

Fall 2007 CH301 Worksheet 8

1. Dr. Laude puts 5 mL of liquid N₂ in an otherwise empty balloon and ties the end. What is the volume of the balloon when all of the liquid has boiled and the balloon has equilibrated with its surroundings? Assume that at equilibrium, P = 1 atm and T = 25°C. The density of liquid N₂ is 0.808 g/mL.

3.53 L

2. Next, Dr. Laude puts the balloon on a chair and sits on it. Suppose 262 lbs of downward force on the balloon increases the pressure in the balloon by 0.5 atm. What is the volume of the balloon now?

2.35 L

3. A rigid, closed vessel of volume 250 mL contains water vapor at a pressure of 1 atm and a temperature of 120°C. The water vapor then completely decomposes into molecular hydrogen and oxygen. What is the new pressure in the vessel?

1.5 atm

4. A blimp contains 7.00×10^6 L of helium gas at a pressure of 2 atm at 25°C. What is the mass of the gas?

2.29×10^6 g

5. How many atoms of helium are in the blimp?

3.44×10^{29} atoms

6. A human breathes about 20 m³ of air per day at STP. If the molar mass of air is 29.0 g, what mass of air do we breathe per day?

25.9 kg

7. What are the basic assumptions of kinetic molecular theory as given by Dr. Laude?

Gas molecules are infinitesimally small hard spheres and experience no intermolecular forces, and the energy in the system is constant.

8. What are the two major flaws of k.m.t.?

Gas molecules have volume and attract each other.

9. At a certain temperature, helium atoms have energy of 7.72×10^{-21} J. How fast does each molecule move?

1.52 km/s

10. At what speed do nitrogen molecules move at the same temperature as in problem 9?

576 m/s

11. At a certain temperature, oxygen molecules diffuse at a rate of $1 \text{ cm}^2/\text{s}$. At what rate do molecules of chloroform diffuse?

$0.518 \text{ cm}^2/\text{s}$

12. Another gas diffuses at a rate of $2 \text{ cm}^2/\text{s}$. What is the molecular weight of this other gas?

8 g/mol

13. Rank the following gases in terms of increasing non-ideality: CH_3OH , He, CO, Ar, CCl_4 .

$\text{He} < \text{Ar} < \text{CCl}_4 < \text{CO} < \text{CH}_3\text{OH}$

14. Rank the following gases in order of increasing rate of effusion: H_2 , Cl_2 , Ne, CH_4 , C_3H_8

$\text{Cl}_2 < \text{C}_3\text{H}_8 < \text{Ne} < \text{CH}_4 < \text{H}_2$

15. The ideal gas law is a better approximation for methane than for chloroform. Why?

Chloroform is polar, and thus deviates more from k.m.t. (stronger intermolecular forces).

16. When Dr. Laude put an air-filled balloon in liquid nitrogen, liquid formed inside the balloon. How did this expose a flaw with k.m.t.?

It showed that gas molecules have volume.

17. Which of the following would you expect to have a larger volume at STP: 1 mole of H_2 or one moles of N_2 ?

H_2

18. What is the proportionality between the energy of a molecule and the temperature?

$E \propto T$

19. What is the proportionality between the energy of molecule and its velocity?

$E \propto v^2$

20. Explain why smell doesn't travel at 1000 mph, even though its individual molecules might.

Each molecule travels a very short distance before it runs into another molecule and changes direction, so it takes a long time to actually get anywhere.