Chapter 5 – Old quiz and exam questions

23. Sodium metal is reacted with excess aqueous HCl to form aqueous NaCl and H₂ gas. If 432 mL of H₂ is collected over water at 25°C and a total pressure of 763 torr, how much sodium reacted? Assume ideal gas behavior. The vapor pressure of water at 25°C is 23.8 torr. The molar mass of Na = 23 g/mol.

a) 9.4 g  
b) 0.82 g  
c) 0.79 g  
d) 0.40 g  
e) none of these

24. A sample of an unknown gas diffuses at half the rate of helium. What is the density of the unknown gas at STP? Assume ideal gas behavior.

a) 16 g/L  
b) 0.83 g/L  
c) 0.045 g/L  
d) 0.71 g/L  
e) none of these

25. A mixture of gas contains 20 grams of oxygen gas and 83 grams of methane (CH₄) gas. If the total pressure is 850 torr, what is the partial pressure of oxygen gas?

a) 91.5 torr  
b) 165 torr  
c) 102 torr  
d) 531 torr  
e) none of these

27. At what temperature is the average speed of O₂ equal to half the average speed of Ne at 25°C?

a) -154°C  
b) -124°C  
c) 119°C  
d) 12.5°C  
e) none of these
39. Consider the following apparatus consisting of two chambers (A and B) separated by a closed valve.

![Diagram of two chambers with hydrogen (H₂) in chamber A and oxygen (O₂) in chamber B.]

Chamber A has a volume of 3.0 L and is filled with 2.0 atm of hydrogen gas at 400K. Chamber B has a volume of 2.0 L and is filled with 3.0 atm of oxygen gas at 400K. The valve between the two chambers is opened, and the hydrogen and oxygen gas react to form water. What is the total pressure in the apparatus? Assume ideal gas behavior and that the reaction goes to completion.

a) 1.2 atm
b) 1.8 atm
c) 5.0 atm
d) 2.4 atm
e) none of these

13. A 4.40-g piece of solid CO₂ (dry ice) is allowed to sublime in a balloon. The final volume of the balloon is 1.00 L at 300 K. What is the pressure of the gas?

a) 2.46 atm
b) 246 atm
c) 0.122 atm
d) 122 atm
e) none of these

14. Which of the following relationships is not true?
   a) PV = constant when temperature and moles of gas are held constant.
   b) V/T = constant when pressure and moles of gas are held constant.
   c) nT = constant when pressure and volume are held constant.
   d) P/n = constant when volume and temperature are held constant.
   e) All of the above are true.

15. Consider a sample of neon gas in a container fitted with a moveable piston (assume the piston is massless and frictionless). The temperature of the gas is increased from 20.0 °C to 40.0 °C. The density of neon ________.

a) increases less than 10%.
b) decreases less than 10%.
c) increases more than 10%.
d) decreases more than 10%.
e) does not change.
16. A sample of nitrogen gas has a volume of 160.0 mL at STP. What volume does the gas occupy if the absolute temperature and pressure are each doubled?

a) 40.00 mL
b) 80.00 mL
c) 160.0 mL
d) 320.0 mL
e) 640.0 mL

17. Body temperature is about 308 K. On a cold day, what volume of air at 273 K must a person with a lung capacity of 2.00 L breathe in to fill the lungs?

a) 2.26 L
b) 1.77 L
c) 1.13 L
d) 3.54 L
e) None of these

18. Given a cylinder of fixed volume filled with 1 mol of argon gas, which of the following is correct? (Assume all gases obey the ideal gas law.)

a) If the temperature of the cylinder is changed from 25 °C to 50 °C, the pressure inside the cylinder will double.
b) If a second mole of argon is added to the cylinder, the ratio \( \frac{V}{P} \) would remain constant.
c) A cylinder of identical volume filled with the same pressure of helium must contain more atoms of He gas because He has a smaller atomic radius than argon.
d) (a) and (b) are both correct.
e) None of the above statements are correct.

19. The two main components in air are nitrogen and oxygen gas. Air is 79% N\(_2\) and 21% O\(_2\) by volume. Considering only N\(_2\) and O\(_2\) in air, calculate the density of air at 1.0 atm, 25 °C.

a) 0.590 g/L
b) 1.18 g/L
c) 2.46 g/L
d) 14.1 g/L
e) None of the above.

