

Test bank chapter (5)

Choose the most correct answer

1. A sample of oxygen occupies V_1 47.2 liters under a pressure of P_1 1240 torr at 25°C. What volume would it occupy at 25°C if the pressure were decreased to P_2 730 torr?

- a) 27.8 L
- b) 29.3 L
- c) 32.3 L
- d) **80.2 L**

$$P_1 V_1 = P_2 V_2$$

$$\frac{1240 \times 47.2}{730} = \frac{730 V_2}{730}$$

$$V_2 = 80.2 \text{ L}$$

2. Under conditions of fixed temperature and amount of gas, Boyle's law requires that

- I. $P_1 V_1 = P_2 V_2$
- II. $PV = \text{constant}$
- III. $P_1/P_2 = V_2/V_1$

- a) I only
- b) II only
- c) III only
- d) **I, II, and III**

$$P_1 V_1 = \text{Constant}, P_2 V_2 = \text{Constant}$$

$$P_1 V_1 = P_2 V_2 \leftarrow \frac{P_1}{P_2} \times \frac{V_1}{V_2}$$

3. The volume of a sample of nitrogen is V_1 6.00 liters at T_1 35°C and P_1 740 torr. What volume will it occupy at (STP)?

- a) 6.59 L
- b) 5.46 L
- c) 6.95 L
- d) **5.18 L**

$$35 + 273.15 = 308.15 \text{ K}$$

$$740 \text{ torr} = \frac{740}{760} = 0.974 \text{ atm}$$

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \Rightarrow \frac{0.974 \times 6}{308.15} = \frac{1 \times V_2}{273.15}$$

$$\Rightarrow \frac{308.15 V_2}{308.15} = \frac{1589.73}{308.15} = 5.16 \text{ L}$$

4. The density of chlorine gas at STP, in grams per liter, is approximately:

- a) 6.2
- b) **3.2**
- c) 3.9
- d) 4.5

$$d = \frac{PM}{RT} = \frac{1 \times 70.91}{0.0821 \times 273.15} = 3.2$$

Explanation: $d = \text{molar mass} \times p / RT = 70 \times 1 / 0.082 \times 273 = 3.17 \text{ g/L}$

5. What pressure (in atm) would be exerted by 76 g of fluorine gas in a 1.50 liter vessel at -37°C?

- a) **26 atm**
- b) 4.1 atm
- c) 19,600 atm
- d) 84 atm

$$PV = \frac{m}{M} RT$$

$$1.5P = \frac{76}{2 \times 16} \times 0.0821 \times 236.15 \Rightarrow 1.5P = 38.78 \Rightarrow P = 25.85 \approx 26 \text{ atm}$$

6. What is the density of ammonia gas at 2.00 atm pressure and a temperature of 25.0°C?

- a) 0.720 g/L
- b) 0.980 g/L
- c) **1.39 g/L**
- d) 16.6 g/L

$$d = \frac{PM}{RT} \Rightarrow d = \frac{2 \times 17.031}{0.0821 \times 298.15}$$

$$d = 1.39 \text{ g/L}$$

7. Convert 2.0 atm to mmHg

- a) 150 mmHg
- b) 0.27 mmHg
- c) 150 mmHg
- d) **1520 mmHg**

$$1 \text{ atm} \rightarrow 760 \text{ mmHg}$$

$$2 \text{ atm} \rightarrow X$$

$$X = 1520 \text{ mmHg}$$

8. A container with volume 71.9 mL contains water vapor at a pressure of 10.4 atm and a temperature of 465°C. How many grams of the gas are in the container?

