Assigning and Facilitating *Roles* in Physics Lab Group Work

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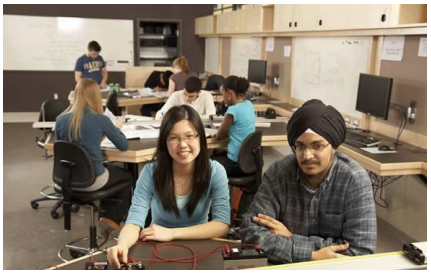
Session A.2, Theatre



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PHY151/152, Calculus-Based Intro Course for Physics Majors

- Students have 3 one-hour lectures per week. These include in-class polling questions for marks and small-group discussion.
- Once per week they meet for one 3-hour Practicals session in a room that has 32 seats (8 pods of 4), and two roaming Teaching Assistants (TAs).
- For the first hour they work on Practice questions together, not for marks, and review solutions with their TAs. Individual work is allowed.
- For the final two hours they work on an experiment involving real apparatus. Students **must** work in teams of 3 or 4. Teams share the mark.

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PHY151 Fall Anonymous Student Evaluations

- *It was a little difficult to work effectively with my team with the amount of work given; we often had to split up responsibilities in order to finish on time.*
- *After the pod switch halfway through the semester, practicals became a lot less enjoyable as I ended up with a group of people that either did not want to work or did not know how to work as a team, as opposed to my first pod where we all were fully engaged throughout. While I did step into a sort of leadership position and we did end up with satisfactory marks, it's really disheartening and fatiguing to constantly have to prod the others*

How do students ***learn*** to work in a team of 3 or 4?

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Assigned roles

- In PHY151 in the fall we talked about rotating roles, but we never really kept track of it, and students often fell into their comfort zone each week, often based on cultural expectations.
- Over the winter break 2022, we decided to formally assign and keep track of **roles** each week in PHY152 Practicals (Jan-Apr).
- We defined four “roles”, and each member of the team of four students had to take on one role each week.
- Every week the roles must rotate, so after every four weeks every student will have taken on each role at least once.

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Experimental Roles in a Team of Four [pg.4 of handout]

1. **Manager**
   - Manage the **time** spent on each activity
   - Suggest delegation of tasks
   - Make sure all members are able to contribute
2. **Archivist**
   - This person should be the main person taking notes in the notebook for marks
3. **Lead Theorist**
   - Before Practicals read the notes and textbook pages on the theory behind today's experiments.
   - Use the whiteboard to write down relevant equations / math / diagrams that are needed to understand the physics here.
4. **Lead Experimentalist**
   - Before Practicals watch the video on the equipment and setup involved in today's activities / experiments.
   - Take the lead on plugging things in, turning things on, setting up apparatus and making measurements.
   - Work with team-mates when possible to make the measuring process more efficient.

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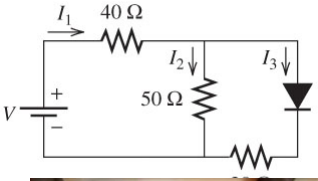
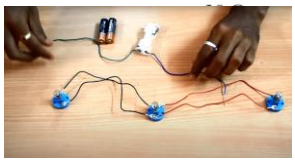
Activity: Form a team of 3 or 4

- **Imagine** an experiment on Diodes and Parallel Circuits.
- You will need to predict and verify currents through various elements of a complex circuit.
- Who will be the group Manager?
- Who will be the group Archivist, keeping the notebook?
- Who will be the Lead Experimentalist?
- Who will be the Lead Theorist?
- [NOTE: In a group of 3, the Manager and Archivist are the same person.]
- DISCUSS: Are you happy with your role? Do you have a good idea of what to expect?