1. (2 pts) What happens to the temperature of a gas when it is compressed at constant pressure and number of moles?

a) The temperature increases.
b) The temperature does not change.
c) The temperature decreases.
d) The temperature becomes unpredictable.
4. (2 pts) The volume of a balloon is 2.74 L at 23.6°C. The balloon is heated to 44.0°C at a constant pressure. Calculate the new volume of the balloon.

   a) 1.47 L  
   b) 2.74 L  
   c) 2.56 L  
   d) 12.93 L  
   e) 5.11 L

7. (3 pts) The density of an unknown gas is 6.60 g/L at a temperature of 302K and pressure of 2.10 atm. What is the molar mass of the gas?

   a) 77.9 g/mol  
   b) 37.7 g/mol  
   c) 7900 g/mol  
   d) 344 g/mol  
   e) 56.9 g/mol

8. (3 pts) A 5.72 gram sample of manganese metal (molar mass = 54.94 g/mol) was reacted with excess HCl to produce H₂ gas and the unknown compound MnClₓ. If 3.77 L of dry H₂ was produced at a pressure of 0.976 atm and a temperature of 287K, then what is the value of “x” in the unknown compound MnClₓ?

   a) 2  
   b) 1  
   c) 4  
   d) 3  
   e) 5

1. (2 pts) The volume of an ideal gas is doubled while the temperature is held constant. How does the pressure change?

   a) The pressure is reduced by one half  
   b) The pressure does not change  
   c) The pressure is doubled  
   d) The change in pressure depends on the gas

4. (2 pts) The diffusion rate of H₂ gas is 6.45 times as great as that of a certain noble gas (both gases are at the same temperature). What is the noble gas?

   a) He  
   b) Ar  
   c) Kr  
   d) Ne  
   e) Xe
7. (3 pts) Iron is reacted with excess HCl according to the following equation:
\[ 2 \text{Fe (s)} + 6 \text{HCl (aq)} \rightarrow 2 \text{FeCl}_3 \text{(aq)} + 3 \text{H}_2 \text{(g)} \].
If 397 mL of H₂ gas is collected over water at 747 torr total pressure and 23°C, how many grams of iron reacted? The vapor pressure of water at 23°C is 21.1 torr.

a) 1.31 g  
b) 0.581 g  
c) 7.48 g  
d) 0.598 g  
e) 0.506 g

8. (3 pts) A closed container is filled with 43.2 g of C₂H₆ gas and 64.3 g of O₂ gas at 400K. A spark results in the combustion of the CH₄ according to the following equation:  
\[ 2 \text{C}_2\text{H}_6 \text{(g)} + 5 \text{O}_2 \text{(g)} \rightarrow 4 \text{CO}_2 \text{(g)} + 2 \text{H}_2\text{O \text{(g)}} \].

What is the mole fraction of CO₂ gas at 400K after the reaction has gone to completion?

a) 0.25  
b) 0.67  
c) 0.75  
d) 0.49  
e) 0.83

2. (2 pts) Consider three 1 L flasks at the same temperature and pressure. Flask A contains CO gas, flask B contains N₂ gas, and flask C contains O₂ gas. In which flask do the molecules have the greatest average kinetic energy?

a) flask A  
b) flask B  
c) flask C  
d) The molecules in all the flasks have the same average kinetic energy.

5. (3 pts) Consider the following reaction: \( \text{CH}_4 + 2 \text{O}_2 \rightarrow \text{CO}_2 + 2 \text{H}_2\text{O} \).

What is the limiting reagent when 2.6 L of CH₄ at 1.4 atm and 25°C reacts with 3.3 L of O₂ at 1.9 atm and 36°C?

a) CH₄  
b) O₂  
c) CO₂  
d) H₂O  
e) More information is needed

6. (3 pts) The following reaction was performed: 2 NaN₃ (s) \( \rightarrow \) 2 Na (s) + 3 N₂ (g)

920. mL of N₂ gas was collected over water at 28.0°C and a total pressure of 752 torr.

