6.STATES OF MATTER - IDEAL GAS & IDEAL GAS EQUATION SOLUTIONS

TEACHING TASK

JEE MAINS LEVEL QUESTIONS

1. A sample of an ideal gas was heated from 30^0C to 60^0C at constant pressure. Which of the following statement(s) is/are true.

(A) Kinetic energy of the gas is doubled **(B) Boyle's law will apply**

(C) Volume of the gas will be doubled **(D) None of the above**

Answer:D

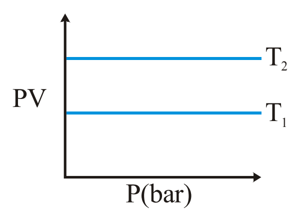
Solution:When an ideal gas is heated from 30°C to 60°C (303K to 333K) at constant pressure:

Kinetic energy (KE): KE α Absolute temperature (T). Since T increases by a factor of $\frac{333}{303} \approx 1.1$ KE does not double. (A is false).

Boyle's law: Applies only for constant temperature, not here. (B is false).

Volume: From Charles's law $(V \alpha T)$ volume increases by ˜1.1×, not double. (C is false).

2. The product of PV is plotted against P at two temperatures T_1 and T_2 and the 'result is shown in figure. What is correct about T_1 and T_2?



(A) $T_1 > T_2$ **(B) $T_2 > T_1$** **(C) $T_1 = T_2$** **(D) $T_1 + T_2 = 1$**

Answer:B

Solution:For an ideal gas, PV=nRT. At high pressures, real gases deviate from ideality.

The plot shows PV vs P:

Higher temperature curves (T_2) lie above lower temperature curves (T_1) because

PV increases with T.

Graph Interpretation:The curve for $T_2 is Above T_1 \rightarrow T_2 > T_1$

3. If a gas expands at constant temperature, it indicates that

(A) kinetic energy of molecules decreases

(B) pressure of the gas increases

(C) kinetic energy of molecules remains the same

(C) number of the molecules of gas increases

Answer:C

Solution:At constant temperature, the average kinetic energy of gas molecules depends only on T$(KE = \frac{3}{2}k_B T)$

4. Equal masses of H_2, O_2 and methane have been taken in a container of volume V at temperature 27°C in identical conditions. The ratio of the volumes of gases $H_2 : O_2 : CH_4$ would be

(A) 8 : 16 : 1 (B) 16 : 8 : 1 (C) 16 : 1 : 2 (D) 8 : 1 : 2

Answer:C

Solution:Given: Equal masses of H_2, O_2, and CH_4 at 27°C in volume V.

Molar masses: H_2 = 2 g/mol, O_2 = 32 g/mol, CH_4 = 16 g/mol.

Step 1: Let the mass of each gas = m grams.

Step 2: Calculate moles of each gas:

$$n_{H_2} = \frac{m}{2}$$

$$n_{O_2} = \frac{m}{32}$$

$$n_{CH_4} = \frac{m}{16}$$

Step 3: Since volume α moles (Avogadro's law), the ratio of volumes is the same as the ratio of moles:

$$\frac{m}{2} : \frac{m}{32} : \frac{m}{16} = \frac{1}{2} : \frac{1}{32} : \frac{1}{16} = 16:1:2$$

5. At what temperature in the celsius scale, V (volume) of a certain mass of gas at 27° C will be doubled keeping the pressure constant

(A) 54° C **(B) 327° C** **(C) 427° C** **(D) 527° C**

Answer:B

Solution:Given: Volume doubles at constant pressure (Charles's law: $V \alpha T$)

Initial T_1 =27^{0}C=300K,final V_2=2V_1

Step 2: Convert T_2 to Celsius: 600K-273K=327° C

6. If pressure becomes double at the same absolute temperature on 2 L CO_2, then the volume of CO_2 becomes

(A) 2 L **(B) 4 L** **(C) 25 L** **(D) 1 L**

Answer:D

Solution:Given: Pressure doubles at constant temperature (Boyle's law: $P\alpha\frac{1}{V}$)

Step 1: $P_1V_1 = P_2V_2 \Rightarrow P_1 \times 2L = 2P_1 \times V_2$

Step 2: $V_2 = \frac{P_1 \times 2L}{2P_1} = 1L$

7. The density of gaseous HF at 1.0 atm and 300 K is 3.17 g/L. Hence, HF in gaseous state is - (F = 18)

(A) Dimer **(B) Monomer** **(C) Tetramer** **(D) Data insufficient**

Answer:C

Solution:Density of HF gas = 3.17 g/L at 1 atm and 300 K.

