

CHEMISTRY 116 - Fall 2021
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Discussion Worksheet - Week 7

1. According to kinetic theory what is the average kinetic energy per mole a function of?
2. Three identical sealed flasks contain the following gases at 273 K:

flask	gas	P(torr)
A	H ₂	100
B	N ₂	250
C	CO	760

In which flask

- a) is the density the greatest? _____
 - b) will the molecules have the greatest average kinetic energy? _____
 - c) will the molecules have the greatest root-mean-square speed, u_{rms} ? _____
3. What is the average kinetic energy of a molecule at 0°C and 1000°C? [(5.66, 26.4) × 10⁻²¹ J]
 4. If $u_{\text{rms}} = 500 \text{ km s}^{-1}$ for hydrogen atoms in a star, what is the temperature of the star? [10⁷ K]
 5. At what temperature will u_{rms} for Ne be the same as u_{rms} for He at 300.0 K? [1513 K]
 6. The vapor densities for neon and argon are the same at their respective normal boiling points (when $P_{\text{gas}} = 1 \text{ atm}$). At these boiling points is the root-mean-square speed of neon vapor molecules less than, the same as, or greater than the rms speed of argon, or indeterminate (not enough information given)? Why?
 7. For O₂ at STP $u_{\text{mp}} = 4.00 \times 10^4 \text{ cm s}^{-1}$ and $\lambda = 7.70 \times 10^{-8} \text{ cm}$. What is the mean time between collisions? [1.71 × 10⁻¹² s]
 8. Give the ratio of initial to final wall collision frequencies for a gas when P is doubled at constant V , P is doubled at constant T , T is doubled at constant V , and T is doubled at constant P . Determine the ratio of initial to final $\langle u \rangle$ for the same four changes.
 9. At what pressure does the mean free path of argon at 25°C become comparable to a) the size of a 1.0 L vessel that contains it or b) the diameters of the atoms themselves? Take πd^2 to be 0.36 nm². [$P = 0.081 \text{ Pa}$]

10. How does the mean free path in a sample of a gas vary with temperature at constant volume?
11. Dry air contains 0.033 percent CO_2 ($M = 44.0098 \text{ g/mol}$) by volume. Determine the total mass of CO_2 that strikes 1 cm^2 of one side of a green leaf in 1 s in dry air at 25°C and 1.00 atm. [5.6 mg]
12. Find the molecular formula for a hydrocarbon gas that effuses 0.872 times as fast as O_2 through a small hole, the temperatures and pressures being equal. [C_3H_6]
13. Draw three isotherms for a gas showing the relationship between P and V at constant T if the gas a) were ideal, b) were real, or c) were to follow the van der Waals equation of state. Explain your sketches.
14. What physical phenomenon can the van der Waals equation of state predict that the ideal gas equation cannot?
15. For a gas that obeys the van der Waals equation of state attractive forces increase, decrease, do not change and repulsive forces increase, decrease, do not change the pressure over what the gas would exert were it to obey the ideal gas equation. (circle answers)