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# Ideal Gas Laws

Exam — States of Matter & Gases

Pre-med/IB-style questions building mastery of gas behavior: Boyle/Charles/Gay-Lussac/Avogadro laws, PV=nRT, unit traps, STP and molar volume, Dalton's law and partial pressures (including gas over water), gas stoichiometry with volumes, density and molar mass from gas data, diffusion/effusion, and when real gases deviate from ideal behavior.

70 items — Printable Exam

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Generated February 20, 2026

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**1** **Which pair of assumptions is made in the ideal gas model?**

- A Gas particles are stationary; gas particles have very large volumes.
- B Gas particles have negligible volume; there are no intermolecular forces between particles.
- C Gas particles attract strongly; collisions are inelastic.
- D Gas particles have fixed positions; pressure is due to attraction to container walls.
- E Gas particles have variable molar mass; temperature depends on pressure only.

**2** **In gas law calculations (e.g., $PV = nRT$), temperature must be expressed in:**

- A °C (Celsius)
- B °F (Fahrenheit)
- C K (Kelvin)
- D atm (atmospheres)
- E mol (moles)

**3** **What is 27°C in Kelvin (K)?**

- A 246 K
- B 273 K
- C 300 K
- D 327 K
- E 400 K

**4** **Boyle's law describes the relationship between pressure and volume for a fixed amount of gas at constant temperature:**

- A P is directly proportional to V
- B P is inversely proportional to V
- C P is independent of V
- D P is proportional to $V^2$
- E P is proportional to $1/V^2$

**5** **A gas is compressed at constant temperature from 6.0 L to 2.0 L. What happens to its pressure?**

- A Pressure halves
- B Pressure stays the same
- C Pressure triples
- D Pressure becomes 6 times larger
- E Pressure becomes one-third

**6** **Charles's law describes the relationship between volume and temperature for a fixed amount of gas at constant pressure:**

- A V is inversely proportional to T(K)
- B V is directly proportional to T(K)
- C V is directly proportional to 1/T(K)
- D V is independent of temperature
- E V is proportional to T(°C)

**7** **At constant pressure, a gas is heated from 300 K to 600 K. What happens to its volume?**

- A It halves
- B It stays the same
- C It doubles
- D It triples
- E It becomes four times larger

**8** **A gas has volume 2.0 L at 300 K. At constant pressure, what is its volume at 450 K?**

- A 1.0 L
- B 2.5 L
- C 3.0 L
- D 4.0 L
- E 6.0 L

**9** **Gay-Lussac's law relates pressure and temperature when volume and amount are constant:**

- A P is inversely proportional to T(K)
- B P is directly proportional to T(K)
- C P is directly proportional to V
- D P is proportional to 1/V

E P is proportional to T(°C)

**10 A gas has pressure 1.0 atm at 300 K in a rigid container. What is its pressure at 450 K (same container)?**

A 0.67 atm

B 1.0 atm

C 1.5 atm

D 2.0 atm

E 3.0 atm

**11 Avogadro's law states that at constant temperature and pressure, the volume of a gas is proportional to:**

A Its molar mass

B The number of moles (amount of gas)

C The number of neutrons

D The density of the gas

E The number of protons

**12 At constant temperature and pressure, a gas sample increases from 2.0 mol to 3.0 mol. What happens to its volume?**

A It decreases by one-third

B It stays the same

C It increases by 50%

D It doubles

E It triples

**13** **Which equation is the combined gas law for a fixed amount of gas?**

A $P1 + V1 = P2 + V2$

B $P1V1T1 = P2V2T2$

C $P1V1/T1 = P2V2/T2$

D $P1/T1 = V2/P2$

E $PV = nT$

**14** **A gas has $P1 = 1.0$ atm, $V1 = 2.0$ L, $T1 = 300$ K. If $P2 = 0.50$ atm and $T2 = 450$ K, what is V2? (Assume amount of gas is constant.)**

A 1.5 L

B 3.0 L

C 4.0 L

D 6.0 L

E 9.0 L

**15** **Which set of conditions corresponds to STP in many high-school gas law problems?**

- A 25°C and 1 atm
- B 0°C and 1 atm
- C 0°C and 2 atm
- D 100°C and 1 atm
- E 273°C and 1 atm

