States of Matter

Question1

2.0 g of H_2 diffuses through a porous container in 10 minutes. How many grams of O_2 would diffuse from the same container in the same time under similar conditions?

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Options:

A.

2.0

B.

4.0

C.

16.0

D.

8.0

Answer: D

Solution:

Graham's Law of Diffusion:

The rate at which a gas diffuses is inversely proportional to the square root of its molar mass. This means, lighter gases diffuse faster than heavier gases.

Setting up the ratio:

The formula is:

$$\frac{\text{Rate of } H_2}{\text{Rate of } O_2} = \sqrt{\frac{\text{Molar mass of } O_2}{\text{Molar mass of } H_2}}$$

The same amount of time is used for both gases. This means we can compare the number of moles of each gas that can diffuse:

$$\frac{n_{H_2}}{n_{O_2}} = \sqrt{\frac{M_{O_2}}{M_{H_2}}}$$

Finding the values:

Molar mass of $H_2 = 2\,\text{g/mol}$ and molar mass of $O_2 = 32\,\text{g/mol}$.

n_{H_2} is the number of moles of hydrogen:

$$n_{H_2} = \frac{2.0\,\text{g}}{2\,\text{g/mol}} = 1\,\text{mol}$$

$$\frac{1}{n_{O_2}} = \sqrt{\frac{32}{2}} = \sqrt{16} = 4$$

So,

$$n_{O_2} = \frac{1}{4} = 0.25\,\text{mol}$$

Calculate the mass of O_2:

Mass of $O_2 = n_{O_2} \times$ Molar mass of O_2

Mass of $O_2 = 0.25 \times 32 = 8\,\text{g}$

Final answer:

8 grams of O_2 would diffuse from the container in the same time under similar conditions.

Question2

At $T(\text{K})$, the u_{rms} of CO_2 is $412\,\text{ms}^{-1}$. What is its kinetic energy (in kJmol^{-1}) at the same temperature ?

$(CO_2 = 44\text{u})$

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Options:

A.

3.7343

B.

7.4687

C.

14.9374

D.

3734.3

Answer: A

Solution:

$v_{\text{rms}} = 412 \text{ m/s}$

Molar mass of $CO_2 = M = 0.044 \text{ kg/mol}$

$$\text{KE} = \frac{1}{2}Mv_{\text{rms}}^2$$
$$\Rightarrow \quad \text{KE} = \frac{1}{2} \times 0.044 \times (412)^2 = 3.7343 \text{ kJ}$$

Question3

The correct equation for one mole of a real gas is a, b are constants)

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Options:

A.

$\left(p + \frac{a}{V^2}\right)(V - b) = RT$

B.

$\left(p - \frac{a}{V^2}\right)(V - b) = RT$

C.

$\left(p + \frac{a}{V^2}\right)(V + b) = RT$

D.

$\left(p + \frac{a}{V}\right)(V - b) = RT$

Answer: A

Solution:

The correct equation (van der Waal's equation) for 1 mole of a real gas is

$\left(p + \frac{a}{V^2}\right)(V - b) = RT$

Question4

A **and** B **are ideal gases. At** $T(\text{ K}), 2 \text{ L of ' } A' \text{ 'with a pressure of 1 bar is mixed with 4 L of ' } B \text{ ' with a pressure } p_B \text{ bar in a 100 L flash. The pressure exerted by gaseous mixture is 0.1 bar. What is the value of } p_B \text{ in bar?}$

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Options:

A.

2

B.

0.04

C.

0.02

D.

1

Answer: A

Solution:

Step 1: Use Boyle's Law for Gas A

Boyle's Law says that for a fixed temperature, pressure times volume stays the same when the gas changes containers.

The formula is: $p_A V_A = p'_A V_{\text{final}}$

So for gas A: $p'_A = \frac{1 \times 2}{100} = 0.02$ bar

Step 2: Use Dalton's Law of Partial Pressures

Dalton's Law says that the total pressure from a mixture of gases is the sum of the pressures each gas would have by itself in the same container.

Total pressure after mixing is given in the question as 0.1 bar. So, $p_{\text{total}} = p'_A + p'_B$ $0.1 = 0.02 + p'_B$ This means $p'_B = 0.08$ bar

Step 3: Find the Original Pressure of Gas B with Boyle's Law

Again, use Boyle's Law for gas B as we did for gas A.

$p_B \times V_B = p'_B \times V_{\text{final}}$

Put the numbers in: $p_B \times 4 = 0.08 \times 100$

So, $p_B = \frac{0.08 \times 100}{4} = 2$ bar

Question5

Consider the following

Statement I If thermal energy is stronger than intermolecular forces, the substance prefers to be in gaseous state.

Statement II At constant temperature, the density of an ideal gas is proportional to its pressure.

The correct answer is

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Options:

A.

Statement-I is correct, but Statement-II is not correct.

B.

Statement-I is not correct, but Statement-II is correct.

C.

Both Statement-I and Statement-II are correct.

D.

Both Statement-I and Statement-II are not correct.

Answer: C

Solution:

Statement I

If thermal energy is stronger than intermolecular forces, the substance prefers to be in gaseous state.

- When **thermal (kinetic) energy** of molecules exceeds the **intermolecular attractive forces**, the molecules move freely, far apart — this is the **gaseous state**.

✅ **Statement I is correct.**

Statement II

At constant temperature, the density of an ideal gas is proportional to its pressure.

From the **ideal gas law**:

$PV = nRT$

or

$P = \frac{n}{V}RT$

Now, $\frac{n}{V} = \frac{\rho}{M}$, where ρ is density and M is molar mass.

Thus,

$P = \frac{\rho}{M}RT \Rightarrow \rho = \frac{PM}{RT}$

At constant T and M:

$\rho \propto P$

✅ **Statement II is also correct.**

✅ **Final Answer:**

Option C — Both Statement-I and Statement-II are correct.

Question6

At $27°C$, 1 L of H_2 with a pressure of 1 bar is mixed with 2 L of O_2 with a pressure of 2 bar in a 10 L flask. What is the pressure exerted by gaseous mixture in bar? (Assume H_2 and O_2 as ideal gases)

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Options:

A.

4

B.

0.05

C.

1

D.

0.5

Answer: D

Solution:

Calculating the partial pressure of H_2 in 10 L flask

$p_{H_2 \text{ initial}} \quad V_{H_2 \text{ initial}} \quad = p_{H_2 \text{ final}} \quad V_{\text{total}}$

$p_{H_2 \text{ final}} \quad = \frac{1 \times 1}{10} = 0.1 \text{bar}$

Using Boyle's law for partial pressure of O_2

$p_{O_2 \text{ final}} \quad = \frac{p_{O_2 \text{ initial}} \quad \times V_{O_2 \text{ initial}}}{V_{\text{total}}}$

$= \frac{2 \times 2}{10} = 0.4 \text{bar}$

Use Dalton's law of partial pressure.

$p_{\text{total}} \quad = p_{H \text{ final}} \quad + p_{O_2 \text{ final}}$
$= 0.1 + 0.4 = 0.5 \text{ bar}$

Question7

Choose the incorrect statement from the following.

Options:

A.

At Boyle temperature a real gas obeys ideal gas law over an appreciable range of pressure.

B.

Critical temperature of CO_2 is $27.5°C$.

C.

Above critical temperature, a real gas behaves like an ideal gas.

D.

At room temperature and 1 atm pressure the compressibility factor (Z) for H_2 gas is greater than 1 .

Answer: B

Solution:

Statement given in option (b) is incorrect. The correct form of option (b) is critical temperature of CO_2 is $31°C$. Critical temperature is the temperature above which a substance cannot be

liquified regardless of the pressure applied.

Question8

At $27°C$ kinetic energy of 4 g of H_2 is x J. What is the kinetic energy (in J) of 6.4 g of oxygen at $127°C$?

Options:

A.

$\frac{x}{15}$

B.

$\frac{4x}{15}$

C.

$\frac{8x}{15}$

D.

$\frac{2x}{15}$

Answer: D

Solution:

Molar mass of $H_2 = 2$ g/mol

Number of moles $= n_{H_2} = \dfrac{\text{Given mass}}{\text{Molar mass}}$

$= \frac{4}{2} = 2$ g/mol

Moles of $O_2 = \frac{6.4}{32} \approx 0.20$ mol

Now, $\dfrac{KE_{O_2}}{KE_{H_2}} = \dfrac{n_{O_2} \times T_{O_2}}{n_{H_2} \times T_{H_2}}$

$\Rightarrow \quad KE_{O_2} = \frac{x \times 0.200 \times 400}{2 \times 300} = \frac{2x}{15}$ J

Question9

At $T(\text{K})$, hydrogen and oxygen gases are mixed in the ratio of $1:2$ by mass in a closed vessel of volume ' V ' litres. If the total pressure of gaseous mixture is ' p ' atm, the partial pressure of oxygen (in atm) is

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Options:

A.

$\frac{p}{9}$

B.

$9p$

C.

$\frac{8p}{9}$

D.

$\frac{p}{6}$

Answer: A

Solution:

Assume a total mass : 1 g of H_2 and 2 g of O_2

$n_{H_2} = \frac{\text{Given mass}}{\text{Molar mass}} = \frac{1}{2} = 0.5$ mol

Similarly, $n_{O_2} = \frac{2}{32} = 0.0625$ mol

Total moles $= n_{\text{Total}} = n_{H_2} + n_{o_2}$
$= 0.5625$ mol

Mole fraction of O_2

$\chi_{o_2} = \frac{n_{o_2}}{n_{\text{total}}} = \frac{0.0625}{0.5625} = \frac{1}{9}$

Partial pressure of O_2

$p_{O_2} = \chi_{O_2} \cdot p_{\text{total}} = \frac{p}{9}$ atm

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Question10

At what temperature (in K) the rms velocity of SO_2 molecules is equal to rms velocity of O_2 molecules at $27°C$?

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Options:

A.

300

B.

1200

C.

600

D.

900

Answer: C

Solution:

We want to find the temperature where the rms (root mean square) speed of SO_2 molecules is equal to the rms speed of O_2 molecules at 27°C.

The formula for rms velocity is: $V_{rms} = \sqrt{\frac{3RT}{M}}$ where R is the gas constant, T is temperature in Kelvin, and M is molar mass.

We set the rms speeds equal: $V_{rms(SO_2)} = V_{rms(O_2)}$ So, $\sqrt{\frac{3RT_{SO_2}}{M_{SO_2}}} = \sqrt{\frac{3RT_{O_2}}{M_{O_2}}}$

Squaring both sides removes the square root: $\frac{T_{SO_2}}{M_{SO_2}} = \frac{T_{O_2}}{M_{O_2}}$

Rearrange for T_{SO_2}: $T_{SO_2} = T_{O_2} \times \frac{M_{SO_2}}{M_{O_2}}$

The temperature given for O_2 is 27°C. Convert this to Kelvin: $27 + 273 = 300$ K

The molar mass of SO_2 is 64, and of O_2 is 32.

Plug in the values: $T_{SO_2} = 300 \times \frac{64}{32} = 300 \times 2 = 600 \ K$

Question11

For one mole of an ideal gas an isochore is obtained. The slope of the isochore is 0.082 atm K^{-1}. What will be its pressure (in atm) when

the temperature is 12.2 K? $\left(R = 0.082 \text{ L atm mol}^{-1} \text{ K}^{-1}\right)$

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Options:

A.

10.0

B.

0.1

C.

1.0

D.

0.5

Answer: C

Solution:

The slope of an isochore (a line where volume does not change) for an ideal gas is given by $\frac{dp}{dT} = \frac{nR}{V}$, where:
n = number of moles, R = gas constant, V = volume.

Here, the slope is 0.082 atm K^{-1}, $n = 1$, and $R = 0.082$ L atm mol^{-1} K^{-1}.

Substitute the known values into the formula:
$0.082 = \frac{1 \times 0.082}{V}$

Solve for V:
$V = 1$ L

Now, use the ideal gas equation: $pV = nRT$.

Substitute the values: $p \times 1 = 1 \times 0.082 \times 12.2$

Calculate the multiplication: $0.082 \times 12.2 = 1.0004$

So, $p = 1.0004$ atm. Round to nearest whole number: $p = 1$ atm

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Question12

At $T(K)$, a gaseous mixture contains H_2 and O_2. The total pressure of the mixture is 2 bar. The partial pressure of H_2 is 1.778 bar. What is the weight (w/w) percentage of H_2 in the mixture?

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Options:

A.

66.67

B.

33.33

C.

80.00

D.

20.00

Answer: B

Solution:

$$p_{\text{Total}} = p_{O_2} + p_{H_2}$$

$$\Rightarrow \quad p_{O_2} = 2 - 1.778 = 0.22 \text{bar}$$

Mole fraction of H_2 and O_2

$$X_{H_2} = \frac{p_{H_2}}{p_{\text{Total}}} = \frac{1.778}{2} = 0.889$$

$$X_{O_2} = 1 - X_{H_2} = 0.111$$

$$m_{H_2} = X_{H_2} \cdot M_{H_2} = 1.778$$

$$m_{O_2} = X_{O_2} \cdot M_{O_2} = 3.552$$

$$\frac{W}{W}\% H_2 = \frac{m_{H_2}}{m_{H_2} + m_{O_2}} \times 100$$

$$= \frac{1.778}{1.778 + 3.552} \times 100 = 33.33\%$$

Question13

The most probable speed (U_{mp}) of 8 g of H_2 is $2 \times 10^2 \text{ ms}^{-1}$. The kinetic energy (in J) of same amount of H_2 gas is

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Options:

A.

480

B.

240

C.

720

D.

120

Answer: B

Solution:

Most probable speed is given by

$U_{mp} = \sqrt{\frac{2RT}{M}}$

On rearranging to obtain the value of RT.

$\frac{U_{mp}^2 \times M}{2} = RT$

Substituting the values

$= \frac{(2 \times 10)^2 \times (2) \times 10^{-3}}{2}$

$RT = 40$

Moles of $H_2 = \frac{8}{2} = 4$

$KE = \frac{3}{2}nRT \Rightarrow \frac{3}{2} \times 4 \times 40 = 240 \text{ J}$
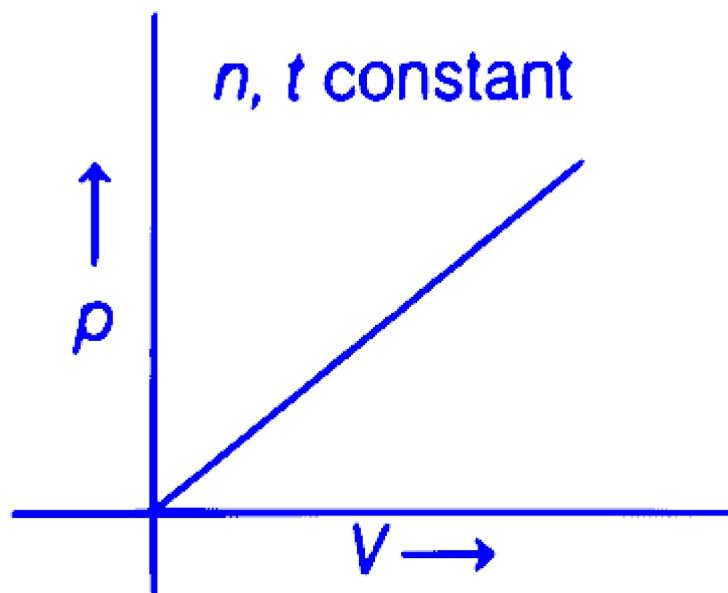
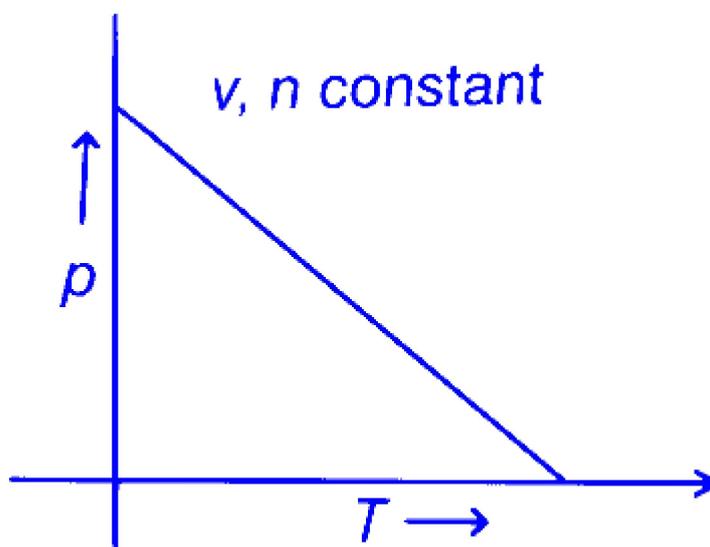# Question14

Which of the following is correct for an ideal gas?