- a) 0.421 g $PV = \frac{m}{MM} RT$
 b) **0.222 g**
 c) 0.183 g
 d) 0.129 g
- $10.4 \times 0.0719 = \frac{m}{18.016} \times 0.0821 \times 738.15$
- $0.74776 = \frac{60.53m}{18.016}$
 $0.74776 = 3.36m$
 $m = 0.222g$

Explanation: $n = PV/RT = 0.0719 \times 10.4 = 0.0821 \times (465 + 273) = 0.012$ mole

Mass = n × molar mass = 0.012 × 18 = 0.222 g

9. What is the molar mass of a pure gaseous compound having a density of 4.95 g/L at -35°C and 1020 torr?

- a) 24 g/mole
 b) 11 g/mole
 c) **72 g/mole**
 d) 120 g/mole
- $d = \frac{PM}{RT} \Rightarrow M = \frac{dRT}{P}$
- $MM = \frac{4.95 \times 0.0821 \times 238.15}{1.34} = 72.14 \text{ g/mole} \approx 72$

10. A 0.580 g sample of a compound containing only carbon and hydrogen contains 0.480 g of carbon and 0.100 g of hydrogen. At STP, 33.6 mL of the gas has a mass of 0.087 g. What is the molecular (true) formula for the compound?

- a) CH₃
 b) C₂H₆
 c) C₂H₅
 d) **C₄H₁₀**
- $\frac{C}{H} = \frac{0.480}{0.100} = \frac{4.8}{1} = \frac{12.016}{1.008} = \frac{1.2}{0.1} = 12$
 Empirical formula: C₂H₅
 $MM = 29.062$
 $d = \frac{m}{V} = 2.59$
 $MM = \frac{dRT}{P} = \frac{2.59 \times 0.0821 \times 273}{1} = 57.9956 \approx 58$
 Ratio = $\frac{58}{29.062} \approx 2$
 Molecular formula: (C₂H₅)₂ = C₄H₁₀

11. Gas occupy 6L at 37°C what will be its volume when its temperature is doubled?

- a) **12 L**
 b) 6L
 c) 3.2 L
 d) 2L
- $\frac{V_1}{T_1} = \frac{V_2}{T_2}$
 $\frac{6}{310.15} = \frac{V_2}{620.3} \Rightarrow V_2 = \frac{6 \times 620.3}{310.15} = 12L$

12. A mixture of 90.0 grams of CH₄ and 10.0 grams of argon has a pressure of 250 torr under conditions of constant temperature and volume. The partial pressure of CH₄ in torr is:

- a) 143
 b) 100
 c) 10.7
 d) **239**
- $n_{CH_4} = \frac{90}{16.04} = 5.61 \text{ mol}$
 $n_{Ar} = \frac{10}{40} = 0.25 \text{ mol}$
 $X_{CH_4} = \frac{5.61}{5.61 + 0.25} = 0.96$
 $P_{CH_4} = 0.96 \times 250 = 239 \text{ torr}$

Explanation: from Dalton law $P_{CH_4} = X_{CH_4} P_{total}$, $n_{CH_4} = 90/16 = 5.625$ mole, $n_{Ar} = 10/39.95 = 0.250$ mole

$X_{CH_4} = n_{CH_4} / (n_{CH_4} + n_{Ar}) = 5.625 / (5.625 + 0.250) = 0.96$
 $P_{CH_4} = 0.96 \times 250 = 239.3 \text{ torr}$

13. What pressure (in atm) would be exerted by a mixture of 1.4 g of nitrogen gas and 4.8 g of oxygen gas in a 200 mL container at 57°C?

- a) 4.7
 b) 34
 c) 47
 d) **27**
- $PV = n_{total} RT$
 $P = \frac{(0.05 + 0.15) \times 0.0821 \times 330.15}{0.2} \Rightarrow P = 27.07 \approx 27 \text{ atm}$

Explanation: $P = n_{total} RT/V$, $n_{N_2} = 1.4/28 = 0.05$ mole, $n_{O_2} = 4.8/32 = 0.15$ mole
 $P = (0.05 + 0.15) \times 0.0821 \times (57 + 273) / 0.2 = 27 \text{ atm}$

$n_{N_2} = \frac{1.4}{28} = 0.05 \text{ mol}$
 $n_{O_2} = \frac{4.8}{32} = 0.15 \text{ mol}$

$n_{O_2} = \frac{4.8}{32} = 0.15 \text{ mol}$

14. A sample of hydrogen gas collected by displacement of water occupied 30.0 mL at 24°C and pressure 736 torr. What volume would the hydrogen occupy if it were dry and at STP? The vapor pressure of water at 24.0°C is 22.4 torr.