What mass of NaN₃ (65 g/mol) was reacted? The vapor pressure of water at 28.0°C is 32 torr.

a) 1740 g  
b) 240 g  
c) 2.29 g  
d) 1.60 g  
e) 1.53 g
7. (4 pts) Consider the following system consisting of two containers separated by a valve:

![Diagram of two containers with volumes and pressures](image)

Container A: 5.4 L, 0.49 atm
Container B: 1.3 L, 0.77 atm

What will be the total pressure when the valve is opened? Assume temperature is constant.

a) 1.26 atm  
b) 0.63 atm  
c) 0.54 atm  
d) 0.34 atm  
e) 0.15 atm

2. (2 pts) Consider a container filled with a gas. Increasing the volume of this container will _______ the number of collisions between gas particles.

a) increase  
b) decrease  
c) not affect

5. (3 pts) It took 530 seconds for 2.1 L of NH₃ gas (17 g/mol) to effuse through a pinhole. If it took 820 seconds for 1.4 L of an unknown gas to effuse under the same conditions, what is the molar mass of the unknown gas?

a) 3.2 g/mol  
b) 16 g/mol  
c) 110 g/mol  
d) 39 g/mol  
e) 92 g/mol

6. (3 pts) Calculate the density of CH₄ gas at 26°C and 1.3 atm.

a) 0.85 g/L  
b) 2.7 g/L  
c) 0.096 g/L  
d) 0.0084 g/L  
e) 9.7 g/L
7. (4 pts) Into a 1.9 L container at 34°C are placed 2.4 moles of H₂S and 4.2 moles of O₂. The following reaction occurs:

\[ 2 \text{H}_2\text{S} (g) + 3 \text{O}_2 (g) \rightarrow 2 \text{SO}_2 (g) + 2 \text{H}_2\text{O} (l) \]

What will be the final pressure at 34°C after the reaction goes to completion? Hint: The final pressure is due to all gaseous products and any remaining reactants.

a) 4.4 atm  
b) 32 atm  
c) 72 atm  
\[ \text{d) 40 atm} \]  
e) 88 atm

1. (3 pts) A balloon initially has a volume of 4.39 L at 44°C. At what temperature will the balloon have a volume of 3.78 L? Assume pressure is constant.

\[ \text{a) 0°C} \]  
b) 38°C  
c) 72.9°C  
d) 273°C  
e) 546°C

3. (3 pts) At what temperature will krypton (Kr) gas have an average speed \( \langle u_{av} \rangle \) of 800 m/s?

\[ \text{a) 256526 K} \]  
b) 253 K  
c) 789 K  
\[ \text{d) 2532 K} \]  
e) 2531941 K

4. (3 pts) Calculate the density of fluorine gas at 29°C and 1.6 atm.

\[ \text{a) 7.85 g/L} \]  
b) 1.23 g/L  
\[ \text{c) 2.45 g/L} \]  
d) 0.126 g/L  
e) 12.8 g/L

6. (4 pts) Into an empty container, 66 grams of SO₂ and 39 grams of O₂ are added. The following reaction then occurs at a constant temperature of 29°C and a constant volume of 10 L:

\[ 2 \text{SO}_2 (g) + \text{O}_2 (g) \rightarrow 2 \text{SO}_3 (g) \]

After the reaction goes to completion, what will be the partial pressure of O₂?

\[ \text{a) 0.00 atm} \]  
b) 3.02 atm  
c) 0.46 atm  
d) 2.56 atm  
\[ \text{e) 1.74 atm} \]
1. (5 pts) At STP, which of the following gases has the lowest average speed?
   a) Ar
   b) N₂
   c) Ne
   d) Ar, N₂, and Ne have the same average speed at STP.

Questions 2-3: An ideal gas is placed into a container. Determine whether the collision rate of the gas (Z) will increase, decrease, or stay the same under the following conditions:

2. (5 pts) The temperature of the gas is decreased.
   a) collision rate (Z) increases  b) collision rate (Z) decreases  c) collision rate (Z) stays the same

3. (5 pts) The volume of the container is increased.
   a) collision rate (Z) increases  b) collision rate (Z) decreases  c) collision rate (Z) stays the same

15. (6 pts) Sodium is reacted with excess HCl according to the following equation:

   \[ 2 \text{Na} \text{(s)} + 2 \text{HCl} \text{(aq)} \rightarrow 2 \text{NaCl} \text{(aq)} + \text{H}_2 \text{(g)} \]

If 462 mL of H₂ gas is collected over water at 742 torr total pressure and 23°C, how many grams of sodium (molar mass = 23 g/mol) reacted? The vapor pressure of water at 23°C is 21.1 torr.

a) 1.28 g  
b) 0.830 g  
c) 10.7 g  
d) 0.854 g  
e) 0.722 g  

16. (6 pts) It took 4.2 minutes for 12.4 L of hydrogen gas to effuse through a porous barrier. How long will it take for 5.2 L of argon gas to effuse under the same conditions?

