ENGR 222 Names: _____

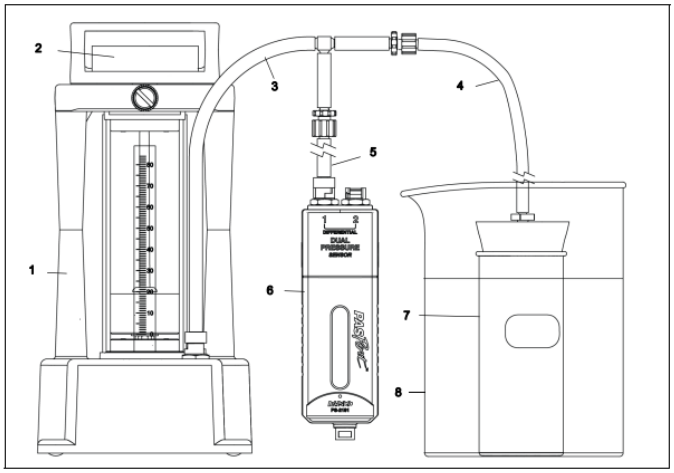
Lab 2: Piston Cylinder & Work

(20-30 min)

_____

Software/Sensor Setup:

- If you have not done so already, locate and download the SPARKvue app from the app store on your phone (it is free).
- Turn on the pressure sensor and temperature sensor (green light will blink by the Bluetooth number if it is on).
- Open the app on your phone and start a new experiment; select “Sensor Data”. You should see on the left side of the screen available sensors you can connect to; select the pressure and temperature sensor with the ID numbers matching the ones at your workstation.
- We suggest that you display the “live” data in “Digits and Graph” form.



Setup Items	Setup Items
1. Heat Engine	2. 200 gram Mass
3. Main Connector Tubing	4. Rubber Stopper Tubing
5. Pressure Sensor Adapter Tubing	6. PASCO Dual Pressure Sensor
7. Thermal Can	8. Container* (one of two)

*You also need hot water (about 80°C) for one container and cool water for the second container.

Lab Setup:

- Write down the information printed on the cylinder (diameter, mass, etc.)
- There are two pails. Fill one pail with cool tap water from a nearby sink; the water level in the pail only needs to be about 3 inches deep (about 1/3 full).
- Use the cordless kettle to boil some water (check the water level in the kettle before turning it on). After it starts boiling, turn off the kettle and pour the hot water **CAREFULLY** into the second pail (again about 3 inches deep).
- Make sure the screw on top and in front of the piston is loose so the piston can move freely.
- For easily visible results, we suggest the piston starts between 20 and 30 mm. If the piston is too low or high initially, unscrew the hose at the base of the piston (quick turn counter-

clockwise), manually lift the top of the piston platform until the bottom of the piston is around 30 mm. While holding the piston in place, reconnect the tube (quick turn clockwise). (The piston might fall a little, but as long as it is between 20 and 30 mm it should be fine.)

- Make sure the valve to the pressure sensor is open (red bar should align with tubes when open).

Experiment Procedure:

- Start the data collection on your smart phone by pressing the green button. You should see the pressure and temperature data.
- Place the air cannister and temperature probe in the cold water pail. Once the piston stops moving, record the position of the piston, the temperature of the water, and the pressure of the air in the system.

  Cold, unweighted 1

Piston Position (mm)	Temperature (°C)	Pressure (kPa)

- Place the air cannister and temperature probe in the hot water pail. The piston should rise. Wait for the piston to stop rising and record the new piston position, temperature, and pressure.

  Hot, unweighted

Piston Position (mm)	Temperature (°C)	Pressure (kPa)

- Calculate the work done **by** the air in the cannister. (If there is a small difference in the pressures, you may take the average between the two.) Show work for this question and all questions on a separate paper; include units in your calculations, and watch signs.
  Report your final answer here: _____

- Place the air cannister and temperature probe in the cold water pail. The piston should fall. Wait for the piston to stop falling and record the new piston position, temperature, and pressure.

  Cold, unweighted 2

Piston Position (mm)	Temperature (°C)	Pressure (kPa)

- Calculate the work done **by** the air in the cannister. (If there is a small difference in the pressures, you may take the average between the two.) Show your work; include units and watch signs. Answer: _____

- Place the 200-gram weight inside the piston platform. Record the new position, temperature, and pressure.

  Cold, weighted

Piston Position (mm)	Temperature (°C)	Pressure (kPa)

- Check the temperature of the hot water. It has likely cooled down since your last measurement. If so, add a little more hot water (you might need to reheat the water in the kettle; pay attention to the water level).
- Once the temperature of the hot water is equivalent to the hot water temperature recorded earlier (or within 1°C of it), place the air cannister in the hot water pail.
- Record the new position, temperature, and pressure.

  Hot, weighted

Piston Position (mm)	Temperature (°C)	Pressure (kPa)

- Calculate the work done **by** the air in the cannister. (If there is a small difference in the pressures, you may take the average between the two.) Show your work; include units and watch signs. Answer: _____

- Based on the value of the mass (and the definition of Pressure), compute the amount that the pressure would be expected to increase when the mass is placed on the piston platform. Show your calculations with units. Compute the percent difference between this value and the actual pressure change observed when adding the mass.
  Percent difference: _____

Answer the following (short answer) questions:

- Consider the volume change of the air when the cannister was moved from the cold water to the hot water. How do the unweighted and the weighted cases compare? Is this what you would expect of an ideal gas? Elaborate.

- Suppose the change of volume were equal for the weighted and unweighted cases. Which case would involve more boundary work, and why?