Good/Bad Magnet Graphs

Bring in examples of good and bad graphs from a paper. I don't need the whole paper. In class, you should be able to discuss why you think they are good or bad.

DO NOT just google looking for good and bad graphs. I want YOU to practice recognizing what makes a graph good or bad-- not someone else. It's ok if we disagree on what is good or bad. Shoot, you can critique my papers if you want. Not all of our graphs communicate as well as I'd like. (Prefer a related graph.)

Date	293 Topic	Homework (with goals color)
18-Aug	Pre-Surveys; What is this Class About?	Partner/Scheduling Info
20-Aug	Distinguishing Types of Magnetism	Reading 1 on Perusall
25-Aug	Holcomb Group Discovery	Reading 2 on Perusall
27-Aug	MOKE versus Other Magnetometry	Watch Video on Perusall
1-Sep	Project Planning: What Kinds of Magnetic Measurements	Syllabus Read/Agree
3-Sep	Finding Published Papers Relevant to Your Project	Bring a Related Paper to Class
8-Sep	Reading and Evaluating Papers	
10-Sep	Best Practices with Lab Notebooks	University Safety Requirement
15-Sep	MOKE Hands-On Demonstration	
17-Sep	VSM Hands-On Demonstration	Important Papers. Why? (2-5)
22-Sep	How to Give Peer Feedback and Group Project Planning	
24-Sep	Planning Group Oral Reports and Peer Grading	~~Mini Reports (in class)~~
29-Sep	Group Project Planning and Refinement	~~Quality Reading on Perusall~~
1-Oct	Assessing the Quality of Materials	Project Proposal
6-Oct	Best Practices with Graphing	Good/Bad Graphs
8-Oct	Fall Break (No Class)	
13-Oct	Introduction to Excel: Spreadsheets, Graphing and Fitting	Next week!
15-Oct	Understanding and Processing Your Data	Lab Notebook Check-In
20-Oct	Building a Story with Your Data When It Isn't Obvious	
22-Oct	Check-In and How Are Materials Grown	
27-Oct	How to Give a Good Talk	
29-Oct	Peer Evaluation of Lab Notebooks (Bring Notebooks)	
3-Nov	Election Day (Vote If You Can)	
5-Nov	Project Speed Dating: Share Your Project with Others	Graphs of Your Data
10-Nov	Time for groups to Discuss Presentation/Data Planning	
12-Nov	Eight Minute Group Presentations	Presentations
17-Nov	Eight Minute Group Presentations	Presentations
19-Nov	How to Write a Good Abstract	
1-Dec	Ask Your Final Questions of Instructor, Partners or Class	
3-Dec	Discussion of Research and Scholarship Opportunities	Abstract & Notebook

Experimental Schedule (phone numbers would help)

Sample	Availability
LSMO	Ready but timing bad for group, Oct 16
FeS (altermagnets?)	Have one, probably could get another
Fe thin film	As soon as it's grown, wait on XRD?
Topological insulator	Getting shipping arranged

Groups (experiments will run for ~24 hours, maybe longer)

- If either purple group is around for late week, could get both
- Oct. 5, Monday 4pm: Ryan, Gavin, Alp **In progress**
- Oct. 13, Tues. 10:15am: Evan, Jeffrey, Austin
- Oct. 16, Friday 5pm: Melissa, Shelby, Leeam
- Oct. 20, Tuesday 4pm: Bryce and Tyler
- Oct. 23, Friday 1:30pm: Nickolai and Durham