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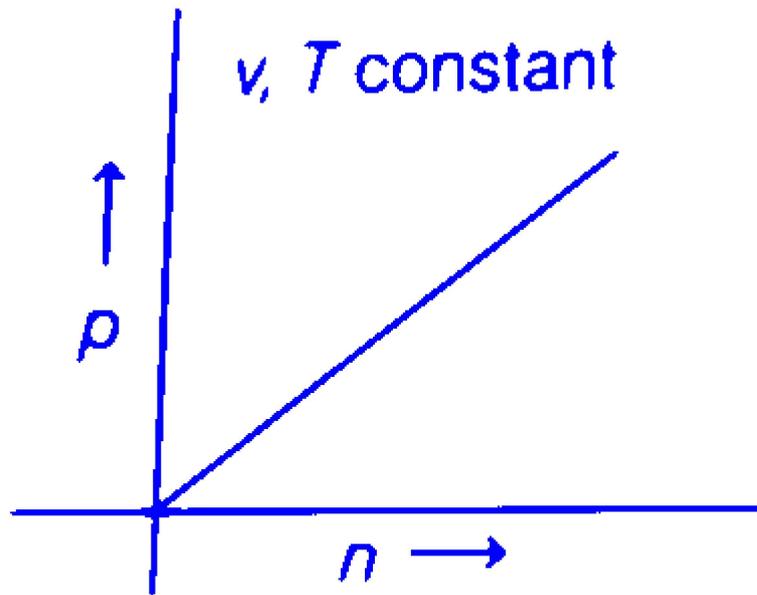
Options:

A.
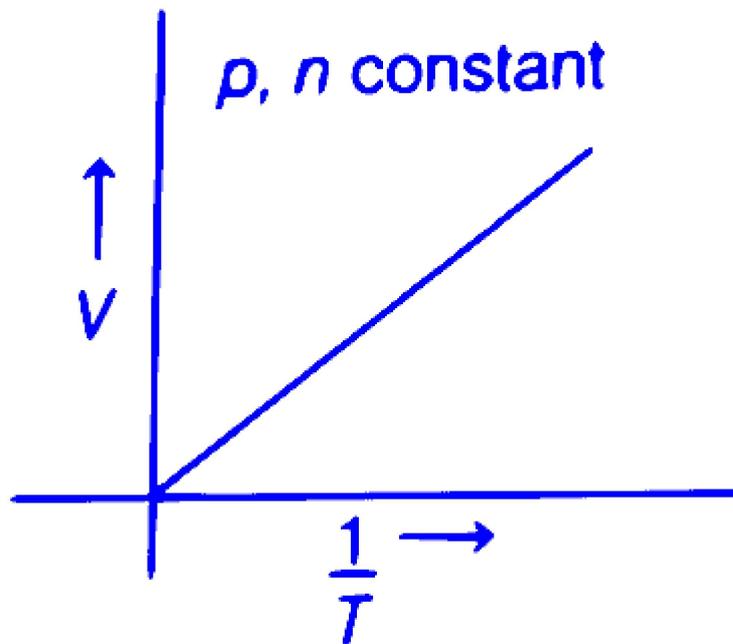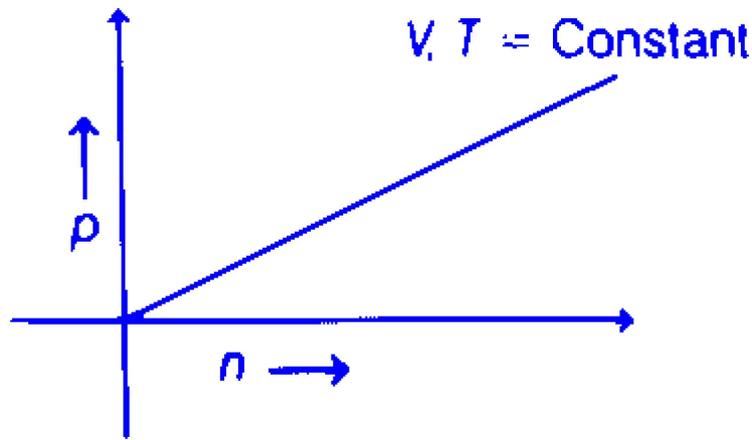

B.

C.

D.

Solution:

Ideal gas equations, $pV = nRT$

$p \propto n, T \Rightarrow p \propto \frac{1}{V}$

So correct graph is

V, T = Constant

Question15

At 256 K , rms speed of SO_2 gas molecules is 3.16×10^2 ms^{-1}. What is the most probable velocity (in ms^{-1}) of same gas at same temperature?

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Options:

A.

2.911×10^2

B.

2.58×10^2

C.

5.16×10^2

D.

129×10^2

Answer: B

Solution:

Root mean square speed is,

$$v_{\text{rms}} = \sqrt{\frac{3RT}{M}}$$

Most probable speed is, $v_{mp} = \sqrt{\frac{2RT}{M}}$

$$\frac{v_{\text{rms}}}{v_{\text{mp}}} = \sqrt{\frac{3}{2}} \Rightarrow v_{\text{MP}} = v_{\text{rms}}\sqrt{\frac{2}{3}}$$

$$\Rightarrow 3.16 \times 10^2 \times \sqrt{\frac{2}{3}}$$

$$v_{\text{mp}} = 2.58 \times 10^2 \text{ m/s}$$

Question16

Consider the following

Statement-I : If the intermolecular forces are stronger than thermal energy, the substance prefers to be in gaseous state.

Statement-II : Among all elements, the total number of elements available as gases at room temperature is 10 .

The correct answer is

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Options:

A.

Both Statement-I and Statement-II are correct.

B.

Both Statement-I and Statement-II are not correct.

C.

Statement-I is correct, but Statement-II is not correct.

D.

Statement-I is not correct, but Statement-II is correct.

Answer: B

Solution:

Both statements I and II are not correct.

The incorrect forms are

If intermolecular forces are stronger than thermal energy, the substance will prefer to be in solid or liquid state.

The total number of elements that are gases at room temperature is II.

Question17

Identify the conditions at which van der Waals' equation of state changes to ideal gas equation.

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Options:

A.

high temperature and high pressure

B.

low temperature and high pressure

C.

high temperature and low pressure

D.

Iow temperature and low pressure

Answer: C

Solution:

At high temperature and low pressure, van der Waals' equation of state changes to ideal gas equation.

Question18

The rms velocity (u_{rms}), mean velocity (u_{av}) and most probability (u_{mp}) of a gas differ from each other at a given temperature. Which of the following ratios regarding them is correct?

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Options:

A. $\frac{u_{\text{rms}}}{u_{\text{av}}} = 1.20$

B. $\frac{u_{\text{av}}}{u_{\text{mp}}} = 1.12$

C. $\frac{u_{\text{rms}}}{u_{\text{mp}}} = 1.15$

D. $\frac{u_{\text{av}}}{u_{\text{rms}}} = 0.98$

Answer: B

Solution:

The root mean square (rms) velocity, mean velocity, and most probable velocity of a gas differ in value at a given temperature. Here is the detailed explanation for each:

Root Mean Square Velocity (u_{rms}):

$$u_{\text{rms}} = \sqrt{\frac{3RT}{M}}$$

Mean Velocity (u_{average}):

$$u_{\text{average}} = \sqrt{\frac{8RT}{\pi M}}$$

Most Probable Velocity (u_{mp}):

$$u_{\text{mp}} = \sqrt{\frac{2RT}{M}}$$

These formulas indicate the velocities in terms of the universal gas constant R, absolute temperature T, and molar mass M.

Considering the ratios:

Ratios Derived:

$$u_{\text{rms}} : u_{\text{av}} : u_{\text{mp}} = \sqrt{3} : \sqrt{\frac{8}{\pi}} : \sqrt{2}$$

Evaluating these expressions approximately gives:

1.732 : 1.596 : 1.414

Calculated Ratios:

$\frac{u_{\text{rms}}}{u_{\text{av}}} = 1.08, \qquad \frac{u_{\text{av}}}{u_{\text{mp}}} = 1.12,$

$\frac{u_{\text{rms}}}{u_{\text{mp}}} = 1.22, \qquad \frac{u_{\text{av}}}{u_{\text{rms}}} = 0.92$

Based on these calculations, the correct option is the one that accurately reflects the derived ratios, specifically noting that the ratio $\frac{u_{\text{av}}}{u_{\text{mp}}}$ equals 1.12, hence confirming the accuracy of this comparison.

Question19

60 cm^3 **of** SO_2 **gas diffused through a porous membrane in '** x **' min. Under similar conditions** 360 cm^3 **of another gas (molar mass** 4 g mol^{-1} **) diffused in '** y **' min. The ratio of** x **and** y **is**

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Options:

A. 3 : 2

B. 2 : 3

C. 1 : 3

D. 3 : 1

Answer: B

Solution:

Given the data:

Volume of SO_2 (V_{SO_2}) = 60 cm^3

Time for SO_2 (t_{SO_2}) = x minutes

Molar mass of SO_2 (M_{SO_2}) = 64 g/mol

For the other gas:

Volume (V_g) = 360 cm^3

Time (t_g) = y minutes

Molar mass (M_g) = 4 g/mol

We apply Graham's law of diffusion, which states that the rate of diffusion (r) is inversely proportional to the square root of the molar mass, as shown below:

$$r \propto \frac{1}{\sqrt{M}}$$

This can be expressed as:

$$\frac{r_{SO_2}}{r_g} = \sqrt{\frac{M_g}{M_{SO_2}}} = \frac{V_{SO_2} \times t_g}{V_g \times t_{SO_2}}$$

Substituting the known values:

$$\sqrt{\frac{4}{64}} = \frac{60 \times y}{360 \times x}$$

Simplifying the above equation gives:

$$\frac{x}{y} = \frac{2}{3}$$

Thus, the ratio of x to y is $2:3$.

Question20

A 10 L vessel contains 1 mole of an ideal gas with pressure of $p(\text{atm})$ and temperature of $T(\text{K})$. The vessel is divided into two equal parts. The pressure (in atm) and temperature in (K) in each part is respectively.

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Options:

A. $\frac{p}{2}, \frac{T}{2}$

B. $\frac{p}{2}, T$

C. p, T

D. $p, \frac{T}{2}$

Answer: C

Solution:

When a 10 L vessel containing 1 mole of an ideal gas is divided into two equal parts, each section now holds a volume of 5 L and 0.5 moles of gas.

To understand the effect on pressure and temperature, we can use the ideal gas law:

$PV = nRT$

Since the ratio $\frac{n}{V}$ remains constant for each section of the divided vessel, the pressure remains unchanged. This is because:

The number of moles n is halved (0.5 moles) and the volume V is also halved (5 L), thus the ratio $\frac{n}{V}$ stays the same.

Both sections maintain the same conditions because dividing the vessel doesn't add or remove any energy from the system.

Therefore, both the pressure p and the temperature T remain the same in each part.

Question21

At $T(\mathrm{K})$ for one mole of an ideal gas, the graph of p (on Y-axis) and V^{-1} (on X-axis) gave a straight line with slope of $32.8\ \mathrm{L\ atm\ mol}^{-1}$. What is the temperature (in K)? $\left(R = 0.082\ \mathrm{L\ atm\ mol}^{-1}\ \mathrm{K}^{-1}\right)$

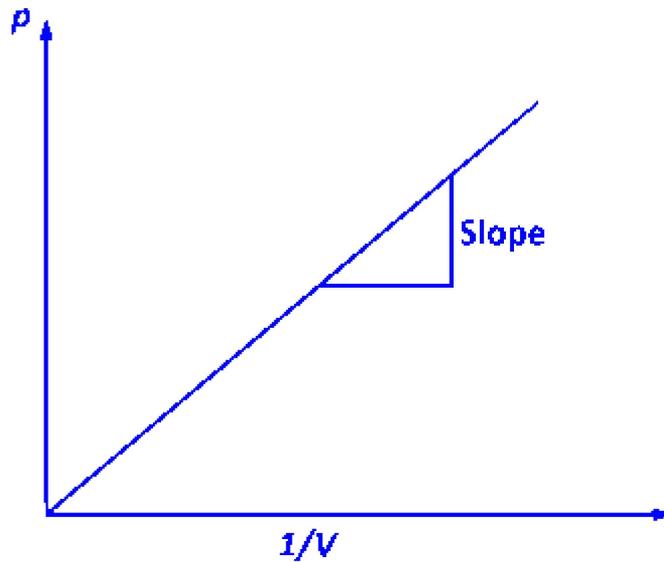**AP EAPCET 2024 - 22th May Evening Shift**

Options:

A. 600

B. 200

C. 800

D. 400

Answer: D

Solution:

Given, Slope $= 32.8\ \mathrm{L\ atm/mol}$

From the graph,

$$\text{slope} = \frac{p}{\frac{1}{V}} \text{ or } pV$$

$$pV = 32.8 \text{ L atm/mol} \quad \ldots(i)$$

Now, using ideal gas equation for 1 mo of ideal gas,

$$pV = RT \qquad \ldots(ii)$$

Compare Eqs. (i) and (ii),

$$32.8 = RT$$

$$T = \frac{32.8}{0.082} = 400 \text{ K}$$

Question22

A vessel of volume V L contains an ideal gas are $T(\text{ K})$. The vessel is partitioned into two equal parts. The volume (in L) and temperature (in K) in each part is respectively.

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Options:

A. $V, \frac{T}{2}$

B. $\frac{V}{2}, T$

C. V, T

D. $\frac{V}{2}, \frac{T}{2}$

Solution:

When a vessel containing an ideal gas is divided into two equal parts, the characteristics of the gas in each part are determined by the properties of volume and temperature:

Volume is an **extensive property**, meaning it depends on the size or extent of the system. Therefore, when the vessel is partitioned into two equal halves, the volume in each part will be half of the original, i.e., $\frac{V}{2}$ liters.

Temperature is an **intensive property**, indicating that it does not depend on the size or amount of the system. As a result, the temperature remains the same in each part after the partitioning, i.e., T Kelvin.

Thus, for each part of the partitioned vessel, the volume is $\frac{V}{2}$ liters and the temperature is T Kelvin.

Question23

At 240.55 K , for one mole of an ideal gas, a graph of p (on Y-axis) and V^{-1} (on X-axis) gave a straight line passing through origin. Its slope (m) is 2000 J mol^{-1}. What is the kinetic energy (in Jmol^{-1}) of ideal gas?

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Options:

A. 2000

B. 3000

C. 6000

D. 1500

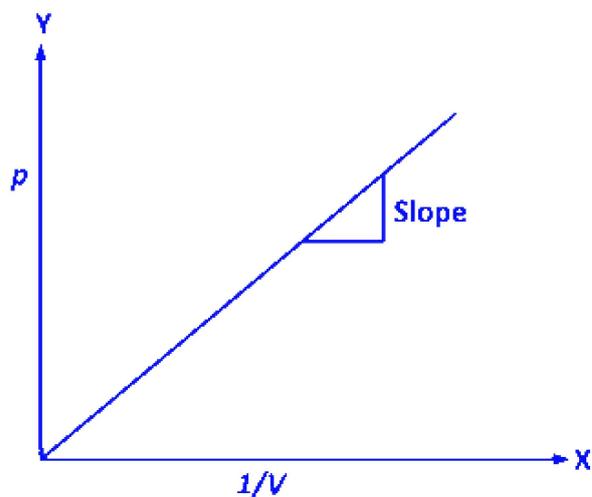## Solution:

Given, 1 mole of ideal gas, $n = 1$
slope $= 2000$ J/mol $\qquad \ldots(i)$
slope $= \dfrac{y}{x} = \dfrac{p}{1/V} = pV \qquad \ldots(ii)$

Using, ideal gas equation, $pV = RT$

$RT = 2000$ J/mol   ... (iii)

Kinetic energy of ideal gas is given by

$$\text{KE} = \frac{3}{2}RT = \frac{3}{2} \times 2000 \text{ J/mol}$$
$$= 3000 \text{ J/mol}$$

Question24

At STP, a closed vessel contains I mole each of He and $\mathrm{CH_4}$. Through a small hole, 2 L of He and LL of $\mathrm{CH_4}$WHS escaped from vessel in ' t ' minutes. What are the mole fractions of He and $\mathrm{CH_4}$ respectively remaining in the vessel? (Assume He and $\mathrm{CH_4}$ as ideal gases. At STP one mole of an ideal gas occupies 22.4 L of volume.)