**16** **Assuming an ideal gas occupies 22.4 L per mole at STP, what volume does 0.25 mol occupy at STP?**

- A 2.24 L
- B 5.60 L
- C 11.2 L
- D 22.4 L
- E 44.8 L

**17** **Assuming 22.4 L/mol at STP, 11.2 L of an ideal gas at STP corresponds to how many moles?**

- A 0.25 mol
- B 0.50 mol
- C 1.0 mol
- D 2.0 mol
- E 4.0 mol

**18** **Using $PV = nRT$ with $R = 0.0821\ L \cdot atm \cdot mol^{-1} \cdot K^{-1}$, which unit set must be used to avoid unit mismatch?**

- A P in kPa, V in mL, T in °C
- B P in atm, V in L, T in K
- C P in mmHg, V in L, T in °C
- D P in atm, V in $m^3$, T in K
- E P in mol, V in L, T in K

**19** **A gas sample has $n = 0.50$ mol, $V = 10.0$ L, $T = 300$ K. What is its pressure? ($R = 0.0821\ L \cdot atm \cdot mol^{-1} \cdot K^{-1}$)**

- A 0.41 atm
- B 0.82 atm
- C 1.23 atm
- D 2.46 atm
- E 12.3 atm

**20** **A gas sample has $P = 2.0$ atm, $V = 4.0$ L, $n = 0.50$ mol. What is its temperature? ($R = 0.0821\ L \cdot atm \cdot mol^{-1} \cdot K^{-1}$)**

- A 49 K
- B 98 K
- C 195 K
- D 390 K

E 780 K

**21** **A student uses PV = nRT but accidentally substitutes T = 25 (°C) instead of 298 (K). How will the calculated number of moles compare to the correct value?**

- A It will be too small because 25 is smaller than 298
- B It will be too large because the denominator RT is too small
- C It will be unchanged because Celsius and Kelvin differ by a constant
- D It will be negative because Celsius can be negative
- E It cannot be predicted without knowing the gas identity

**22** **Dalton's law of partial pressures states that, for a mixture of non-reacting gases:**

- A The gas with the greatest molar mass has the greatest partial pressure
- B Total pressure equals the sum of the partial pressures of each gas
- C All gases have equal partial pressures regardless of amounts
- D Partial pressure depends only on volume, not on moles
- E Total pressure equals the product of the partial pressures

**23** **A gas mixture has total pressure 3.0 atm. Two components have partial pressures 1.2 atm and 0.8 atm. What is the partial pressure of the third gas?**

- A 0.6 atm

B 1.0 atm

C 1.2 atm

D 1.8 atm

E 2.2 atm

**24** **A mixture contains 2 mol He and 3 mol Ne in the same container. If total pressure is 1.0 atm, what is the partial pressure of He?**

A 0.20 atm

B 0.40 atm

C 0.50 atm

D 0.60 atm

E 0.80 atm

**25** **A gas mixture has $P_{total} = 4.0$ atm and $P_{N2} = 3.0$ atm. What is the mole fraction of N2?**

A 0.25

B 0.50

C 0.75

D 1.00

E 3.0

**26** A gas is collected over water at 25°C. Atmospheric pressure is 760 mmHg and water vapor pressure at 25°C is 24 mmHg. What is the pressure of the dry gas?

- A 736 mmHg
- B 760 mmHg
- C 784 mmHg
- D 24 mmHg
- E 0 mmHg

**27** A gas is collected over water. Atmospheric pressure is 101.3 kPa and water vapor pressure is 3.2 kPa. What is the pressure of the dry gas?

- A 98.1 kPa
- B 101.3 kPa
- C 104.5 kPa
- D 3.2 kPa
- E 32.0 kPa

**28** For 2H2(g) + O2(g) → 2H2O(g), at the same temperature and pressure, 10 L of H2 would require what volume of O2 for complete reaction?

- A 2.5 L
- B 5.0 L
- C 10 L
- D 20 L
- E 40 L

**29** For $2H_2(g) + O_2(g) \rightarrow 2H_2O(g)$, at the same temperature and pressure, reacting 10 L of $H_2$ with excess $O_2$ would produce what volume of $H_2O(g)$?

