of longer expts + team management quiz 4: plan of work update 5: data from new/deeper experiment + comparison to prior
10	record keeping/lab notebook

PackBack participation

- Should have gotten an email this morning
- Basically: moderated discussion
- Post 1 question, answer 2 per week
- Start next week. See slides @ end of this deck
- Community lookup key:

  c65c7672-f4fa-4be4-8561-f67491eabdae

Lectures/discussions planned

- This one – safety, record keeping
- Design tools & tactics
- Analysis and visualization
- Constructing a paper
- Curve fitting
- Electrical measurements
- Feedback and control

Short assignments

- First one today
- short theoretical examples or skill building
  - Information scavenger hunt
  - Project mock-up/case study
  - Paper outline
  - Data visualization
  - Curve fitting
- First step from theory to practice

Mini experiments

- Dipping our toes in the water
- Round 1: each around half a class period (pick 2)
  - Modulation techniques
  - Absorption spectroscopy
  - Mechanical properties – Young's modulus
  - Electronic noise
  - Microwave optics
  - Radioactivity

Mini experiments

- Round 2: a full class period
  - Advanced optical spectroscopy (FTIR, UV-VIS)
  - X-ray diffraction
  - Impedance spectroscopy
  - Noise spectroscopy
  - Mechanical properties
  - Precision timing
  - Advance fabrication techniques (CAD/CAM)

Longer experiments

- I throw you in the deep end.
- 4-10 weeks (either 1 or 2 of these)
- Your team gets a basic task & direction, you take it from there

- (chance to switch after ~4 weeks just in case)

Example longer experiments

- Unknown material challenge (materials char., design of expt.)
- Falling sphere viscometer (mechanical, fluid, video, build)
- Cavendish balance / measure G (fundamentals, build, precision)
- Mechanical properties (mechanical, build, computational)
- Environmental radioactivity (gamma spec, activity, nuclear)
- Noise spectroscopy (signal processing, electronics)
- Modulation techniques (lock-in amplifier and low noise tech.)
- Ray optics: time-of-flight apparatus (optics, electronics, signals)
- Wave optics (microwave experiments; interference/diffraction)

Safety first

- dangerous to work without knowing the hazards
- your primary responsibility is to work safely.
- common lab hazards
  - **Compressed Gas** – kaboom
  - **Electric Shock** – it burns
  - **Cryogens** – it also burns, but can suffocate too
  - **Chemicals** – wide variety here
  - **Lasers** - do you value depth perception?
  - **X-Rays** - burns, and more, probably including electric shock
  - **Physical Strain** - use the right tool for the job
  - **Fire** - see many items above

Beware

- A compressed gas cylinder contains an extremely large amount of stored energy (tens of MJ)
- Many, many liquids can be hazardous to the eyes – wear safety glasses
- Every wire should be handled as if there is a danger of electric shock

Make safety part of the procedure

- If in doubt, ask. Working unsafely will aggravate me *far* more than asking too many questions (and no one has yet asked too many questions)
- Don’t sacrifice safety for speed. Speed isn’t a useful metric.
- Always follow the proper procedures.
- If there is no procedure yet, be on high alert
- Use your senses to notice when something needs attention.
- Never work alone.

(pre) Crisis!!!