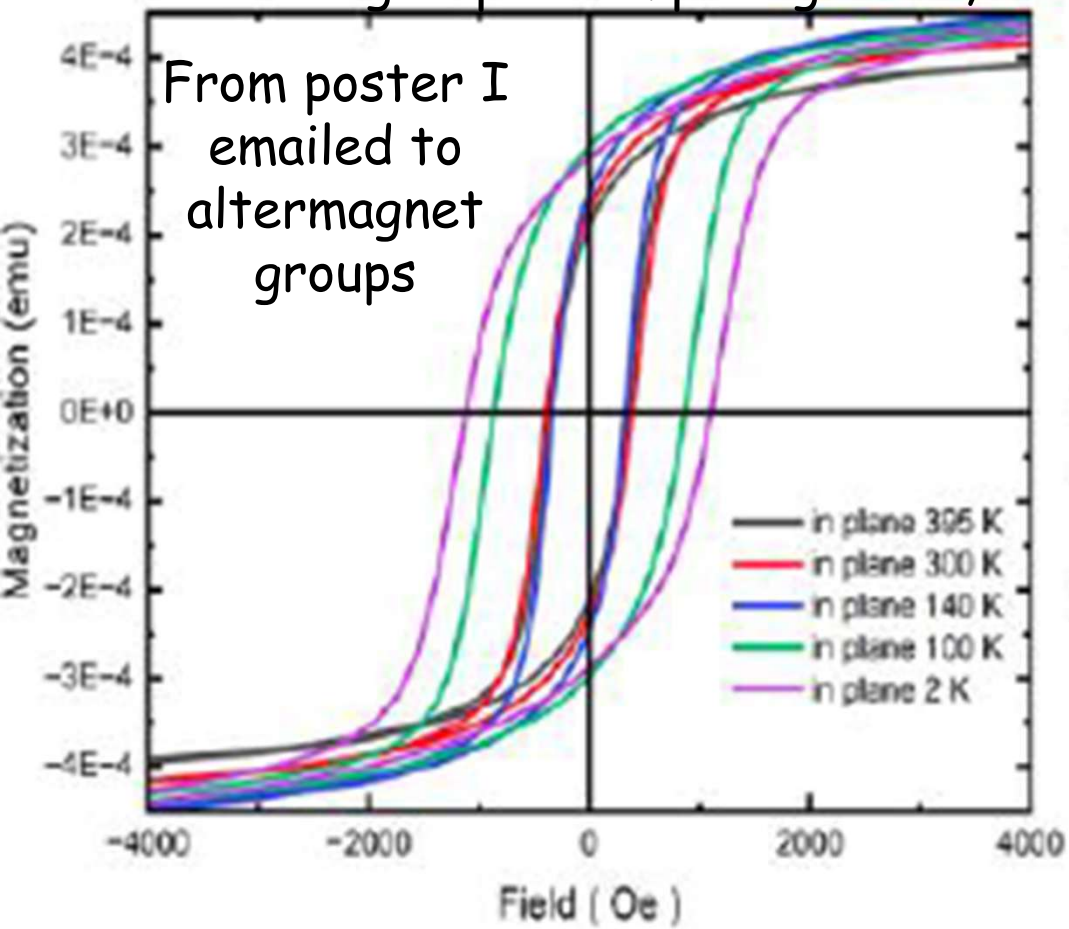
Soon: meet as groups briefly to discuss.

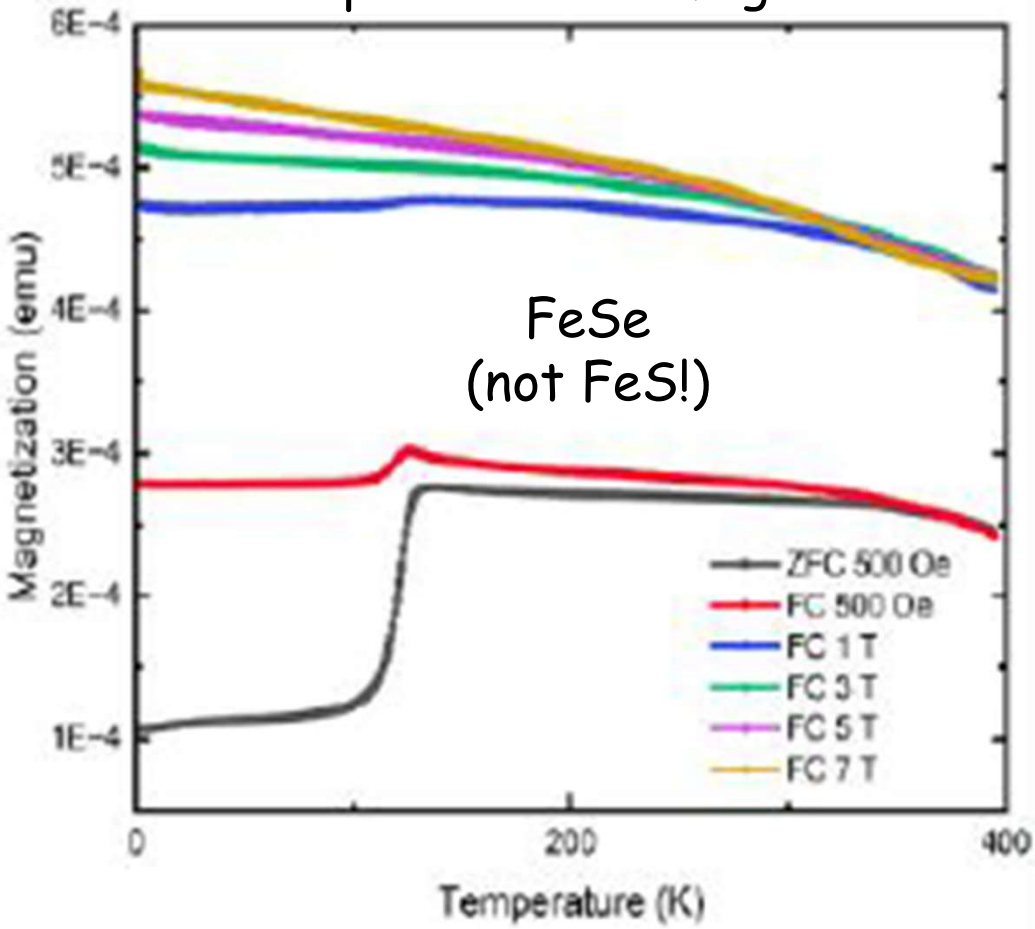
Likely experiments

- I recommend everyone will do at least one MvsT curve. What field do you want it measured in? (discuss LSMO and powders as examples) You can do more than one. Measure in warming? Most common.
- I also recommend that people do at least two hysteresis loops. More is fine. What temperatures? IF you have magnetism at room temp, I recommend that. If not, I recommend lower temps. You may not know until you do MvsT. We can take this first and let you know, but you'll want to get back to us same day.

An example: First altermagnet group

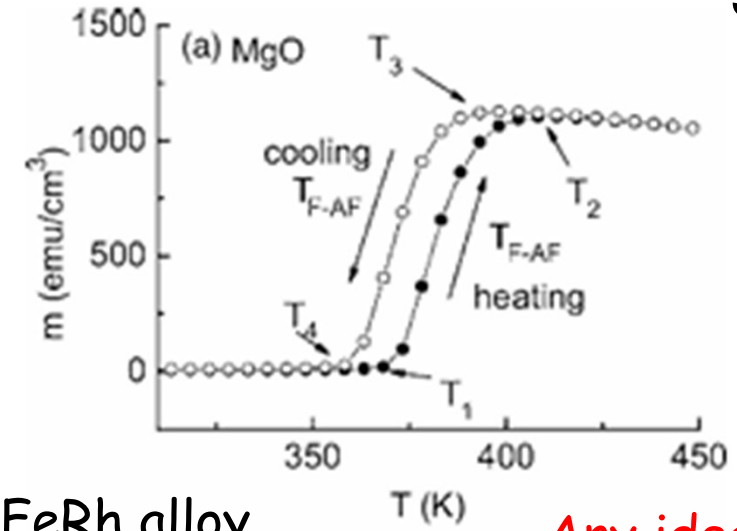
Lian Li's group is comparing FeSe, FeS and FeTe as possible altermagnets



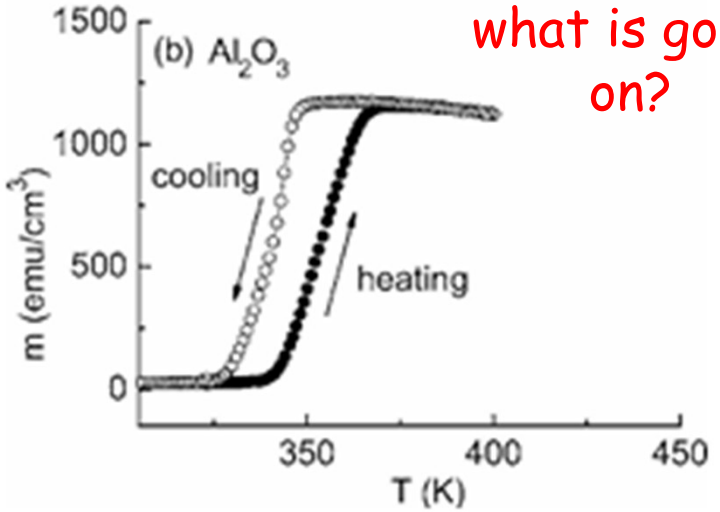


If we are going to compare things, what makes sense to do? We probably have enough time to do 2-3 M vs T loops if desired and a bunch of loops.