- A 5 L
- B 10 L
- C 15 L
- D 20 L
- E 40 L

**30** For $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$, at the same temperature and pressure, 15 L of $H_2$ reacting with excess $N_2$ produces what volume of $NH_3$?

- A 5.0 L
- B 10.0 L
- C 15.0 L
- D 20.0 L
- E 30.0 L

**31** For $N_2(g) + 3H_2(g) \rightarrow 2NH_3(g)$, you mix 10 L $N_2$ with 20 L $H_2$ at the same temperature and pressure. What is the maximum $NH_3$ volume formed?

- A 10.0 L
- B 13.3 L
- C 20.0 L
- D 26.7 L

E 40.0 L

**32** **In the same scenario (10 L $N_2$ and 20 L $H_2$), what volume of $N_2$ remains unreacted (same T and P)?**

- A 0 L
- B 3.33 L
- C 6.67 L
- D 10.0 L
- E 13.3 L

**33** **Graham's law: The rate of diffusion/effusion is inversely proportional to the square root of molar mass. Compared to $O_2$ (M = 32), $H_2$ (M = 2) effuses at what relative rate?**

- A $H_2$ is 2 times faster
- B $H_2$ is 4 times faster
- C $H_2$ is 8 times faster
- D $H_2$ is 16 times faster
- E $H_2$ is 4 times slower

**34** **Using Graham's law, He (M = 4) effuses how many times faster than $CO_2$ (M = 44)?**

- A 1.0×

B 2.2×

C 3.3×

D 11×

E 44×

**35** **An unknown gas effuses at half the rate of N2 (M = 28). What is the molar mass of the unknown gas (approx.)?**

A 14 g/mol

B 28 g/mol

C 56 g/mol

D 112 g/mol

E 224 g/mol

**36** **Ideal gas behavior is most closely approached when gases are at:**

A High pressure and low temperature

B Low pressure and high temperature

C High pressure and high temperature

D Low pressure and low temperature

E Any pressure as long as temperature is 0°C

**37** **Real gases deviate MOST from ideal behavior under which conditions?**

- A Low pressure and high temperature
- B High pressure and low temperature
- C Low pressure and low temperature
- D High temperature only
- E When volume is measured in liters

**38** **According to kinetic molecular theory, gas pressure is mainly caused by:**

- A Attraction between gas particles and the container walls
- B Repulsion between gas particles
- C Collisions of gas particles with the container walls
- D The mass of neutrons in the gas particles
- E The volume of the container being large

**39** **Average kinetic energy of gas particles is directly proportional to:**

- A Pressure
- B Volume
- C Temperature in Kelvin
- D Molar mass
- E Number of neutrons

**40** **If the Kelvin temperature of an ideal gas sample is doubled, what happens to the average kinetic energy of its particles?**

- A It halves
- B It stays the same
- C It doubles
- D It quadruples
- E It becomes $\sqrt{2}$ times larger

**41** **The root-mean-square (rms) speed of gas particles is proportional to:**

- A T
- B $\sqrt{T}$
- C 1/T
- D M
- E M×T

**42** **At the same temperature, which gas has the highest average molecular speed?**

- A H2
- B N2
- C O2
- D CO2
- E Cl2

**43** At the same temperature and pressure, which gas would have the greatest density (assume ideal behavior)?

A $H_2$

B He

C $N_2$

D $O_2$

E $Cl_2$

**44** What is the density of $CO_2$ at 1.00 atm and 300 K? ($M(CO_2)=44$ g/mol, $R=0.0821$ L · atm · mol$^{-1}$ · K$^{-1}$)

A 0.18 g/L

B 0.74 g/L

C 1.79 g/L

D 4.40 g/L

E 17.9 g/L

**45** A gas has density 1.25 g/L at 1.00 atm and 300 K. What is its molar mass? ($R = 0.0821$ L · atm · mol$^{-1}$ · K$^{-1}$)

A 5.0 g/mol

B 18 g/mol

C 31 g/mol

D 44 g/mol

E 62 g/mol

**46** $O_2$ gas (M = 32 g/mol) has density 1.50 g/L at 300 K. What is the pressure? (R = 0.0821 L · atm · $mol^{-1}$ · $K^{-1}$)