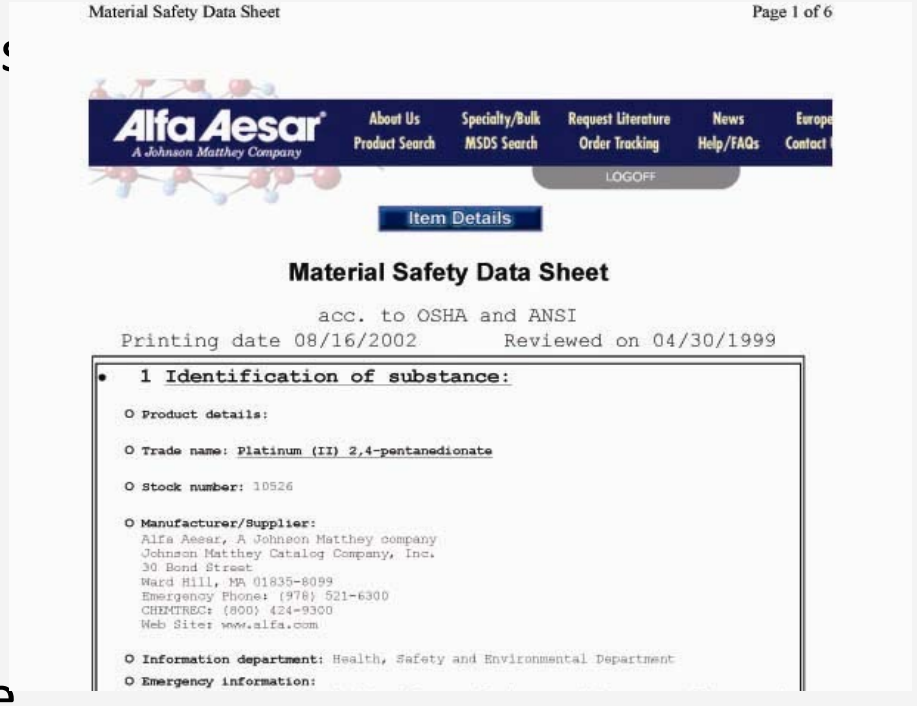
- Where is the nearest fire extinguisher?
- Where is the nearest eye-wash station?
  - What does it imply if there isn't one?
- Where is the nearest chemical shower?
  - What does it imply if there isn't one?
- Where is the nearest fire alarm?
- What's the quickest way out of the building?

Crisis!!

- **Lab Matters:**
  - water leaks, etc:
  - find the instructor or building rep (Kuykendall)
  - find a faculty member (names on doors)
  - find a grad student
  - find literally any staff
  - after hours: contact campus police 8-5454.
    - (why is it 5454, and get off my lawn)

Chemical safety

- Chemicals in use have their hazards listed in a MSDS:
  MATERIALS
  SAFETY
  DATA
  SHEET
- By construction, this will not come up much in this class
- Still: you can and should look these up for materials you use



Material Safety Data Sheet Page 1 of 6

Alfa Aesar® A Johnson Matthey Company

About Us | Product Search | Specialty/Bulk | MSDS Search | Request Literature | Order Tracking | News | Help/FAQs | Europe | Contact

LOGOFF

Item Details

Material Safety Data Sheet

acc. to OSHA and ANSI

Printing date 08/16/2002 Reviewed on 04/30/1999

1 Identification of substance:

O Product details:

O Trade name: Platinum (II) 2,4-pentanedionate

O Stock number: 10526

O Manufacturer/Supplier:
Alfa Aesar, A Johnson Matthey company
Johnson Matthey Catalog Company, Inc.
30 Bond Street
Ward Hill, MA 01835-8099
Emergency Phone: (978) 521-6300
CHEMTREC: (800) 424-9300
Web Site: www.alfa.com

O Information department: Health, Safety and Environmental Department

O Emergency information:

What's in an MSDS

- Sect. 1 Chemical Identification
- Sect. 2 Composition/Identification of ingredients
- Sect. 3 Hazards Identification
- Sect. 4 First Aid Measures
- Sect. 5 Fire Fighting Measures
- Sect. 6 Accidental Release Measures
- Sect. 7 Handling and Storage
- Sect. 8 Exposure Controls/Personal Protection
- Sect. 9 Physical and Chemical Properties
- Sect. 10 Stability and Reactivity
- Sect. 11 Toxicological information
- Sect. 12 Ecological Information
- Sect. 13 Disposal Considerations
- Sect. 14 Transportation Information
- Sect. 15 Regulatory Information
- Sect. 16 Other Information