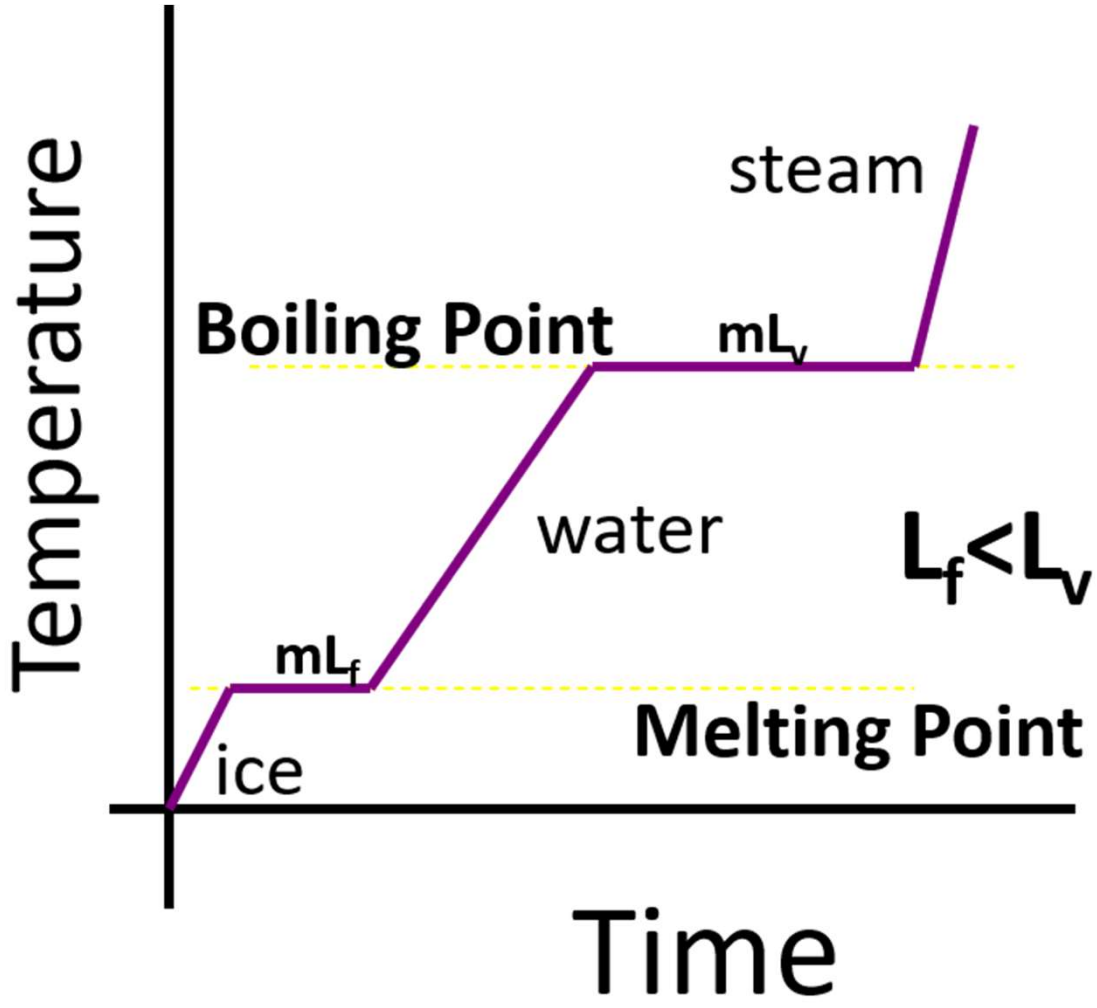
Why does the sample remain ferromagnetic to a lower temperature on cooling than the temperature at which it originally became ferromagnetic during heating?



