1. STATES OF MATTER - GAS LAWS & IDEAL GAS EQUATION SOLUTIONS

TEACCHING 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:Temperature Conversion to Kelvin:30°C = 303 K, 60°C = 333 K

(A) Kinetic energy of the gas is doubledFalse.

The average kinetic energy of an ideal gas is directly proportional to its absolute temperature (Kelvin), i.e. $K.E\alpha T$

But since the temperature goes from 303 K to 333 K, the kinetic energy increases by: $\frac{KE_{final}}{KE_{initial}} = \frac{333}{303} \approx 1.099$

So, kinetic energy increases by about 9.9%, not doubled.

(B) False.Boyle's Law applies only when temperature is constant:

$$P\alpha \frac{1}{V}(atcons\tan tT)$$

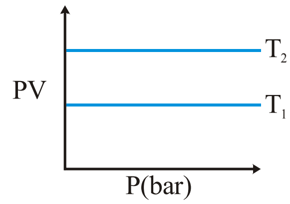
But here, temperature is changing, so Boyle's law does not apply.

(C) False:At constant pressure, the ideal gas law becomes:

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \Rightarrow \frac{V_2}{V_1} = \frac{T_2}{T_1} = \frac{333}{303} \approx 1.099$$

So, volume increases by ~9.9%, not doubled.

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:We are given a graph where PV is plotted against Pressure (P) at two different temperatures, T_1 and T_2. The graph shows horizontal lines for both temperatures, but the line for T_2 lies above the line for T_1.

That means: $(PV)_{T_2} > (PV)_{T_1}$ ---->$T_2 > T_1$

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

(D) number of the molecules of gas increases

Answer:C

Solution:At constant temperature, the gas undergoes isothermal expansion. According to the kinetic theory of gases, the average kinetic energy of gas molecules is directly proportional to temperature:KE α T

Since temperature is constant, the kinetic energy remains the same.

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:Molar Masses:H_2=2g/mol

O_2=32g/mol

CH_4 =16g/mol

Since masses are equal, the number of moles is inversely proportional to molar mass: $n_{H_2}=\frac{m}{2}, n_{O_2}=\frac{m}{32}, n_{CH_4}=\frac{m}{16}$

Simplifying, the ratio of moles is: $n_{H_2}:n_{O_2}:n_{CH_4}=\frac{1}{2}:\frac{1}{32}:\frac{1}{16}=16:1:2$

Volume Ratio (Avogadro's Law):At the same P and T, volume is directly proportional to the number of moles.

Thus, the volume ratio is the same as the mole ratio: $V_{H_2}:V_{O_2}:V_{CH_4}=16:1:2$

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:Use Charles's Law: $\frac{V_1}{T_1}=\frac{V_2}{T_2}\Rightarrow\frac{1}{T_1}=\frac{2}{T_2}\Rightarrow T_2=2T_1$

Given:T_1 =27°C=300K

So,T_2 =2×300=600K

Convert back to Celsius:600-273=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:Use Boyle's Law: $P_1V_1=P_2V_2\Rightarrow V_2=\frac{P_1}{P_2}\times V_1=\frac{1}{2}\times 2=1L$

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:Given Data:Density (ρ) = 3.17

Pressure (P) = 1atm

Temperature (T) = 300K

Molar Mass Calculation:

Using the ideal gas equation in terms of density:

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

$$3.17 = \frac{1 \times M}{0.0821 \times 300}$$

$$M = 3.17 \times 0.0821 \times 300 = 78.1 g/mol$$

Theoretical Molar Mass of HF:

H=1g/mol

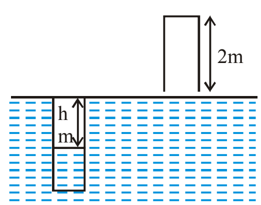
F=18g/mol (as per the question)

Monomer (HF) = 1+18=19g/mol

Dimer ($(HF)_2$) = 2×19=38g/mol

Tetramer ($(HF)_4$) = 4×19=76g/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:Let the cross section area be a now as per Boyle's law

$P_1V_1=P_2V_2$

(10+h)h×a=10×2×a

$10h+h^2=20$

h=1.71m

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

d = 2.00P + 0.020 P^2

Need to find molecular weight (M) of the gas.

Step 1: Use Ideal Gas Equation (in density form)

From ideal gas law:

$$PV = nRT \Rightarrow \frac{PM}{RT} = density = d$$

$$d = \frac{PM}{RT} \Rightarrow M = \frac{dRT}{P}$$

Now substitute the given expression of d into this:

$$M = \frac{(2.00P + 0.020P^2)25}{P}$$

$$M = 25(2 + 0.02P)$$

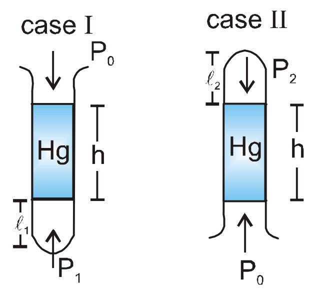
M=25·(2.00+0.020P)=50+0.5P

This implies the molecular weight varies with pressure, which is physically impossible for a single gas.

So for this expression to represent a real molar mass, it must hold for low pressure, i.e., ideal behavior.

So take P $\to$ 0, then:M= $\lim_{P\to 0}$ (50+0.5P)=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

Gas Pressure (P_1): The pressure of the gas column is balanced by the atmospheric pressure and the pressure due to the mercury column.

$P_1 = P + h$

Volume of Gas: The length of the gas column is

Case II: Open End Downwards

Gas Pressure (P_2): The pressure of the gas column is balanced by the atmospheric pressure minus the pressure due to the mercury column.

$P_2 = P - h$

Volume of Gas: The length of the gas column is l_2

Applying Boyle's Law

For an ideal gas at constant temperature, the product of pressure and volume is constant: $P_1 l_1 = P_2 l_2$

Substituting the expressions for P_1 and P_2: $(P+h)l_1 = (P-h)l_2$

Expanding the equation:

$Pl_1 + hl_1 = Pl_2 - hl_2$

$P = \frac{h(l_1 + l_2)}{l_2 - l_1}$

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)** 656.1m

Answer:A

Solution:Given:

Diameter of bubble at surface,d_1=4mm

Diameter of bubble at bottom, d_2=1mm

Atmospheric pressure ,P_{atm}=1atm

Density of water, ρ_{water} =1 g/ml=1000kg/m^3

Density of mercury, $\rho_{Hg} = 13.6$ g/ml

Temperature is constant.

Pressure at the bottom:The bubble at the bottom experiences atmospheric pressure plus the hydrostatic pressure due to the depth h of the lake: $P_{bottom} = P_{atm} + \rho_{water} gh$

Boyle's Law (since temperature is constant):

The product of pressure and volume is constant for the gas in the bubble:

$P_{surface} V_{surface} = P_{bottom} V_{bottom}$

Volumes of the bubble:

The volume of a spherical bubble is

$V = \frac{4}{3}\pi r^3$

$\frac{V_{suface}}{V_{bottom}} = \frac{r_1}{r_2}^3 = \frac{d_1}{d_2}^3 = \frac{4}{1}^3 = 64$

Substitute into Boyle's Law:

$$P_{atm}\times 64=(P_{atm}+\rho_{water}gh)\times 1$$
$$64atm=1atm+\rho_{water}gh$$
$$63atm=\rho_{water}gh$$

Convert atm to Pascals and solve for h:

$$1atm=1.013\times 10^5=1000\times 9.81\times h$$
$$h=\frac{63\times 1.013\times 10^5}{1000\times 9.81}\approx 651.1m$$

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:Initial conditions: P_1=1atm,T_1=300K,V_1=12000litres

Final conditions:P_2=0.5atm,T_2=250K

Gas: Hydrogen (assumed to behave ideally)

Approach:

Use the Combined Gas Law:

For an ideal gas, the relationship between pressure, volume, and temperature is given by: $\frac{P_1V_1}{T_1}=\frac{P_2V_2}{T_2}$

$$V_2=12000\times\frac{1}{0.5}\times\frac{250}{300}=20000litres$$

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 identical conditions of temperature and pressure, equal volumes of gases contain the same number of molecules, regardless of their chemical nature or molar mass.

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:(A) Thermal energy = Molecular attraction:

This is false because in gases, thermal energy dominates over molecular attraction.

(B) Thermal energy >> Molecular attraction:

This is true for the gaseous state.

(C) Thermal energy << Molecular attraction:

This describes liquids or solids, not gases. Thus, this is false for the gaseous state.

(D) Molecular forces >> Those in liquids:

This is false because molecular forces in gases are much weaker than in liquids.

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:

True (from $P \alpha T$, doubling T doubles P).

(B) The rate of collision increases:

True (higher temperature = higher molecular speed = more collisions per second).

(C) The number of moles of gas increases:

False (the flask is closed; no gas is added or removed).

(D) The energy of gaseous molecules increases:

True (kinetic energy α T, so doubling T doubles the average kinetic energy).

Statement Type

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 states that at constant temperature, $P\alpha\frac{1}{V}$.Thus, a plot of P Vs $\frac{1}{V}$ is a straight line, confirming the Assertion is true.

The Reason claims PαV which is false (it contradicts Boyle's Law).

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: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

Solution: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 intermolecular 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:When additional gas is introduced, the total number of molecules increases, leading to more collisions and thus higher pressure (Assertion is true).

The Reason correctly explains this phenomenon, as pressure arises from molecular collisions.