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Options:

A. $0.512, 0.488$

B. $0.329, 0.671$

C. $0.5, 0.5$

D. $0.488, 0.512$

Solution:

Assuming He and CH₄ behave as ideal gases, note that at STP, 1 mole occupies 22.4 liters.

Calculations:

Helium:

Moles of He that escaped = $\frac{2}{22.4}$

Remaining moles of He = $1 - \frac{2}{22.4} = 0.91$

Methane:

Moles of CH₄ that escaped = $\frac{1}{22.4}$

Remaining moles of CH₄ = $1 - \frac{1}{22.4} = 0.95$

Mole Fractions:

Mole fraction of He:

$\frac{0.91}{0.91+0.95} = 0.489 \approx 0.488$

Mole fraction of CH₄:

$1 - 0.488 = 0.512$

The mole fractions of the remaining gases are approximately 0.488 for helium and 0.512 for methane.

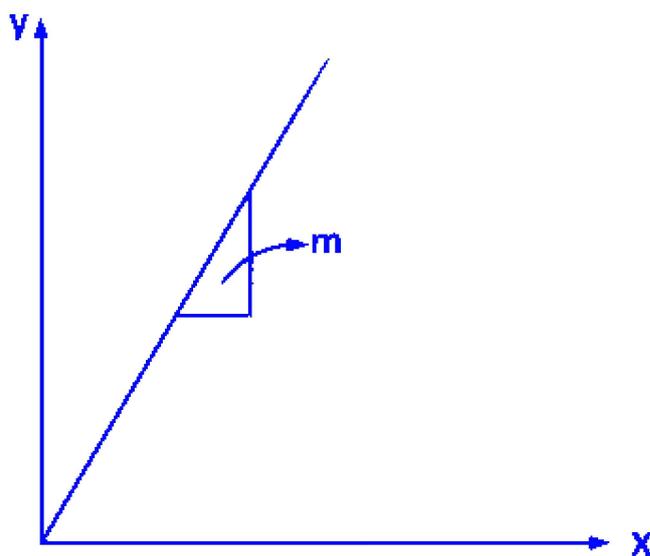---

Question25

At $T(\text{ K})$, the p, V and u_{rms} of 1 mole of an ideal gas were measured. The following graph is obtained. What is it slope (m)?

(x-axis $= pV$: y-axis u_{rms}^2, $M = $ Molar mass)

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Options:

A. $\frac{3}{M}$

B. $\frac{M}{3}$

C. $\left(\frac{M}{3}\right)^{\frac{1}{2}}$

D. $\left(\frac{3}{M}\right)^{\frac{1}{2}}$

Answer: A

Solution:

The RMS velocity of ideal gas is given by

$$v_{\text{ms}} = \sqrt{\frac{3RT}{M}} \qquad \ldots(i)$$
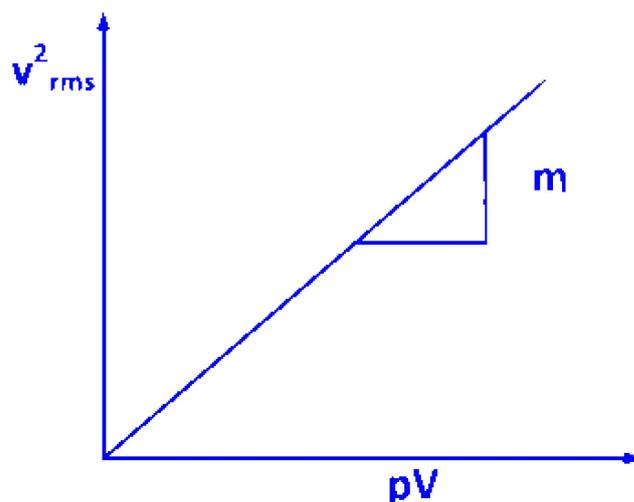
Squaring on both side,

$$v_{\text{ms}}^2 = \frac{3RT}{M} \qquad \ldots(ii)$$

Now, using ideal gas equation for 1 mole of gas.

$$pV = RT \qquad \ldots(iii)$$

Substitute the value of RT in Eq. (ii),

$$v_{\text{ms}}^2 = \frac{3}{M}pV \qquad \ldots(iv)$$

Compare it with straight line equation passing from origin.

$y = mx + c$ (as $c = 0$)

$\because \ m = \frac{3}{M}$

Question26

Three layers of liquid are flowing over fixed solid surface as shown below. The correct order of velocity of liquid in these layers is

AP EAPCET 2024 - 21th May Evening Shift

Options:

A. $v_1 > v_2 > v_3$

B. $v_1 = v_2 = v_3$

C. $v_3 > v_2 > v_1$

D. $v_3 > v_1 > v_2$

Answer: C

Solution:

In the system of three layers of liquid flowing over a fixed solid surface, the velocities of these layers are ordered as follows:

$v_3 > v_2 > v_1$

This sequence indicates that the velocity of the liquid is highest at the topmost layer and decreases as you move to the layers beneath it. The reduced frictional resistance experienced by the top layer, compared to the layers closer to the solid surface, allows it to achieve the highest velocity. Conversely, the bottom layer, in direct contact with the solid surface, encounters the greatest viscosity and thus has the lowest velocity.

Question27

The RMS velocity (u_{rms}) of one mole of an ideal gas was measured at different temperatures and the following graph is obtained. What is the slope (m) of straight line ?

$$\left(X\text{-axis } = T(\mathrm{K}) : Y\text{-axis } = (u_{\mathrm{rms}})^2 : M = \text{molar mass} : R = \text{ gas constant}\right.$$
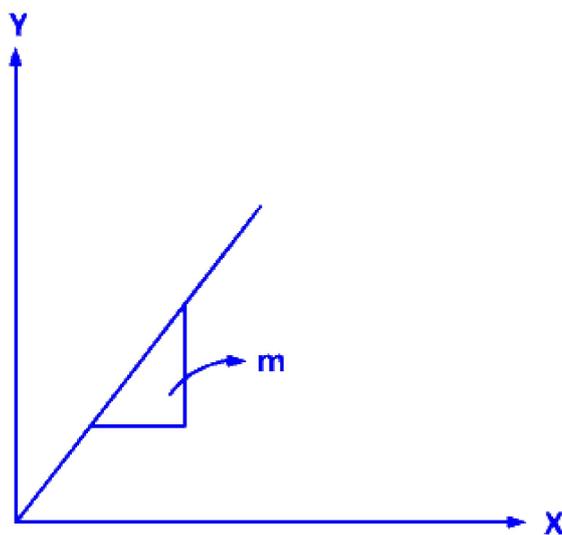
AP EAPCET 2024 - 21th May Morning Shift

Options:

A. $\left(\frac{3R}{M}\right)^{1/2}$

B. $\left(\frac{M}{3R}\right)^{1/2}$

C. $\frac{M}{3R}$

D. $\frac{3R}{M}$

Solution:
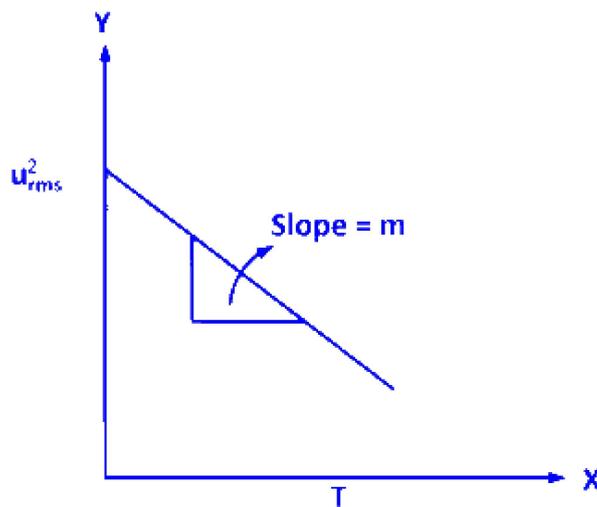
RMS velocity of ideal gas is given by

$$u_{mms} = \sqrt{\frac{3RT}{M}}$$

Squaring both sides

$$u_{rms}^2 = \frac{3RT}{M}$$

Now plotting graph between μ_{rms}^2 on Y-axis and T on X-axis

Slope $= m$

Compare Eq. (i) with straight line equation $\Rightarrow y = mx + C$

$$C = 0, m = \frac{3R}{M}$$

Question28

Two statements are given below.

Statement I : Viscosity of liquid decreases with increase in temperature.

Statement II : The units of viscosity coefficient are pascal.

The correct answer is

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Options:

A. Both statement I and statement II are correct .

B. Both statement I and statement II are not correct.

C. Statement I is correct but statement II is not correct.

D. Statement I is not correct but statement II is correct.

Answer: C

Solution:

Statement I: "Viscosity of liquid decreases with increase in temperature."

This is **correct** in general. As the temperature rises, the intermolecular forces in a liquid weaken, causing the viscosity to decrease.

Statement II: "The units of viscosity coefficient are pascal?"

The SI unit of (dynamic) viscosity is actually **Pascal-second (**$Pa \cdot s$**)**, not just Pascal (Pa). So, stating that the units are only "pascal" is **incorrect**.

Hence,

Statement I is **correct**.

Statement II is **incorrect**.

Therefore, the correct choice is:

> **Option C: Statement I is correct but statement II is not correct.**

Question29

What is the kinetic energy (in $\mathrm{Jmol^{-1}}$) of one mole of an ideal gas (molar mass $= 0.1 \mathrm{~kg~mol^{-1}}$) if its rms velocity is $4 \times 10^2 \mathrm{~ms^{-1}}$ at $T(\mathrm{~K})$?

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Options:

A. 2×10^5

B. 8×10^4

C. 8×10^2

D. 8×10^3

Answer: D

Solution:

To find the kinetic energy of one mole of an ideal gas, we'll use the following given data:

The root mean square velocity, v_{rms}, is $4 \times 10^2 \, \text{m/s}$.

The molar mass is $0.1 \, \text{kg/mol}$.

First, we need to calculate the mass of one mole of the gas.

Mass = molar mass $\times$ number of moles = $0.1 \, \text{kg/mol} \times 1 \, \text{mol} = 0.1 \, \text{kg}$

The relationship between kinetic energy (E) and v_{rms} is given by the following formula:

$$v_{\text{rms}} = \sqrt{\frac{2E}{m}}$$

Squaring both sides of the equation, we have:

$$v_{\text{rms}}^2 = \frac{2E}{m}$$

From this, we can solve for E:

$$E = \frac{v_{\text{rms}}^2 \times m}{2}$$

Now, substitute the known values into the equation:

$$E = \frac{(4 \times 10^2)^2 \times 0.1}{2} = \frac{16 \times 10^4 \times 0.1}{2}$$

Simplifying, we find:

$$E = \frac{1.6 \times 10^4}{2} = 8 \times 10^3 \, \text{J/mol}$$

Therefore, the kinetic energy of one mole of the ideal gas is $8 \times 10^3 \, \text{J/mol}$.

Question30

Two statement are given below.

Statement I : The ratio of the molar volume of a gas to that of an ideal gas at constant temperature and pressure is called the compressibility factor.

Statement II : The rms velocity of a gas is directly proportional to square root of $T(\text{K})$.

The correct answer is

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Options:

A. Both statement I and statement II are correct.

B. Both statement I and statement II are not correct.

C. Statement I is correct but statement II not correct.

D. Statement I is not correct but statement II is correct.

Answer: A

Solution:

Let's analyze each statement step by step:

Statement I:

The compressibility factor Z for a gas is defined as the ratio of its molar volume V to that of an ideal gas V_{ideal} at the same temperature and pressure.

For an ideal gas, under a given temperature T and pressure p, the molar volume is given by $V_{\text{ideal}} = \frac{RT}{p}$.

Therefore, the compressibility factor is:

$$Z = \frac{V}{V_{\text{ideal}}} = \frac{V}{RT/p} = \frac{pV}{RT}.$$

This matches the statement provided. Hence, Statement I is correct.

Statement II:

The root-mean-square (rms) velocity of gas molecules is given by:

$$v_{\text{rms}} = \sqrt{\frac{3RT}{M}},$$

where M is the molar mass of the gas.

From this expression, it is clear that v_{rms} is proportional to the square root of the temperature T (when M is constant), i.e.,

$v_{\text{rms}} \propto \sqrt{T}.$

Therefore, Statement II is also correct.

Since both statements are correct, the correct answer is:

Option A: Both statement I and statement II are correct.

Question31

At 133.33 K . the rms velocity of an ideal gas is $\left(M = 0.083 \text{ kg mol}^{-1}; R = 8.3 \text{ J mol}^{-1} \text{ K}^{-1}\right)$

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Options:

A. 200 ms^{-1}

B. 150 ms^{-1}

C. 2000 ms^{-1}

D. 400 ms^{-1}

Answer: A

Solution:

Given:

Temperature, $\text{T} = 133.33 \text{ K}$

Molar mass, $M = 0.083 \text{ kg/mol}$

Universal gas constant, $R = 8.3 \text{ J/(mol} \cdot \text{K)}$

The root mean square (RMS) velocity for an ideal gas is calculated using the formula:

$v_{\text{RMS}} = \sqrt{\frac{3RT}{M}}$

Substituting the given values into the formula:

$$v_{\text{RMS}} = \sqrt{\frac{3 \times 8.3 \times 133.33}{0.083}}$$

$$v_{\text{RMS}} = \sqrt{39,999}$$

Therefore:

$$v_{\text{RMS}} \approx 200 \, \text{m/s}$$

Question32

Identify the correct statements from the followingI. For an ideal gas, the compressibility factor is 1.0II. The kinetic energy of $NO(g)$ (molar mass $= 30$ g mol^{-1}) at $T(K)$ is x J mol^{-1}. The kinetic energy of $N_2O_4(g)$ (molar mass $= 92$ g mol^{-1}) at $T(K)$ is $2x$ J mol^{-1}III. The rate of diffusion of a gas is inversely proportional to square root of its density.

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Options:

A. I, II, III

B. II, III, only

C. I, III only

D. I, II only

Answer: C

Solution:

Let's analyze each statement step by step:

Statement I:

For an ideal gas, the equation of state is

$pV = nRT$.

The compressibility factor Z is defined as

$Z = \frac{pV}{nRT}$.

For an ideal gas, this gives:

$Z = 1$.

Therefore, Statement I is correct.

Statement II:

The average translational kinetic energy per mole for any ideal gas is given by

$\langle E_k \rangle = \frac{3}{2} RT,$

regardless of the molecular mass. Although the average speed of the molecules depends on the mass (with lighter molecules moving faster), the kinetic energy per mole at a given temperature is the same for all gases. Hence, if the kinetic energy per mole of NO(g) is x J, then that of $N_2O_4(g)$ must also be x J – not $2x$ J.

Therefore, Statement II is incorrect.

Statement III:

From kinetic theory, the rate of diffusion (or effusion) of a gas is proportional to the average speed, which is given by

$\bar{v} \propto \frac{1}{\sqrt{M}},$

where M is the molar mass. For gases under the same conditions, the density (ρ) is proportional to the molar mass. Thus, the diffusion rate is inversely proportional to the square root of the density:

Rate $\propto \frac{1}{\sqrt{\rho}}$.

Hence, Statement III is correct.

In summary:

Statement I is correct.

Statement II is incorrect.

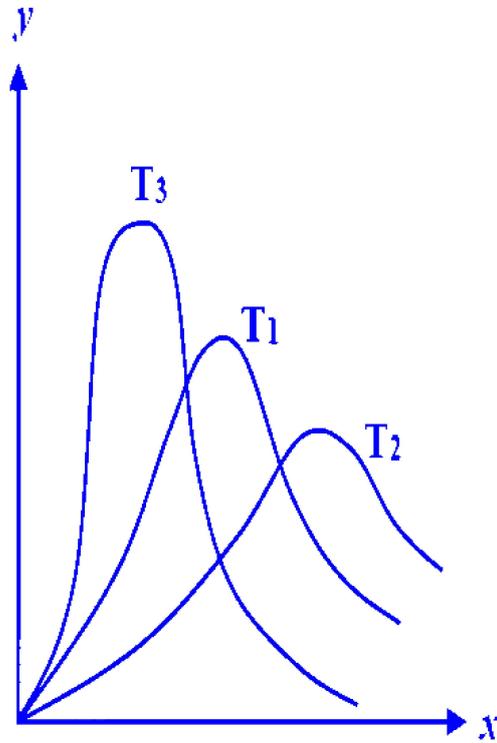Statement III is correct.