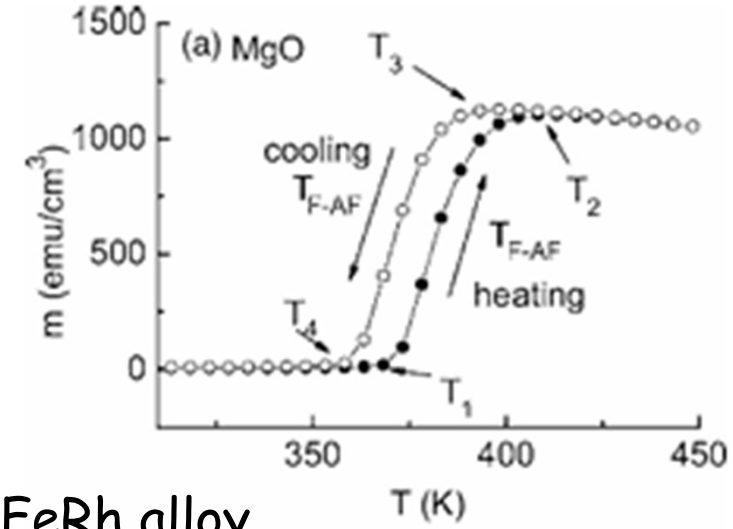
FeRh alloy



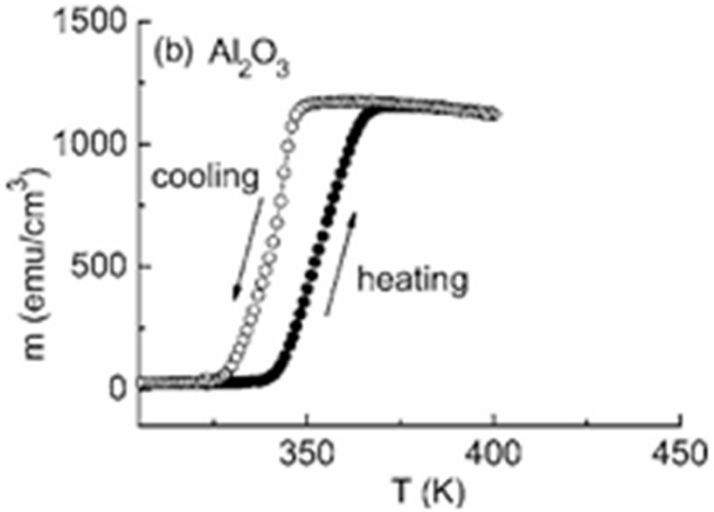
Any idea what is going on?



https://journals.aps.org/prb/abstract/10.1103/PhysRevB.72.214432

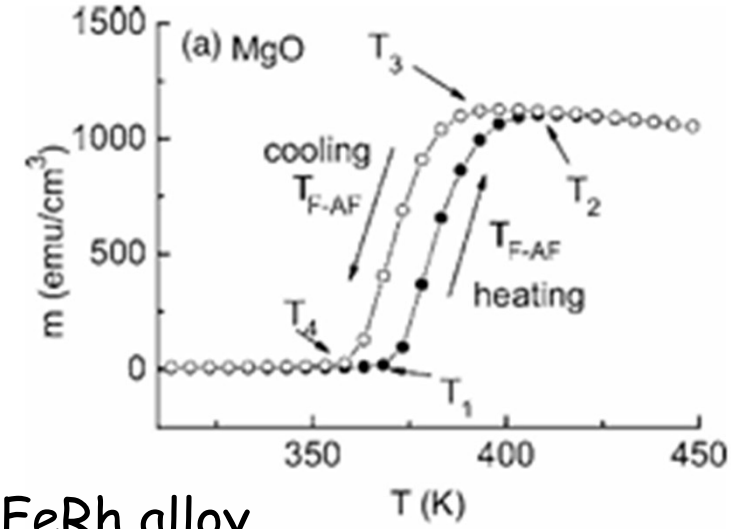


FeRh alloy

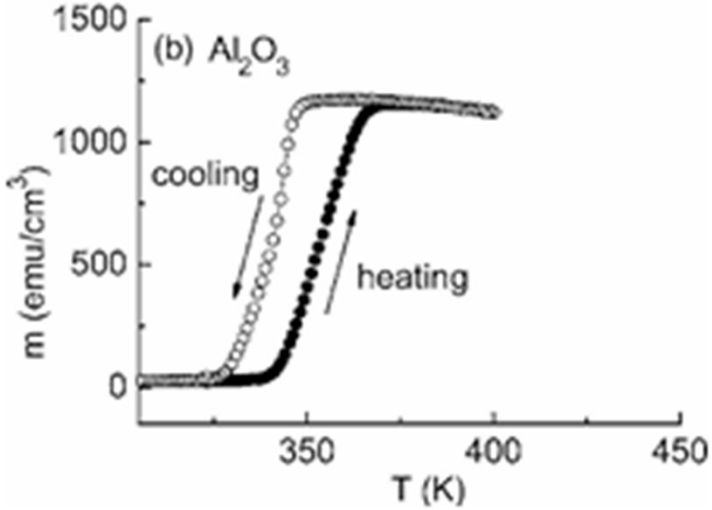


The atoms have to rearrange both their magnetic order and slightly their crystal structure. Starting that rearrangement takes energy. Because of this energy barrier, the transition temperature is different depending on whether the sample is heating up or cooling down.