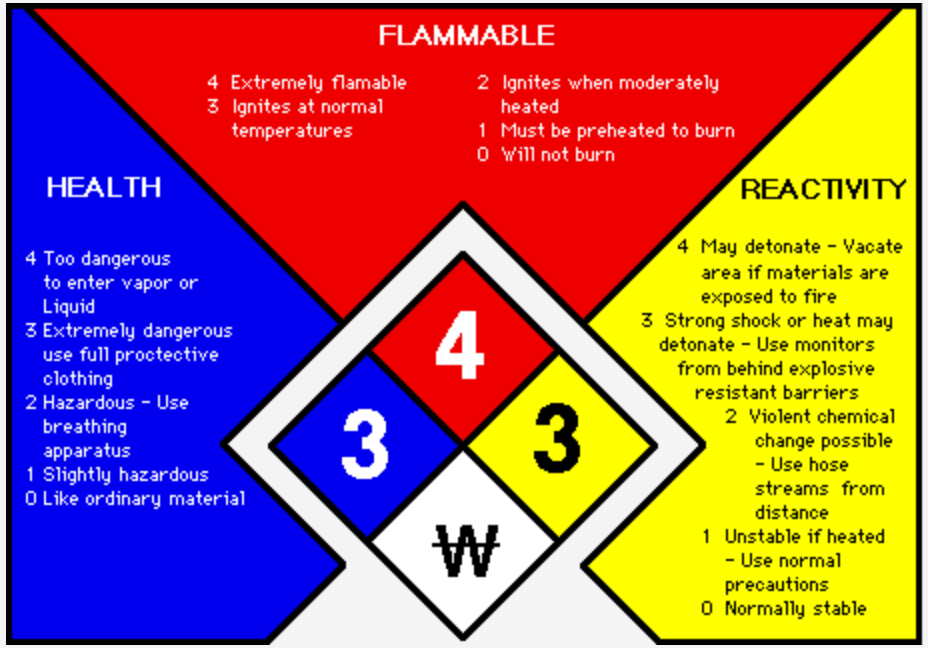
Chemical labeling

- Contains X, Y, Z
- YOUR NAME
- DATE

- When you leave your "waste stream" will have to be disposed of.
- KNOWNS can be easily disposed of
- UNKNOWNS are difficult to dispose of ($, time)

Hazard Identification

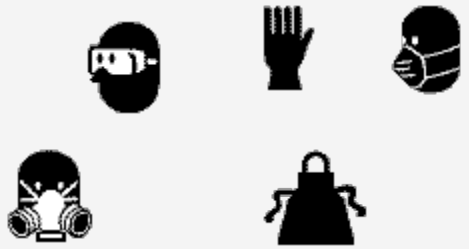
- National Fire Protection Association method of hazard identification
  0 (no hazard) to 4 (Extremely Hazardous)



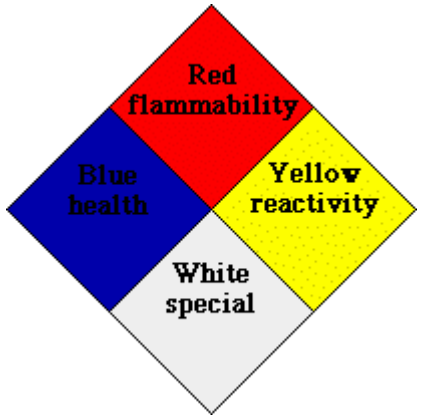
Flammable

HEALTH Reactivity

Personal Protective Equipment PPE (iconic)



NFPA Chemical Hazard Labels



Special Notice Key (White)

W	Water Reactive
Oxy	Oxidizing Agent

Health (Blue)

4	**Danger**	May be fatal on short exposure. Specialized protective equipment required
3	**Warning**	Corrosive or toxic. Avoid skin contact or inhalation
2	**Warning**	May be harmful if inhaled or absorbed
1	**Caution**	May be irritating
0		No unusual hazard

Flammability (Red)

4	**Danger**	Flammable gas or extremely flammable liquid
3	**Warning**	Flammable liquid flash point below 100° F
2	**Caution**	Combustible liquid flash point of 100° to 200° F
1		Combustible if heated
0		Not combustible

Reactivity (Yellow)

4	**Danger**	Explosive material at room temperature
3	**Danger**	May be explosive if shocked, heated under confinement or mixed with water
2	**Warning**	Unstable or may react violently if mixed with water
1	**Caution**	May react if heated or mixed with water but not violently
0	**Stable**	Not reactive when mixed with water

Your job

- Learn to perform research properly.
- Teach each other.
- Keep accurate and complete records of your activities
- Process results fully to understand the purpose, procedure and outcome of the experiment.
- Present and publish research results.
- Recognize new discoveries.