- a) 32.4 mL
 b) 21.6 mL
 c) 36.8 mL
 d) **25.9 mL**

$$P_T = P_{H_2} + P_{H_2O} \Rightarrow P_{H_2} = P_T - P_{H_2O}$$

$$P_{H_2} = 736 - 22.4 = 713.6 \text{ torr} \Rightarrow 0.939 \text{ atm}$$

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

Explanation: from Dalton law $\gg P_{H_2} = P_{\text{total}} - P_{H_2O}$, $P_{H_2} = 736 - 22.4 = 713.6$ torr

$$n = PV/RT \gg n = (713.6/760) \times 0.03 / 0.0821 \times (24+273) = 0.00115 \text{ mole}$$

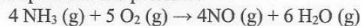
$$\text{at STP} \gg V = nRT/P = 0.00115 \times 0.0821 \times 273 / 1 = 0.026 \text{ L} \times 1000 = 25.89 \text{ mL}$$

$$\frac{1 \times V_1}{273.15} = \frac{0.030 \times 0.939}{297.15}$$

$$297.15 V_1 = 7.69$$

$$V_1 = 0.0259 \text{ L} \Rightarrow V = 25.9 \text{ mL}$$

15. Ammonia burns in oxygen gas to form nitric oxide (NO) and water vapor. How many volumes of NO are obtained from one volume of ammonia at the same temperature and pressure?



- a) **One**
 b) (b) Two
 c) (c) Three
 d) (d) Four

$$\frac{V_1}{n_1} = \frac{V_2}{n_2}$$

$$\frac{1}{4} = \frac{V_2}{4} \Rightarrow V_2 = 1$$

16. The pressure of 6.0 L of an ideal gas in a flexible container is decreased to one-third of its original value, and its absolute temperature is decreased by one-half. What is the final volume of the gas?

- a) **9.0 L**
 b) 6.0 L
 c) 4.0 L
 d) 1 L

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$\frac{6P}{T} = \frac{2P}{\frac{1}{2}T} \Rightarrow V_2 = \frac{6 \times 3}{2} = \frac{18}{2} = 9 \text{ L}$$

Explanation: let $V_1 = 6$ & $V_2 = ?$, $T_1 = T$ & $T_2 = \frac{1}{2}T$, $P_1 = P$ & $P_2 = \frac{1}{3}P$

$$\text{From combined gas law } P_1 V_1 / T_1 = P_2 V_2 / T_2 \gg \frac{P \times 6}{T} = \frac{\frac{1}{3}P \times V_2}{\frac{1}{2}T} \gg V_2 = \frac{P \times 6 \times T \times 3}{T \times 2 \times P} = 9 \text{ L}$$

17. Gas A is at 30°C and gas B is at 20°C. Both gases are at 1 atmosphere. What is the ratio of the volume of 1 mole gas A to 1 mole of gas B

- a) 606:303
 b) 3:2
 c) 2:3
 d) **303:293**

$$V_A = \frac{1}{303.15}, V_B = \frac{1}{293.15} \Rightarrow \frac{V_A}{303.15} = \frac{V_B}{293.15}$$

$$\text{Explanation: } \frac{V_A}{T_A} = \frac{V_B}{T_B} \gg \frac{V_A}{30+273} = \frac{V_B}{20+273} \gg \frac{V_A}{303} = \frac{V_B}{293}$$

18. The sample of argon occupies 50L at standard temperature. Assuming constant pressure, what volume with the gas occupy if the temperature is doubled.

