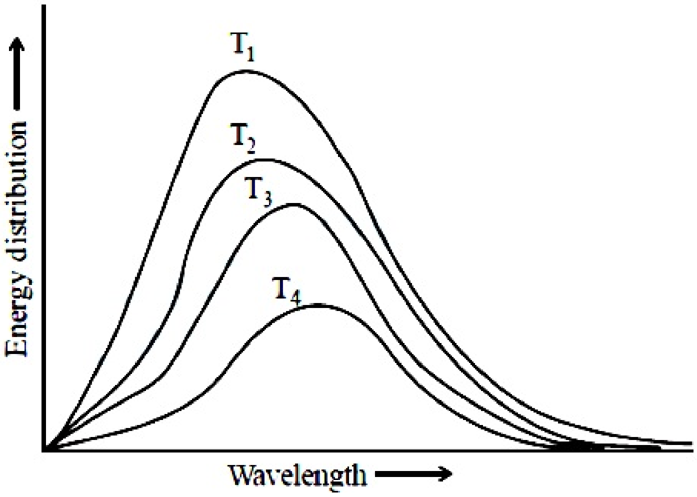
States of Matter

Question1

Following figure shows spectrum of an ideal black body at four different temperatures. The number of correct statement/s from the following is___



A. $T_4 > T_3 > T_2 > T_1$
B. The black body consists of particles performing simple harmonic motion.
C. The peak of the spectrum shifts to shorter wavelength as temperature increases.
D. $\frac{T_1}{v_1} = \frac{T_2}{v_2} = \frac{T_3}{v_3} \neq$ constant
E. The given spectrum could be explained using quantisation of energy.
[24-Jan-2023 Shift 2]

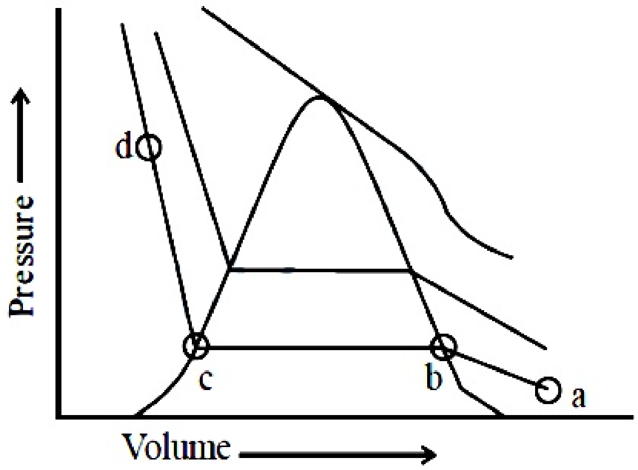
Answer: 2

Solution:

The spectrum of Black body radiation is explained using quantization of energy. With increase in temperature, peak of spectrum shifts to shorter wavelength or higher frequency. For above graph $\rightarrow T_1 > T_2 > T_3 > T_4$.

Question2

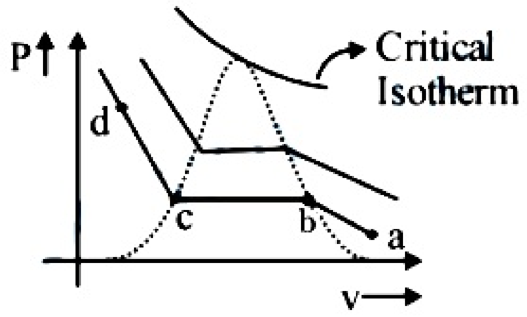
The number of statement's, which are correct with respect to the compression of carbon dioxide from point (a) in the Andrews isotherm from the following is____



A. Carbon dioxide remains as a gas upto point (b)
B. Liquid carbon dioxide appears at point (c)
C. Liquid and gaseous carbon dioxide coexist between points (b) and (c)
D. As the volume decreases from (b) to (c), the amount of liquid decreases
[24-Jan-2023 Shift 2]

Answer: 2

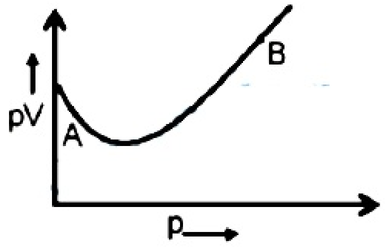
Solution:



At
(a) →CO_2 exist as gas
(b) → liquefaction of CO_2 starts
(c) → liquefaction ends
(d) →CO_2 exist as liquid.
Between (b) & (c) → liquid and gaseous CO_2 co-exist.
As volume changes from (b) to (c) gas decreases and liquid increases.
(A), (C) → correct

Question3

For 1 mol of gas, the plot of pV vs p is shown below. p is the pressure and V is the volume of the gas.
What is the value of compressibility factor at point A ?



