Practice Exam

February 22, 2018

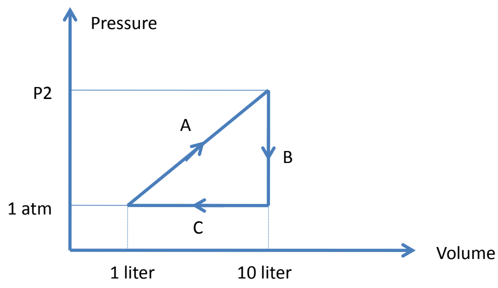
QUESTION 1 **(80 points)**

An ideal diatomic gas, in a cylinder with a movable piston, has initial volume 1 liter and initial pressure of 1 atm. The gas expands to a final volume of 10 liters such that the pressure rises in a direct proportion to the volume, as shown in step A of the figure. Assume that the rotational degrees of freedom are active, while the vibrational degrees of freedom are frozen. **Hint: you DO NOT need to know the number of molecules to solve this problem.**

1. **Compute** the pressure P_2.
2. **Compute** the **work** done on the gas, the **change in the internal energy**, and the **heat added** to the gas in **step A**.
3. **Compute** the **work** done on the gas, the **change in the internal energy**, and the **heat added** to the gas in **step B**.
4. **Compute** the **work** done on the gas, the **change in the internal energy**, and the **heat added** to the gas in **step C**.
5. **Compute** the **net work done** on the gas, **net heat** added to the system, and the **net change** in the internal energy.

QUESTION 2 **(20 points)**

The heat capacitance of the Ammonia gas NH_3 at constant pressure, C_P, is approximately 37.395 Joule/(mole.K). Find the average speed of the gas molecules at 20° C assuming that



the gas is ideal. The Nitrogen has 7 protons and 7 neutrons, while the Hydrogen has a single proton. The proton mass is almost equal to the neutron mass = 1.67×10^{-27} kg.

Miscellaneous formula

$$
\begin{aligned}
PV &= NkT, \\
Nk &= nR, \\
\Delta U &= W + Q, \\
dW &= -PdV, \\
U &= \frac{f}{2} NkT, \\
C_V \text{ for ideal gas} &= \frac{f}{2} Nk, \\
C_P \text{ for ideal gas} &= \frac{2+f}{2} Nk, \\
k &= 1.38 \times 10^{-23} \text{ Joule/K}, \\
R &= 8.31 \text{ Joule/(Mole.K)}, \\
1 \text{ m}^3 &= 10^3 \text{ liter}, \\
1 \text{ atm} &= 10^5 \text{ Pa}, \\
1 \text{ K} &= 273.15^\circ\text{C}.
\end{aligned}
$$