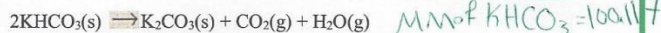
- a) 25L
 b) 50L
 c) **100L**
 d) 100 mL

علاقة طردية بين الحجم والحرارة
 $T \uparrow, V \uparrow$
 بما انه T تتدبل يعني ان V تتدبل
 $50 \times 2 = 100 \text{ L}$

$$\frac{50}{273.15} = \frac{V_2}{273.15 \times 2} \Rightarrow V_2 = \frac{50 \times 546.3}{273.15} = 100 \text{ L}$$

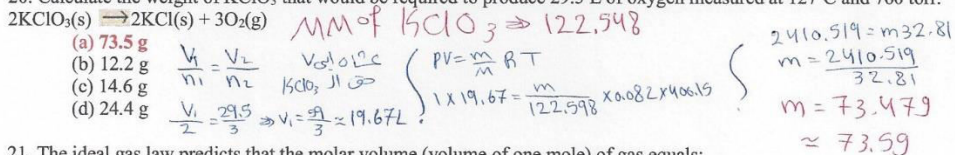
او الحد المثلثون:

19. What total gas volume (in liters) at 520°C and 880 torr would result from the decomposition of 33 g of potassium bicarbonate according to the equation:



- (a) 56 L
 (b) 37 L
 (c) 10 L
 (d) 19 L
- $PV = nRT$
 $1.16 \times V = \frac{33}{100.117} \times 0.082 \times 793.15 \Rightarrow V = \frac{21.44}{1.16} = 18.5 \approx 19 \text{ L}$

20. Calculate the weight of KClO_3 that would be required to produce 29.5 L of oxygen measured at 127°C and 760 torr.



21. The ideal gas law predicts that the molar volume (volume of one mole) of gas equals:

- (a) mRT/PV
 (b) $(MM)P/RT$
 (c) $1/2ms^{-2}$
 (d) RT/P
- molar volume $(\frac{V}{n})$
 $PV = nRT \Rightarrow \frac{V}{n} = \frac{RT}{P}$

22. For a gas, which pair of variables are inversely proportional to each other (if all other conditions remain constant)?

- a) $P, V \rightarrow$ inverse
 b) $V, T \rightarrow$ direct
 c) $n, V \rightarrow$ direct
 d) n, P

23. Convert 562 mmHg to atm

- a) 0.739 atm
 b) 4.27×10^5 atm
 c) 1.05 atm
 d) 0.562 atm
- $x = \frac{562}{760} = 0.739 \text{ atm}$

24. What is the volume of one mole of an ideal gas at STP?

- a) 24.5 L
 b) 22.4 L
 c) 1.0 L
 d) 10.0 L

25. What are standard temperature and pressure (STP)?

- a) 0 C, 1 torr
 b) 25 C, 1 torr
 c) 0 C, 1 atm
 d) 25 °C, 1 atm
- $\begin{matrix} T & P \\ \downarrow & \downarrow \\ 0^\circ\text{C} & 1 \text{ atm} \end{matrix}$

26. What is the unit of mole fraction

- a) mol
 b) mol^{-1}
 c) unitless
- x_i

27. Refer to Dalton's law of partial pressures and explain what mole fraction is
- The number of moles of one component
 - The ratio of the number of moles of one component to the number of moles of all components present.**
 - The number of moles of one component divided by 100
 - The ratio of the number of moles of all components present to the number of moles of one component.
28. Write the ideal gas equation. Give the units for each term in the equation
- $PV = nRT$; P in torr, V in L, n in mol, R in Latm/Kmol, T in °C.
 - $PV = nRT$; P in torr, V in L, n in mol, R in Latm/Kmol, T in K.
 - (c) $PV = nRT$; P in atm, V in L, n in mol, R in Latm/Kmol, T in K.**
 - $PV = nRT$; P in atm, V in L, n in mol, R in Latm/Kmol, T in °C.
29. What is the difference between a gas and a vapor?
- A gas is a substance normally in the gaseous state at normal atmospheric conditions (25C, 1 atm); a vapor is the gaseous form of any substance that is a liquid or a solid at normal temperatures and pressures.**
 - A gas is the gaseous form of any substance; a vapor refers to a gas over a water surface.
 - A gas is a substance normally in the gaseous state at normal atmospheric conditions (25C, 1 atm); a vapor is a gas over a water surface.
 - A gas and a vapor are two interchangeable nomenclatures; they are identical.
30. What volume is occupied by 19.6 g of methane (CH₄) at 27°C and 1.59 atm?
- 1.71 L
 - 18.9 L**
 - 27.7 L
 - 302 L

31. A 4.37 gram sample of a certain diatomic gas occupies a volume of 3.00 L at 1.00 atm and a temperature of 45°C. Identify this gas.

$d = \frac{m}{V} = \frac{4.37}{3} = 1.46$ $PV = \frac{m}{M} RT$
 $d = \frac{PMM}{RT} \Rightarrow MM = \frac{dRT}{P} = 38.1$ $M = \frac{mRT}{PV}$
 $MM = \frac{4.37 \times 0.082 \times 318.15}{1 \times 3} \Rightarrow MM = 38 \text{ g/mol}$

28 g/mol ← a) F₂
 28 g/mol ← b) N₂
 2 g/mol ← c) H₂
 32 g/mol ← d) O₂

Explanation: $MM = mRT/PV \gggg MM = 4.37 \times 0.0821 \times (45+273) / 1 \times 3 = 37.77/2 = 18.88 \text{ g/mole- F}_2$

32. A sample of hydrogen gas was collected over water at 21°C and 685 mmHg. The volume of the container was 7.80 L. Calculate the mass of H₂(g) collected. (Vapor pressure of water = 18.6 mmHg at 21°C.)

$P_T = P_{H_2} + P_{H_2O}$
 $P_{H_2} = 685 - 18.6 = 666.4 \text{ mmHg} \approx 0.88 \text{ atm}$
 $m = \frac{PV}{RT} \times MM$
 $m = \frac{0.88 \times 7.80 \times 2.016}{0.082 \times 294.15} = 0.5739$

33. Which of the following is/are characteristic(s) of gases?

- High compressibility
- Relatively large distances between molecules
- Formation of homogeneous mixtures regardless of the nature of gases
- High compressibility, relatively large distances between molecules AND formation of homogeneous mixtures regardless of the nature of gases**

34. A small bubble rises from the bottom of a lake, where the temperature and pressure are 4°C and 3.0 atm , to the water's surface, where the temperature is 25°C and the pressure is 0.95 atm . Calculate the final volume of the bubble if its initial volume was 2.1 mL .

- a) 0.72 mL
 b) 6.2 mL
 c) 41.4 mL
 d) 7.1 mL

Handwritten solution for Q34:

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$\frac{3 \times 2.1}{277.15} = \frac{0.95 \times V_2}{298.15}$$

$$0.0227 = 3.17 \times 10^{-3} V_2$$

$$V_2 = 7.1\text{ mL}$$

35. Calculate the mass, in grams, of 2.74 L of CO gas measured at 33°C and 945 mmHg .

- a) 0.263 g
 b) 2.46 g
 c) 3.80 g
 d) 35.2 g

Handwritten solution for Q35:

$$PV = nRT$$

$$PV = \frac{m}{MM} RT$$

$$m = \frac{PVM}{RT}$$

$$m = \frac{1.24 \times 2.74 \times 28.01}{0.082 \times 306.15}$$

$$m = 3.79\text{ g} \approx 3.8\text{ g}$$

36. Which of the following gases will have the greatest density at the same specified temperature and pressure?

- a) H_2
 b) CCl_4
 c) CO_2
 d) C_2H_6

Handwritten solution for Q36:

$$D = \frac{PM}{RT} \Rightarrow P, T \text{ constant} \Rightarrow d = \frac{M}{R}$$

$$a) D_{\text{H}_2} = \frac{1.008 \times 2}{0.082} = 24.59\text{ g/L}$$

$$c) D_{\text{CO}_2} = \frac{44.01}{0.082} = 536.72$$

$$b) D_{\text{CCl}_4} = \frac{154.46}{0.082} = 1273.9\text{ g/L}$$

$$d) D_{\text{C}_2\text{H}_6} = \frac{30.07}{0.082} = 366.71$$

37. Determine the molar mass of chloroform gas if a sample weighing 0.389 g is collected in a flask with a volume of 102 cm^3 at 97°C . The pressure of the chloroform is 728 mmHg .