Procedure

- Keep a complete notebook.
- Record use of equipment in instrument logbooks.
- Notify proper personnel of broken/malfunctioning equipment.
- Return tools or equipment after use.
- Try to leave the work environment in a better condition then when you started.
- If in doubt, ask.

Lab Notebook

- Record date and time at beginning of each activity.
- Record initial condition of instrument to be used
- Record result of activity *especially when things go wrong.*
- Record filenames of all collected data STANDARDIZE
- Record material, dimensions, and other relevant information for processed samples.
- Record instrument condition at end of the activity.

Your logbook

- Always with you when doing research
- You should write down
  - procedures, results, ideas, *details* – enough to replicate
- Entries need to include a date
- Should be written in ink if hard copy
- If electronic, think *carefully* about how you do it
  - Can you read it in 10 years?
  - Can you *find* it in 10 years
- This is where important information is kept.
- ELECTRONIC DATA – back it up, and organize it
  - Hierarchical organization with useful file and folder names

Computering

- Careful about portability
  - File format, storage location, etc.
- Python, excel, mathlab, mathematica, originlab – all good, stable, and (probably) not going anywhere
- Writing: TeX will never die, neither will Word.
- Google is probably not going anywhere
- Backup: UA+Box does it for you.
  - Your machine? What's your plan?

Tools

- If you borrow it, leave a note. Then bring it back.
- If you use it, bring it back right away.
- If you break it, fix it or arrange for it to be fixed.
- Admit you broke it. No penalty, only analysis.
- Find out how to get replacements for missing/broken tools
- Leave the place in a better condition than when you started.

Keep clean

- Place tools, manuals, and materials in their proper locations
  - *even ones you didn't use*. not your *fault*, but now your *problem*
- Remove hazardous and unwanted materials when finished.
- Clean work area before and after each project.
- Leave a note on projects "in progress" giving date, name, and contact information.
- Leave the area cleaner then when you started.

Equipment Maintenance

- Always use the proper tools for disassembly and reassembly.
  - The tools rarely include pliers or hammers.
- Replace broken or missing parts before reassembly.
- Never tamper with an interlock.
- Check for leaks, shorts, loose parts, oil levels, strange noises, smoke, and puddles.
- Leave the equipment in a better condition than you found it.

Lab etiquette

- If you use the next-to-last item, ask to order more.
- Place a note on malfunctioning equipment.
- Interact with other experimenters.
- Leave a note when you borrow something:
  - Where did it go?
  - Who took it?
  - When was it taken?
  - How can I get it back?
- Be considerate of others—share to evolve.
- If in doubt, ask.

Compressed gasses

Serious energy content.
Review these explosions at your leisure.

https://www.youtube.com/watch?v=ejEJGNLTo84
https://www.youtube.com/watch?v=Yj9tRcCTKIY
https://www.youtube.com/watch?v=pYApHYiUM4E

Cryogenics

- Potential for severe burns – Helium 4.2°K, Nitrogen 77°K
- Not that likely to come up tbh
- Use gloves when using any cryogens
- Only put cryogens in specialized purpose-built containers
  - Guess what happens when you put them in closed bottles with no pressure relief

High voltage

- One of the more common lab hazards
- I have been adjacent to a serious arcing incident
  - The person was lucky to lose half a finger
- Do not perform electrical diagnostics ALONE
  electricity can cause muscles to contract and clench
- Don’t open anything that plugs into the wall, go to the shop.

Group work

- By now you know how this goes
- You have a class or two to figure this out
- Strongly suggesting groups of 3 or 4. Grad/UG mix is fine.
- *Make sure you have somewhat compatible schedules*
  - *If you can't meet or work in real time, this won't work*
- Figure out how to share data, analysis, writing
- Figure out how to effectively communicate

First assignment (on Blackboard too)

- One page response to “Inverse Occam’s Razor”
- https://www.nature.com/articles/s41567-022-01575-2
- Information-finding scavenger hunt
- Due at 25 Aug class
- (This is all written up and will be online.)
- “A day in the library is worth a week in the lab.”
  - (if you know how to use the library and the lab)

Inverse Occam's razor

Igor Mazin

Nature Physics **18**, 367–368 (2022) | Cite this article

Don't try to buy a $5 model with $0.50 data, for example.
Write a (min) 1 page response with your thoughts
Don't summarize the article, I read it. React to it.