Step 1: Calculate molar mass from density (using PV=nRT)

$$MolarMass = \frac{dRT}{P} = \frac{3.17 \times 0.0821 \times 300}{1} \approx 78g/mol$$

Step 2: Compare with theoretical molar mass of HF:

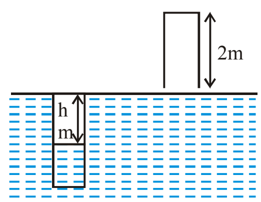
Monomer (HF): 1 + 19 = 20 g/mol

Dimer (H_2F_2): 40 g/mol

Tetramer (H_4F_4): 80 g/mol

Step 3: Observed molar mass (78 g/mol) is closest to tetramer (80 g/mol).

8. A 2 m long tube closed at one end is lowered vertically into water until the closed end is flush with the water surface. See figure below. Calculate the water level heigtht in the tube. (Barometric pressure - 1 atm = 10 m of hydrostatic water head, Temperature = 25°C, Density of water = 1.00 g/ml. Neglect water vapour pressure).



(A) 1.01 m (B) 0.29 m (C) 1.71 m (D) 0.92 m

Answer:C

Solution:P_1 =10+h , V_1= ha

P_2=10m,V_2=2a

$$P_1V_1 = P_2V_2$$
$$(10+h)h\times a = 10\times 2\times a$$
$$\Rightarrow 10h + h^2 = 20$$
$$\Rightarrow h = 1.71$$

9. At a certain temperature for which RT = 25 lit. atm. mol^{-1}, the density of a gas, in gm lit^{-1}, is d = 2.00P + 0.020 P^2, where P is the pressure in atmosphere. The molecular weight of the gas in gm/mol is :

(A) 25 (B) 50 (C)75 (D) 100

Answer:B

Solution:Given d = 2.00P + 0.020 P^2

RT = 25 lit. atm. mol^{-1}

M=?

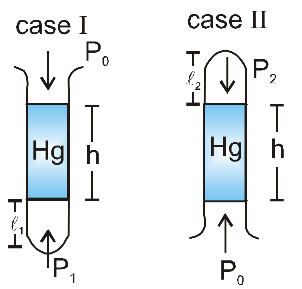
M=dRT/P

$$\lim_{P \to 0} \frac{d}{P} = \frac{M}{RT}$$

$$2 = \frac{M}{RT}$$

M=2(25)=50

10. A gas column is trapped between closed end of a tube and a mercury column of length (h) when this tube is placed with its open end upwards the length of gas column is (l_1), the length of gas column becomes (l_2) when open end of tube is held downwards. Find atmospheric pressure in terms of height of Hg column.



(A) $\frac{h(\ell_1+\ell_2)}{(\ell_2-\ell_1)}$ **cm of Hg column**

(B) $\frac{h(\ell_1-\ell_2)}{(\ell_2-\ell_1)}$ **cm of Hg column**

(C) $\frac{h(\ell_1+\ell_2)}{(\ell_2+\ell_1)}$ **cm of Hg column**

(D) $\frac{h(\ell_1-\ell_2)}{(\ell_2+\ell_1)}$ **cm of Hg column**

Answer : A

Solution:Case I (Open end upwards):

The pressure due to the mercury column (h) acts downward.

The gas pressure (P_1) balances the atmospheric pressure (P_{atm}) and the pressure due to the mercury column.

Thus, $P_1 = P_{atm} + h(incmofHg)$

Case II (Open end downwards):

The pressure due to the mercury column (h) acts upward.

The gas pressure (P_2) balances the atmospheric pressure (P_{atm}) minus the pressure due to the mercury column.

Thus, $P_2 = P_{atm} - h(incmofHg)$

Boyle's Law Application:

For the trapped gas, the product of pressure and volume is constant (assuming temperature remains the same).

Therefore,

$$P_1 l_1 = P_2 l_2$$
$$(P_{atm} + h)l_1 = (P_{atm} - h)l_2$$
$$P_{atm} l_1 + hl_1 = P_{atm} l_2 - hl_2$$
$$P_{atm}(l_1 - l_2) = -h(l_1 + l_2)$$
$$P_{atm} = \frac{h(l_1 + l_2)}{(l_2 - l_1)}$$

11. The diameter of a bubble at the surface of a lake is 4 mm and at the bottom of the lake is 1 mm. If atmospheric pressure is 1 atm and the temperature of the lake water and the atmosphere are equal. what is the depth of the lake ?

(The density of the lake water and mercury are 1 g/ml and 13.6 g/ml respectively. Also neglect the contribution of the pressure due to surface tension)

(A) 651.1 m (B) 655.1 m (C)653.1 m (D) 656.1 m

Answer:A

Solution:Surface of the lake:

Bubble diameter = 4 mm $\rightarrow$ Radius r_1=2 mm.

Pressure P_1 =1 atm (atmospheric pressure).

Bottom of the lake:

Bubble diameter = 1 mm $\rightarrow$ Radius r_2 =0.5 mm.