1. Manager
2. Archivist
3. Lead Theorist
4. Lead Experimentalist

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Reflecting on Roles

1. Manager
2. Archivist
3. Lead Theorist
4. Lead Experimentalist

- Show of hands for the four roles one by one.
- Was anyone unhappy with the role they were assigned?
- If you were **forced** to be certain roles, are there roles you would rather not be?
- What role, do you suppose, is the most difficult?
- What role, do you suppose, is the least difficult?
- What role, do you suppose, is the most work?
- What role, do you suppose, is the least work?
- To calm your fears, what resources would you like to have before lab that would help you with these roles?

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Supporting the Manager Role [pgs.5-7 of handout]

- As of now, this was just a handout I discussed at the beginning of the semester. Students who were Manager for the first time were encouraged to read the handout, and review it on their second time as Manager.
- The Handout covers:
  - Teamwork Basics
  - Ground Rules
  - Agreeing on Goals
  - The Responsibilities of the Manager
  - Hints for Handling Difficult Individual Behaviour
  - Hints for Handling Group Problems
- Managers submitted a short online “Groupwork Reflection” after Practical to describe any major issues that occurred.

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Supporting the Archivist Role [pg.8 of handout]

- As of now, this was just a handout I discussed at the beginning of the semester. Students who were Archivist for the first time were encouraged to read the handout, and review it on their second time as Archivist.
- The Handout covers:
  - The TERM Notebook (like a Lab Notebook)
  - What the Notebook is For
  - When Entries are Made in the Notebook
  - What Should be Entered in Your Lab Notebook

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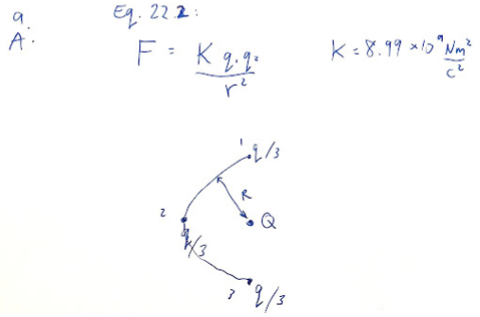
Supporting the Lead Theorist Role [pgs.9,10 of handout]

- Each week resources are provided for the Theorist to review for that specific experiment and activities.
- There were notes and, textbook pages.

- Activities 1 and 2 (and 3 if you have time) have to do with Chapter 22 from your textbook. Please read this before coming to Practical.
- Note in particular Section 22.3.3 on Charge Polarization, and Section 22.3.4 on The Electric Dipole.
- This will help explain why, in real life, neutral objects tend to be attracted to any charged object.

What follows are some calculations relevant to Activity 9.



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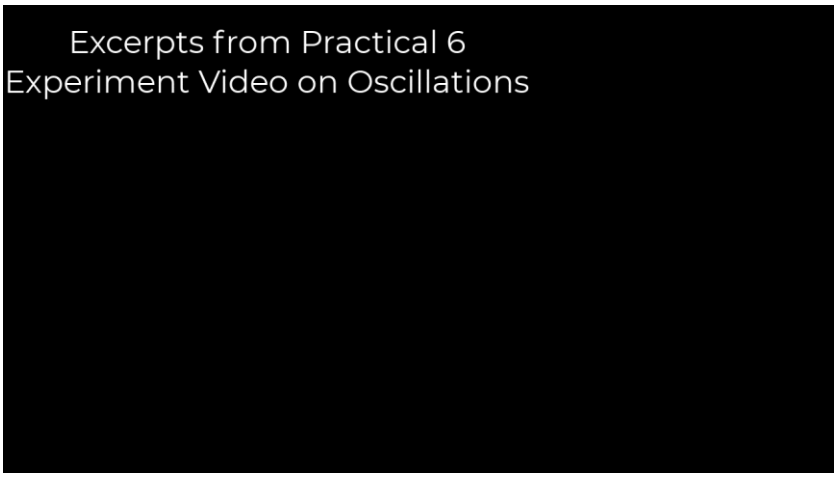
Supporting the Lead Experimentalist Role [pgs.11 of handout]

- Each week a short video was recorded by me and the link made available to that week's Lead Experimentalist in each group.
- Here is an excerpt of one:



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Inspirational PER Paper

- **"Hermione and the Secretary: How gendered task division in introductory physics labs can disrupt equitable learning"** European Journal of Physics 41 (2020) https://arxiv.org/abs/1908.06827
- By Danny Doucette, Russell Clark, Chandralekha Singh, Department of Physics and Astronomy, University of Pittsburgh
- "Students who adopt the **Secretary** archetype are relegated to recording and analyzing data, and thus may miss out on much of the opportunity to grow their physics and science identities by engaging fully in the experimental work."
- "Meanwhile, students in the **Hermione** archetype shoulder a disproportionate amount of managerial work, and also may not get an adequate opportunity to engage with different aspects of the experimental work that is essential for helping them develop their physics and science identities."

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Mid-Semester Student Survey: 180 respondents

- I asked students **“Each week in Practicals, the "Roles" are assigned formally, and this is kept track of by your TAs, to make sure you rotate the roles. What impact does this have on your overall Practicals experience?”**
- Strong positive impact 35 19%
- Slight positive impact 54 30%
- Neutral impact or none 47 26%
- Slight negative impact 32 18%
- Strong negative impact 13 7%
- **Positivity: 49%**
- **Negativity: 25%**

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Mid-Semester Student Survey: 180 respondents

- **Some assorted comments from students:**
- *I adore the practical roles since a group works in parallel, which permits people to work more consistently, cutting down on stress and indecisiveness, which I like as an individual with ASD.*
- *I like that the TAs choose our roles for the next practical, it helps in preparing for it instead of deciding which member is taking upon which role on the day of.*
- *I feel as though the manager role has promise in theory, but practically the manager ends up just being a pseudo experimentalist or theorist or both. Possibly there could be two archivists who each perform the role for 1 hour as writing for the whole two hours can be tiresome and I feel as though the archivist ends up missing a lot of the concepts because they are writing what the others are saying without much thought.*
- *I notice that the archivist ends up doing most of the work, while it is difficult the others, especially the manager, to contribute significantly and be kept occupied. It might be a better idea for each person to take on the role of archivist for different questions.*
- **And from the end-of-course anonymous evaluations:**
- *Instructions for each role were very clear with videos being provided for the more "hands–on" roles that helped significantly!*
- *Practical is much better than last semester (more fun and organized)*

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Mid-Semester Student Survey: 180 respondents

- I asked students **"Each week in Practicals, the "Roles" are assigned formally, and this is kept track of by your TAs, to make sure you rotate the roles. What impact does this have on your overall Practicals experience?"**

- FEMALES ONLY (29% of class)
- Strong positive impact 12 24%
- Slight positive impact 20 39%
- Neutral impact or none 11 22%
- Slight negative impact 7 14%
- Strong negative impact 1 2%
- **Positivity: 63%**

- MALES ONLY (70% of class)
- Strong positive impact 22 18%
- Slight positive impact 31 25%
- Neutral impact or none 35 29%
- Slight negative impact 22 18%
- Strong negative impact 12 10%
- **Positivity: 43%**

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PHY151 fall (No assigning roles during Practicals)

252 students 29.4% female	Class Avg	Male Avg	Female Avg	Mark Diff Male – Female
Practicals	82.3	82.5	81.8	+0.6

PHY152 winter (Same students as PHY151, but with roles assigned during Practicals)

200 students 29.0% female	Class Avg	Male Avg	Female Avg	Mark Diff Male – Female
Practicals	84.5	84.2	85.1	−0.9

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Conclusions

- Many students dislike group work. It might be okay to allow individual learning for some students, while allowing others to team up, if they know are more social learners.
- When my students are forced to work in teams, students overall react well to some guidance about how to structure the social dynamics and divide the work.
- Assigning roles, keeping track of student behaviour and providing extra resources for each role can provide this structure.
- In a class dominated by males, female students react even better to this social guidance and roles structure, in terms of happiness and achievement.

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