

Physics/Chemistry Lab 6.5: Under Pressure + Energy Transfers & Transformations

Goals: Improve communication and teamwork capacities; Improve confidence in hands-on work with equipment; Improve ability to make, describe, and record observations; Gain kinesthetic and observational experiences with pressure differences, how pressure difference manifest macroscopically, and various kinds of energy transfers and transformations.

Equipment: You will be oriented to the equipment, set-up, and use of the equipment for today's investigation, which involves a series of stations. Make sure you include sketches of the various experimental set-ups in your lab notebook.

Groups & Lab Notebook: Groups of 2 or 3. Update your Table of Contents. General Lab Notes guidelines apply. See earlier lab handouts for details. Recall that for math and physics labs, your notebook should reflect your learning and your engagement, and should serve as a stand-alone representation of what you did and what you learned. **Reminder: Lab Notebook Check – turn in math & physics lab notebooks outside Krishna's office Lab 2 3255 by 5 pm Friday November 20.**

Part 0: Getting Started. You will be oriented to equipment and today's investigations in the opening remarks. You can do the stations in any order; skip around as needed so you don't get stuck waiting for a station.

UNDER PRESSURE

Part I: The Heat is On

Station 1: HullaBalloon – DEMONSTRATION

- CAUTION: Pay attention to make sure that all the heating water doesn't boil away.
- Carefully pour a small amount of boiling water into the plastic ehrlenmeyer flask. Only a little bit is needed. Make sure it is nice and steamy in the flask.
- Quickly stretch a balloon over the mouth of flask.
- Observe what happens to the balloon as soon as it is put on the flask and for about 2 minutes.
- Turn off the heat to the hot plate. Check on the flask approximately every 5 minutes while you work on other stations (it may be placed in an ice bath to speed up cooling rate). Make notes of your activities and observations.

Station 2: I Can Crush You – HANDS-ON

- CAUTION: Make sure that you don't boil away all the water while the can is on the hot plate.
- Pour a small amount of water into one of the soda cans, and place it on the hot plate. Turn on the heat.
- At some point, steam will be emerging from the can; this may occur before the water is at a rolling boil. Once steam is emerging from the can, get ready.
- Using the beaker tongs, quickly move the can and invert it into the container of ice water. You need to completely submerge the opening of the can under water so that you create a seal. Hold the can in that position for a little while, until something startling happens.
- Turn off the heat to the hot plate. Make notes of your activities and observations.

Station 3: Boiling Lukewarm? – HANDS-ON

- CAUTION: Pay attention to make sure that all the heating water doesn't boil away.
- Carefully pour a boiling water into the plastic ehrlenmeyer flask until it is about $\frac{1}{4}$ height full.
- Immediately put the flask into your plastic pressure chamber. Note whether or not the water is boiling.
- Quickly, evacuate the chamber using the vacuum port. What do you observe?
- Push the release button on your pressure chamber. If needed dry out your pressure chamber with a paper towel. Repeat if you like (you may need to replace the water in the flask with water from the hot plate).
- Turn off the heat to the hot plate. Attach the hose to the air port and blow the hose dry.
- Make notes of your activities and observations.

Part II: The Pressure's High, Tell Me Can You Feel It?

Station 4: Feel it – HANDS-ON

- Each member of your group should actually do the hands-on part of the following activities, as part of the task is to actually feel the effort you are exerting for use as a comparative measure. Repeat several times as necessary.
- Assemble the smallest pressure chamber. Put the lid on the container. Then pull them apart, paying attention to the relative difficult of assembly and disassembly.
- Reassemble your chamber, and then pump on it using the hand pump. As you continue to pump, what do you notice about the effort it takes to continue pumping?
- Now, try to disassemble the chamber. What do you notice, especially as compared to when you disassembled it previously, before it was pumped?
- Reset the chamber, paying very careful attention, *especially with your ears*. What do you notice?
- Now try to disassemble the chamber. What do you notice as compared to your immediately prior attempt?
- Ask your instructor to work with you on an associated activity involving suction cups and the Magdeburg sphere.
- Make notes of your activities and observations.