Pressure P_2=P_1 + ρ gh (where h is the depth).

Densities:

Lake water (water) = 1 g/mL = 1000 kg/m³.

Mercury (Hg) = 13.6 g/mL = 13600 kg/m³.

Assumptions:

Temperature is constant.

Neglect surface tension effects.

Boyle's Law for the Bubble:

The bubble contains gas, so $P_1V_1 = P_2V_2$ (since temperature is constant).

Volume of a sphere:

$$P_1V_1 = P_2V_2$$
$$V = \frac{4}{3}\pi r^3$$
$$P_1\frac{4}{3}\pi r_1^3 = P_2\frac{4}{3}\pi r_2^3$$
$$P_1r_1^3 = P_2r_2^3$$
$$P_2 = P\frac{r_1}{r_2}^3$$
$$P_2 = 1atm\times\frac{2}{0.5}^3 = 1\times 64 = 64atm$$

Hydrostatic Pressure Calculation:

The pressure at the bottom is due to atmospheric pressure and the water column:

$$P_2 = P_1 + \rho_{water}gh$$
$$64atm = 1atm + \rho_{water}gh$$
$$63atm = \rho_{water}gh$$

Convert atm to consistent units (e.g., Pascals or cm of Hg):

$$1atm = 76cmOfHg = \rho H_g g\times 76\times 10^{-2}m$$
$$\rho H_g g\times 0.76m = 1atm$$
$$Thus, 63atm = 63\times\rho H_g g\times 0.76$$

Substitute into the equation:

$$63\times 13600\times 9.81\times 0.76 = 1000\times 9.81\times h$$
$$h = \frac{63\times 13600\times 0.76}{1000}$$
$$h = 63\times 13.6\times 0.76 = 63\times 10.336 = 651.168m$$

12. A weather balloon filled with hydrogen at 1 atm and 300 K has volume equal to 12000 litres. On ascending it reaches a place where temperature is 250 K and pressure is 0.5 atm. The volume of the balloon is :

(A) 24000 litres (B) 20000 litres (C) 10000 litres (D) 12000 litres

Answer:B

Solution:

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$V_2 = \frac{P_1V_1T_2}{P_2T_1} = \frac{1\times250\times12000}{0.5\times300} = 20000L$$

13. Four one litre flasks are separately filled with the gases, O_2, F_2, CH_4 and CO_2 under the same conditions. The ratio of number of molecules in these gases :

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

Answer:B

Solution:Under the same temperature and pressure, equal volumes of gases contain the same number of molecules.

This means that the number of molecules is independent of the type of gas if the volume, temperature, and pressure are the same.

Therefore, the ratio of the number of molecules for O_2, F_2, CH_4 and $CO_2$is 1 : 1 : 1 : 1.

JEE ADVANCED LEVEL QUESTIONS

Multi Correct Answer Type

14. Which of the following is not true about gaseous state

(A) Thermal energy = Molecular attraction

(B) Thermal energy >> Molecular attraction

(C) Thermal energy << Molecular attraction

(D) Molecular forces >> Those in liquids

Answer:A,C,D

Solution:Gaseous State Characteristics:

In gases, thermal energy (kinetic energy of molecules) is much greater than the intermolecular forces of attraction. This is why gases are highly compressible and fill their containers.The correct relationship is: Thermal energy >> Molecular attraction (Option B is true).

15. In a closed flask of 5 litres, 1.0 g of H_2 is heated from 300 to 600 K. which statement(s) is correct

(A) Pressure of the gas increases (B) The rate of collision increases

(C) The number of moles of gas increases

(D) The energy of gaseous molecules increases

Answer:A,B,D

Solution:(A) Pressure of the gas increases $\rightarrow$ Correct

At constant volume, increasing temperature increases pressure (Gay-Lussac's law: P α T).

(B) The rate of collision increases $\rightarrow$ Correct — Higher temperature means faster moving molecules ? more frequent collisions.

(C) The number of moles of gas increases $\rightarrow$Incorrect — The amount of gas (0.5 mol) is constant; temperature does not change number of moles.

(D) The energy of gaseous molecules increases $\rightarrow$Correct — Temperature is directly proportional to average kinetic energy of molecules.

Statement Type

(A) Assertion is true, Reason is true and Reason is correct explanation for Assertion.

(B) Assertion is true, Reason is true and Reason is not correct explanation for Assertion.

(C) Assertion is true, Reason is false. **(D)** Assertion is false, Reason is true.

(E) Both Assertion and Reason are False.

16. Assertion : Plot of P Vs. 1/V (volume) is a straight line.

Reason : Pressure is directly proportional to volume.

Answer:C

Solution:Boyle's Law: $P\alpha\frac{1}{V}$

Thus, a plot of P Vs $\frac{1}{V}$ is a straight line. The Assertion is true.

The Reason states P α V which is incorrect (it contradicts Boyle's Law).

The correct relationship is $P\alpha\frac{1}{V}$

17. Assertion : 1 mol of H_2 and O_2 each occupy 22.4 L of volume at 0°C and 1 bar pressure.

Reason : Molar volume for all gases at the same temperautre and pressure has the same volume.

Answer:D

Solution:Solution:Avogadro's Law states that 1 mole of any ideal gas occupies 22.4 L at

STP (0°C, 1 atm). However, the given pressure is 1 bar (0.987 atm), not exactly STP.
At 1 bar, the molar volume is 22.7 L, not 22.4 L. Thus, the Assertion is false for the given conditions.
The Reason is true for ideal gases under identical conditions, but it does not justify the Assertion because the conditions are misstated.

18. Assertion : Absolute zero temperature is a theoretically possible temperature at which the volume of the gas becomes zero.

Reason : The total kinetic energy of the molecules is zero at this temperature.

Answer:D

SolutionSolution:Absolute zero (0 K) is the temperature where kinetic energy of molecules

theoretically reaches zero (Reason is true).
However, the volume of a real gas never actually reaches zero due to intermo-lecular
forces and quantum effects (Assertion is false).

19. Assertion : In a container containing gas 'A' at temp 400 K, some more gas A at temp. 300 K is introduced. The pressure of the system increases.

Reason : Increase in gaseous particles increases the number of collisions among the molecules.

Answer:A

Solution:Assertion:

Adding more gas (even at a lower temperature) increases the total number of molecules, thus increasing pressure (from P= nRT/V).

The Assertion is true.

Reason:

More molecules lead to more collisions, which increases pressure.

The Reason is true and correctly explains the Assertion.

Comprehension Type

It states "at constant pressure, the volume of a given mass of a gas, increases or decreases by $\frac{1}{273.15}$ th of its volume at 0°C for every rise or fall of one degree in temperature".

A car tyre has a volume of 10 litre when inflated. The tyre is inflated to a pressure of 3 atm at 17°C with air. Due to driving the temperature of tyre increases to 47°C.

20. What would be pressure at this temperature ?

(A) 3.6103 atm (B) 3.8103 atm (C) 3.5103 atm (D) 3.9103 atm

Answer:C

Solution:Given:

Initial volume of tyre = 10 L

Initial pressure = P_1 =3 atm

Initial temperature T_1 =17 ° C=290 K

Final temperature = T_2 =47°C=320 K

Volume remains constant during heating → Use Gay-Lussac's Law:

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

$$\frac{3}{290} = \frac{P_2}{320}$$

$$P_2 = 3.3103 atm$$

21. How many litres of air measured at 47°C and pressure of 1 atm should be left out to restore the tyre to 3 atm at 47°C

(A) 3.105 L (B) 3.205 L (C) 3.305 L (D) 3.405 L

Answer:A

Solution:Dcreased Pressure =3.31-3=0.31atm

Let V is the volume

P_1= 0.31atm, V_1=10L
P_2=1 atm, V_2=?,Temperature Constant

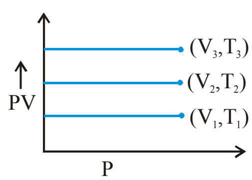
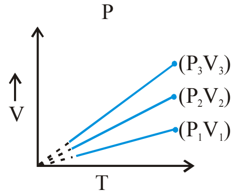
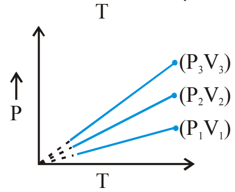
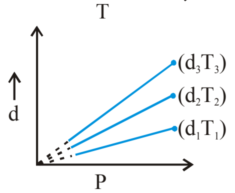
$P_1V_1 = P_2V_2$

$0.31 \times 10 = 1V_2$

$V_2 = 3.1L$

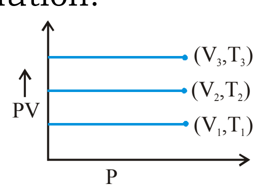
Matching Type

22 For a fixed amount of the gas match the two column :

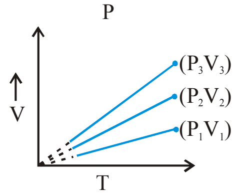
Column-I	**Column-II**
(A) 	**(p)** $T_1 > T_2 > T_3$
(B) 	**(q)** $P_1 > P_2 > P_3$
(C) 	**(r)** $V_1 > V_2 > V_3$
(D) 	**(s)** $d_1 > d_2 > d_3$

Answer:A-s,B-q,C-r,D-p

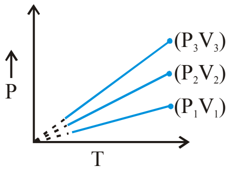
Solution:

(A) 

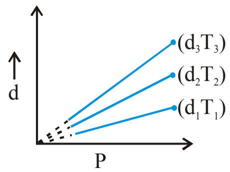
$V_1 < V_2 < V_3$ V increases density decreases then $d_1 > d_2 > d_3$

(B) 

$V_1 < V_2 < V_3$, $P \alpha \frac{1}{V}$ So, $P_1 > P_2 > P_3$

(C) 

$P_3 > P_2 > P_1,\ P \alpha \frac{1}{V}$, then $\mathbf{V_1 > V_2 > V_3}$

(D) 

(p) $\mathbf{T_1 > T_2 > T_3}$

Integer Type

23. A gas is initially at 1 atm pressure. To compress it to 1/4 th of initial volume, what will be the pressure required is _____

Answer:4

Solution: P_1=1atm, V_1=V

P_2=?, V_2=V/4

$P_1V_1=P_2V_2$

1(V)=P_2(V/4)

P_2=4atm

LEARNERS TASK

CONCEPTUAL UNDERSTANDING QUESTIONS (CUQ's)

1. Which one of the following statements is not correct about the three states of matter i.e. solid, liquid and gaseous

(A) Molecules of a solid possess least energy whereas those of a gas possess highest energy

(B) The density of solid is highest whereas that of gases is lowest

(C) Gases like liquids possess definite volumes

(D) Molecules of a solid possess vibratory motion

Answer:C

Solution: Gases do not have definite volumes; they expand to fill their container. This is incorrect.

2. Kinetic energy of molecules is highest in

(A) Gases **(B) Solids** **(C) Liquids** **(D) Solutions**

Answer:A

Solution: In gases, molecules move freely with the highest kinetic energy.

3. At constant temperature, in a given mass of an ideal gas

(A) The ratio of pressure and volume always remains constant

(B) Volume always remains constant

(C) Pressure always remains constant

(D) The product of pressure and volume always remains constant

Answer:D

Solution: This is Boyle's Law (PV=constant at constant temperature)

4. Air at sea level is dense. This is a practical application of

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

Answer:A

Solution: Higher pressure (at sea level) compresses air, increasing its density ($P\alpha\frac{1}{V}$)

5. At constant pressure, the volume of fixed mass of an ideal gas is directly proportional to

(A) Absolute temperature (B) Degree centigrade

(C) Degree Fahrenheit (D) None

Answer:A

Solution:This is Charles's Law ($V\alpha T$ at constant pressure).

6. Which of the following expression at constant pressure represents Charle's law

(A) $V \propto \frac{1}{T}$ **(B)** $V \propto \frac{1}{T^2}$ **(C)** $V \propto T$ **(D)** $V \propto d$

Answer:C

Solution:Charles's Law states That At constant pressure, the volume of a gas is directly proportional to its absolute temperature (in Kelvin). $V \propto T$

7. Use of hot air balloons in sports and meteorological obsevations is an application of

(A) Boyle's law (B) Newtonic law (C) Kelvin's law (D) Charle's law

Answer:D

Solution:Heating air increases its volume (per Charles's Law), making balloons rise.

8. Pressure remaining the same, the volume of a given mass of an ideal gas increases for every degree centigrade rise in temperature by definite fraction of its volume at

(A) 0°C **(B) Its critical temperature**

(C) Absolute zero **(D) Its Boyle temperature**

Answer:A

Solution: Charles's Law uses the volume at 0°C as a reference for expansion.

9. "One gram molecule of a gas at N.T.P. occupies 22.4 litres." This fact was derived from

(A) Dalton's theory **(B) Avogadro's hypothesis**

(C) Berzelius hypothesis **(D) Law of gaseous volume**

Answer:B

Solution:Avogadro's Law states equal volumes of gases at same T and P contain equal molecules.

10. In the equation of sate of an ideal gas $PV = nRT$, the value of the universal gas constant would depend only on

(A) The nature of the gas **(B) The pressure of the gas**

(C) The units of the measurement **(D) None of these**

Answer:C

Solution:?

R is a universal constant and depends only on the units (e.g., J/mol·K or L·atm/mol·K).

11. In the ideal gas equation, the gas constant R has the dimensions of

(A) mole-atm K^{-1} **(B) litre mole** **(C) litre-atm K^{-1} mole^{-1}** **(D) erg K^{-1}**

Answer:C

Solution:The dimensions of R are:litre-atm K^{-1} mole^{-1}

12. In the equation $PV = nRT$, which one cannot be the numerical value of R

(A) $8.31\times10^{7}\,erg\,K^{-1}mol^{-1}$ **(B)** $8.31\times10^{7}\,dyne\,cm\,K^{-1}mol^{-1}$

(C) $8.31\,JK^{-1}mol^{-1}$ **(D)** $8.31\,atm.K^{-1}mol^{-1}$

Answer:D

Solution:Units of R

(i) In lit-atm R = $\frac{1\ atm\times 22.4\,lit}{273\ K}$ = 0.0821 lit-atm $mol^{-1}K^{-1}$

(ii) In C.G.S system R = $\frac{1\times 76\times 13.6\times 980\ dyne\,cm^{-2}\times 22400\,cm^{3}}{273\ K}$

= 8.314×10^{7} erg $mole^{-1}K^{-1}$.

(iii) In M.K.S. system R = 8.314 Joule $mole^{-1}K^{-1}$. [10^{7} erg = 1 joule]

(iv) In calories R = $\frac{8.314\times10^{7}\ erg\,mole^{-1}K^{-1}}{4.184\times10^{7}\,erg}$

= 1.987 $\approx$2 calorie $mol^{-1}K^{-1}$.

13. Which one of the following indicates the value of the gas constant R

(A) 1.987 cal K^{-1} mol^{-1} **(B) 8.3 cal K^{-1} mol^{-1}**

(C) 0.0821 lit K^{-1} mol^{-1} **(D) 1.987 Joules K^{-1} mol^{-1}**

Answer:A

Solution: R = $\frac{8.314\times10^{7}\ erg\,mole^{-1}K^{-1}}{4.184\times10^{7}\,erg}$

= 1.987 $\approx$2 calorie $mol^{-1}K^{-1}$.

14. The constant R is

(A) Work done per molecule **(B) Work done per degree absolute**

(C) Work done per degree per mole **(D) Work done per mole**

Answer: C

Solution:R is derived from work done per mole per degree (Kelvin) during expansion or heating of an ideal gas.

15. Select one correct statement. In the gas equation, $PV = nRT$

(A) n is the number of molecules of a gas

(B) V denotes volume of one mole of the gas

(C) n moles of the gas have a volume V

(D) P is the pressure of the gas when only one mole of gas is present

Answer:C

Solution:The ideal gas equation

PV=nRT describes the state of a gas where:

n: Number of moles of gas (not molecules).

V: Total volume occupied by n moles (not volume per mole).

P: Pressure exerted by n moles (not specific to 1 mole).

JEE MAINS LEVEL QUESTIONS

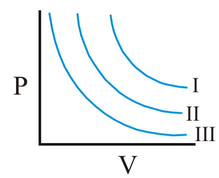
16. I, II, III are three isotherms respectively at T_1, T_2 and T_3 as shown in graph. Temperature will be in order

(A) $T_1 = T_2 = T_3$

(B) $T_1 < T_2 < T_3$

(C) $T_1 > T_2 > T_3$

(D) $T_1 > T_2 = T_3$



Answer:C

Solution:Each curve shown in the PV graph is an isotherm (i.e., temperature is constant along each curve).

In a P–V graph, higher isotherms lie farther from the origin, i.e., at higher temperature.

So, the topmost curve = highest temperature.

From the image:Curve I is highest, then II, then III (lowest).

17. If 20 cm^3 gas at 1 atm. is expanded to 50 cm^3 at constant T, then what is the final pressure

(A) $20 \times \frac{1}{50}$ **(B)** $50 \times \frac{1}{20}$ **(C)** $1 \times \frac{1}{20} \times 50$ **(D) None of these**

Answer:A

Solution:$P_1V_1=P_2V_2$

$1 \times 20 = P_2 \times 50$

$P_2 = 20 \times \frac{1}{50}$

18. Which of the following statement is false

(A) The product of pressure and volume of fixed amount of a gas is independent of temperature

(B) Molecules of different gases have the same K.E. at a given temperature

(C) The gas equation is not valid at high pressure and low temperature

(D) The gas constant per molecule is known as Boltzmann constant

Answer:A

Solution:(A) False: Product of pressure and volume depends on temperature — from the ideal gas law: $PV = nRT \Rightarrow PV \alpha T$

19. Densities of two gases are in the ratio 1 : 2 and their temperatures are in the ratio 2 : 1, then the ratio of their respective pressures is

(A) 1 : 1 **(B) 1 : 2** **(C) 2 : 1** **(D) 4 : 1**

Answer:A

Solution:

$$\frac{d_1}{d_2} = \frac{1}{2}, \frac{T_1}{T_2} = \frac{2}{1}$$

$$d = \frac{PM}{RT}, P\alpha dT$$

$$\frac{P_1}{P_2} = \frac{d_1 T_1}{d_2 T_2} = \frac{1\times 2}{2\times 1} = \frac{1}{1}$$

20. A 10 g of a gas at atmospheric pressure is cooled from 273°C to 0°C keeping the volume constant, its pressure would become

(A) 1/2 atm **(B) 1/273 atm** **(C) 2 atm** **(D) 273 atm**

Answer:A

Solution:Given,P_1=1atm,T_1=273°C +273K=546K,T_2=0°C+273K=273K

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$
$$\frac{1}{546} = \frac{P_2}{273}$$
$$P_2 = \frac{1}{2}$$

21. A certain sample of gas has a volume of 0.2 litre measured at 1 atm. pressure and 0°C. At the same pressure but at 273°C, its volume will be

(A) 0.4 litres (B) 0.8 litres (C) 27.8 litres (D) 55.6 litres

Answer:A

Solution:V_1=0.2 litre ,P_1=1atm,T_1=0°C+273=273K,T_2=273°C+273=546K

$$\frac{V_2}{V_1} = \frac{T_2}{T_1}$$
$$\frac{V_2}{0.2} = \frac{546}{273}$$
$$V_2 = 0.4 litres$$

22. 400 cm^3 of oxygen at 27°C were cooled to –3°C without change in pressure. The contraction in volume will be

(A) 40 cm^3 (B) 30 cm^3 (C) 44.4 cm^3 (D) 360 cm^3

Answer:A

Solution:V_1=400 cm^3 ,T_1= 27°C +273=300K,T_2= –3°C +273=270K

$$\frac{V_2}{V_1} = \frac{T_2}{T_1}$$
$$\frac{V_2}{400} = \frac{270}{300}$$
$$V_2 = 360 litres$$
$$V_1 - V_2 = 400 - 360 = 40 litres$$

23. The pressure p of a gas is plotted against its absolute temperature T for two different constant volumes, V_1 and V_2. When $V_1 > V_2$, the

(A) Curves have the same slope and do not intersect

(B) Curves must intersect at some point other than T = 0

(C) Curve for V_2 has a greater slope than that for V_1

(D) Curve for V_1 has a greater slope than that for V_2

Answer:C

Solution: $V_1 > V_2$

$$\frac{nR}{V_1} < \frac{nR}{V_2}$$

Therefore, curve for V_2 has greater slope than that for V_1

24. Two closed vessels of equal volume containing air at pressure P_1 and temperature T_1 are connected to each other through a narrow tube. If the temperature in one of the vessels is now maintained at T_1 and that in the other at T_2, what will be the pressure in the vessels

(A) $\frac{2P_1T_1}{T_1+T_2}$ **(B)** $\frac{T_1}{2P_1T_2}$ **(C)** $\frac{2P_1T_2}{T_1+T_2}$ **(D)** $\frac{2p_1}{T_1+T_2}$

Answer:C

Solution:For equal volumes ,Initial volume =Final volume

Initial State:

Total moles of gas: $n_{total} = \frac{P_1V}{RT_1} + \frac{P_1V}{RT_1} = \frac{2P_1V}{RT_1}$

Final State: $n_{total} = \frac{PV}{RT_1} + \frac{PV}{RT_2} = \frac{PV}{R}(\frac{1}{T_1} + \frac{1}{T_2}) = \frac{PV}{R}(\frac{T_1+T_2}{T_1T_2})$

n initial=n final

$$\frac{2P_1V}{RT_1} = \frac{PV}{R}(\frac{T_1+T_2}{T_1T_2})$$

$$2P_1(\frac{T_2}{T_1+T_2}) = P$$

25. Which is not true in case of an ideal gas

(A) It cannot be converted into a liquid

(B) There is no interaction between the molecules

(C) All molecules of the gas move with same speed

(D) At a given temperature, PV is proportional to the amount of the gas

Answer:C

Solution:(A) It cannot be converted into a liquid:

True. Ideal gases are hypothetical and assumed to never liquefy.

(B) There is no interaction between the molecules:

True. Ideal gases assume zero intermolecular forces.

(C) All molecules of the gas move with the same speed:

False. Molecules have a distribution of speeds (Maxwell-Boltzmann distribution).

(D) At a given temperature, PV is proportional to the amount of the gas:

True. From PV=nRT,

$PV \alpha n$ at constant T.

JEE ADVANCED LEVEL QUESTIONS

Multi Correct Answer Type

26. Which of the following statement(s) is incorrect

(A) In all the three states the molecules possess random translational motion

(B) Gases cannot be converted into solids without passing through liquid state

(C) One of the common property of liquids and gases is viscosity

(D) According to Boyle's law V/P is constant at constant T

Answer:A,B,D

Solution:(A) False. Only gases and liquids exhibit random translational motion. Solids have molecules in fixed positions with only vibrational motion.

(B) False. Gases can undergo deposition (direct conversion to solid, e.g., frost formation).

(C) True. Both liquids and gases resist flow (viscosity), though gases have much lower viscosity.