The correct option is therefore:

Option C: I, III only.

Question33

The following graph is obtained for a gas at different temperatures (T_1, T_2, T_3). What is the correct order of temperature? (x-axis = velocity, y-axis = number of molecules)

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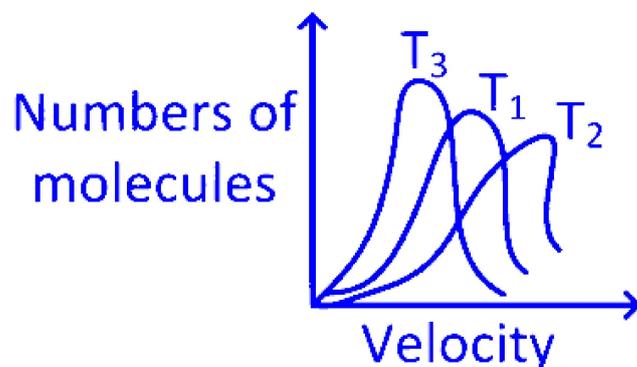**Options:**

A. $T_2 > T_1 > T_3$

B. $T_2 > T_3 > T_1$

C. $T_3 > T_1 > T_2$

D. $T_3 > T_2 > T_1$

Answer: A

Solution:

Velocity of gas is given by

$$v_{\mathrm{MF}} = \sqrt{\frac{2RT}{M}} \quad \text{or} \quad v_{\mathrm{MP}} \propto \sqrt{\frac{T}{M}}$$

As the temperature is increased, the value of most probable speed increases but fraction of particles passing most probable speed decreases.

Hence, $T_2 > T_1 > T_3$

Question34

RMS velocity of one mole of an ideal gas was measen at different temperatures. A graph of $(\mu_{\mathrm{ma}})^{-2}$ (on Y-sdi) and $T(\mathrm{K})$ (on X-axis) gave straight line passing through the origin and its slope is $249 \ \mathrm{m}^2 \ \mathrm{s}^{-2} \ \mathrm{K}^{-1}$. What is the molar mass (in kg mol^{-1}) of ideal gas? $\left(R = 83 \ \mathrm{J} \ \mathrm{mol}^{-1} \ \mathrm{K}^{-1}\right)$
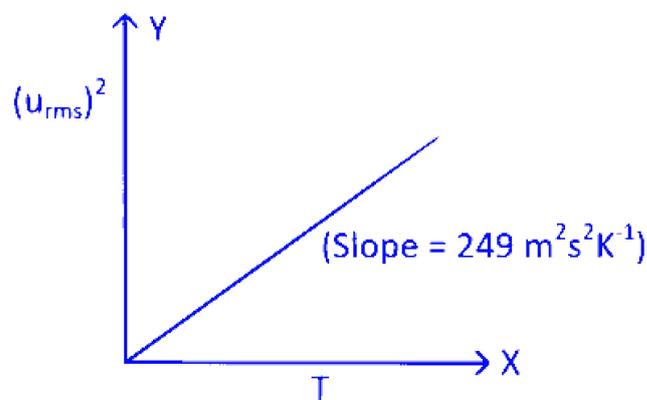
AP EAPCET 2024 - 18th May Morning Shift

Options:

A. 10

B. 1.0

C. 24.9

D. 1×10^{-1}

Answer: D

Solution:

Slope from the above graph is

$$\frac{(u_{rms})^2}{T} = 249 \text{ m}^2 \text{ s}^2 \text{ K}^{-1}$$

From, RMS velocity of gas molecule

$$u_{rms} = \sqrt{\frac{3RT}{M}} \text{ or } \frac{(u_{rmss})^2}{T} = \frac{3R}{M}$$

Comparing Eq. (i) and (ii),

$$249 = \frac{3R}{M} \text{ or } M = \frac{3R}{249} \Rightarrow \frac{3 \times 8.3}{249}$$
$$\Rightarrow M = 0.1 \text{ kg/mol or } 1 \times 10^{-1} \text{ kg mol}^{-1}$$

Question35

Given below are two statements.

Statement I : Viscosity of liquid decreases with increase in temperature.

Statement II : The units of viscosity are $\text{kgm}^{-1} \text{ s}^{-1}$.

The correct answer is

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Options:

A. Both StatementI and Statement II are correct.

B. Both Staternent I and Statement Il are not correct.

C. Statement I is correct but Statement Il is not corect.

D. Statement I is not corroct but Statement. II is conest

Answer: C

Solution:

Statement I is correct but Statement II is incorrect. The correct form of incorrect statement is:
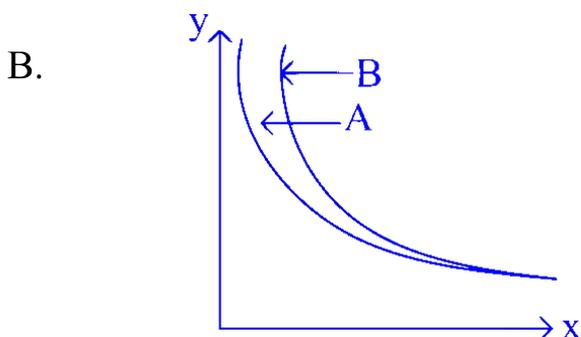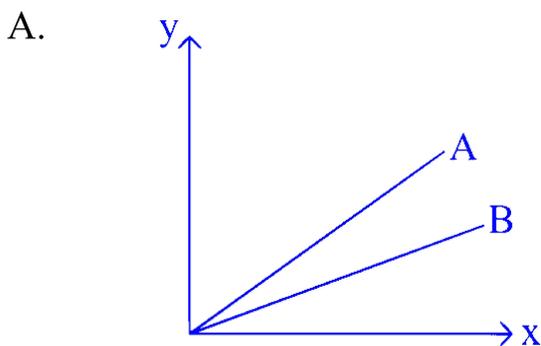
SI unit of visocity is $kg - m^{-1} s^{-1}$.

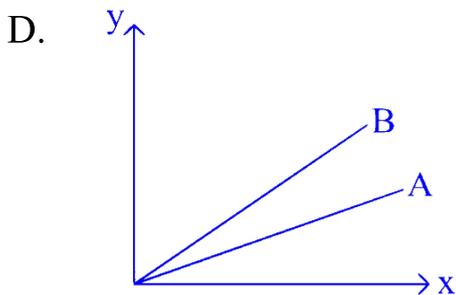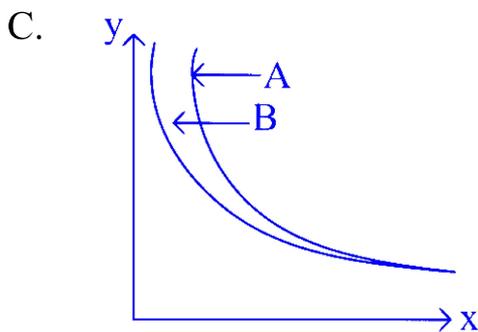
Question36

Identify the correct variation of pressure and volume of a real gas (A) and an ideal gas (B) at constant temperature. $(y = p; x = V)$

AP EAPCET 2022 - 5th July Morning Shift
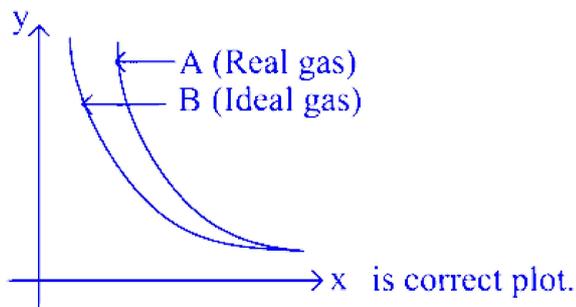
Options:

A.

B.

C.

D.

Answer: C

Solution:

Ideal gas equation $= pV = nRT$

On rearranging $p = \frac{nRT}{V}$ or $V = \frac{nRT}{p}$

i.e. $p \propto \frac{1}{V}$ or $V \propto \frac{1}{p}$

is correct plot.