Scientists have long preferred the simplest possible explanation of their data. More recently, a worrying trend to favour unnecessarily complex interpretations has taken hold.

One of the fundamental principles in science is the law of parsimony. It is usually (but probably incorrectly) attributed to William of Ockham, a fourteenth-century English philosopher, and therefore colloquially referred to as Occam's razor. Of many equivalent formulations of this principle, I personally favour the following: of two competing theories, the simpler explanation of an entity is to be preferred (https://www.britannica.com/topic/Occams-razor).

For centuries, starting with Galileo, this credo has been a cornerstone of the scientific method. In the past decades it seems it has been supplanted by the opposite maxim, which I call inverse Occam's razor: of two competing interpretations, the more exotic one is to be preferred. In a way, it is but human nature to chase after something more intriguing, less quotidian – but that isn't a new factor. What is at work here and now is a more pragmatic assumption – that a more exciting interpretation can get your paper published in a high-profile journal.

Scavenger hunt 1 (literature)

- Ivar Giaever shared a Nobel for electron tunneling into superconductors.

a) In his Nobel lecture, he begins with a quote from his lab notebook. What is it?

b) In his first paper on tunneling, what was the lowest measurement temperature?

c) According to APS, how many citations does that paper have? Provide the citation please.

Scavenger hunt 2 (data)

a) What is the f_1 x-ray scattering form factor for Co at 10keV?
b) What is the Nuclear-Thomson correction to the x-ray form factor for Co?
c) What are reasonable values for the Poisson ratio of cork, rubber, and steel?
d) Will a magnet stick to 316 steel?

Scavenger hunt 3 (more data, and connections)

- I have a bath of liquid helium, ^{4}He.

a) I can reduce the pressure above the liquid to 0.5 Torr. What is the liquid temperature?

b) What if it were ^{3}He instead?

c) Where would I get liquid helium from, to deliver to UA campus?

Scavenger hunt 4 (chaos round)

- My friend Harm Wieldraaijer did his PhD in the same group, we worked together.

a) What was the cover art on his dissertation?

b) What is the third reference on page 111 of his dissertation?
   Does it seem unusual for a physics dissertation?

c) What does Harm do now?

Enough talk for now

- Time remaining:
  - Questions
  - Quick description of mini-experiments
  - Think about forming groups (3-4)
  - Let’s get after the scavenger hunt or the article

Mini experiments again

- Modulation techniques
  - Signal processing, electronics, core experimental techniques
- Absorption spectroscopy
  - Materials, control experiments, Fourier-transform techniques
- Mechanical properties – Young's modulus
  - Largely overlooked in courses, materials, building
- Electronic noise
  - Hardcore electronics and signal processing stuff. Stat mech.
- Radioactivity
  - Particle physics, natural radioactivity, assessing activity

Packback

For participation
Required for undergrads

Packback is an AI-supported online discussion platform that is a space to develop critical thinking, curiosity, and writing skills.

> **Student Feedback**
> Spring 2019 Student Feedback Survey
> **"In past classes where Packback wasn't used, I wasn't all that interested in the material. I just did what I had to do to pass the class. I didn't think I'd care about a GenEd ever before Packback."**

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The Impact

Critical Questioning skills are *essential* to college and post-grad life:

- In asking effective questions while interviewing to select the right job after graduation.
- In identifying opportunities for innovation, when starting a business, or working within a team.
- In learning new skills independently after graduation, to keep adapting to a changing world!