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:P_1=3atm,T_1=17+273=290K,T_2=47+273=320K

Volume is constant : Use Gay-Lussac's Law:

$$P_2 = P_1\frac{T_2}{T_1} = 3(\frac{320}{290}) = 3.31atm$$

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:Pressure is restored ,decreased pressure=3.31-3=0.31atm

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

At constant temperature,$P_1V_1=P_2V_2$

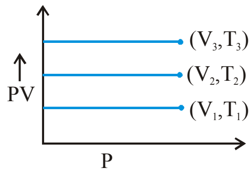
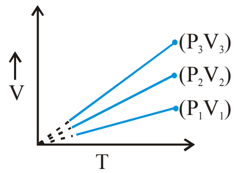
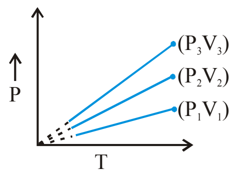
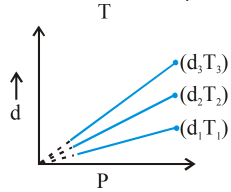
V_2=0.31(10)/1=3.1litres

Matching Type

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

Solution:

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)** $d_1 > d_2 > d_3$

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:We use Boyle's Law, which states that for a fixed amount of gas at constant temperature:$P_1V_1=P_2V_2$

$$1(V)=P_2(V/4)$$

$$P_2=4\text{atm}$$

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 a definite volume; they expand to fill their container. Only solids and liquids have definite volumes.

2. Kinetic energy of molecules is highest in

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

Answer:A

Solution:Gas molecules have the highest kinetic energy due to weak intermolecular forces and free movement.

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$\alpha \frac{1}{V}$ at constant temperature).

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 (VαT in Kelvin 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 V α T (Kelvin) at constant pressur

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), decreasing density and causing the balloon to 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:The fractional increase (1/273 per °C) is based on the volume at 0°C.

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 the 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 constant but its numerical value changes with units (e.g., 8.314 J/mol·K or 0.0821 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: $R = \frac{(\text{atm}) \times (\text{litres})}{(\text{mol}) \times (\text{K})} = \text{litre-atm K}^{-1}\text{mol}^{-1}$

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

(A) $8.31 \times 10^7 \text{erg K}^{-1}\text{mol}^{-1}$ **(B)** $8.31 \times 10^7 \text{dyne cm K}^{-1}\text{mol}^{-1}$

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

Answer:D

Solution:**(D)** $8.31 \text{atm.K}^{-1}\text{mol}^{-1}$ Invalid, because the correct value is 0.0821 lit atm K^{-1} mol^{-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=1.987 cal K^{-1} mol^{-1} is correct for calorimetry.

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:D

Solution:R represents work done per mole per Kelvin (Joules K^{-1} $mol^{-1)}$

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

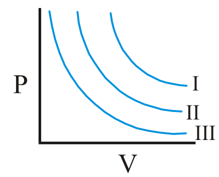
(D) P is the pressure of the gas when only one mole of gas is present

Answer:C

Solution:V is the total volume occupied by n moles of gas at P and T.

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:If isotherm I is above isotherm II, which is above isotherm III, then:

$T_1 > T_2 > T_3$

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)** $1\times\frac{1}{20}\times50$ **(D)** None of these

Answer:A

Solution:$P_1V_1=P_2V_2$

$V_1=20\ cm^3$,$P_1=1$ atm

$V_2=50\ cm^3$

$1(20)=P_2(50)$

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

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: PV is directly proportional to temperature (T) when n (number of moles) and R (gas constant) are constant.

So, PV depends on temperature.

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:Relate density, pressure, and temperature using the Ideal Gas Law:

$$PV = nRT \Rightarrow P = \frac{dRT}{M}$$

$$\frac{P_1}{P_2} = \frac{d_1T_1}{d_2T_2}$$

$$\frac{P_1}{P_2} = \frac{1}{2} \times \frac{2}{1} = 1$$

The ratio of pressures is 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:T_1=273+273=546K,P_1=1atm

T_2=0+273=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=0.2litres,T_1=0+273=273K

T_2=273+273=546K

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

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+273=300k

V_2=?,T_2=-3+273=270k

$$\frac{V_1}{T_1}=\frac{V_2}{T_2}$$
$$\frac{400}{300}=\frac{V_2}{270}$$
$$V_2=\frac{400}{300}\times 270=360cm^3$$

$$\Delta V=V_1-V_2=400-360=40cm^3$$

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:From the Ideal Gas Law (PV=nRT)

P=nRT/V

The slope of the P Vs T graph id nR/V,where n is the number of moles and

R is the gas constant.

For Two Different Volumes ($V_1 > V_2$)

Slope for $V_1 : \frac{nR}{V_1}$

Slope for $V_2 : \frac{nR}{V_2}$

Since $V_1 > V_2$, the slope for V_1 is less than the slope for V_2

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 α 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. Answer:A-3,B-4,C-1,D-2

Solution:

Column-I	**Column-II**
(A) $P_1V_1 = P_2V_2 = P_3V_3 = \ldots\ldots\ldots\ldots\ldots\ldots$	**(3)** Boyle's law
(B) $\frac{V_1}{T_1} = \frac{V_2}{T_2} = \frac{V_3}{T_3} = \ldots\ldots\ldots\ldots\ldots$ 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-p,B-q,C-r,D-s		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	D	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						