**CHEM 3423 001 Spring 2024** **Name:** **ID:** Key

**Worksheet # 3** (Total number of points you can get is **3 pts**)

1. Suppose we have a gas consisting of molecules A. The temperature is raised from $T_1$ to $T_2 = 2T_1$.
   a. What is relationship between the average molecular speeds $u_1$ and $u_2$?
   Assume $\bar{u} \propto \sqrt{\overline{u^2}}$

$\bar{u} \propto \sqrt{\overline{u^2}}$, $\overline{u^2} \propto T \Rightarrow \bar{u} \propto \sqrt{T} \Rightarrow \bar{u}_2 = \sqrt{2}\,\bar{u}_1$

   b. What is the relationship between collision frequencies $Z_{A1}$ and $Z_{A2}$?

$$Z_A = \frac{\sqrt{2}\,\pi d_A^2 N_A}{V}\,\bar{u}_A \Rightarrow Z_{A2} = \sqrt{2}\,Z_{A1}$$

   c. What is the relationship between the mean free paths $\lambda_1$ and $\lambda_2$?

$$\lambda = \frac{V}{\sqrt{2}\,\pi d_A^2 N_A} \Rightarrow \lambda_1 = \lambda_2$$

2. What is the total kinetic energy of 3 mol of an ideal monoatomic gas confined to 10 l at 200 kPa? What is the root-mean-square-speed of the gas particles? ($M = 1\,g/mol$)

$$E_{kin} = \frac{3}{2} nRT \qquad PV = nRT$$

$$= \frac{3}{2} PV = \frac{3}{2} \cdot 10 \cdot 10^{-3}\,m^3 \cdot 200 \cdot 10^3\,Pa = 3000\,J$$

$$\overline{v^2} = \frac{3RT}{M} \Rightarrow \sqrt{\overline{v^2}} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3PV}{nM}} = \sqrt{\frac{6000}{3 \cdot 10^{-3}}}$$

$$= \sqrt{2} \cdot 10^3\,m/s$$

$$= 1414\,m/s$$

3. It takes a certain gas three times as long to effuse through an orifice as the same amount of oxygen (M = 32 g/mol). What is the molar mass of the gas?

$$\text{Rate} \propto 1/\sqrt{M} \Rightarrow \frac{\text{rate}(A)}{\text{rate}(O_2)} = \frac{1}{3} = \frac{\sqrt{M_{O_2}}}{\sqrt{M_A}} \Rightarrow M_A = 9\,M_{O_2}$$

$$= 288\,g/mol$$