PHY3063 Fall 2018

HOMEWORK III

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Due: September 19, 2018

EX 1. What is the volume occupied by 1 mole of gas at 10^{-11} torr, the pressure inside an *ultra high vacuum* (UHV) chamber? What is the average distance between the gas molecules? (1 torr = 133.32 Pa).

1. Prob. 3.2.
Know what is the system. When the tank is rotating, there is mechanical energy. What happen to this mechanical energy?

2. Prob. 3.4.
Book-keeping problem. Heat and work. Where do they flow?

3. Prob. 3.7
Which part of this process work is done? Draw a V-P diagram.

4. Prob. 3.12.

5. Prob. 3.14.

6. Prob. 3.19.
I worked on a similar example in my lecture.

7. Prob. 3.20.

8. How do we determine γ experimentally? In principle you can measure C_V and C_P. But here is a another way to measure γ done by Rüchhardt.

A ball of mass m is placed snuggly inside the neck of a bottle of volume V (see figure below), and can move inside without friction. The neck has a cross-sectional area of A. The pressure inside the bottle P is slightly higher than atmospheric pressure P_o so that the weight of the ball maintains the balance: $P = P_o = mg/A$. Show that if the ball is pushed down slightly and let go, it will undergo simple harmonic oscillation with period τ given by

$$\tau = 2\pi\sqrt{\frac{mV}{\gamma P A^2}}.$$

Since the oscillation is quite fast, one can assume that P and V change adiabatically.
$PV^\gamma = const$. This leads to $d(PV^\gamma) = 0$. Therefore, $dP/P = -\gamma dV/V$ or $\Delta P/P = -\gamma \Delta V/V$. Express the quantities in this equation in terms of the displacement (x) of the ball from its equilibrium position. The displacement will create the net force $F = A\Delta P$ and the volume change $\Delta V = Ax$. Eventually you will have to extract the Hooke's law: $\vec{F} = -k\vec{x}$. Then $\tau = 2\pi\sqrt{\frac{m}{k}}$.

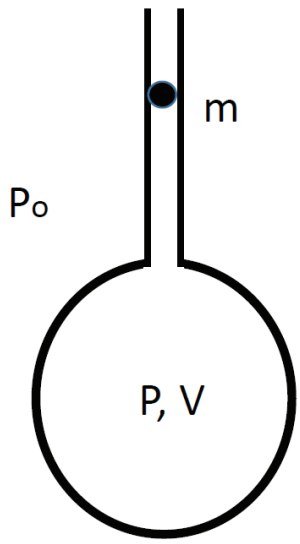

FIG. 1: