



CHEM • CHEMISTRY

04. Gases

Official PMDC Solved Past Paper Topical Booklet • High-Yield Examination Series

© 65 Solved Questions

📅 2010 to 2024 Archive

📋 Boards: BUMHS, DUHS, KMU, MDCAT, NUMS, PMDC

📄 Weightage: 27% of MDCAT (54 MCQs)

Curated by Ibrahim for fellow bees. Every question in this chapter has been verified against official UHS, NUMS, SZABMU, DUHS, and KMU answer keys. Propolis cognitive autopsies are provided at the end of this booklet to explain core concepts and break down common distractor traps.

OFFICIAL SOLVED EDITION

Q1.

UHS 2024

Intermolecular forces between molecules of ideal gas are: [UHS (2024)]

- (A) Strong
- (B) Moderate
- (C) Weak
- (D) Absent

Q2.

UHS 2024

The correct ideal gas equation is: [UHS (2024)]

- (A) $qV=nRT$
- (B) $PV=nRT$
- (C) $gV=nRT$
- (D) $yV=nRT$

Q3.

UHS 2024

The real gases show deviation from ideal behaviour at: [UHS (2024)]

- (A) Low temperature and low pressure
- (B) High temperature and high pressure
- (C) Low temperature and high pressure
- (D) High temperature and low pressure

Q4.

SZABMU 2024

Which of the following law helps to calculate the absolute temperature? [SZABMU (2024)]

- (A) Avogadro's Law
- (B) Boyle's Law
- (C) Charle's Law
- (D) Dalton's Law

Q5.

SZABMU 2024

Formula for partial pressure calculation of any component in mixture of gases is _ . (Out of syllabus) [SZABMU (2024)]

- (A) $P_i = P_t / X_i$
- (B) $P_i = P_t + X_i$
- (C) $P_i = P_t R$
- (D) $P_i = P_t X_i$

Q6.

SZABMU 2024

The S.I unit of R in general gas equation is: [SZABMU-RC (2024)]

- (A) $8.3143 \text{ NmK}^{-1} \text{ mol}^{-1}$
- (B) $0.0821 \text{ dm}^3 \text{ atom mol}^{-1} \text{ K}^{-1}$
- (C) $8.3143 \text{ J mol}^{-1} \text{ K}^{-1}$
- (D) $0.0821 \text{ dm}^3 \text{ torr K}^{-1} \text{ mol}^{-1}$

Q7.

SZABMU 2024

$PV = \frac{1}{3}mN\overline{c^2}$ is called: [SZABMU-RC (2024)]

- (A) Ideal gas equation
- (B) Vander walls equation
- (C) Kinetic equation
- (D) Henderson equation

Q8.

SZABMU 2024

When the pressure of a gas is plotted against volume at constant temperature curve obtained is known as: [SZABMU-RC (2024)]

- (A) Isobar
- (B) Isotherm
- (C) Isochoric
- (D) Isotonic

Q9.

SZABMU 2024

Which variable mentioned in ideal gas is assumed to be constant in other gas laws? [SZABMU-RC (2024)]

- (A) Volume
- (B) Temperature
- (C) Pressure
- (D) Number of moles

Q10.

DUHS 2024

According to Charle's, at 0K (-273.15°C), the volume of a gas should be: [DUHS (2024)]

- (A) -2
- (B) zero
- (C) -1
- (D) +2

Q11.

DUHS 2024

Collection of gas over water is an example of: (Out of Syllabus) [DUHS (2024)]

- (A) Boyle's law
- (B) Avogadro's law
- (C) Dalton's law
- (D) Graham's law

Q12.

DUHS 2024

Low atmospheric pressure system is called: (Out of Syllabus) [DUHS (2024)]

- (A) Diffusion
- (B) Depression
- (C) Effusion
- (D) Contraction

Q13.

BUMHS 2024

Inter molecular repulsive forces in gases are due to: [BMU (2024)]

- (A) Ionic bonding
- (B) Vander Waal's forces
- (C) Dipoles
- (D) Covalent bonding

Q14.

BUMHS 2024

5 calories are equivalent to joule. [BMU (2024)]

- (A) 4.184
- (B) 10.26
- (C) 20.92
- (D) 25.65

Q15.

BUMHS 2024

Which of the following is NOT the state of matter? [BMU (2024)]

- (A) Plasma
- (B) Liquids
- (C) Gases
- (D) Ether

Q16.

BUMHS 2024

Conversion of Fahrenheit to Celsius scale by: [BMU (2024)]

- (A) $^{\circ}\text{C} = 5/9(^{\circ}\text{F} + 32)$
- (B) $^{\circ}\text{C} = 9/5(^{\circ}\text{F} - 32)$
- (C) $^{\circ}\text{C} = 5/9(^{\circ}\text{F} - 32)$
- (D) $^{\circ}\text{C} = 9/5(^{\circ}\text{F} + 32)$

Q17.

NUMS 2024

The relationship between the absolute temperature and the velocities of the gas molecules is given by: [NUMS (2024)]

- (A) $C_{rms} = \sqrt{3RT/M}$
- (B) $PV = nRT$
- (C) $V = \sqrt{2E_k/m}$
- (D) $PV = 1/3mN\bar{c}^2$

Q18.

UHS 2023

Which one of the following gases has the lowest density under room conditions? [UHS (2023)]

- (A) Neon
- (B) Nitrogen
- (C) Oxygen
- (D) Fluorine

Q19.

UHS 2023

The process of heat flow between hotter and colder gases remains continued until all the molecules have equal: [UHS (2023)]

- (A) Average translational kinetic energy
- (B) Average rotational kinetic energy
- (C) Average translational potential energy
- (D) Average vibrational kinetic energy

Q20.

SZABMU 2023

Intermolecular forces between molecules of ideal gas are: [SZABMU (2023)]

- (A) Very strong
- (B) Very weak
- (C) Zero
- (D) Moderately strong

Q21.

SZABMU 2023

The real gases show deviation from ideal behaviour at: [SZABMU (2023)]

- (A) Low temperature and low-pressure
- (B) High temperature and high pressure
- (C) Low temperature and high-pressure
- (D) High temperature and low pressure

Q22.

KMU 2023

1 atm of pressure is equal to all of the following except: [ETEA (2023)]

- (A) 760 cm Hg
- (B) 760 mm Hg
- (C) 760 torr
- (D) 101325 Pa

Q23.

KMU 2023

The volume of a given mass of an ideal gas at certain pressure is x at constant temperature. What will be its volume when the pressure is reduced to half? [ETEA (2023)]

- (A) $\frac{x}{2}$
- (B) $2x$
- (C) $4x$
- (D) $\frac{x}{4}$

Q24.

DUHS 2023

Graph of volume versus total pressure at constant temperature is: [DUHS (2023)]

- (A) A straight-line
- (B) First a curve and then a straight line
- (C) First a straight line & then a curve line
- (D) Non-linear

Q25.

DUHS 2023

1 atm of nitrogen is at 25°C, its pressure has increased to 2 atm at 50°C. Volume will change from 1 dm³ to: [DUHS (2023)]

- (A) 0.542 dm³
- (B) 2 dm³
- (C) 3 dm³
- (D) 4 dm³

Q26.

DUHS 2023

Which of the following temperatures is referred to as the absolute zero? [DUHS (2023)]

- (A) -273.16 °C
- (B) -273.16 K
- (C) 0 °C
- (D) 32 °F

Q27.

BUMHS 2023

A set of postulates that explain the behavior of ideal gases is called: [BUMHS (2023)]

- (A) Bohr theory
- (B) Kinetic molecular theory of gases
- (C) Rutherford theory
- (D) Dalton's theory

Q28.

BUMHS 2023

Air at sea level is dense. This is practical application of. [BUMHS (2023)]

- (A) Boyle's law
- (B) Charle's law
- (C) Avogadro's law
- (D) Dalton's law

Q29.

NUMS 2023

The idea that molecules in gases are in constant movement is called: [NUMS (2023)]

- (A) Kinetic theory of gases
- (B) Crystal field theory
- (C) Molecular orbital theory
- (D) Transition state theory

Q30.

NUMS 2023

The SI unit for pressure is: [NUMS (2023)]

- (A) mm of Hg
- (B) Pascal
- (C) Bar
- (D) Torr

Q31.

NUMS 2023

If both temperature and volume of gas are doubled, the pressure: [NUMS (2023)]

- (A) Cannot be predicted
- (B) Is reduced to $1/2$
- (C) Remains unchanged
- (D) Is doubled

Q32.

UHS 2022

A gaseous mixture contains 9.6% NH_3 , 22.6% N_2 and 67.8% H_2 gases. If the total pressure is 50 atm, then the partial pressure of H_2 is: [UHS (2022)]

- (A) $67.8 \times 100/50$
- (B) $50 \times 100/100$
- (C) $67.8 \times 50/100$
- (D) $67.8 + 50/100$

Q33.

UHS 2022

If we want to raise the temperature of one mole of an ideal gas by 1K, we have to provide how much amount of energy? [UHS (2022)]

- (A) 0.0821J
- (B) 0.0821KJ
- (C) $8.314 \text{ dm}^3 \text{ atm}$
- (D) $0.0821 \text{ dm}^3 \text{ atm}$

Q34.

UHS 2022

The process of heat flow between hotter and colder gases remains continued until all the molecules have equal: [UHS (2022)]

- (A) Average translational K.E
- (B) Average rotational K.E
- (C) Average translational P.E
- (D) Average vibrational K.E

Q35.

SZABMU 2022

Air is a mixture of gases. The molecules of air do not settle down due to: [SZABMU (2022)]

- (A) Different molar mass
- (B) Non polar nature of gases
- (C) Presence of dust particles in air
- (D) Elastic collision of gas molecules

Q36.

SZABMU 2022

Collision shown by gases involve the following: [SZABMU (2022)]

- (A) No energy change
- (B) No pressure change
- (C) Small energy change
- (D) Large energy change

Q37.

SZABMU 2022

According to Charles law volume of gas reduce to zero at: [SZABMU (2022)]

- (A) -12°C
- (B) -0°C
- (C) -273.15°C
- (D) -210°C

Q38.

KMU 2022

Which of the following shows marked deviation from ideal behaviour at a given temperature and pressure? [ETEA (2022)]

- (A) CO_2
- (B) He
- (C) N_2
- (D) H_2

Q39.

DUHS 2022

The kinetic molecular theory of gases explains: [DUHS (2022)]

- (A) Mass number
- (B) Atoms number
- (C) The behavior of gases
- (D) Electron

Q40.

DUHS 2022

The comparison of rate of diffusion of H_2 & O_2 is in the ratio of: [DUHS (2022)]

- (A) 2:1
- (B) 1:4
- (C) 3:2
- (D) 4:1

Q41.

DUHS 2022

Gases deviate from ideal behavior more: [DUHS (2022)]

- (A) Gases do not deviate from ideal behavior
- (B) Both temperature & pressure low
- (C) Both temperature & pressure high
- (D) At high pressure & low temperature
- (E) At low pressure & high temperature

Q42.

BUMHS 2022

Ideal gas equation helps to calculate the following property of ideal gas except: [BMU (2022)]

- (A) Pressure
- (B) Density
- (C) Moles
- (D) Molarity

Q43.

BUMHS 2022

The volume of a given mass of a gas according to Charle's law should be zero at: [BMU (2022)]

- (A) -273°C
- (B) 273°C
- (C) 100°C
- (D) 25°C

Q44.

NUMS 2022

Which of the following represents equation for ideal gas? [NUMS (2022)]

- (A) $PV=nRT$
- (B) $P=nRT$
- (C) $PT=nRv$
- (D) $T=npv/R$

Q45.

NUMS 2022

How should the condition be changed to prevent the value of a given gas from expanding when its mass is increased? [NUMS (2022)]

- (A) Temperature is lowered & pressure is increased
- (B) Temperature is increased & pressure is lowered
- (C) Temperature & pressure both are lowered
- (D) Temperature & pressure both are increased

Q46.

NUMS 2022

Which variable mentioned in ideal gas is assumed to be constant in other gas laws? [NUMS (2022)]

- (A) Volume
- (B) Pressure
- (C) Temperature
- (D) Number of moles

Q47.

NUMS 2022

Which of the following molecules will show a higher rate of evaporation? [NUMS (2022)]

- (A) Acetone
- (B) Water
- (C) Ethanol
- (D) Ethylene glycol

Q48.

PMDC 2021

PV/nRT for an ideal gas is called: [PMC (2021)]

- (A) Expansion factor
- (B) Depression factor
- (C) Compressibility factor
- (D) Diffusion factor

Q49.

PMDC 2021

212 degree Fahrenheit is expressed in Kelvin as: [PMC (2021)]

- (A) 373
- (B) 273
- (C) 173
- (D) 0

Q50.

PMDC 2021

When temperature increases, isotherm moves? [PMC (2021)]

- (A) Away from both axis
- (B) Toward x axis
- (C) Toward y axis
- (D) Remains at same position

Q51.

PMDC 2021

General gas equation is also known as: [PMC (2021)]

- (A) Vander walls equation
- (B) Ideal gas equation
- (C) Non-ideal gas equation
- (D) Vant-hoff equation

Q52.

PMDC 2020

According to the general gas equation, density of an ideal gas depends upon: [NMDCAT (2020)]

- (A) Pressure
- (B) Temperature
- (C) Molar mass of the gas
- (D) All of the above

Q53.

PMDC 2020

The actual volume of gas molecules is considered negligible at following pressures. [NMDCAT (2020)]

- (A) 2 atm
- (B) 4 atm
- (C) 6 atm
- (D) 8 atm

Q54.

MDCAT 2019

All the collisions between the particles of gases are elastic in nature. What is meant by "Elastic Collisions"? [MDCAT (2019)]

- (A) The velocity of the molecules changes
- (B) No change in mass during the collisions
- (C) No change in the kinetic energy (no change in total energy)
- (D) No change in potential energy during the Collisions

Q55.

SET 2019

Which of the statement is applicable for both ideal and real gases molecules? [SET (2019)]

- (A) Have no forces of attraction
- (B) Collisions between the molecules is elastic
- (C) Molecules are in random movement
- (D) The actual volume of gas is negligible as compared to the volume of gas

Q56.

MDCAT 2018

Gas is enclosed in a container of 20 cm^3 with the moving piston. According to kinetic theory of gases, what is the effect on freely moving molecules of the gas if temperature is increased from 20°C to 100°C ? [MDCAT (2018)]

- (A) Colliding capability of molecule will become lower
- (B) Pressure will become one half
- (C) Temperature has no effect on freely moving molecules
- (D) Volume will be increased

Q57.

MDCAT 2018

Which of the following is the correct equation to calculate relative molecular mass of a gas? [MDCAT (2018)]

- (A) $M = \frac{mPRT}{V}$
- (B) $M = \frac{mPR}{VT}$
- (C) $M = \frac{PV}{mRT}$
- (D) $M = \frac{mRT}{PV}$

Q58.

MDCAT 2017

Identify the value of R at STP. [MDCAT (2017)]

- (A) $8.314 \text{ atm dm}^3 \text{ mol}^{-1}$
- (B) $0.0821 \text{ atm dm}^3 \text{ K}^{-1} \text{ mol}^{-1}$
- (C) $0.0821 \text{ cal K}^{-1} \text{ mol}^{-1}$
- (D) $8.314 \text{ cal K}^{-1} \text{ mol}^{-1}$

Q59.

MDCAT 2017

In the equation $\left(P + \frac{n^2a}{V^2}\right)(V - nb) = RT$, 'b' represents the: [MDCAT (2017)]

- (A) Excluded volume
- (B) Actual volume
- (C) Excluded pressure
- (D) Excluded volume per mole

Q60.

KMU 2016

At absolute zero the molecules of hydrogen gas will have: [ETEA (2016)]

- (A) Only translational motion
- (B) Only vibrational motion
- (C) Only rotational motion
- (D) All the motion are ceased

Q61.

MDCAT 2015

Which graph represents Boyle's law? [MDCAT (2015)]

- (A) Graph of Volume vs Pressure showing an increasing curve
- (B) Graph of Volume vs Pressure showing a horizontal line
- (C) Graph of Volume vs $1/\text{Pressure}$ showing a straight line passing through the origin
- (D) Graph of Volume vs Pressure showing a decreasing straight line

Q62.

MDCAT 2013

There are four gases H_2 , He , N_2 and CO_2 at 0°C . Which gas shows greater non-ideal behavior? [MDCAT (2013)]

- (A) He
- (B) H_2
- (C) CO_2
- (D) N_2

Q63.

MDCAT 2012

The number of molecules in 22.4 dm^3 of H_2 gas at 0°C and 1 atm are: [MDCAT (2012)]

- (A) 6.02×10^{24}
- (B) 6.02×10^{25}
- (C) 6.02×10^{23}
- (D) 6.02×10^{22}

Q64.

MDCAT 2010

Which one of the following expressions represent the Avogadro law? [MDCAT (2010)]

- (A) $V = RnT/P$ (When T and n are constant)
- (B) $V = RnT/P$ (When T and P are constant)
- (C) $V = RnT/P$ (When P and n are constant)
- (D) $V = RP/nT$ (When T, P and n are constant)

Q65.

MDCAT 2010

The root mean square velocity of gases is inversely proportional to square root of their: **[MDCAT (2010)]**

- ☐ (A) Temperature
 - ☐ (B) Pressure
 - ☐ (C) Molar mass
 - ☐ (D) Volume
-

RAPID 5–COLUMN ANSWER KEY

Official PMDC verified answer keys for 04. Gases.

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Q#	KEY	BOARD	Q#	KEY	BOARD	Q#	KEY	BOARD	Q#	KEY	BOARD	Q#	KEY	BOARD
1	D	UHS 2024	14	C	BUMHS 2024	27	B	BUMHS 2023	40	D	DUHS 2022	53	A	PMDC 2020
2	B	UHS 2024	15	D	BUMHS 2024	28	A	BUMHS 2023	41	D	DUHS 2022	54	C	MDCAT 2019
3	C	UHS 2024	16	C	BUMHS 2024	29	A	NUMS 2023	42	D	BUMHS 2022	55	C	SET 2019
4	C	SZABMU 2024	17	A	NUMS 2024	30	B	NUMS 2023	43	A	BUMHS 2022	56	D	MDCAT 2018
5	D	SZABMU 2024	18	A	UHS 2023	31	C	NUMS 2023	44	A	NUMS 2022	57	D	MDCAT 2018
6	A	SZABMU 2024	19	A	UHS 2023	32	C	UHS 2022	45	A	NUMS 2022	58	B	MDCAT 2017
7	C	SZABMU 2024	20	C	SZABMU 2023	33	D	UHS 2022	46	D	NUMS 2022	59	D	MDCAT 2017
8	B	SZABMU 2024	21	C	SZABMU 2023	34	A	UHS 2022	47	A	NUMS 2022	60	D	KMU 2016
9	D	SZABMU 2024	22	A	KMU 2023	35	D	SZABMU 2022	48	C	PMDC 2021	61	C	MDCAT 2015
10	B	DUHS 2024	23	B	KMU 2023	36	A	SZABMU 2022	49	A	PMDC 2021	62	C	MDCAT 2013
11	C	DUHS 2024	24	D	DUHS 2023	37	C	SZABMU 2022	50	A	PMDC 2021	63	C	MDCAT 2012
12	B	DUHS 2024	25	A	DUHS 2023	38	A	KMU 2022	51	B	PMDC 2021	64	B	MDCAT 2010
13	B	BUMHS 2024	26	A	DUHS 2023	39	C	DUHS 2022	52	D	PMDC 2020	65	C	MDCAT 2010

TOTAL
MCQS
65

CORRECT

INCORRECT

BLANK

ACCURACY

%

Scan the booklet QR code to enter answers in
BeambePrep Grind Mode for automated error
 autopsies.

PROPOLIS COGNITIVE ERROR AUTOPSIES

Step-by-step conceptual derivations, formula working, and distractor autopsies for every question.

Question #1 Key: (D)

UHS 2024

Intermolecular forces between molecules of ideal gas are: [UHS (2024)]

CORE CONCEPT AND DERIVATION

The Kinetic Molecular Theory sets specific boundary conditions to define what makes a gas behave "ideally" according to $PV = nRT$.

Solution:

- An ideal gas is a hypothetical construct. To make the math of the ideal gas law perfectly linear, scientists assume that gas particles act completely independently.
- Therefore, a core postulate states that there are no attractive or repulsive forces—van der Waals, dipole, or otherwise—between the molecules.
- In an ideal state, these forces are totally **absent**.

Why other options are incorrect:

- **Options A, B, & C:** If any level of force (even weak) exists, the gas will deviate from ideal laws (it becomes a "real gas"), especially at high pressures or low temperatures where these forces cause the gas to condense.

Question #2 Key: (B)

UHS 2024

The correct ideal gas equation is: [UHS (2024)]

CORE CONCEPT AND DERIVATION

The ideal gas equation represents the mathematical synthesis of Boyle's, Charles's, and Avogadro's laws into a single unified equation of state.

Solution:

- The universal variables defining the state of a gas are Pressure (P), Volume (V), Number of Moles (n), and absolute Temperature (T).
- The constant of proportionality that links them is the Universal Gas Constant (R).
- Combining them yields the classic equation: **$PV = nRT$** .

Why other options are incorrect:

- **Options A, C, & D:** The letters q, g, and y do not represent standard macroscopic thermodynamic state variables in this context. The variable representing the force per unit area on the container must be 'P' (Pressure).

Question #3 Key: (C)

UHS 2024

The real gases show deviation from ideal behaviour at: [UHS (2024)]

CORE CONCEPT AND DERIVATION

Ideal gas behavior is based on the assumption that gas molecules have negligible volume and zero intermolecular forces. Real gases deviate when these assumptions fail.

Solution:

- At **high pressure**, gas molecules are forced close together. The empty space is minimized, making the actual physical volume of the gas molecules significant compared to the container's total volume.
- At **low temperature**, the kinetic energy of the molecules drops. Because they are moving slower, their weak intermolecular attractive forces (van der Waals forces) have time to take effect, pulling them together.
- Therefore, the combination of low temperature and high pressure causes the most significant deviation from ideal behavior, often leading to liquefaction.

Why other options are incorrect:

- **Option D:** High temperature and low pressure are the exact conditions where real gases behave most ideally (fast-moving and far apart).
- **Options A & B:** These provide conflicting conditions where one variable promotes ideality and the other promotes deviation.

Question #4 Key: (C)

SZABMU 2024

Which of the following law helps to calculate the absolute temperature? [SZABMU (2024)]

CORE CONCEPT AND DERIVATION

Charles's Law defines the direct proportional relationship between the volume of a gas and its temperature. Extrapolating this relationship to zero volume leads to the derivation of absolute zero.

Formula:

$$V_t = V_o \left(1 + \frac{t}{273.15}\right)$$

Solution:

- In the quantitative form of Charles's Law, V_t is the volume at temperature t (in Celsius), and V_o is the volume at 0°C .
- To find the theoretical point where all kinetic motion stops (and volume becomes zero), we set $V_t = 0$.
- Solving for t yields: $0 = 1 + \frac{t}{273.15} \implies t = -273.15^\circ\text{C}$.
- This specific temperature is defined as **Absolute Zero (0 K)**. Thus, Charles's law provides the mathematical framework for absolute temperature.

Why other options are incorrect:

- **Option B:** Boyle's law relates pressure and volume at a constant temperature.
- **Option A & D:** Avogadro's and Dalton's laws deal with moles and partial pressures, respectively, not the definition of a temperature scale.

Question #5 Key: (D)

SZABMU 2024

Formula for partial pressure calculation of any component in mixture of gases is _ . (Out of syllabus) [SZABMU...]

CORE CONCEPT AND DERIVATION

According to Dalton's Law of Partial Pressures, the partial pressure of a specific gas in an ideal gas mixture is proportional to its mole fraction in that mixture.

Formula:

$$P_i = P_t \times X_i$$

Solution:

- Let P_i be the partial pressure of gas component i .
- Let P_t be the total pressure of the gaseous mixture.
- Let X_i be the mole fraction of gas i (moles of i divided by total moles).
- The partial pressure is calculated by simply multiplying the total pressure by the mole fraction of that specific gas:
 $P_i = P_t X_i$.

Why other options are incorrect:

- **Options A, B, & C:** These represent mathematically invalid operations (division, addition, or incorporating the gas constant R incorrectly) for determining partial pressure from mole fraction.

Question #6 Key: (A)

SZABMU 2024

The S.I unit of R in general gas equation is: [SZABMU-RC (2024)]

CORE CONCEPT AND DERIVATION

The universal gas constant (R) changes its numerical value and units depending on the units used for pressure and volume in the ideal gas equation ($PV = nRT$).

Solution:

- In the International System of Units (SI), Pressure is measured in Pascals (N/m^2) and Volume in cubic meters (m^3).
- The product of $P \times V$ yields $\text{N/m}^2 \times \text{m}^3 = \text{N} \cdot \text{m}$ (Newton-meters).
- A Newton-meter (Nm) is the strict fundamental definition of a Joule (J).
- Therefore, the standard SI value of R is $8.3143 \text{ J K}^{-1} \text{ mol}^{-1}$, which is identically equal to $8.3143 \text{ Nm K}^{-1} \text{ mol}^{-1}$.
- *Note: While Option C is also functionally correct, Option A is explicitly highlighted in the source's answer key to emphasize the fundamental dimensional units of Work (Force $\times$ Distance).*

Why other options are incorrect:

- **Options B & D:** These use non-SI units for volume (dm^3) and pressure (torr), which correspond to the 0.0821 numerical value but are definitively not SI units.

Question #7 Key: (C)

SZABMU 2024

*[Formula] is called: [SZABMU-RC (2024)]***CORE CONCEPT AND DERIVATION**

The Kinetic Molecular Theory bridges microscopic particle motion to macroscopic properties (pressure and volume) through a fundamental equation.

Formula:

$$PV = \frac{1}{3}mN\overline{c^2}$$

Solution:

- In this equation, P is pressure, V is volume, m is the mass of a single gas molecule, N is the total number of molecules, and $\overline{c^2}$ is the mean square velocity of the molecules.
- This fundamental derivation from Newtonian mechanics is universally known as the **Kinetic gas equation**.
- From this single equation, all other simple gas laws (Boyle's, Charles's, Avogadro's) can be mathematically deduced.

Why other options are incorrect:

- Option A:** The ideal gas equation is $PV = nRT$.
- Option B:** The van der Waals equation introduces correction factors 'a' and 'b' for real gases.
- Option D:** The Henderson-Hasselbalch equation is used in acid-base chemistry to calculate the pH of buffer solutions.

Question #8 Key: (B)

SZABMU 2024

When the pressure of a gas is plotted against volume at constant temperature curve obtained is known as: [SZAB...]

CORE CONCEPT AND DERIVATION

In thermodynamics, specific terms are used to describe processes where a particular state variable is held strictly constant.

Solution:

- The prefix '**iso-**' comes from Greek meaning 'equal' or 'same'.
- The suffix '**-therm**' relates to thermal energy or temperature.
- Therefore, an **isotherm** is a curve on a graph (usually a P-V diagram representing Boyle's Law) that connects points representing states of identical temperature.

Why other options are incorrect:

- Option A:** An isobar represents a process or graph at constant pressure ('bar' = pressure).
- Option C:** Isochoric (or isometre) represents a process at constant volume.
- Option D:** Isotonic refers to solutions with equal osmotic pressure, typically in biology/chemistry contexts.

Question #9 Key: (D)

SZABMU 2024

Which variable mentioned in ideal gas is assumed to be constant in other gas laws? [SZABMU-RC (2024)]

CORE CONCEPT AND DERIVATION

The simple empirical gas laws (Boyle's, Charles's, and Gay-Lussac's laws) govern the behavior of gases within a closed system.

Solution:

- A "closed system" strictly dictates that matter (gas) cannot enter or leave the container.
- Consequently, the mass of the gas—and therefore the **number of moles (n)**—remains permanently constant across all these foundational experiments.
- For example, Boyle's law requires constant T and n ; Charles's law requires constant P and n . The number of moles is the universally constant variable across them all.

Why other options are incorrect:

- **Options A, B, & C:** These variables are actively manipulated against each other. While one is held constant in a *specific* law (e.g., Temperature in Boyle's Law), they are not universally constant across *all* the basic gas laws like moles are.

Question #10 Key: (B)

DUHS 2024

According to Charles's, at 0K (-273.15°C), the volume of a gas should be: [DUHS (2024)]

CORE CONCEPT AND DERIVATION

Charles's Law establishes that the volume of an ideal gas is directly proportional to its absolute temperature (Kelvin).

Formula:

$$V_t = V_o \left(1 + \frac{t}{273.15}\right)$$

Solution:

- If the temperature is theoretically reduced to Absolute Zero (-273.15°C), we substitute this into the equation.
- $V_t = V_o \left(1 - \frac{273.15}{273.15}\right)$.
- $V_t = V_o(1 - 1) = V_o(0)$.
- Therefore, at 0 Kelvin, the mathematical volume of an ideal gas drops to exactly **zero**. (Note: Real gases liquefy or solidify before reaching this temperature).

Why other options are incorrect:

- **Options A & C:** Volume is a physical space and cannot be a negative mathematical value.
- **Option D:** Volume decreases as temperature drops; it would not remain at a positive integer value.

Question #11 Key: (C)

DUHS 2024

Collection of gas over water is an example of: (Out of Syllabus) [DUHS (2024)]

CORE CONCEPT AND DERIVATION

When a gas is synthesized in a lab and collected by bubbling it through water, the collected gas is not pure; it mixes with water vapor.

Formula:

$$P_{total} = P_{dry\ gas} + P_{water\ vapor}$$

Solution:

- To find the true pressure of the dry gas, we must subtract the "aqueous tension" (partial pressure of the water vapor) from the total measured pressure in the collection flask.
- This principle—that the total pressure is the simple sum of the individual partial pressures of the non-reacting gases in the mixture—is the direct practical application of **Dalton's Law of Partial Pressures**.

Why other options are incorrect:

- **Options A & B:** Boyle's and Avogadro's laws deal with single-gas volume relationships, not multi-gas mixtures.
- **Option D:** Graham's law governs the rates of diffusion and effusion, not static partial pressures.

Question #12 Key: (B)

DUHS 2024

Low atmospheric pressure system is called: (Out of Syllabus) [DUHS (2024)]

CORE CONCEPT AND DERIVATION

This is a geography/meteorology question related to atmospheric pressure states, rather than pure chemical thermodynamics.

Solution:

- In meteorology, a region where the atmospheric pressure is significantly lower than the surrounding area is formally called a **depression** (or a low-pressure area / cyclone).
- Depressions usually result in cloud formation, wind, and precipitation.
- *Note: The source document's answer key erroneously lists "C" (Effusion) for this question. However, effusion is a chemical kinetic process where gas escapes through a pinhole. The scientifically and geographically correct term is Depression.*

Why other options are incorrect:

- **Options A & C:** Diffusion and Effusion are molecular kinetic processes of gases, completely unrelated to macroscopic weather systems.
- **Option D:** Contraction refers to a decrease in volume, not an atmospheric weather state.

Question #13 Key: (B)

BUMHS 2024

*Inter molecular repulsive forces in gases are due to: [BMU (2024)]***CORE CONCEPT AND DERIVATION**

Real gases experience both attractive and repulsive intermolecular forces, which cause them to deviate from ideal behavior under varying conditions of pressure and temperature.

Solution:

- The broad category of non-covalent, non-ionic interactions between molecules is collectively referred to as **van der Waals forces**.
- While usually discussed in terms of attraction (like London dispersion forces), the van der Waals equation ($(P + a/V^2)(V - nb) = RT$) also accounts for repulsive forces at very short ranges via the 'b' constant (excluded volume).
- When gas molecules are forced incredibly close together, their electron clouds experience Pauli repulsion. In the context of real gas terminology, both these attractive and repulsive intermolecular phenomena fall under the umbrella of van der Waals interactions.

Why other options are incorrect:

- **Options A & D:** Ionic and covalent bonds are strong *intramolecular* forces that hold atoms together within a compound, not forces between separate gas molecules.
- **Option C:** Dipoles are a specific type of attractive van der Waals force, but they do not account for the fundamental short-range repulsion experienced by all gases (even non-polar ones).

Question #14 Key: (C)

BUMHS 2024

*5 calories are equivalent to joule. [BMU (2024)]***CORE CONCEPT AND DERIVATION**

The calorie is a historical unit of energy defined as the amount of heat required to raise the temperature of 1 gram of water by 1°C. It has a strict conversion factor to the SI unit of energy, the Joule.

Formula:

$$1 \text{ calorie} = 4.184 \text{ Joules}$$

Solution:

- To find the equivalent energy of 5 calories in Joules, we multiply by the conversion factor.
- Energy in Joules = $5 \text{ cal} \times 4.184 \text{ J/cal}$.
- Calculation: $5 \times 4 = 20$ and $5 \times 0.184 = 0.92$.
- Adding them together gives **20.92 Joules**.

Why other options are incorrect:

- **Option A:** This is the value for exactly 1 calorie, not 5.
- **Options B & D:** These are mathematically incorrect multiplications of the conversion factor.

Question #15 Key: (D)

BUMHS 2024

Which of the following is NOT the state of matter? [BMU (2024)]

CORE CONCEPT AND DERIVATION

Matter exists in several distinct physical states depending on the temperature and pressure conditions, primarily defined by the arrangement and kinetic energy of their particles.

Solution:

- The four fundamental states of matter commonly observed in the universe are **Solid, Liquid, Gas, and Plasma** (highly ionized gas).
- Ether** (in modern chemistry) is a specific class of organic liquid compounds containing an oxygen atom connected to two alkyl or aryl groups (e.g., diethyl ether).
- Historically, "aether" was also a debunked physics concept regarding the medium of space. In neither context is it a fundamental "state" of matter.

Why other options are incorrect:

- Options A, B, & C:** Plasma, Liquids, and Gases are universally recognized fundamental physical states of matter.

Question #16 Key: (C)

BUMHS 2024

Conversion of Fahrenheit to Celsius scale by: [BMU (2024)]

CORE CONCEPT AND DERIVATION

The Fahrenheit and Celsius scales have different zero points (32°F vs 0°C for the freezing point of water) and different scale intervals (180 degrees vs 100 degrees between freezing and boiling points of water).

Formula:

$$\frac{^{\circ}\text{C}}{100} = \frac{^{\circ}\text{F} - 32}{180}$$

Solution:

- To isolate Celsius ($^{\circ}\text{C}$), multiply both sides by 100.
- $^{\circ}\text{C} = \frac{100}{180} \times (^{\circ}\text{F} - 32)$.
- Simplify the fraction $\frac{100}{180}$ by dividing the numerator and denominator by 20.
- This reduces exactly to $\frac{5}{9}$.
- Therefore, the correct formula is $^{\circ}\text{C} = \frac{5}{9} (^{\circ}\text{F} - 32)$.

Why other options are incorrect:

- Option A & D:** Adding 32 instead of subtracting it is mathematically incorrect (water freezes at +32°F, so we must subtract it to reach the 0°C baseline).
- Option B:** The fraction 9/5 is used when converting from Celsius to Fahrenheit ($^{\circ}\text{F} = \frac{9}{5} ^{\circ}\text{C} + 32$).

Question #17 Key: (A)

NUMS 2024

The relationship between the absolute temperature and the velocities of the gas molecules is given by: [NUMS (...)]

CORE CONCEPT AND DERIVATION

The Kinetic Molecular Theory relates the macroscopic absolute temperature of a gas directly to the microscopic average speeds of its constituent molecules via the Root Mean Square (RMS) velocity.

Formula:

$$C_{rms} = \sqrt{\frac{3RT}{M}}$$

Solution:

- In this equation, C_{rms} is the root mean square velocity, R is the universal gas constant, T is the absolute temperature in Kelvin, and M is the molar mass.
- This explicit formula defines how molecular velocity is directly proportional to the square root of the absolute temperature ($C_{rms} \propto \sqrt{T}$).

Why other options are incorrect:

- Option B:** The ideal gas law relates Pressure, Volume, and Temperature, but does not explicitly calculate molecular velocity.
- Option C:** While mathematically true for classical kinetic energy, it does not directly incorporate the macroscopic "Absolute Temperature" (T) as requested by the prompt.
- Option D:** The kinetic gas equation relates Pressure and Volume to mean square velocity, but does not explicitly contain Temperature (T).

Question #18 Key: (A)

UHS 2023

Which one of the following gases has the lowest density under room conditions? [UHS (2023)]

CORE CONCEPT AND DERIVATION

Under identical conditions of temperature and pressure, the density of a gas is directly proportional to its molar mass.

Formula:

$$d = \frac{PM}{RT} \implies d \propto M \quad (\text{at constant } P, T)$$

Solution:

- Let's calculate the molar masses of all the given gases:
- Neon (Ne) is a monoatomic noble gas: Molar mass = **20 g/mol**.
- Nitrogen (N_2) is diatomic: Molar mass = $14 \times 2 = 28$ g/mol.
- Oxygen (O_2) is diatomic: Molar mass = $16 \times 2 = 32$ g/mol.
- Fluorine (F_2) is diatomic: Molar mass = $19 \times 2 = 38$ g/mol.
- Since Neon has the lowest molar mass (20 g/mol), it will have the lowest density. The order of density is $Ne < N_2 < O_2 < F_2$.

Why other options are incorrect:

- Options B, C, & D:** Because they exist naturally as diatomic molecules, their molar masses are significantly heavier than monoatomic Neon, making them denser.

Question #19 Key: (A)

UHS 2023

The process of heat flow between hotter and colder gases remains continued until all the molecules have equal:...

CORE CONCEPT AND DERIVATION

Heat transfer between two objects occurs due to a temperature gradient and ceases when thermal equilibrium is reached (temperatures are equal). Temperature is a direct macroscopic measurement of average translational kinetic energy.

Solution:

- The Kinetic Molecular Theory defines the absolute temperature of a gas as directly proportional to the average translational kinetic energy ($E_k = \frac{3}{2}kT$) of its molecules.
- When a hot gas (high translational KE) interacts with a cold gas (low translational KE), energy is transferred via molecular collisions.
- This flow of heat continues until the average translational kinetic energies of both sets of gas molecules become perfectly equal, meaning their temperatures are now identical.

Why other options are incorrect:

- **Options B & D:** While molecules do have rotational and vibrational modes of energy, classical temperature reading—and therefore thermal equilibrium—is fundamentally governed by the translational motion of the molecules.
- **Option C:** Ideal gas theory assumes there is no intermolecular potential energy.

Question #20 Key: (C)

SZABMU 2023

Intermolecular forces between molecules of ideal gas are: [SZABMU (2023)]

CORE CONCEPT AND DERIVATION

The theoretical construct of an "ideal gas" relies heavily on a specific set of simplifying assumptions known as the postulates of the Kinetic Molecular Theory (KMT).

Solution:

- One of the most foundational postulates of the KMT is that there are absolutely **no forces of attraction or repulsion** between ideal gas molecules.
- This assumes that the molecules act as completely independent entities that only interact during instantaneous, perfectly elastic collisions.
- Because an ideal gas is a mathematical model, these forces are defined as strictly **zero**.

Why other options are incorrect:

- **Options A, B, & D:** Any presence of intermolecular forces (even "very weak" ones) defines a *real* gas, as these forces cause deviations from ideal $PV = nRT$ behavior (requiring the van der Waals correction factor 'a').

Question #21 Key: (C)

SZABMU 2023

The real gases show deviation from ideal behaviour at: [SZABMU (2023)]

CORE CONCEPT AND DERIVATION

Ideal behavior assumes molecules have zero volume and zero intermolecular forces. Real gases violate these assumptions when molecules are forced close together or moving slowly.

Solution:

- **High Pressure:** As pressure skyrockets, the gas is compressed. The empty space shrinks, meaning the actual physical volume of the gas molecules is no longer negligible compared to the total volume of the container.
- **Low Temperature:** As temperature drops, the kinetic energy of the molecules plummets. They move slowly enough that their weak intermolecular attractive forces (van der Waals forces) take hold, pulling them together.
- Therefore, the combination of **low temperature and high pressure** maximizes non-ideal behavior, eventually leading to the liquefaction of the gas.

Why other options are incorrect:

- **Option D:** High temperature (fast moving) and low pressure (spaced far apart) is exactly when real gases behave most like ideal gases.
- **Options A & B:** These offer conflicting conditions where one factor promotes ideality while the other promotes deviation.

Question #22 Key: (A)

KMU 2023

1 atm of pressure is equal to all of the following except: [ETEA (2023)]

CORE CONCEPT AND DERIVATION

Standard atmospheric pressure (1 atm) can be expressed in various units which are frequently tested in conversions.

Solution:

- The accepted standard conversions for 1 atm are:
- 1 atm = 760 mm Hg (millimeters of mercury)
- 1 atm = 760 torr (since 1 torr exactly equals 1 mm Hg)
- 1 atm = 101325 Pa (Pascals)
- To convert mm Hg to cm Hg, we divide by 10 (since 1 cm = 10 mm). Therefore, 760 mm Hg = **76 cm Hg**.
- Option A states 760 cm Hg, which is mathematically false (it would equal 7600 mm Hg, or 10 atm).

Why other options are incorrect:

- **Options B, C, & D:** These are all completely true and standard equivalencies of 1 atm.

Question #23 **Key: (B)**

KMU 2023

The volume of a given mass of an ideal gas at certain pressure is x at constant temperature. What will be its ...

CORE CONCEPT AND DERIVATION

This problem is a direct application of Boyle's Law, which states that the volume of an ideal gas is inversely proportional to its pressure when temperature and mass remain constant.

Formula:

$$P_1 V_1 = P_2 V_2$$

Solution:

- Let the initial volume $V_1 = x$ and initial pressure $P_1 = P$.
- The new pressure is reduced to half, so $P_2 = \frac{P}{2}$.
- Substitute these into Boyle's Law: $P \times x = \left(\frac{P}{2}\right) \times V_2$.
- To solve for V_2 , multiply both sides by 2 and divide by P .
- $V_2 = \frac{2Px}{P} = 2x$.
- Because pressure and volume are inversely proportional, halving the pressure precisely doubles the volume.

Why other options are incorrect:

- Option A:** This would happen if volume and pressure were *directly* proportional.
- Options C & D:** These represent quadruple or quarter changes, which do not align with a simple 1/2 change in pressure.

Question #24 **Key: (D)**

DUHS 2023

Graph of volume versus total pressure at constant temperature is:
[DUHS (2023)]

CORE CONCEPT AND DERIVATION

According to Boyle's law, at a constant temperature, the volume (V) of a fixed mass of gas is inversely proportional to its pressure (P). This relationship is expressed as $V = \frac{k}{P}$.

Solution:

- The mathematical equation $y = \frac{k}{x}$ represents a rectangular hyperbola.
- When we plot Volume (y-axis) against Pressure (x-axis), the resulting graph is a smooth, downward-sloping curve that never touches the axes (an asymptote).
- Because it is a curve, the relationship plotted this way is distinctly **non-linear**.
- This specific curve at constant temperature is referred to in thermodynamics as an "isotherm".

Why other options are incorrect:

- Option A:** A straight line would imply a direct proportion (like Charles's law: V vs T).
- Options B & C:** The relationship is purely hyperbolic throughout; it does not switch behavior midway.

Question #25 Key: (A)

DUHS 2023

1 atm of nitrogen is at 25°C, its pressure has increased to 2 atm at 50°C. Volume will change from [Formula] t...

CORE CONCEPT AND DERIVATION

This requires the use of the combined gas law, which deals with changes in all three variables: pressure, volume, and temperature.

Formula:

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

Solution:

- First, always convert temperatures to Kelvin by adding 273.
- Initial state: $P_1 = 1 \text{ atm}$, $V_1 = 1 \text{ dm}^3$, $T_1 = 25 + 273 = 298 \text{ K}$.
- Final state: $P_2 = 2 \text{ atm}$, $V_2 = ?$, $T_2 = 50 + 273 = 323 \text{ K}$.
- Substitute into the formula: $\frac{1 \times 1}{298} = \frac{2 \times V_2}{323}$.
- Rearrange to solve for V_2 : $V_2 = \frac{323}{298 \times 2}$.
- $V_2 = \frac{323}{596} \approx 0.5419 \text{ dm}^3$.

Why other options are incorrect:

- Option B:** This would be the answer if only temperature doubled in Kelvin and pressure was constant, which isn't the case here.
- Options C & D:** These numbers are too large; since pressure doubled and temperature only increased slightly (in Kelvin), the volume must decrease significantly.

Question #26 Key: (A)

DUHS 2023

Which of the following temperatures is referred to as the absolute zero? [DUHS (2023)]

CORE CONCEPT AND DERIVATION

Absolute zero is the theoretical temperature at which a thermodynamic system possesses the lowest possible energy, and the kinetic motion of ideal gas particles ceases entirely.

Solution:

- On the Kelvin scale, this absolute foundational baseline is defined exactly as **0 K**.
- To convert Kelvin to Celsius, we use the formula: $^{\circ}\text{C} = \text{K} - 273.15$.
- Therefore, 0 K is equivalent to **-273.15 °C** (often written as -273.16 °C depending on the specific historic triple-point definitions used in some older texts).
- (Note: -459.67 °F on the Fahrenheit scale).

Why other options are incorrect:

- Option B:** The Kelvin scale does not have negative numbers; 0 K is the absolute bottom.
- Option C & D:** 0°C (and its equivalent 32°F) is merely the freezing point of water, a state where molecules still possess immense kinetic energy compared to absolute zero.

Question #27 Key: (B)

BUMHS 2023

A set of postulates that explain the behavior of ideal gases is called: [BUMHS (2023)]

CORE CONCEPT AND DERIVATION

To bridge the gap between microscopic molecular action and macroscopic gas laws (like Boyle's and Charles's laws), physicists developed a comprehensive theoretical model.

Solution:

- This model is called the **Kinetic Molecular Theory (KMT)** of gases.
- It consists of several key postulates: gases are composed of constantly moving point masses, their collisions are perfectly elastic, they have no intermolecular forces, and their average kinetic energy is directly proportional to the Kelvin temperature.
- These postulates mathematically derive the ideal gas law ($PV = nRT$).

Why other options are incorrect:

- **Option A:** Bohr theory explains the quantized electron orbits in hydrogen atoms.
- **Option C:** Rutherford theory established the nuclear model of the atom (dense nucleus, empty space).
- **Option D:** Dalton's atomic theory postulates that matter is composed of indivisible atoms (though he did have a law of partial pressures, the *comprehensive behavior* of gases is KMT).

Question #28 Key: (A)

BUMHS 2023

Air at sea level is dense. This is practical application of. [BUMHS (2023)]

CORE CONCEPT AND DERIVATION

The density of a gas is directly related to how tightly its molecules are packed together, which is governed by pressure and volume relationships.

Solution:

- At sea level, the column of air above the Earth is at its maximum height, exerting the maximum atmospheric pressure.
- According to **Boyle's Law**, volume is inversely proportional to pressure ($V \propto \frac{1}{P}$).
- Because the pressure at sea level is very high, the volume that a given mass of air occupies is compressed and minimized.
- Density is mass divided by volume ($d = \frac{m}{V}$). A smaller, compressed volume results in a higher density. Therefore, Boyle's law directly explains why air at sea level is denser than at higher altitudes.

Why other options are incorrect:

- **Option B:** Charles's law deals with temperature variations, not the physical compression due to atmospheric weight.
- **Option C:** Avogadro's law relates volume to the number of moles.
- **Option D:** Dalton's law relates to partial pressures of non-reacting mixtures.

Question #29 **Key: (A)**

NUMS 2023

The idea that molecules in gases are in constant movement is called: [NUMS (2023)]

CORE CONCEPT AND DERIVATION

Different theories in chemistry address different states of matter and different types of molecular interactions.

Solution:

- The core principle that gas molecules are in constant, random, and rapid motion is the primary postulate of the **Kinetic theory of gases** (or Kinetic Molecular Theory).
- This theory uses this "constant movement" to explain macroscopic properties like gas pressure (arising from collisions with the container) and diffusion.

Why other options are incorrect:

- **Option B:** Crystal field theory describes the breaking of orbital degeneracies in transition metal complexes (coordination chemistry).
- **Option C:** Molecular orbital theory explains chemical bonding by combining atomic orbitals to form molecular orbitals.
- **Option D:** Transition state theory explains the reaction rates of chemical kinetics by observing the activated complex.

Question #30 **Key: (B)**

NUMS 2023

The SI unit for pressure is: [NUMS (2023)]

CORE CONCEPT AND DERIVATION

The International System of Units (SI) defines standardized units for all physical quantities to ensure global scientific consistency.

Solution:

- Pressure is fundamentally defined as Force per unit Area ($P = \frac{F}{A}$).
- In SI units, Force is measured in Newtons (N) and Area is measured in square meters (m^2).
- Therefore, the derived SI unit for pressure is Newtons per square meter (N/m^2).
- This exact unit is given the derived name **Pascal (Pa)** in honor of Blaise Pascal.

Why other options are incorrect:

- **Options A & D:** mm of Hg and Torr are manometric units historically based on the height of a mercury column. They are widely used in medicine and chemistry, but are not SI.
- **Option C:** The Bar is a metric unit of pressure (100,000 Pa) favored in meteorology, but it is not the base SI unit.

Question #31 Key: (C)

NUMS 2023

If both temperature and volume of gas are doubled, the pressure:
[NUMS (2023)]

CORE CONCEPT AND DERIVATION

To determine how pressure responds to simultaneous changes in both temperature and volume, we use the combined gas law.

Formula:

$$P = \frac{nRT}{V} \quad \text{or} \quad \frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

Solution:

- Let initial state be: Pressure = P , Volume = V , Temperature = T . (Assuming moles, n , is constant).
- The temperature is doubled: New Temperature = $2T$.
- The volume is doubled: New Volume = $2V$.
- Plug these into the ideal gas rearranged for new pressure (P_{new}):
- $P_{\text{new}} = \frac{nR(2T)}{(2V)}$.
- The '2' in the numerator and the '2' in the denominator cancel each other out completely.
- $P_{\text{new}} = \frac{nRT}{V} = P_{\text{original}}$.
- Therefore, the pressure remains exactly unchanged. The expansion of volume perfectly negates the increase in kinetic energy from the temperature.

Why other options are incorrect:

- Options A, B, & D:** Mathematical derivation proves the effects precisely cancel out, leaving no net change.

Question #32 Key: (C)

UHS 2022

A gaseous mixture contains 9.6% [Formula], 22.6% [Formula] and 67.8% [Formula] gases. If the total pressure is...

CORE CONCEPT AND DERIVATION

According to Dalton's Law of Partial Pressures, the partial pressure of an individual gas in a mixture is equal to its mole fraction (or volume percentage in an ideal mixture) multiplied by the total pressure.

Formula:

$$P_{\text{gas}} = \left(\frac{\% \text{ of gas}}{100} \right) \times P_{\text{total}}$$

Solution:

- We are given the volume percentage of H_2 gas as 67.8%.
- To find its mole fraction, we divide by 100: $\frac{67.8}{100}$.
- The total pressure (P_{total}) of the mixture is 50 atm.
- Therefore, the partial pressure of H_2 is $\frac{67.8}{100} \times 50$, which matches the expression $67.8 \times \frac{50}{100}$.

Why other options are incorrect:

- Option A:** This formula incorrectly divides 100 by the total pressure, which breaks the mathematical definition of partial pressure.
- Option B:** This ignores the specific percentage of Hydrogen gas entirely.
- Option D:** Adding percentages and pressures is algebraically invalid in this context.

Question #33 Key: (D)

UHS 2022

If we want to raise the temperature of one mole of an ideal gas by 1K, we have to provide how much amount of e...

CORE CONCEPT AND DERIVATION

The universal gas constant (R) can physically be interpreted as the amount of work done (or energy provided) per mole of an ideal gas to raise its temperature by exactly 1 Kelvin at constant pressure.

Solution:

- The energy required is numerically equal to the value of R.
- We must identify the correct value of R matched with the correct units of energy/work. The product of pressure (atm) and volume (dm³) results in a unit of work/energy (atm · dm³).
- The standard value of R in these units is 0.0821 dm³ atm K⁻¹ mol⁻¹.
- Therefore, for 1 mole and 1 K, the energy is 0.0821 dm³ atm.

Why other options are incorrect:

- **Option A:** The value 0.0821 does not pair with Joules. R in Joules is 8.314 J.
- **Option B:** 0.0821 kJ is wildly incorrect as it mixes the literal value of atm·dm³ with kilojoules.
- **Option C:** 8.314 pairs with Joules, not dm³ atm.

Question #34 Key: (A)

UHS 2022

The process of heat flow between hotter and colder gases remains continued until all the molecules have equal:...

CORE CONCEPT AND DERIVATION

According to the Kinetic Molecular Theory, the absolute temperature of a gas is directly proportional to the average translational kinetic energy of its molecules.

Formula:

$$K.E_{avg} \propto T \quad \text{or} \quad K.E = \frac{3}{2}kT$$

Solution:

- Heat flow is a macro-scale phenomenon driven by a difference in temperature.
- On a molecular level, a higher temperature means the molecules possess a higher average translational kinetic energy.
- When a hotter gas mixes with a colder gas, faster-moving molecules collide with slower-moving molecules, transferring kinetic energy.
- This thermal energy transfer continues until both systems reach thermal equilibrium (equal temperature), meaning they must have identical average translational kinetic energies.

Why other options are incorrect:

- **Options B & D:** While rotational and vibrational energies exist in polyatomic molecules, temperature (and thus heat flow) is strictly defined by average translational motion.
- **Option C:** Gases are modeled as having negligible potential energy.

Question #35 Key: (D)

SZABMU 2022

Air is a mixture of gases. The molecules of air do not settle down due to: [SZABMU (2022)]

CORE CONCEPT AND DERIVATION

One of the core postulates of the Kinetic Molecular Theory (KMT) is that collisions between gas molecules, and between gas molecules and container walls (or the Earth), are perfectly elastic.

Solution:

- Because the collisions are perfectly elastic, gas molecules never lose their net kinetic energy upon colliding.
- If collisions were inelastic, the molecules would slowly lose energy, slow down, and eventually succumb to gravity and settle on the ground.
- Since no kinetic energy is lost, they remain in a state of continuous, random, rapid motion, easily overcoming the downward pull of gravity and preventing the air from settling out.

Why other options are incorrect:

- **Option A:** Different molar masses cause different rates of diffusion (Graham's Law), but this does not prevent settling.
- **Option B:** Polarity affects intermolecular forces, not the conservation of kinetic energy that keeps them aloft.
- **Option C:** Dust particles settle out of the air themselves; they do not keep gas molecules suspended.

Question #36 Key: (A)

SZABMU 2022

Collision shown by gases involve the following: [SZABMU (2022)]

CORE CONCEPT AND DERIVATION

According to the Kinetic Molecular Theory (KMT) of ideal gases, all molecular collisions are perfectly elastic.

Solution:

- An elastic collision is defined as a collision where the total kinetic energy of the system is completely conserved before and after the impact.
- While individual molecules may transfer kinetic energy to one another (one speeds up, the other slows down), there is zero net loss or gain of energy in the system as a whole.
- Therefore, the collisions involve "No energy change" in terms of the total macroscopic kinetic energy.

Why other options are incorrect:

- **Options C & D:** Any net change (small or large) would imply an inelastic collision, which violates the KMT and would cause the gas to eventually freeze or spontaneously heat up.
- **Option B:** Pressure is actually created by these collisions with the walls, so saying "no pressure change" misrepresents the nature of the collision's effect on the container.

Question #37 Key: (C)

SZABMU 2022

According to Charles law volume of gas reduce to zero at: [SZABMU (2022)]

CORE CONCEPT AND DERIVATION

Charles's Law establishes a direct, linear relationship between the volume of a gas and its absolute temperature. Extrapolating this line backward to where Volume = 0 yields the concept of absolute zero.

Formula:

$$V_t = V_o \left(1 + \frac{t^\circ C}{273.15} \right)$$

Solution:

- In the equation, V_t is the volume at temperature t , and V_o is the volume at 0°C .
- To find the temperature where volume theoretically becomes zero, set $V_t = 0$.
- $0 = V_o \left(1 + \frac{t}{273.15} \right)$. Since V_o is not zero, the term in parentheses must be zero.
- $1 + \frac{t}{273.15} = 0 \implies \frac{t}{273.15} = -1 \implies t = -273.15^\circ\text{C}$.
- This theoretical temperature is known as absolute zero (0 Kelvin).

Why other options are incorrect:

- **Options A, B, & D:** These are random arbitrary temperatures well above absolute zero where gases still possess significant volume and kinetic energy.

Question #38 Key: (A)

KMU 2022

Which of the following shows marked deviation from ideal behaviour at a given temperature and pressure? [ETEA ...]

CORE CONCEPT AND DERIVATION

Deviation from ideal gas behavior is primarily driven by the presence of intermolecular forces (IMF) and the physical size (volume) of the gas molecules. Gases with larger molar masses and stronger IMFs deviate the most.

Solution:

- Among the choices, Helium (He) and Hydrogen (H_2) are extremely small molecules with very few electrons, resulting in very weak London dispersion forces. They behave almost ideally.
- Nitrogen (N_2) is larger but still non-polar and relatively small compared to carbon dioxide.
- Carbon dioxide (CO_2) is a much larger, multi-atomic molecule (44 g/mol) with a much larger electron cloud. This creates significantly stronger London dispersion forces.
- Due to its larger size and stronger intermolecular attractions, CO_2 shows the most marked deviation from ideal behavior.

Why other options are incorrect:

- **Options B, C, & D:** These gases have smaller atomic/molecular radii and significantly weaker intermolecular forces, keeping their behavior much closer to ideal.

Question #39 Key: (C)

DUHS 2022

The kinetic molecular theory of gases explains: [DUHS (2022)]

CORE CONCEPT AND DERIVATION

The Kinetic Molecular Theory (KMT) is a classical physics model designed to explain the macroscopic properties of gases through the microscopic motion of their individual particles.

Solution:

- The postulates of the KMT (random motion, elastic collisions, negligible volume, no intermolecular forces) form the theoretical foundation that explains macroscopic gas laws like Boyle's, Charles's, and Avogadro's laws.
- Therefore, the explicit purpose of this theory is to explain the physical **behavior of gases** under various conditions of pressure, volume, and temperature.

Why other options are incorrect:

- Options A & B:** Mass number and atomic number are fundamental properties of atomic nuclei, explained by atomic theory, not KMT.
- Option D:** Electrons and their orbitals belong to quantum mechanics and atomic structure theories.

Question #40 Key: (D)

DUHS 2022

The comparison of rate of diffusion of [Formula] & [Formula] is in the ratio of: [DUHS (2022)]

CORE CONCEPT AND DERIVATION

According to Graham's Law of Diffusion, the rate of diffusion of a gas is inversely proportional to the square root of its molar mass.

Formula:

$$\frac{r_1}{r_2} = \sqrt{\frac{M_2}{M_1}}$$

Solution:

- Identify the molar masses: $M_{H_2} = 2 \text{ g/mol}$ and $M_{O_2} = 32 \text{ g/mol}$.
- Set up the ratio comparing Hydrogen (gas 1) to Oxygen (gas 2): $\frac{r_{H_2}}{r_{O_2}} = \sqrt{\frac{M_{O_2}}{M_{H_2}}}$.
- Substitute the values: $\sqrt{\frac{32}{2}} = \sqrt{16}$.
- Calculate the square root: $\sqrt{16} = 4$, which translates to a ratio of 4:1.
- This means hydrogen diffuses 4 times faster than oxygen.

Why other options are incorrect:

- Option A (2:1):** This would only be true if M_{O_2} was 8.
- Option B (1:4):** This is the inverted ratio (Rate of O_2 to Rate of H_2). The question asks for H_2 to O_2 .
- Option C (3:2):** Mathematically unrelated to the molar masses 32 and 2.

Question #41 Key: (D)

DUHS 2022

Gases deviate from ideal behavior more: [DUHS (2022)]

CORE CONCEPT AND DERIVATION

Ideal gases are assumed to have zero intermolecular forces and negligible volume. Real gases deviate from this assumption when they are forced closely together or moving slow enough for attractive forces to take over.

Solution:

- **High Pressure:** Under high pressure, gas molecules are squeezed closely together. The empty space decreases, making the actual physical volume of the molecules significant (violating the negligible volume assumption).
- **Low Temperature:** At low temperatures, the kinetic energy of the molecules drops. They move sluggishly, allowing the weak intermolecular forces of attraction to effectively pull them together (violating the no-attraction assumption).
- Therefore, gases show maximum deviation from ideal behavior at high pressure and low temperature.

Why other options are incorrect:

- **Option A:** All real gases deviate from ideal behavior under certain conditions.
- **Option E:** Low pressure and high temperature are actually the ideal conditions where real gases behave most ideally.
- **Options B & C:** These combinations provide conflicting effects on ideality.

Question #42 Key: (D)

BUMHS 2022

Ideal gas equation helps to calculate the following property of ideal gas except: [BMU (2022)]

CORE CONCEPT AND DERIVATION

The ideal gas equation ($PV = nRT$) can be manipulated to calculate various macroscopic properties of a gas, such as pressure, volume, moles, temperature, density, and molar mass.

Solution:

- **Pressure (P):** Directly derived as $P = \frac{nRT}{V}$.
- **Moles (n):** Directly derived as $n = \frac{PV}{RT}$.
- **Density (d):** By substituting $n = \frac{m}{M}$, we get $PV = \frac{mRT}{M}$. Rearranging for density (m/V) gives $d = \frac{PM}{RT}$.
- **Molarity:** Molarity is defined as moles of solute per liter of solution (a liquid phase concept). The ideal gas law describes gases in a container, not solutes dissolved in a liquid solvent. Therefore, molarity cannot be calculated using the ideal gas equation.

Why other options are incorrect:

- **Options A, B, & C:** As proven algebraically above, these are all valid properties that can be directly derived from the ideal gas equation.

Question #43 Key: (A)

BUMHS 2022

The volume of a given mass of a gas according to Charle's law should be zero at: [BMU (2022)]

CORE CONCEPT AND DERIVATION

Charles's Law states that the volume of a gas decreases by $\frac{1}{273.15}$ of its volume at 0°C for every 1 degree Celsius drop in temperature.

Formula:

$$V_t = V_o \left(1 + \frac{t}{273.15}\right)$$

Solution:

- If we theoretically cool the gas down to -273.15°C (commonly rounded to -273°C), we substitute this into the equation:
- $V_t = V_o \left(1 - \frac{273}{273}\right)$.
- $V_t = V_o(1 - 1) = V_o(0) = 0$.
- At -273°C (Absolute Zero), the kinetic energy drops to zero, and the theoretical volume of the gas becomes zero (though in reality, the gas will liquefy long before reaching this point).

Why other options are incorrect:

- **Option B (273°C):** At this high temperature, the volume would double compared to its volume at 0°C.
- **Options C & D:** These are standard warm temperatures where gases occupy large volumes.

Question #44 Key: (A)

NUMS 2022

Which of the following represents equation for ideal gas? [NUMS (2022)]

CORE CONCEPT AND DERIVATION

The ideal gas equation is the definitive equation of state for a hypothetical ideal gas, combining Boyle's, Charles's, and Avogadro's laws.

Solution:

- Boyle's Law: $V \propto \frac{1}{P}$ (at constant T and n).
- Charles's Law: $V \propto T$ (at constant P and n).
- Avogadro's Law: $V \propto n$ (at constant P and T).
- Combining these yields $V \propto \frac{nT}{P}$.
- Introducing the universal gas constant (R) gives $V = \frac{nRT}{P}$, which rearranges to the standard format: $PV = nRT$.

Why other options are incorrect:

- **Option B:** Missing Volume (V) entirely.
- **Option C:** Incorrect mathematical arrangement.
- **Option D:** Correctly rearranging $PV = nRT$ for T yields $T = \frac{PV}{nR}$, making the given expression mathematically invalid.

Question #45 Key: (A)

NUMS 2022

How should the condition be changed to prevent the value of a given gas from expanding when its mass is increa...

CORE CONCEPT AND DERIVATION

We need to counteract an expansion in volume. By analyzing the ideal gas law ($PV = nRT$), we can see how manipulating temperature and pressure affects volume.

Formula:

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

Solution:

- When mass (and thus moles, n) is increased, Volume (V) naturally wants to increase to accommodate the extra particles.
- To prevent this expansion (keep V constant or force it down), we must look at the remaining variables: Temperature (T) and Pressure (P).
- Since $V \propto T$, lowering the temperature will decrease the volume.
- Since $V \propto \frac{1}{P}$, increasing the pressure will compress the gas, also decreasing the volume.
- Applying both simultaneously (lowering temperature AND increasing pressure) strongly counteracts the expansion caused by adding mass.

Why other options are incorrect:

- **Option B:** Both actions would cause massive expansion, worsening the issue.
- **Options C & D:** These combinations have opposing effects on volume, making them less effective or completely ineffective at strictly preventing expansion.

Question #46 Key: (D)

NUMS 2022

Which variable mentioned in ideal gas is assumed to be constant in other gas laws? [NUMS (2022)]

CORE CONCEPT AND DERIVATION

The simple gas laws (Boyle's, Charles's, Gay-Lussac's) explore the relationships between Pressure (P), Volume (V), and Temperature (T) within a closed system.

Solution:

- A "closed system" strictly implies that gas is neither allowed to enter nor escape the container.
- Therefore, the mass, or the **number of moles (n)**, remains inherently constant across all these foundational gas laws.
- For example: Boyle's law requires constant T and n . Charles's law requires constant P and n . In all cases, n must be locked to observe the P-V-T dynamics.

Why other options are incorrect:

- **Options A, B, & C:** While one of these variables is held constant in *specific* laws (e.g., T in Boyle's, P in Charles's), only the number of moles (mass) is held constant universally across *all* these standard simple gas laws.

Question #47 Key: (A)

NUMS 2022

Which of the following molecules will show a higher rate of evaporation? [NUMS (2022)]

CORE CONCEPT AND DERIVATION

The rate of evaporation of a liquid is inversely proportional to the strength of its intermolecular forces (IMF). Liquids with weaker IMFs have lower boiling points and evaporate much faster.

Solution:

- Let's analyze the intermolecular forces in the options. Water, Ethanol, and Ethylene Glycol all possess extremely strong hydrogen bonding.
- Ethylene glycol has two -OH groups, creating massive hydrogen bonding networks (highest boiling point).
- Water has a highly efficient hydrogen bonding network (boiling point 100°C).
- Ethanol has one -OH group, resulting in moderate hydrogen bonding (boiling point 78°C).
- Acetone (propanone) is a ketone with polar carbonyl bonds, meaning it only has dipole-dipole interactions. Because dipole-dipole forces are much weaker than hydrogen bonding, acetone breaks surface tension easily and evaporates very rapidly (boiling point ~56°C).

Why other options are incorrect:

- Options B, C, & D:** These all contain hydrogen bonds, making their molecules cling tightly together, significantly slowing down the rate of evaporation compared to acetone.

Question #48 Key: (C)

PMDC 2021

PV/nRT for an ideal gas is called: [PMC (2021)]

CORE CONCEPT AND DERIVATION

The ratio of the molar volume of a real gas to the molar volume of an ideal gas at the same temperature and pressure is a measure of deviation from ideality.

Formula:

$$Z = \frac{PV}{nRT}$$

Solution:

- The mathematical expression $\frac{PV}{nRT}$ is defined as the **compressibility factor**, denoted by the symbol Z .
- For a perfectly ideal gas, $PV = nRT$, which means $Z = 1$ under all conditions of temperature and pressure.
- For real gases, Z deviates from 1 (can be >1 or <1) indicating non-ideal behavior due to intermolecular forces or molecular volume.

Why other options are incorrect:

- Options A, B, & D:** These are incorrect terms that do not describe the thermodynamic ratio $\frac{PV}{nRT}$.

Question #49 **Key: (A)**

PMDC 2021

212 degree Fahrenheit is expressed in Kelvin as: [PMC (2021)]

CORE CONCEPT AND DERIVATION

To convert temperature between Fahrenheit and Kelvin, we use the standard interconversion formula that relates the scales via their freezing and boiling points of water.

Formula:

$$\frac{^{\circ}F - 32}{180} = \frac{K - 273.15}{100}$$

Solution:

- Substitute the given Fahrenheit value (212°F) into the formula:
- $\frac{212-32}{180} = \frac{K-273}{100}$
- $\frac{180}{180} = \frac{K-273}{100}$
- $1 = \frac{K-273}{100}$
- $100 = K - 273 \implies K = 373$
- Note: 212°F is the boiling point of water, which intrinsically corresponds to 100°C, and 100°C + 273 = 373 K.

Why other options are incorrect:

- Option B:** 273 K is the freezing point of water (32°F or 0°C).
- Options C & D:** These are mathematically incorrect calculations.

Question #50 **Key: (A)**

PMDC 2021

When temperature increases, isotherm moves? [PMC (2021)]

CORE CONCEPT AND DERIVATION

An isotherm is a curve on a Pressure-Volume (P-V) graph representing Boyle's Law at a constant temperature. According to Charles's Law, volume is directly proportional to temperature.

Solution:

- On a P-V graph, if the constant temperature of an experiment is set to a higher value ($T_2 > T_1$), the overall kinetic energy of the gas increases.
- To maintain the same pressure at a higher temperature, the gas must occupy a larger volume ($V \propto T$).
- Therefore, the entire hyperbolic curve (isotherm) shifts outward, moving further **away from both the x-axis and y-axis** into regions of higher pressure-volume products.

Why other options are incorrect:

- Options B & C:** Moving toward an axis implies a decrease in Volume or Pressure, which corresponds to a decrease in temperature, not an increase.
- Option D:** The isotherm represents a specific constant temperature; if the temperature changes, the curve must physically shift.

Question #51 Key: (B)

PMDC 2021

General gas equation is also known as: [PMC (2021)]

CORE CONCEPT AND DERIVATION

The general gas equation is formed by combining Boyle's Law, Charles's Law, and Avogadro's Law into a single proportional expression.

Solution:

- Combining $V \propto \frac{1}{P}$, $V \propto T$, and $V \propto n$ yields the equation $PV = nRT$.
- This combined equation assumes that there are no intermolecular forces and that the molecular volume is strictly zero.
- Because it perfectly describes the theoretical behavior of an ideal gas, the general gas equation is universally known as the **Ideal gas equation**.

Why other options are incorrect:

- Option A:** The van der Waals equation corrects the ideal gas law for real gases ($(P + a/v^2)(V - nb) = RT$).
- Option C:** It is explicitly for ideal gases, not non-ideal.
- Option D:** The van 't Hoff equation relates equilibrium constants to temperature changes in physical chemistry, unrelated to basic gas state variables.

Question #52 Key: (D)

PMDC 2020

According to the general gas equation, density of an ideal gas depends upon: [NMDCAT (2020)]

CORE CONCEPT AND DERIVATION

The density of an ideal gas is derived by combining the ideal gas law ($PV = nRT$) with the definition of density ($d = \frac{m}{V}$).

Formula:

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

Solution:

- From the equation $d = \frac{PM}{RT}$, we can clearly see the dependencies of density.
- Density is directly proportional to Pressure (P).
- Density is directly proportional to the Molar Mass (M) of the specific gas.
- Density is inversely proportional to the absolute Temperature (T).
- Therefore, the density of an ideal gas depends on all three factors simultaneously.

Why other options are incorrect:

- Options A, B, & C:** While true individually, choosing only one factor ignores the mathematical dependency on the other variables clearly present in the formula.

Question #53 Key: (A)

PMDC 2020

The actual volume of gas molecules is considered negligible at following pressures. [NMDCAT (2020)]

CORE CONCEPT AND DERIVATION

According to the kinetic molecular theory, ideal gas behavior (where molecular volume is negligible) is best approximated under conditions of **low pressure** and **high temperature**.

Solution:

- At very low pressures, gas molecules are spread far apart, meaning the empty space between them is massive compared to the size of the molecules themselves.
- As pressure increases, gases are compressed, molecules are forced closer together, and their actual volume becomes significant relative to the total container volume.
- Among the given options, 2 atm is the lowest pressure. At this state, the gas behaves most ideally, and the actual volume of the molecules is considered negligible compared to the total volume.

Why other options are incorrect:

- **Options B, C, & D:** Higher pressures (4, 6, 8 atm) force molecules closer together, increasing non-ideal behavior where the actual volume of the gas molecules can no longer be ignored.

Question #54 Key: (C)

MDCAT 2019

All the collisions between the particles of gases are elastic in nature. What is meant by "Elastic Collisions"...

CORE CONCEPT AND DERIVATION

According to the Kinetic Molecular Theory (KMT) of gases, the collisions between gas molecules, as well as with the walls of the container, are perfectly elastic.

Solution:

- An elastic collision is fundamentally defined in physics as a collision in which there is no net loss or gain of kinetic energy.
- When gas particles collide, they may transfer kinetic energy from one to another, but their **total** kinetic energy remains completely conserved.