Handwritten notes for Q37:
 $1\text{ L} = 1000\text{ mL}$
 $1\text{ mL} = 1\text{ cm}^3$
 $102 \times 10^{-3} = 0.102\text{ L}$

- a) 187 g/mol
 b) 121 g/mol
 c) 112 g/mol
 d) 31.6 g/mol

Handwritten solution for Q37:

$$PV = nRT$$

$$PV = \frac{m}{MM} RT$$

$$MM = \frac{mRT}{PV}$$

$$MM = \frac{0.389 \times 0.082 \times 370.15}{0.102 \times 0.96}$$

$$MM = 120.58 \approx 121\text{ g/mol}$$

38. What is the molar mass of Freon-11 gas if its density is 6.13 g/L at STP ?

- a) 0.274 g/mol
 b) 3.64 g/mol
 c) 78.2 g/mol
 d) 137 g/mol

Handwritten solution for Q38:

$$D = \frac{PM}{RT}$$

$$MM = \frac{DRT}{P}$$

$$MM = \frac{6.13 \times 0.082 \times 273.15}{1} = 137.3 \approx 137\text{ g/mol}$$

40. A mixture of three gases has a total pressure of $1,380\text{ mmHg}$ at 298 K . The mixture is analyzed and is found to contain 1.27 mol CO_2 , 3.04 mol CO , and 1.50 mol Ar . What is the partial pressure of Ar ?

- a) 0.258 atm
 b) 301 mmHg
 c) 356 mmHg
 d) $5,345\text{ mmHg}$

Handwritten solution for Q40:

$$P_{\text{Ar}} = (X_{\text{Ar}}) \cdot P_T$$

$$X_{\text{Ar}} = \frac{1.50}{1.50 + 1.27 + 3.04} = 0.258$$

$$P_{\text{Ar}} = 0.258 \times 1380 = 356.04 \approx 356\text{ mmHg}$$

41. A sample of hydrogen gas was collected over water at 21°C and 685 mmHg. The volume of the container was 7.80 L. Calculate the mass of H₂(g) collected. (Vapor pressure of water = 18.6 mmHg at 21°C.)

- a) 0.283 g
- b) 0.572 g
- c) 0.589 g
- d) 7.14 g

42. A 0.271 g sample of an unknown vapor occupies 294 mL at 140°C and 847 mmHg. The empirical formula of the compound is CH₂. What is the molecular formula of the compound?

MM = 14.027 g/mol

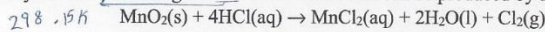
- a) CH₂
- b) C₂H₄
- c) C₃H₆
- d) C₄H₈

$PV = \frac{m}{MM} RT$
 $MM = \frac{mRT}{PV}$

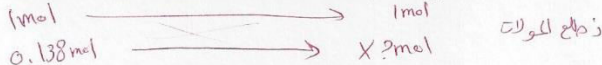
$MM = \frac{0.271 \times 0.082 \times 413.15}{0.294 \times 0.294}$
 $MM = 28.13 \text{ g/mol}$

Ratio = $\frac{28.13}{14.027} \approx 2$
 $(CH_2)_2 \Rightarrow C_2H_4$

43. How many liters of chlorine gas at 25°C and 0.950 atm can be produced by the reaction of 12.0 g of MnO₂?



- a) 5.36×10^{-3} L
- b) 0.138 L
- c) 0.282 L
- d) 3.55 L



$X = 0.138 \text{ mol}$

$PV = nRT \Rightarrow V = \frac{nRT}{P}$

$= \frac{0.138 \times 0.082 \times 298.15}{0.950} = 3.55 \text{ L}$