Objectives

Our specific Packback course objectives

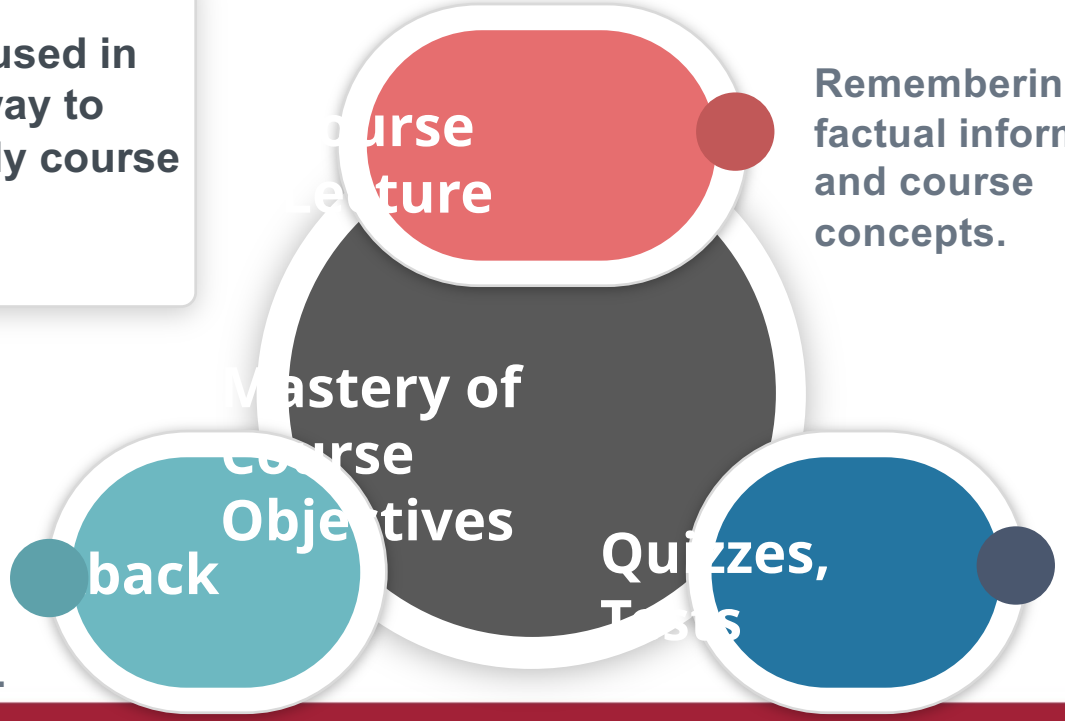
In this class, we're using Packback to:

- **Discuss material together in more detail outside class**
- **Think and discuss about the applications of course content**
- **Satisfy your curiosity!**

Course Design

How Packback discussion fits into this course

Packback will be used in this course as a way to integrate and apply course concepts.



Remembering new factual information and course concepts.

Analyzing, Evaluating, and Generating discussion into broader contexts.

Proving **Understanding** of course information and concepts.