- A 0.58 atm
- B 0.94 atm
- C 1.15 atm
- D 2.30 atm
- E 4.60 atm

**47** How many moles of gas are in a 5.0 L container at 2.0 atm and 300 K? (R = 0.0821 L · atm · $mol^{-1}$ · $K^{-1}$)

- A 0.081 mol
- B 0.41 mol
- C 1.0 mol
- D 2.0 mol
- E 4.1 mol

**48** Convert 380 mmHg to atm (1 atm = 760 mmHg).

- A 0.25 atm
- B 0.50 atm
- C 1.0 atm
- D 2.0 atm

E 760 atm

**49** **Convert 2.5 atm to kPa (1 atm = 101.3 kPa).**

A 25.3 kPa

B 101 kPa

C 203 kPa

D 253 kPa

E 506 kPa

**50** **A gas has volume 1.00 L at 27°C and constant pressure. What is its volume at 127°C? (Assume ideal behavior.)**

A 1.10 L

B 1.27 L

C 1.33 L

D 2.00 L

E 4.70 L

**51** **A gas has V1 = 2.0 L at P1 = 1.0 atm and T1 = 300 K. What is V2 at P2 = 0.50 atm and T2 = 600 K?**

A 2.0 L

B 4.0 L

C 6.0 L

D 8.0 L

E 12.0 L

**52** **A gas has V1 = 3.0 L at P1 = 2.0 atm and T1 = 250 K. What is V2 at P2 = 1.0 atm and T2 = 300 K? (n constant)**

A 1.8 L

B 3.6 L

C 7.2 L

D 12.0 L

E 18.0 L

**53** **At constant volume and temperature, the number of moles of a gas is doubled. What happens to the pressure?**

A It halves

B It stays the same

C It doubles

D It quadruples

E It becomes zero

**54** **At constant temperature and pressure, the amount of gas increases by 50%. What happens to volume?**

- A Volume decreases by 50%
- B Volume stays the same
- C Volume increases by 50%
- D Volume doubles
- E Volume quadruples

**55** **A fixed amount of gas is compressed isothermally so that its volume becomes one-quarter of its original value. What happens to pressure?**

- A Pressure becomes one-quarter
- B Pressure becomes one-half
- C Pressure stays the same
- D Pressure becomes 4 times larger
- E Pressure becomes 16 times larger

**56** **Which graph would be a straight line for Boyle's law (constant T and n)?**

- A P vs V
- B P vs 1/V
- C V vs T(°C)
- D P vs T(K)
- E V vs $P^2$

**57** **Which graph should be approximately a straight line passing through the origin (for ideal behavior) for Charles's law?**

- A V vs T(K)
- B V vs T(°C)
- C P vs V
- D P vs 1/T(K)
- E P vs $V^2$

**58** **Extrapolating the V vs T(K) line for an ideal gas suggests that gas volume would reach zero at approximately:**

- A 0°C
- B −273°C
- C 273°C
- D −100°C
- E 100°C

**59** **For a fixed amount of gas, if pressure and volume are both held constant, which relationship must be true?**

- A n is proportional to T
- B nT is constant
- C n/V is constant
- D P/T is constant

E V/T is constant

**60** **A sealed rigid container holds O2 at some temperature. If you add helium to the container and keep the temperature constant, what happens to the partial pressure of O2?**

A It increases because total pressure increases

B It decreases because helium "dilutes" oxygen

C It stays the same because $P_{O2}$ depends only on $n_{O2}$, T, and V

D It becomes zero because oxygen is displaced

E It depends on molar mass, so it must change

**61** **A gas mixture is in a container at constant temperature. The container's volume is doubled without changing the number of moles of each gas. What happens to each partial pressure?**

A Each partial pressure doubles

B Each partial pressure stays the same

C Each partial pressure halves

D Only the heaviest gas partial pressure changes

E Partial pressures cannot be predicted without knowing the gases

**62** **A gas mixture is in a rigid container at constant temperature. Half of the gas molecules (of every component) are removed. What happens to total pressure?**

A It doubles

B It stays the same

C It halves

D It becomes zero

E It increases by 50%

**63** **For 2H2(g) + O2(g) → 2H2O(g), 1.00 L of O2 at 1.00 atm and 300 K reacts with excess H2. How many moles of H2O form? (R = 0.0821 L · atm · mol$^{-1}$ · K$^{-1}$)**

