Lab Book: Lab 1

Ratio of Specific Heats

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Version 01 — January 2022

1 Clément-Desormes method

1.1 Preparation

Goal: measure $\gamma = C_P/C_V$ for Ar, N_2, CO_2, air.

TL;DR of the general procedure:

1. Fill a flask with a given gas
2. Increase pressure by allowing more gas in
3. Let reach equilibrium pressure P_0 (state A from lab manual Fig. 3)
4. Open flask for a second such that P goes to atmospheric (state B)
5. Let reach thermal equilibrium P_1 (state C)

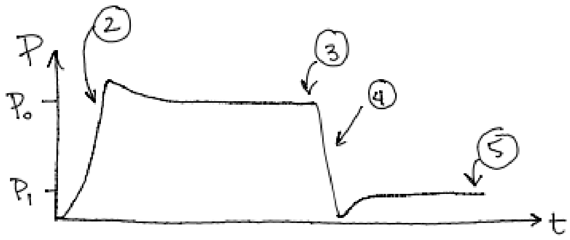

Figure 1: Typical graph for one run of C-D

Graph should look like Fig. 1.

Ar: 39.948 amu; CO_2: $(12.009 + 2 \times 15.999)$ amu; N_2: 2×14.006 amu

1.2 Lab notes

Data taken Oct 30, 2020, 4-9 pm.

- Ambient pressure per lab barometer (located inside lab): (101.5 ± 0.2) kPa
- Ambient pressure per weather.gc.ca (ECCC) at McTavish (outside): 101.2 kPa

Equipment:

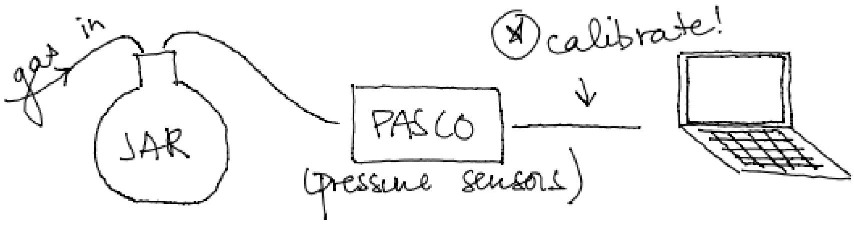

Figure 2: Scheme of the setup for Clément-Desormes

- PASCO 850 Universal Interface (EQ3725, set #01)
- PASCO Differential Pressure Sensor PS-2181

Setup in Fig. 2.

4:00-4:30 pm: Have quickly checked for container flask leaks. Using air, I increased the pressure up to 119 kPa and let it reach equilibrium over 30 minutes; levels off as expected. Pressure 2 mins later was 114.73 kPa; after 10 min 114.72 kPa; after 30 min 114.71 kPa; was constant for the last 17 mins. See file "CD_Leak_Check.csv".

4:35 have performed calibration; starting experiment with air. Am waiting 10 to 15 mins for thermal equilibrium. Data saved in "CD_Air.csv".

6:30 Flushing jar with N_2 and starting to record data. Not sure it's necessary to wait that long for thermal equilibrium; as seen in leak check, pressure changes very little after 10 mins. Will wait 5-10 mins from now on. "CD_N2.csv"

7:25 Flushing jar with Ar; starting to record data. "CD_Ar.csv"

8:10 Flushing jar with CO_2. "CD_CO2.csv"

2 Ruchardt's method

2.1 Prep

Goal: measure τ (Fig. 3). For more accuracy, measure τ' (over all oscillations) and divide by number of oscillations.

TL;DR of general procedure:

1. Activate sensor
2. Push piston up
3. Let it oscillators; record the motion.

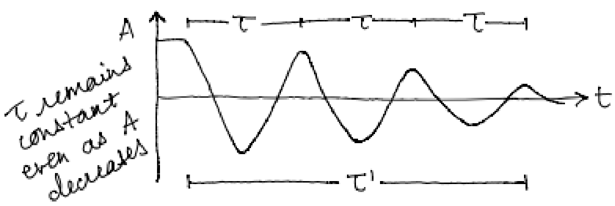

Figure 3: Typical graph for one run of R's

2.2 Lab notes

Data taken on Jan. 7, 2021, 12:00-12:30 pm.

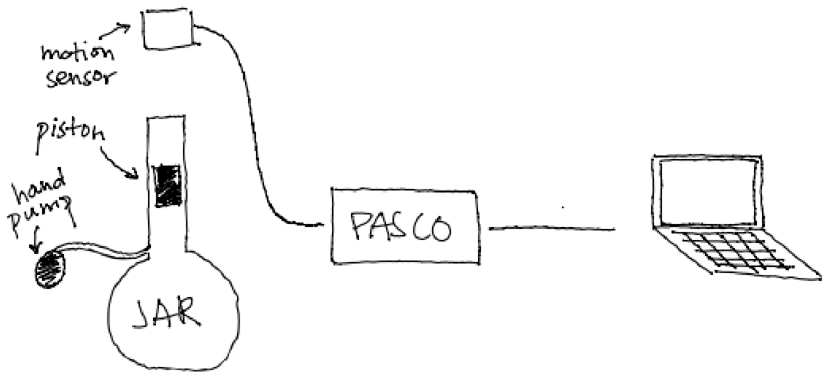

Figure 4: Scheme of the setup for Ruchardt's

- Ambient pressure per lab barometer (inside lab): (101.6 ± 0.2) kPa
- Ambient pressure per ECCC (outside): 102.4 kPa

Using set #6:

- Mass of cylindrical bob: (17.622 ± 0.001) g
- Diameter of tube: (16.00 ± 0.02) mm
- Volume of jar: $(9.3008 \pm 0.008) \times 10^{-3}$ m^3

Equipment:

- PASCO 850 Universal Interface (EQ3726, set #02)
- PASCO Motion Sensor PS-2103A (EQ3808, set#7)

Used circular levels to make sure that the pressure sensor and the cylinder containing the piston were aligned. Setup in Fig. 4.

12:05 Calibrating and testing. Keeping the sampling rate at 100 Hz; motion becomes erratic if I increase it to next available rate of 200 Hz.

12:07 Started recording data. Data very consistent; about 8 or 9 oscillations per run. Results calculated by Capstone (the PASCO interface) for τ and γ are consistent with literature, but must calculate them for myself with more accuracy.

Data in file "Ruchardts.csv."