a) 11.09 minutes  
b) 7.84 minutes  
c) 4.2 minutes  
d) 5.51 minutes  
e) 0.94 minutes
18. (6 pts) A 5.2 gram mixture contains unknown amounts of solid BaO (molar mass = 153.33 g/mol) and solid CaO (molar mass = 56.07 g/mol). The sample was placed into a rigid 3.4 L flask containing CO₂ (g) at 394 K and 0.644 atm. The following reactions take place:

\[
\text{BaO (s) + CO}_2 (g) \rightarrow \text{BaCO}_3 (s)
\]
\[
\text{CaO (s) + CO}_2 (g) \rightarrow \text{CaCO}_3 (s)
\]

After these reactions go to completion, the pressure of the remaining CO₂ is 0.177 atm at 394 K. Calculate the mass of BaO in the original mixture. Assume the volumes of all solids are negligible.

a) 1.3 g
b) 2.7 g
c) 2.5 g
d) 3.9 g
e) 4.7 g

2. (5 pts) When the temperature of an ideal gas is increased from 25°C to 50°C, the average kinetic doubles.

a) True
b) False

c) 6.09 atm
d) 3.07 atm

11. (6 pts) A 10.3 L vessel contains 3.30 g of nitrogen gas, 0.564 g of hydrogen gas, and 86.4 g of argon gas. What is the total pressure in the vessel at 25.6°C?

a) 215 atm
b) 0.522 atm
c) 9.60x10⁻⁴ atm
d) 6.09 atm
e) 3.07 atm

12. (6 pts) A sample contains gas molecules with an average speed \( \langle \text{v}_\text{avg} \rangle \) of 458 meters per second at 251 K. What is the molar mass of the gas in grams per mole?

a) 0.0253 g/mol
b) 0.250 g/mol
c) 1.2x10⁻¹ g/mol
d) 25.3 g/mol
e) 12.0 g/mol

13. (6 pts) A 250.0 mL flask is filled with an unknown gas to a pressure of 0.945 atm at a temperature of 100.0°C. If the gas weighs 0.356 g, then what is the molar mass of the unknown gas?

a) 11.7 g/mol
b) 34.8 g/mol
c) 46.1 g/mol
d) 7.72 g/mol
e) 28.8 g/mol
18. (6 pts) Consider the following apparatus consisting of two containers, at the same temperature, separated by a valve:

![Diagram of two containers A and B with a valve]

Container A has a volume of 3.8 L and is filled with 0.576 atm of NH₃. Container B has a volume of 1.5 L and is filled with 2.52 atm of O₂. The valve between the two containers is opened, and the following reaction happens at a constant temperature:

\[ 4 \text{NH}_3(\text{g}) + 5 \text{O}_2(\text{g}) \rightarrow 4 \text{NO}(\text{g}) + 6 \text{H}_2\text{O}(\text{g}) \]

Calculate the partial pressure of NO gas after the reaction has gone to completion with 100% yield.

(a) 0.41 atm  
(b) 0.89 atm  
(c) 0.71 atm  
(d) 3.15 atm  
(e) 0.58 atm

1. (4 pts) Assuming constant volume and number of gas particles, increasing the temperature of an ideal gas from 100K to 200K will double the collision frequency (Z).

   a) True  
   b) False

2. (4 pts) Assuming constant volume and number of gas particles, increasing the temperature of an ideal gas from 100K to 200K will double the pressure.

   a) True  
   b) False

12. (6 pts) A bicycle tire is filled with air to a pressure of 3600 torr at a temperature of 22°C. Riding the bike on a hot day increases the temperature of the tire to 50°C. The volume of the tire increases by 4.5%. What is the new pressure in the tire?

   a) 7829 torr  
   b) 87590 torr  
   c) 4640 torr  
   d) 181800 torr  
   e) 3772 torr

14. (6 pts) In an experiment, it took 2.8 minutes for 14.3 L of hydrogen gas to effuse through a porous barrier. How long will it take for 5.9 L of neon gas to effuse under the same conditions?

   a) 5.2 minutes  
   b) 2.8 minutes  
   c) 6.7 minutes  
   d) 3.7 minutes  
   e) 0.88 minutes
18. (6 pts) Consider the following reaction: \(4 \text{C}_2\text{H}_2 (g) + 5 \text{O}_2 (g) \rightarrow 4 \text{CO}_2 (g) + 2 \text{H}_2\text{O} (g)\)