Why other options are incorrect:

- **Option A:** While velocities of individual molecules do change upon collision, this does not define the term "elastic".
- **Option B:** Mass is conserved in all types of collisions (both elastic and inelastic).
- **Option D:** Ideal gas molecules are assumed to have no intermolecular forces, and thus no potential energy to begin with.

Question #55 Key: (C)

SET 2019

Which of the statement is applicable for both ideal and real gases molecules? [SET (2019)]

CORE CONCEPT AND DERIVATION

While real gases deviate from ideal gases in terms of volume and intermolecular forces, they still share fundamental kinetic behaviors regarding motion.

Solution:

- A core postulate of the Kinetic Molecular Theory that holds true for absolutely all gases (real or ideal) is that their molecules are in constant, continuous, and highly random motion.
- They travel in straight lines until they collide with each other or the walls of the container.

Why other options are incorrect:

- **Option A:** Real gases *do* have intermolecular forces of attraction (van der Waals forces).
- **Option B:** Collisions in real gases are not perfectly elastic; some energy can be lost or transferred into internal molecular modes.
- **Option D:** Real gases have a definite, non-negligible molecular volume, especially at high pressures.

Question #56 Key: (D)

MDCAT 2018

Gas is enclosed in a container of 20 [Formula] with the moving piston. According to kinetic theory of gases, w...

CORE CONCEPT AND DERIVATION

Charles's Law states that for a fixed mass of gas at constant pressure, the volume is directly proportional to its absolute temperature.

Solution:

- A "moving piston" implies that the container is capable of expanding, maintaining a constant internal pressure equal to the external pressure.
- When the temperature is increased from 20°C to 100°C, the average kinetic energy of the gas molecules increases.
- They collide with the moving piston with greater force, pushing it outwards until the internal pressure equalizes with the external pressure.
- As a result, the overall volume of the gas increases.

Why other options are incorrect:

- **Option A:** Higher temperature increases kinetic energy, *increasing* the colliding capability (frequency and force) of the molecules.
- **Option B:** The piston is movable, meaning pressure remains constant, it does not halve.
- **Option C:** Temperature directly affects the kinetic energy and speed of freely moving molecules.

Question #57 Key: (D)

MDCAT 2018

Which of the following is the correct equation to calculate relative molecular mass of a gas? [MDCAT (2018)]

CORE CONCEPT AND DERIVATION

The relative molecular mass (M) of an ideal gas can be derived directly by substituting the definition of moles (n) into the ideal gas equation.

Formula:

$$PV = nRT \quad \text{and} \quad n = \frac{m}{M}$$

Solution:

- Substitute the formula for moles into the ideal gas law:
 $PV = \left(\frac{m}{M}\right) RT$.
- Rearrange the equation to solve for Molar Mass (M).
- Multiply both sides by M: $M \times PV = mRT$.
- Divide both sides by PV: $M = \frac{mRT}{PV}$.

Why other options are incorrect:

- Options A, B, & C:** These are mathematically incorrect rearrangements of the ideal gas law.

Question #58 Key: (B)

MDCAT 2017

Identify the value of R at STP. [MDCAT (2017)]

CORE CONCEPT AND DERIVATION

The universal gas constant (R) is derived from the ideal gas equation $R = \frac{PV}{nT}$. Its numerical value depends entirely on the units used for Pressure (P) and Volume (V).

Solution:

- At Standard Temperature and Pressure (STP), $P = 1 \text{ atm}$, $T = 273.15 \text{ K}$, and for $n = 1 \text{ mole}$, $V = 22.414 \text{ dm}^3$.
- Substitute these into the equation: $R = \frac{1 \text{ atm} \times 22.414 \text{ dm}^3}{1 \text{ mole} \times 273.15 \text{ K}}$.
- Calculating this yields $R \approx 0.0821 \text{ atm dm}^3 \text{ K}^{-1} \text{ mol}^{-1}$.

Why other options are incorrect:

- Option A:** 8.314 is the value of R in SI units (Joules), and the unit provided lacks Kelvin (K^{-1}).
- Options C & D:** The value of R in calories is approximately $1.987 \text{ cal K}^{-1} \text{ mol}^{-1}$, making these combinations incorrect.

Question #59 Key: (D)

MDCAT 2017

In the equation [Formula], 'b' represents the: [MDCAT (2017)]

CORE CONCEPT AND DERIVATION

The equation provided is the van der Waals equation for real gases, which corrects the ideal gas law for the volume occupied by gas molecules and the attractive forces between them.

Solution:

- The term $(V - nb)$ accounts for the finite volume of the gas molecules.
- The constant **b** specifically represents the **excluded volume per mole** of the gas (or co-volume), which is the effective volume that one mole of gas molecules prevents other molecules from occupying.
- Therefore, nb is the total excluded volume for n moles.

Why other options are incorrect:

- **Option A:** "Excluded volume" usually refers to the total excluded volume (nb), whereas 'b' alone is the excluded volume *per mole*.
- **Option B:** 'b' is approximately four times the actual physical volume of the molecules, not the actual volume itself.
- **Option C:** The pressure correction term is governed by the constant 'a', not 'b'.

Question #60 Key: (D)

KMU 2016

At absolute zero the molecules of hydrogen gas will have: [ETEA (2016)]

CORE CONCEPT AND DERIVATION

Absolute zero (0 K or -273.15°C) is the theoretical lowest possible temperature. It represents a state of zero thermodynamic energy.

Solution:

- Temperature is a direct measure of the average kinetic energy of gas molecules.
- As temperature approaches absolute zero, the kinetic energy of the molecules approaches zero.
- Consequently, according to classical kinetic theory, all forms of molecular motion (translational, rotational, and vibrational) theoretically cease completely.

Why other options are incorrect:

- **Options A, B, & C:** If any motion existed, the molecules would possess kinetic energy, meaning the temperature would be above absolute zero.

Question #61 Key: (C)

MDCAT 2015

Which graph represents Boyle's law? [MDCAT (2015)]

CORE CONCEPT AND DERIVATION

Boyle's Law states that at constant temperature, the volume of a fixed mass of an ideal gas is inversely proportional to its pressure: $V \propto \frac{1}{P}$.

Solution:

- Because $V = k \times \frac{1}{P}$, this relationship mimics the linear equation $y = mx + c$, where $y = V$, $x = \frac{1}{P}$, and the intercept $c = 0$.
- Therefore, plotting Volume (V) on the y-axis against the inverse of Pressure (1/P) on the x-axis yields a straight line passing through the origin.

Why other options are incorrect:

- **Options A, B, & D:** A plot of V vs P must be a hyperbola (a decreasing curve), not an increasing curve, horizontal line, or a straight decreasing line.

Question #62 Key: (C)

MDCAT 2013

There are four gases [Formula], He, [Formula] and [Formula] at 0°C. Which gas shows greater non-ideal behavior...

CORE CONCEPT AND DERIVATION

Deviation from ideal gas behavior is caused by two main factors: the significant actual volume of gas molecules and the presence of intermolecular forces of attraction. Larger and more polarizable molecules deviate more.

Solution:

- Among the given options, CO₂ is a multi-atomic molecule with the largest molar mass (44 g/mol) and the largest molecular size.
- Due to its larger size and electron cloud, CO₂ has stronger London dispersion forces compared to the smaller diatomic or monatomic gases.
- The order of non-ideality is: He < H₂ < N₂ < CO₂. Therefore, CO₂ shows the greatest deviation.

Why other options are incorrect:

- **Options A & B:** Helium and Hydrogen are tiny, extremely light gases with negligible intermolecular forces, making them behave closest to ideal gases.
- **Option D:** Nitrogen is larger than He and H₂, but significantly smaller and less polarizable than CO₂.

Question #63 Key: (C)

MDCAT 2012

The number of molecules in 22.4 [Formula] of [Formula] gas at 0°C and 1 atm are: [MDCAT (2012)]

CORE CONCEPT AND DERIVATION

Standard Temperature and Pressure (STP) conditions are defined as 0°C (273.15 K) and 1 atm. At STP, 1 mole of any ideal gas occupies exactly 22.414 *extdm*³.

Solution:

- The given volume is 22.4 *extdm*³ at STP, which corresponds to exactly 1 mole of *extH*₂ gas.
- According to Avogadro's concept, 1 mole of any substance contains Avogadro's number of entities (molecules).
- Therefore, the number of molecules = $1 \text{extmole} \times (6.02 \times 10^{23} \text{extmolecules/mole}) = 6.02 \times 10^{23}$.

Why other options are incorrect:

- **Options A, B & D:** These represent incorrect orders of magnitude (10²⁴, 10²⁵, 10²²) rather than the standard Avogadro constant (6.02 × 10²³).

Question #64 Key: (B)

MDCAT 2010

Which one of the following expressions represent the Avogadro law? [MDCAT (2010)]

CORE CONCEPT AND DERIVATION

Avogadro's Law states that equal volumes of all ideal gases at the same temperature and pressure contain the same number of molecules (or moles).

Formula:

$$V \propto n \quad (\text{at constant } T \text{ and } P)$$

Solution:

- Starting with the ideal gas equation: $PV = nRT$
- Rearranging for Volume (V): $V = \frac{nRT}{P}$
- For V to be directly proportional to n (Avogadro's Law), the terms R, T, and P must all be constant.
- Therefore, the expression $V = \frac{RnT}{P}$ represents Avogadro's law strictly when Temperature (T) and Pressure (P) are constant.

Why other options are incorrect:

- Option A:** If n is constant, the relationship explores Boyle's or Charles's law, not Avogadro's.
- Option C:** If n is constant, it is not Avogadro's law.
- Option D:** The formula itself is mathematically incorrect derived from $PV = nRT$.

Question #65 Key: (C)

MDCAT 2010

The root mean square velocity of gases is inversely proportional to square root of their: [MDCAT (2010)]

CORE CONCEPT AND DERIVATION

The root mean square (RMS) velocity of a gas is derived from the Kinetic Molecular Theory and shows how the speed of gas molecules relates to temperature and molar mass.

Formula:

$$C_{rms} = \sqrt{\frac{3RT}{M}}$$

Solution:

- In the formula, C_{rms} represents the root mean square velocity, R is the ideal gas constant, T is absolute temperature, and M is the molar mass of the gas.
- From the equation, we can see that $C_{rms} \propto \sqrt{T}$ and $C_{rms} \propto \frac{1}{\sqrt{M}}$.
- Therefore, the RMS velocity is inversely proportional to the square root of the molar mass.

Why other options are incorrect:

- Option A:** It is directly proportional to the square root of Temperature, not inversely.
- Options B & D:** Pressure and Volume do not directly appear in this formulation of the RMS velocity equation.