A 0.0203 mol

B 0.0406 mol

C 0.0812 mol

D 0.162 mol

E 0.406 mol

**64** **CaCO3(s) → CaO(s) + CO2(g). If 5.00 g CaCO3 decomposes completely, what volume of CO2 is produced at 1.00 atm and 300 K? (Mr(CaCO3)=100.0, R=0.0821)**

A 0.246 L

B 0.616 L

C 1.23 L

D 2.46 L

E 12.3 L

**65** **What mass of $N_2$ is contained in 10.0 L at 1.00 atm and 300 K? ($M(N_2)=28$ g/mol, $R=0.0821$)**

- A 1.14 g
- B 5.6 g
- C 11.4 g
- D 28.0 g
- E 114 g

**66** **Which statement is correct at the same temperature and pressure?**

- A 1.0 L of He contains more molecules than 1.0 L of $CO_2$
- B 1.0 L of He contains fewer molecules than 1.0 L of $CO_2$
- C 1.0 L of He contains the same number of molecules as 1.0 L of $CO_2$
- D Only gases with the same molar mass have equal molecules in equal volumes
- E The number of molecules depends only on molar mass, not volume

**67** **At constant temperature and pressure, 0.25 mol He occupies 3.0 L. What volume will 0.50 mol He occupy?**

- A 1.5 L
- B 3.0 L
- C 4.5 L
- D 6.0 L
- E 12.0 L

**68** **One reason the measured pressure of a real gas can be LOWER than the ideal gas prediction (at the same T, V, n) is that:**

- A Gas particles have no volume
- B Intermolecular attractions pull particles away from the walls, reducing collision force
- C The container walls absorb gas and increase collisions
- D Real gases have fewer moles than ideal gases
- E Temperature becomes negative at high pressure

**69** **One reason the measured pressure of a real gas can be HIGHER than the ideal gas prediction at very high pressures is that:**

- A Gas particles occupy significant volume, reducing free space and increasing collision frequency
- B Intermolecular attractions become infinite and increase pressure
- C Molar mass increases with pressure
- D Avogadro's constant changes at high pressure
- E Temperature automatically becomes higher

**70** **Which statement is true for an ideal gas (a key consequence of the ideal gas model)?**

- A Internal energy depends on pressure only
- B Internal energy depends on volume only
- C Internal energy depends only on temperature
- D Internal energy depends on molar mass only

E Internal energy is always zero for gases

| # | Ans | Answer Text |
|---|---|---|
| 1 | B | Gas particles have negligible volume; there are no intermolecular forces... |
| 2 | C | K (Kelvin) |
| 3 | C | 300 K |
| 4 | B | P is inversely proportional to V |
| 5 | C | Pressure triples |
| 6 | B | V is directly proportional to T(K) |
| 7 | C | It doubles |
| 8 | C | 3.0 L |
| 9 | B | P is directly proportional to T(K) |
| 10 | C | 1.5 atm |
| 11 | B | The number of moles (amount of gas) |
| 12 | C | It increases by 50% |
| 13 | C | $P_1V_1/T_1 = P_2V_2/T_2$ |
| 14 | D | 6.0 L |
| 15 | B | 0°C and 1 atm |
| 16 | B | 5.60 L |
| 17 | B | 0.50 mol |
| 18 | B | P in atm, V in L, T in K |
| 19 | C | 1.23 atm |
| 20 | C | 195 K |
| 21 | B | It will be too large because the denominator RT is too small |
| 22 | B | Total pressure equals the sum of the partial pressures of each gas |
| 23 | B | 1.0 atm |
| 24 | B | 0.40 atm |
| 25 | C | 0.75 |
| 26 | A | 736 mmHg |
| 27 | A | 98.1 kPa |
| 28 | B | 5.0 L |
| 29 | B | 10 L |
| 30 | B | 10.0 L |
| 31 | B | 13.3 L |
| 32 | B | 3.33 L |
| 33 | B | $H_2$ is 4 times faster |
| 34 | C | 3.3× |
| 35 | D | 112 g/mol |
| 36 | B | Low pressure and high temperature |
| 37 | B | High pressure and low temperature |
| 38 | C | Collisions of gas particles with the container walls |