3.8 moles of \(\text{C}_2\text{H}_2\) is reacted with 6.5 moles of \(\text{O}_2\) at a constant pressure of 1 atm. Calculate the total volume of gas at 453 K after the reaction has gone to completion.

a) 381 L  
b) 212 L  
c) 141 L  
d) 71 L  
**c) 275 L**

1. (5 pts) Container A is filled with 100 grams of helium. Container B is filled with 100 grams of hydrogen. Both containers have the same volume and temperature. Which of the following statements is true:

a) The gas in Container A has a higher pressure than the gas in Container B  
**b) The gas in Container B has a higher pressure than the gas in Container A**  
c) The gases in Container A and Container B have the same pressure  
d) The temperature must be known

9. (6 pts) At what temperature will oxygen gas have an average root-mean-squared speed \(v_{rms}\) of 610 m/s?

a) 360 K  
b) 239 K  
**c) 477 K**  
d) 2.4x10^5 K  
e) 4.8x10^5 K

11. (6 pts) Hydrogen peroxide decomposes according to the following reaction: \(2 \text{H}_2\text{O}_2 (l) \rightarrow 2 \text{H}_2\text{O} (l) + \text{O}_2 (g)\)

790 mL of oxygen gas is collected over water at a total pressure of 757 torr and temperature of 23.0°C. How many grams of \(\text{H}_2\text{O}_2\) (34.0 g/mol) reacted? The vapor pressure of water at 23.0°C is 22.0 torr. Assume the reaction goes to completion.

a) 2.20 g  
b) 27.5 g  
c) 28.4 g  
**d) 2.14 g**  
e) 1.54 g

12. (6 pts) A mixture containing 3.8 moles of \(\text{CO}\) and 2.2 moles of \(\text{SO}_2\) is added to a sealed container. If the partial pressure of \(\text{CO}\) in the mixture is 0.66 atm, what is the total pressure of the mixture?

a) 0.42 atm  
b) 0.38 atm  
c) 2.4 atm  
d) 1.4 atm  
**e) 1.0 atm**
13. (6 pts) A hot air balloon is filled to a volume of 13000 L at 750 torr and 29°C. The air in the balloon is heated to 91°C, causing the balloon to expand to a volume of 13390 L. What is the ratio of the number of moles of air in the heated balloon to the original number of moles of air in the balloon? Hint: Openings in the balloon allow air to flow out, keeping the pressure constant.

(a) 0.85  
(b) 0.92  
(c) 0.64  
(d) 1.08  
(e) 0.33

1. (5 pts) As temperature increases, the density of an ideal gas will ____________

(a) increase  
(b) decrease  
(c) stay the same

2. (5 pts) Of the following gases ____________ will have the fastest effusion rate at a given temperature.

(a) NH₃  
(b) CH₄  
(c) Ar  
(d) HBr  
(e) All of these will have the same effusion rate

3. (5 pts) Of the following gases, ____________ will have the lowest average kinetic energy \((KE)_{av}\) at a given temperature.

(a) NH₃  
(b) CH₄  
(c) Ar  
(d) HBr  
(e) All of these will have the average kinetic energy
11. (5 pts) Consider the following system consisting of two chambers separated by a valve:

![Diagram of two chambers with volumes and pressures indicated](image)

What will be the total pressure in the system when the valve is opened? Assume temperature is constant.

a) 3.23 atm  
b) 1.62 atm  
c) 1.03 atm  
d) 0.85 atm  
e) 1.39 atm

15. (6 pts) Iron is reacted with excess HCl according to the following equation:

\[ 2 \text{Fe (s) + 6 HCl (aq) \rightarrow 2 FeCl}_3 \text{(aq) + 3 H}_2 \text{(g)} \]

If 384 mL of H₂ gas is collected over water at 23°C and a total pressure of 742 torr, how many grams of iron reacted?

The vapor pressure of water at 23°C is 21.1 torr.

a) 424 g  
b) 0.558 g  
c) 0.862 g  
d) 0.579 g  
e) 0.838 g

9. (6 pts) A 6.60-g piece of dry ice (solid CO₂, molar mass = 44 g/mol) is allowed to vaporize in a balloon. After all of the CO₂ vaporizes, the volume of the balloon is 1.30 L at 280 K. What is the pressure of the gas?

a) 5.71 \times 10^{-5} \text{ atm}  
b) 0.377 \text{ atm}  
c) 2.65 \text{ atm}  
d) 1.17 \times 10^2 \text{ atm}  
e) 32.3 \text{ atm}