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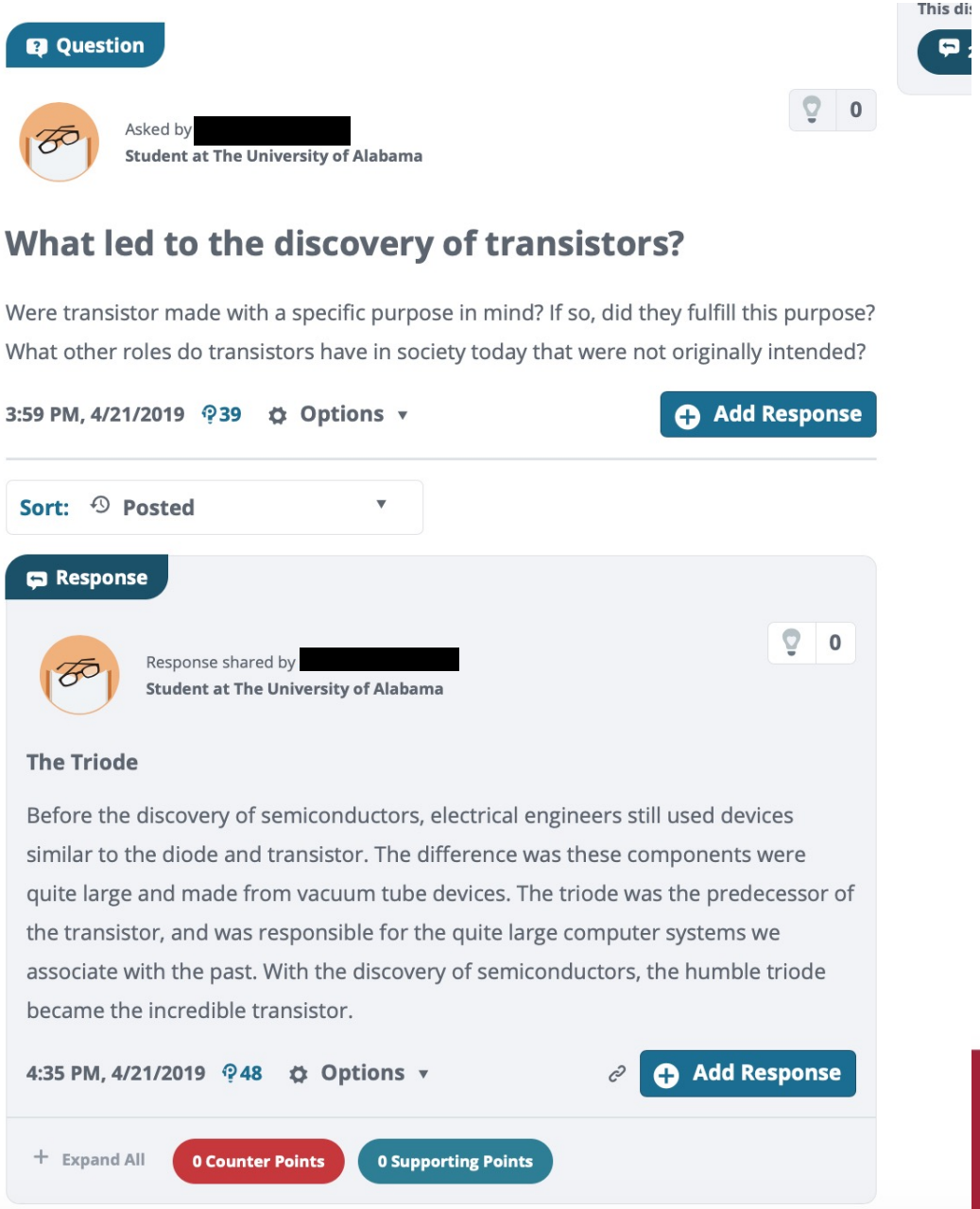
Example



Ideally: add a supporting link

Participation requirements & How you will be graded

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Grading & Requirements

UNDERGRADS:
Packback is worth 10% of your final grade!

This is an *important* assignment, please take it *seriously* as it will affect your final grade.

It is essentially a letter grade difference, and all you have to do is post online. Which you are already doing elsewhere anyway.

Grading & Requirements

Participation Requirements

Weekly Deadline

[Monday] at [11:59 PM]

What to Post
per Deadline period

Post **3** Questions + Responses (any combination)

Other Expectations

- Some ‘catch up’ is allowed, within reason

Packback's AI & How to check your grade

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Auto-Moderation

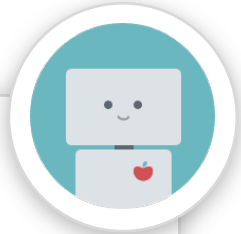
Posts on Packback are Reviewed by AI

Packback's AI

Packback's AI "flags" posts that may be violating community guidelines.

Posts are then reviewed by Packback moderators.

Offending posts are Moderated and **no longer count for credit**.



Packback's AI auto-flags for:

- **Plagiarism**
- **Closed-Ended Questions (e.g. "What is the definition of mitosis?")**
- **Class Logistics Posts (e.g. "When is the next test"?)**
- **Low effort / Low detail posts**

Auto-Moderation

What happens if your post is moderated?

Post is “Flagged”

If your post is “Flagged”, you have not yet lost points!

At this time, your post is still published and still counts for credit.

Post is “Moderated”

If your post is moderated, it is unpublished and no longer counts for credit.

If your post is “Moderated”, you receive an email notifying you.

Post is “Republished”

From the email, you can “edit & re-publish” the post.

Doing so will earn back your points for the post without penalty, so long as you edit before grades are entered.