D)False. Boyle's law states PV=Constant not V/P

27. If P, V, T represent pressure, volume and temperature of the gas, the correct representation of Boyle's law is

(A) $V \propto \frac{1}{T}$ **(at constant P)** **(B) PV = RT(C)** $V \propto 1/P$ **(at constant T)** **(D) PV = nRT**

Answer:C

Solution:Correct. Boyle's law states PV=k for a fixed mass of gas at constant temperature.

Statement Type

28. Assertion : Pressure exerted by gas in a container with increasing temperature of the gas.

Reason : With the rise in temperature, the average speed of gas molecules increases.

Answer:A

Solution:Assertion is True:

From Gay-Lussac's Law, $P \alpha T$ at constant volume. Higher temperature ? higher pressure.

Reason is True and Correctly Explains Assertion:

Increased temperature $\rightarrow$ higher kinetic energy $\rightarrow$ faster molecular motion $\rightarrow$ more frequent collisions with walls $\rightarrow$ higher pressure.

29. Assertion : Gases do not settle to the bottom of container.

Reason : Gases have high kinetic energy.

Answer:B

Solution:Assertion is True:

Gases fill the entire container uniformly due to random motion (diffusion).

Reason is True but Incomplete Explanation:

High kinetic energy prevents settling, but the primary reason is weak intermolecular forces (not just kinetic energy).

Conclusion:

Both Assertion and Reason are true, but the Reason does not fully explain the Assertion.

30. Assertion : Wet air is heavier than dry air.

Reason : The density of dry air is more than density of water.

Answer:E

Solution:Humid air is less dense than dry air because H_2O molecules are lighter than N_2/O_2

Comprehension Type

Ideal gas equation PV = nRT is a relation between four variables and it describes the state of any gas. For this reason, it is also called Equation of State.

31. Find the lifting power of a 100 litre balloon filled with He at 730 mm and 25°C. (Density of air = 1.25 g /L).

(A) 109.28 gm (B) 190.28 gm (C) 119.28 gm (D) 129.28 gm

Answer:A

Solution:Given:

Volume of balloon (V)=100L

Gas: Helium (He) at:

Pressure (P)=730mm

Temperature (T)=25°C=298K

Density of air(ρ_{air})=1.25g/L

Molar mass of He = 4 g/mol

Molar mass of air ˜ 28.8 g/mol (average)

Objective:

Find the lifting power (buoyant force) of the balloon in grams.

Convert Pressure to atm: $P = \frac{730mmHg}{760mmHg/atm} = 0.9605atm$

Calculate Moles of He in the Balloon:

Using the ideal gas law PV=nRT

$$n_{He} = \frac{PV}{RT} = 3.93moles$$

Mass of He=n_{He} ×Molar mass of He=3.93moles×4g/mol=15.72g

The balloon displaces 100 L of air.

Mass of displaced air=Volume×Density of air=100L×1.25g/L=125g

Lifting power=Mass of displaced air-Mass of He=125g-15.72g=109.28g

Matching Type

32. Column-I Column-II

Column-I	Column-II
(A) $P_1V_1 = P_2V_2 = P_3V_3 =$	**(1) Isotherm**
(B) $\frac{V_1}{T_1}=\frac{V_2}{T_2}=\frac{V_3}{T_3}=$ .... at constant pressure.	**(2) Isobar**
(I) Graph between P and V at constant temperature	**(3) Boyle's law**
(J) Graph between V and T at constant pressure	**(4) Charles' law**

Answer:A-3,B-4,C-1,D-2

Solution:

(A) $P_1V_1 = P_2V_2 = P_3V_3 =$	**(3)** Boyle's law
(B) $\frac{V_1}{T_1}=\frac{V_2}{T_2}=\frac{V_3}{T_3}=$ .... at constant pressure.	**(4)** Charles' law
(I) Graph between P and V at constant temperature	**(1)** Isotherm
(J) Graph between V and T at constant pressure	**(2)** Isobar

Integer Type

34. The presuure exerted by gas at sea level is ________ mm of Hg

Answer:760

Solution:Atmospheric pressure is the force exerted by the weight of the air above a surface.

At sea level, this pressure is standardized as 1 atmosphere (atm), which equals 760 mm Hg.

KEY

					TEACCHING TASK				
1	2	3	4	5	6	7	8	9	10
D	B	C	C	B	D	C	C	B	A
11	12	13	14	15	16	17	18	19	20
A	B	B	A,C,D	A,B,D	C	D	D	A	C
21	22		23						
A	A-s,B-q,C-r,D-p		4						
					LEARNERS TASK				
1	2	3	4	5	6	7	8	9	10
C	A	D	A	A	C	D	A	B	C
11	12	13	14	15	16	17	18	19	20
C	D	A	C	C	C	A	A	A	A
21	22	23	24	25	26	27	28	29	30
A	A	C	C	C	A,B,D	C	A	B	E
31	32		34						
A	A-3,B-4,C-1,D-2		760						