Homework 03 - Non-Ideal Gases

Question 1

2 pts

Two gases are contained in gas bulbs connected by a valve. Gas A is present in a 1 liter bulb at a pressure of 818 torr. Gas B exerts a pressure of 328 torr in a 1 liter bulb. The valve is opened and the two gases come to equilibrium. What is the partial pressure of gas A expressed after equilibrium?

- 409 torr
- 1640 torr
- 164 torr
- 656 torr

Question 2

2 pts

A mixture of oxygen and helium is 92.3% by mass oxygen. It is collected at atmospheric pressure (745 torr). What is the partial pressure oxygen in this mixture? Hint: partial pressures are calculated from the total pressure via MOLE FRACTIONS.

- 447 torr
- 688 torr
- 412 torr
- 333 torr

Question 3

2 pts

If the average speed of a water molecule at 25°C is 640 m/s, what is the average speed at 100°C?

- 1280 m/s
- 716 m/s
- 320 m/s
- 572 m/s

Question 4

2 pts

Air bags in automobiles contain crystals of sodium azide (NaN_3) which, during a collision, decompose rapidly to give nitrogen gas and sodium metal. (Potassium nitrate and silicon dioxide are added to remove the sodium metal by converting it into a harmless material.) The nitrogen gas liberated behaves as an ideal gas and any solid produced has a negligible volume (its volume can be ignored). Calculate the mass of sodium azide required to generate enough nitrogen gas to fill a 57.0 L air bag at 1.04 atm and 16°C.

- 163 g
- 1960 g
- 106 g
- 2.50 g

Question 5

1 pts

What is the root-mean square speed of the nitrogen gas molecules generated in question 4?

- 16.0 m/s
- 50.4 m/s
- 507 m/s
- 1.59 m/s

Question 6

1 pts

Which of the following statements about Kinetic-Molecular Theory of gases is FALSE?

- Collisions between molecules are elastic.
- Gases consist of molecules in continuous random motion.
- The average kinetic energy of gas molecules in a sample of gas is independent of temperature.
- The distance between molecules is much larger than the diameter of each molecule.

Question 7

1 pts

A plot of the Maxwell distribution of speeds for the same sample of gas at different temperatures shows that...

- as the temperature increases, a high proportion of molecules have very slow speeds.
- as the temperature decreases, the distribution of speeds widens.
- at high temperatures, most molecules have speeds close to their average speed.
- at low temperatures, most molecules have speeds close to their average speed.
- as the temperature decreases, a high proportion of molecules have very high speeds.

Question 8

1 pts

Consider the gases H_2, Ne, O_2, and Ar. Put them in order of their DECREASING rate of effusion.

[Select] > [Select] >

[Select] > [Select]

Question 9

1 pts

Calculate the ratio of the rate of effusion of CO_2 to that of He.

- 3.3 : 1
- 0.090 : 1
- 12 : 1
- 11 : 1
- 0.30 : 1

Question 10

1 pts

A sample of He gas and O_2 have the same temperature, pressure, and volume. Which gas has a greater number of collisions of gas molecules with the walls of the container?

- They are the same since the pressure is the same.
- The O_2 gas since it has a higher average kinetic energy because it is more massive.
- The He gas because it is less massive and moving with a higher average velocity.
- The O_2, since it has a higher average momentum as it is more massive.

Question 11

2 pts

Nitric acid is produced commercially by the Ostwald process. In the first step, ammonia is oxidized to nitric oxide via the following reaction equation:

$4NH_3(g) + 5O_2(g) \rightarrow 4NO(g) + 6H_2O(g)$

A sample of NH_3 gas in a 2.00 L container exerts a pressure of 0.500 atm. A sample of O_2 gas in a 1.00 L container exerts a pressure of 1.50 atm. If these two gases are pumped into a 3.00 L container and allowed to react with one another (with proper catalysts), calculate the partial pressure of NO after the reaction is complete. Assume 100% yield for the reaction at a constant temperature.

- 0.333 atm
- 0.400 atm
- 0.250 atm
- 1.00 atm

Question 12

2 pts

A 5.0 L flask containing O_2 at 2.00 atm is connected to a 3.0 L flask containing H_2 at 4.00 atm and the gases are allowed to mix. What is the mole fraction of H_2?

- 0.33
- 0.67
- 0.25
- 0.55

Question 13

2 pts

A gas mixture being used to simulate the atmosphere of another planet at 22°C consists of 237 mg of methane, 148 mg of argon, and 210 mg of nitrogen. The partial pressure of nitrogen at 206 K is 19.0 kPa. Calculate the total pressure of the mixture.

- 81.6 kPa
- 165 kPa
- 29.1 kPa
- 109 kPa

Question 14

1 pts

Calculate the volume of the mixture described in question 13.

- 5.902 L
- 0.971 L
- 9.56 mL
- 0.228 L

Question 15

2 pts

When heated, solid mercury oxide (HgO) will decompose into mercury and oxygen gas according to following equation:

$2HgO(s) \longrightarrow 2Hg(g) + O_2(g)$

Starting with a container that has only solid HgO in it, the temperature is raised to 700 K and all of the solid decomposes. The total pressure in the container is 0.75 bar. What is the partial pressure of oxygen?

- 0.125 bar
- 0.25 bar
- 0.75 bar
- 0.50 bar

Question 16

1 pts

All gases exhibit ideal behavior in low pressure situations because when the pressure is very low, the gas particles are...

- experiencing a balance of kinetic and potential energy.
- undergoing only elastic collisions.
- slightly attracted to one another.
- moving very slowly.
- far apart and rarely interacting.

Question 17

2 pts

Deviations from ideal gas behavior can be modeled with other equations of state. One such equation attempts to account for the repulsive interactions of gas particles is the hard sphere model:

$P(V-nb) = nRT$

A 1 mole sample of He gas at 1000 K and 500 bar has a volume of 0.176 L. Estimate the value of the constant 'b' in the hard sphere model for He.

- b = 0.01 L/mol
- 0.176 L/mol
- 0.166 L/mol
- b = 0.025 L/mol

Question 18

1 pts

The ideal gas equation models the gas behavior observed in the world...

- perfectly for pressures under 20 atm.
- perfectly for some gases, but not for others.
- very well under some conditions, but shows large errors in others.
- perfectly for temperatures under 1000 K.
- very well under all conditions for most gases.

Question 19

1 pts

Which of the following gases would you predict to have the largest value of the van der Waals coefficient, 'b'?

- C_2F_4
- C_2FCl_3
- $C_2F_2Cl_2$
- O_2
- CO_2

Question 20

2 pts

Consider the following van der Waals coefficients:

Gas	a / L^2 atm mol^{-2}	b / L mol^{-1}
ammonia	4.17	0.0371
chlorine	6.49	0.0562
helium	0.034	0.0237
neon	0.211	0.0171
water	5.46	0.0305

Which of the following gases has the largest attractive forces?

- neon
- chlorine
- water
- helium
- ammonia