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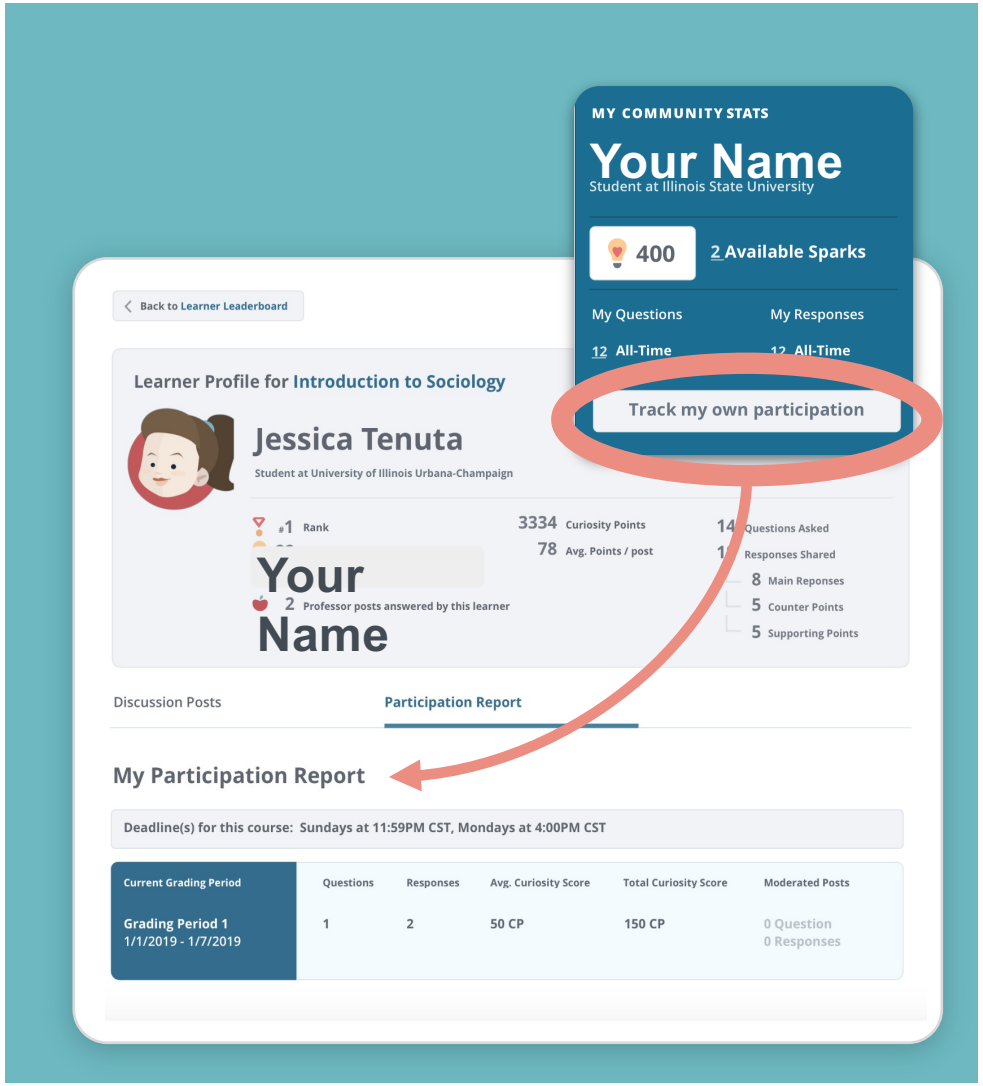
Monitor

Track Participation

You can check your current participation by Deadline period to make sure you've earned your full points for the week.

Note: If you have any Moderated posts, you can track them here!



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Getting started & Getting help

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Register

Registering for Packback

You will have received an invitation in your school email inbox.

- Follow the instructions in the email to checkout and finish registration.
- Be sure to create an account with the **same email** where you were sent the invitation!

Don't see it? Check Spam!

Didn't get an email?

- Sign up directly on Packback
- Click "Join Community" button
- Enter the "**Community Look-Up Key**" from our course syllabus
  - *You **only** need this key if you didn't get the invite.*

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Register

Registering for Packback

community look-up key for this course is:

c65c7672-f4fa-4be4-8561-f67491eabdae

get the *access code* via RedShelf link
on BlackBoard page - fee then waived

Get Help!

Need Help? Email Holla@packback.co

Packback's support team is available 7 days a week, and will help you will all technical issues.

Do NOT email me with Packback issues; their team will be able to help faster!

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