

Quiz 5

Answer ONE of the following questions. Both are worth 50 points. You will not receive extra credit for answering both.

OPTION 1: Determine the pressure at which the mean free path of a molecule of hydrogen gas will be 1 m at 25°C. The diameter of the hydrogen molecule is approximately 2.0 Å.

Or

OPTION 2: The kinetic model of gases assumes that the molecules in our gas are in ceaseless random motion in all directions. Describe (in words) a gas-phase system that would NOT obey this assumption.

$$1) \lambda = \frac{k_B T}{\sigma P} \quad ; \quad P = \frac{k_B T}{(\pi d^2) \lambda} = \frac{(1.38 \times 10^{-23} \text{ J/K})(298 \text{ K})}{(\pi)(2.0 \times 10^{-10} \text{ m})^2 (1 \text{ m})}$$
$$P = 0.033 \text{ J/m}^3 = 0.033 \frac{\text{Pa} \cdot \text{m}^3}{\text{m}^3} = 0.033 \text{ Pa}$$
$$P = 0.033 \text{ Pa} \left(\frac{1 \text{ atm}}{10^5 \text{ Pa}} \right) = 3.3 \times 10^{-7} \text{ atm}$$

2) Any system in which motion was biased in one direction would not obey our assumption. A molecule with a permanent magnetic dipole moment passing through a magnetic field would have its motion biased in one direction. There are other examples.