If I repeat this experiment twice as slowly, what do you predict will happen?



FeRh alloy



- **Curves become much closer together** → the hysteresis was largely due to nonequilibrium measurement conditions.
- **Curves stay separated** → the hysteresis is an intrinsic property of the phase transition.
- Note: How you measure matters!

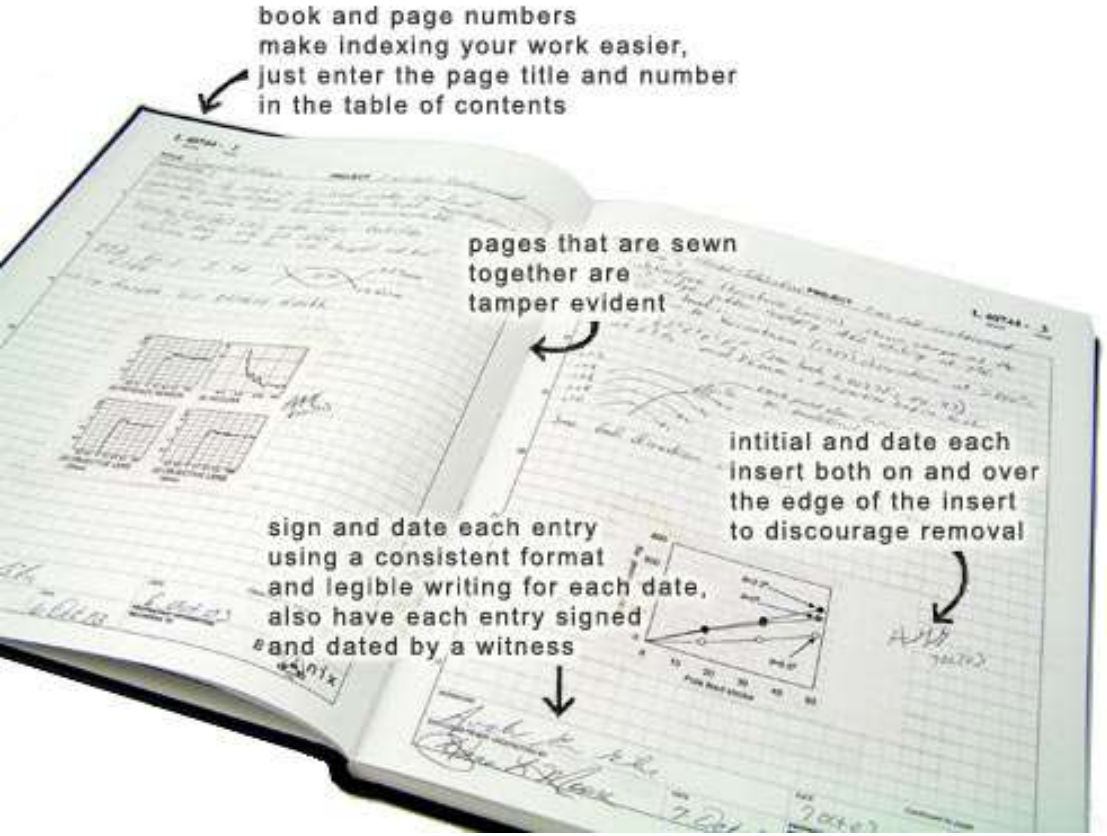
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Likely experiments

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Write down what you did, why you did it, what happened, what surprised you, and what you think should happen next.

If a future researcher would need the information to understand, reproduce, or troubleshoot your measurement, it belongs in the notebook!



Examples

Sample information: Sample name/ID, Film composition, Film thickness, Substrate material and thickness, Any relevant processing (annealing, oxidation, looks weird, etc.)

Scientific goal: What question are you trying to answer? What do you expect to see?

Sample mounting: How was the sample mounted? Any concerns about the mounting method?

Instrument settings: Record anything that could affect the data: Maximum field, Field step size, Temperature, Any calibration performed

Observations: Write down things that seem unimportant.