At low pressures, the real gas shows very small deviation from ideal behaviour and the curve for ideal gas and real gas almost coincides. There is a large deviation from ideal gas behaviour at high pressure, hence the curve are fai apart.

Question37

The gaseous mixture used for welding of metals is

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Options:

A. C_2H_4, O_2

B. C_4H_{10}, O_2
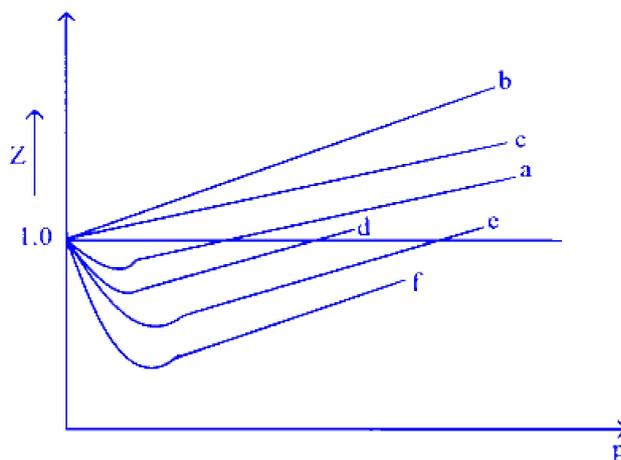
C. $C_2H_2,\ N_2$

D. C_2H_2, O_2

Answer: D

Solution:

Mixture of acetylene and oxygen is used as a fuel for oxy-welding. As this mixture forms flames hot enough, cutting and welding of metals becomes easier.

Question38

Among the gases a, b, c , d, e and f, the gases that show only positive deviation from ideal behaviour at all pressures in the graph are

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Options:

A. b and c only

B. b, c, and a only

C. d and e only

D. d, e and f only

Answer: A

Solution:

A gas shows a positive deviation from ideal behaviour, if there is a force of attraction between the molecules. For such gases, the compressibility factor, Z is more than 1 or

$$Z = \frac{pV}{nRT} > 1$$

Hence, only gases (b) and (c) shows positive deviation from ideal behaviour at all pressures.

Question39

When the temperature of a gas is increased from $30°C$ to $930°C$, the root mean square speed of the gas would

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Options:

A. get doubled

B. remain constant

C. gets halved

D. increase by 5.5 times

Answer: A

Solution:

The temperature is changed from $30°C$ to $930°C$.

We need to convert these temperatures to Kelvin:
$T_1 = 30°C = 303\,\text{K}$
$T_2 = 930°C = 1203\,\text{K}$

The root mean square (rms) speed of a gas is given by:
$v_{\text{rms}} = \sqrt{\frac{3KT}{m}}$

This means that v_{rms} is proportional to $\sqrt{T}$.
So, when temperature changes:
$\frac{(v_{\text{rms}})_1}{(v_{\text{rms}})_2} = \sqrt{\frac{T_1}{T_2}}$

Put the values in:
$\sqrt{\frac{303}{1203}}$

By calculating, we find:
$(v_{\text{rms}})_2 = 2(v_{\text{rms}})_1$

Therefore, the root mean square speed becomes double.

Question40

Three flasks of equal volume contain CH_4, CO_2 and Cl_2 gases respectively. They will contain equal number of molecules, if

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Options:

A. the mass of all the gases is same.

B. the mass of all the gases is same but temperature is different.

C. temperature and pressure of all the flasks are same.

D. temperature, pressure and masses are same in the flasks.

Answer: C

Solution:

Three flasks of equal volumes contain CH_4, CO_2 and Cl_2 gases respectively. They will contain equal number of molecules if temperature and pressure of all flasks are same.

According to Avogadro law, at same condition of temperature and pressure, equal volumes of different gases contain equal number of molecules.

Question41

Which among the following statements is/areincorrect regarding real gases?

(i) Their compressibility factor is never equalto unity ($Z \neq 1$).

(ii) The deviations from ideal behaviour areless at low pressures and high temperatures.

(iii) Intermolecular forces among gasmolecules are equal to zero.

(iv) They obey van der Waals' equation,$pV = nRT$

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Options:

A. (i), (ii) and (iv)

B. (ii) and (iv)

C. Only (ii)

D. (iii) and (iv)

Answer: D

Solution:

(i) Compressibility factor (Z) of real gas cannot beunity, while compressibility factor for an idealgas is one.

(ii) At low pressure and high temperature a gasbehaves more like an ideals gas, so the deviation is very less.

(iii) Intermolecular forces among gas molecules areweak as compare to liquid and solid but, theseforces cannot be zero.

(iv) Ideal gas follows van der Waals' equation

$pV = nRT$

Gases which do not follow this equation are realgases.

Therefore, statements (iii) and (iv) are incorrect.

Question42

Among the following the maximum deviation from ideal gas behaviour is expected from

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Options:

A. $He(g)$

B. $CH_4(g)$

C. $NH_3(g)$

D. $H_2(g)$

Answer: C

Solution:

The deviations from ideal gas $(pV = nRT)$ depend on the temperature pressure and nature of gas. Among all options, NH_3 is the one which show maximum deviation under the same conditions. NH_3 will show maximum deviation from ideal gas due to more dipole-dipole attractions which leads to more attractive forces between molecules of NH_3. In NH_3 there are strong intermolecular force of attraction, so the van der Waals' constant value is high.

Question43

Which of the following graphs correctly represents Boyle's Law?
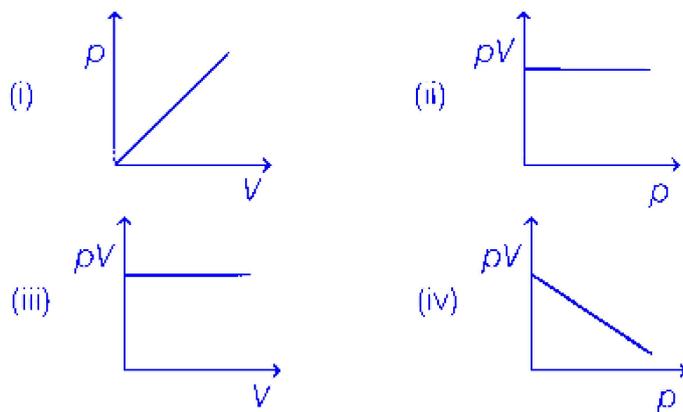
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Options:

A. (i), (ii) and (iii)

B. (ii) and (iii)

C. (iii) and (iv)

D. (iii) and (iv)

Answer: B

Solution:

Boyle's law states that pressure of given mass of an ideal gas is inversely proportional to its volume at a constant temperature.
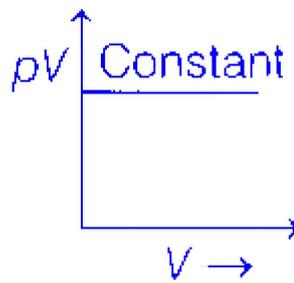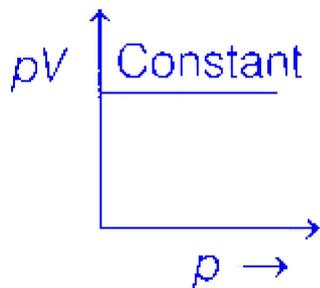
For ideal gas, $pV = nRT$

where, T = constant

$pV = k$ .... (i)

For Eq. (i), i.e. $xy = c^2$ (i.e. hyperbola)

$p = kT$ ..... (ii)

i.e. $y = mx$ (i.e. straight line)

pV = constant ...... (iii)

Question44

The density of an ideal gas can be given by........, where p, V, M, T and R respectivelydenote pressure, volume, molar-mass,temperature and universal gas constant.

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Options:

A. $\frac{pM}{RT}$

B. $\frac{pV}{RT}$

C. $\frac{RT}{pM}$

D. $\frac{RT}{pV}$

Answer: A

Solution:

For an ideal gas, $pV = nRT$ .... (i)

Here, p = pressure, V = volume of gas, n = moles, R = rate constant, T = Temperature

$pV = RT$ (For 1 mole)

$V = RT/p$ .... (ii)

Now, density is given by $D = M/V$

Put value of (ii) in density,

we get, $D = \frac{M}{RT/p} \Rightarrow D = \frac{pM}{RT}$