Station 5: See It – HANDS-ON

- Place an inflated balloon into the pressure chamber. Close the lid.
- Use the vacuum port to pump out the chamber using house vacuum. Observe the balloon.
- Reset your chamber. Observe the balloon. Make notes of your activities and observations.

Station 6: Weight It – HANDS-ON

- Record the mass of the large chamber with lid (use nearby top-loading balance, NOT an analytical balance).
- Use the vacuum port to pump out the chamber (don't do this on the balance) using house vacuum.
- Record the mass of the pumped out chamber and lid.

Station 7: Poke It – HANDS-ON (group of 4)

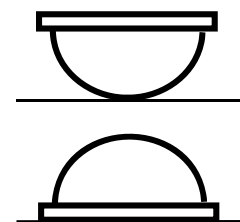
- Do this at the sink. Take one of the plastic bottles with screw top lid. You are going to poke a hole in a bottle full of water. What do you think will happen after poking the hole?
- Fill the bottle with water, and cap it tightly. Make sure you're above the sink. Poke a hole in the side of the bottle, somewhere in the lower half, with the push pin. You'll want the hole to go completely through the side of the bottle, but you don't want or need a very large hole. What happens after you poke the hole?
- Make sure you are still above the sink. Loosen the cap on the bottle. What happens after you loosen the cap?
- Tighten the cap again. What happens after you tighten the cap? Make notes of your activities and observations. Remove the holey bottle from the sink area.

Station 8: Ex-Straw-Vaganza – DEMONSTRATION Do this with your instructor. Record activity and observations.

ENERGY TRANSFERS & TRANSFORMATIONS

Station 9: Hoppers & Poppers – HANDS-ON Find a "hopper", which looks like half of a hollow rubber ball. Be prepared for some minor excitement.

- Invert the hopper (turn it inside out). Then place the hopper on the floor or table with the curved side down and the diameter up, and release it. What do you observe?
- Invert the hopper again. This time place the hopper on the floor or table with the curved side up and the diameter down on the surface, then release it. Wait a short while until something exciting happens again. Was this more or less exciting than before? In what way(s) was this behavior different than the previous situation? Do you think you "stored" more, less, or the same amount of energy by inverting the hopper as previously? Why do you think the outcome was different than before? Make notes of your activities and observations.
- Brainstorm for ways to get the hopper to pop higher in the air, given the same initial inversion.



Station 10: Hand Crank Generator – HANDS-ON. The Genecon hand-crank generator should be attached via alligator clips to a light bulb in a socket. Each person in the group should do the following activities, so everyone in your group gets a chance to try for themselves.

- Turn the crank on the tool clockwise about twice per second. What do you observe?
- Turn the crank on the tool counterclockwise. What do you observe?
- Turn the crank faster (but not too fast!). What do you observe, comparing when you turn the crank slow vs. fast?
- Pick a reasonable speed to turn the crank constantly, and pay attention to how hard it is to turn the crank.
- While continuing to turn the crank at a steady rate, have one partner disconnect one lead from one end of the light bulb, then reconnect it. Repeat several times, while continuing to turn the crank at a steady rate. What do you observe about the effort it takes to turn the crank when the bulb is connected versus not connected? Make notes of your activities and observations.

Station 11: ZeeBeez – HANDS-ON. Find a "ZeeBeez". Be prepared for some minor excitement.

- Invert the ZeeBeez, and place it on the floor so that the "knob" is in the air. Do you observe anything interesting?
- Hold the inverted ZeeBeez about one inch above the floor by the knob, and let it fall straight down (it might help to spin the knob like a top so that the ZeeBeez spins like a top on its way down; that helps stabilize it and allows to land flat – this isn't necessary). Do you observe anything interesting?
- Repeat the previous step, but this time release it from a bit higher above. Do you observe anything interesting?
- Repeat, each time increasing its height, until something exciting does happen. What do you observe? Make notes of your activities and observations.