Examples: Initial scan looked noisy. Instrument required re-centering.

Pictures and sketches: A picture says 1000 words

Include: Sample orientation, Field direction, Holder geometry

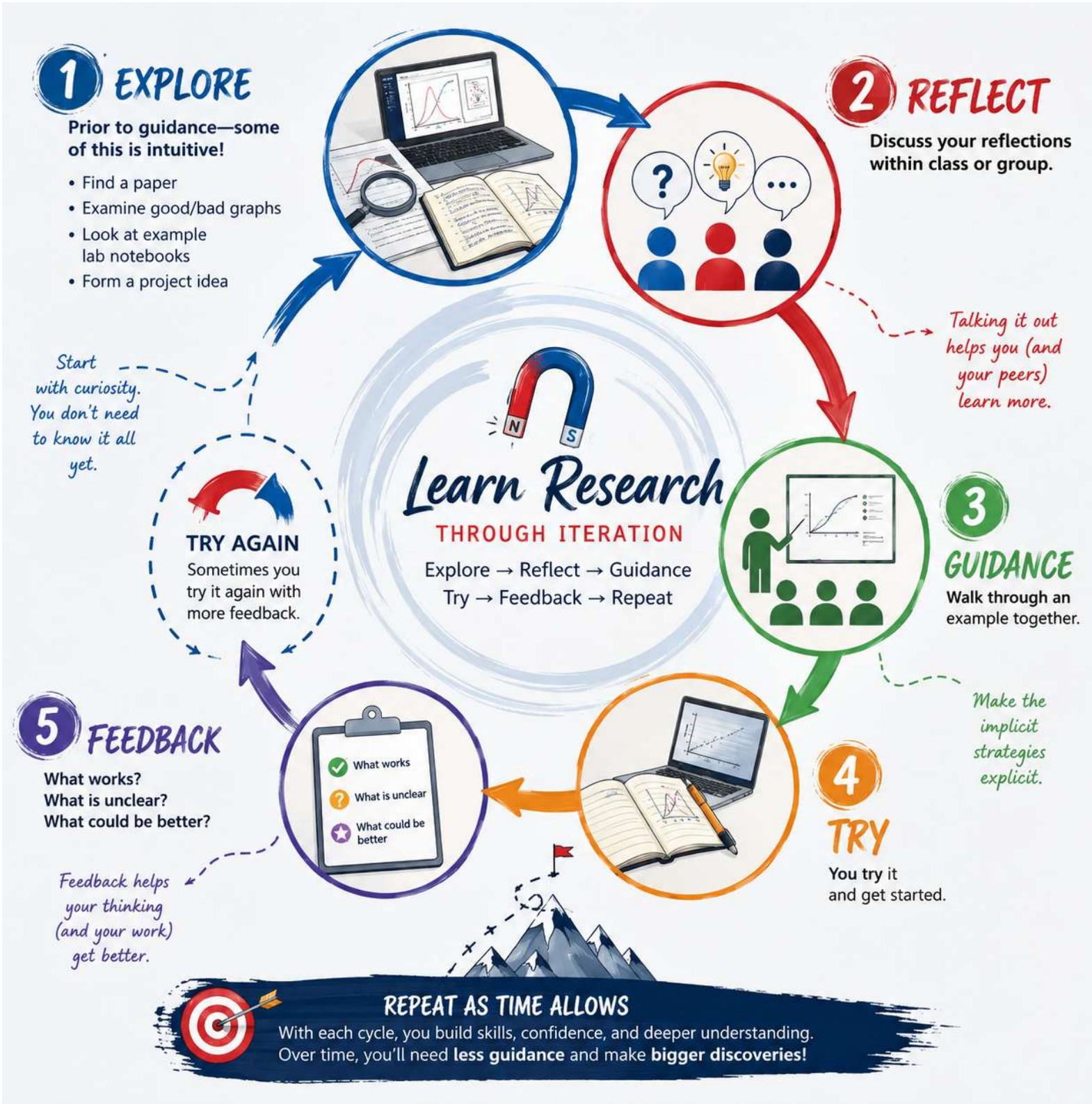
What does the data look like? Sketch it. (Include later.)

What surprised you?

