

## Homework 1

**part A**

1a. Determine the mean free path and average collision time of gas molecules in a vacuum chamber at room temperature filled with  $N_2$  at 1 bar and at  $10^{-9}$  mbar.

b. What are the mean free path and average collision time for an electron under the same conditions?

2a. Determine the time needed to cover a Ni(111) surface with a monolayer of  $O_2$  when the gas is at room temperature and 1 bar. Assume that  $O_2$  dissociates immediately on impact with the surface, that one O atom occupies covers one Ni atom, and that the sticking coefficient is unity.

b. Repeat the above calculation for a pressure of  $10^{-9}$  mbar.

c. A common unit of gas dose in surface science work is the Langmuir. One Langmuir is the amount of gas that impacts one  $cm^2$  of area in one second at  $10^{-6}$  Torr pressure. How many Langmuirs of gas are needed to cover a Ni(111) surface with a monolayer of O atoms under the above conditions if the sticking coefficient remains at unity throughout?

3. Determine the pressures (in mbar and Torr) that define the cutoffs for the three flow ranges (viscous, Knudsen, molecular) in a chamber with an internal diameter of 0.5 m and in a tube with an internal diameter of 2.5 cm.