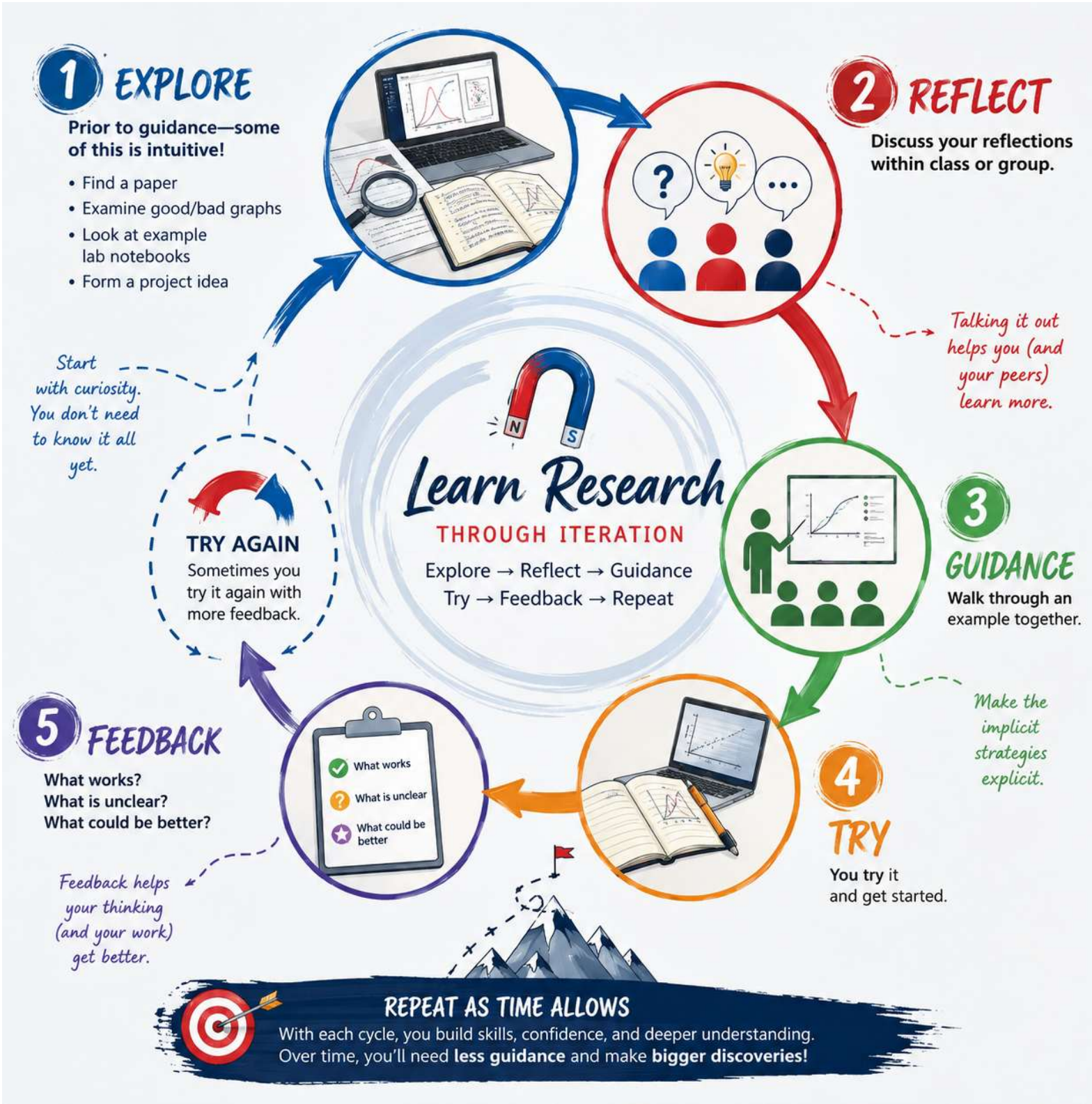
Rest of the Class on Beginning to Explore Graphing

Meta Cognition Note

I want you to notice this because it helps you see these assignments not as random but designed to try to help.



You explored by finding graphs. Soon we discuss them. Next times are guidance.



There are two components of graphing:

Figuring out how to do it and designing it to communicate your message

The nuts and bolts of making graphs can get us focused on details, so today I want to focus on the visual part. Later we'll get into how to.

Good and Bad Graphs

Let's take a look at your examples that you brought.

Discuss what you like and don't like about the graphs. What could be done to improve?

If you don't have one for whatever reason, pair up with someone that does.

Back up option next slide