[29-Jan-2023 Shift 1]

Options:

A. $1 - \frac{a}{RTV}$

B. $1 + \frac{b}{V}$

C. $1 - \frac{b}{V}$

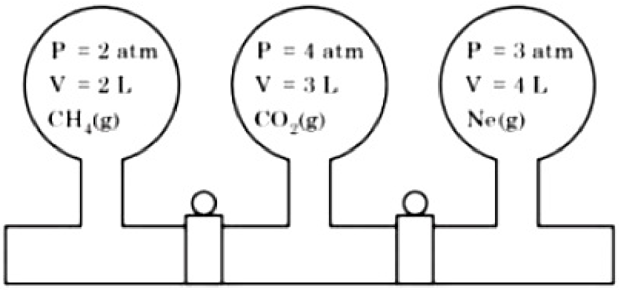
D. $1 + \frac{a}{RTV}$

Answer: A

Solution:

Solution:
For 1 mole of real gas
PV = ZRT
from graph PV for real gas is less than PV for ideal gas at point A
$Z < 1$
$Z = 1 - \frac{a}{V_m RT}$

Question4



Three bulbs are filled with CH_4, CO_2 and Ne as shown the picture. The bulbs are connected through pipes of zero volume. When the stopcocks are opened and the temperature is kept constant throughout, the pressure of the system is found to be _______ atm. (Nearest integer) [8-Apr-2023 shift 1]

Answer: 3

Solution:

$$P_f V_f = P_1 V_1 + P_2 V_2 + P_3 V_3$$
$$P_f \times 9 = 2 \times 2 + 4 \times 3 + 3 \times 4$$
$$P_f = \frac{28}{9} = 3.11 \simeq 3$$

Question5

Arrange the following gases in increasing order of van der waals constant ' a '
A. Ar
B. CH_4
C. H_2O
D. C_6H_6
Choose the correct options from the following
[8-Apr-2023 shift 2]

Options:

A. A, B, C and D

B. B, C, D and A

C. C, D, B and A

D. D, C, B and A

Answer: A

Solution:

Solution:
A α force of attraction vanderwal force depends on molecular size and molecular mass and there is H-bonding in water, so correct option will be A < B < C < D.

Question6

At constant temperature, a gas is at pressure of 940.3 mm Hg. The pressure at which its volume decreases by 40% is ________ mm Hg. (Nearest integer)
[10-Apr-2023 shift 1]

Answer: 1567

Solution:

$P_{\text{initial}} = 940.3\,\text{mm Hg} \quad \text{Vinitial} = 100 \ \text{(Assume)}$
$P_{\text{final}} = ?$
$P_iV_i = P_fV_f$
$940.3 \times 100 = P_f \times 60$
$P_f = 1567.16\,\text{mm of Hg}$
$P_f = 1567$

Question7

A certain quantity of real gas occupies a volume of 0.15dm^3 at $100\,\text{atm}$ and 500K when its compressibility factor is 1.07 . Its volume at $300\,\text{atm}$ and 300K (When its compressibility factor is 1.4) is ____$\times 10^{-4}\text{dm}^3$. (Nearest integer)
[13-Apr-2023 shift 1]

Answer: 392

Solution:

$$Z = \frac{PV}{nRT}$$
$$\frac{Z_1}{Z_2} = \left(\frac{P_1V_1}{nRT_1}\right) \times \left(\frac{nRT_2}{P_2V_2}\right)$$
$$\frac{1.07}{1.4} = \left(\frac{100 \times 0.15}{500}\right)\left(\frac{300}{300 \times V_2}\right)$$
$$V_2 = \frac{0.03 \times 1.4}{1.07} = 0.03925$$
$$= 392 \times 10^{-4}\text{dm}^3$$

Question8

At 300K, a sample of 3.0g of gas A occupies the same volume as 0.2g of hydrogen at 200K at the same pressure. The molar mass of gas A is ______ gmol^{-1}. (nearest integer) Assume that the behaviour of gases as ideal.
(Given : The molar mass of hydrogen (H_2) gas is 2.0gmol^{-1}.)
[24-Jun-2022-Shift-2]

Answer: 45

Solution:

Both gas A and Hydrogen (H_2) gas have same volume at same pressure. Let both 's volume is V and pressure P.
For gas A :
Pressure $= P$
$\text{Temperature}(T) = 300K$
Volume $= V$
Mass $= 3g$
Molar mass $= M\,gm / mol$
using ideal gas equation,
$PV = nRT$
$\Rightarrow PV = \frac{3}{M} \times R \times 300 \ldots .(1)$
For Hydrogen,
Pressure $= P$
Temperature $(T) = 200K$
Volume $= V$
Mass $= 0.2g$
Molar mass $= 2\,gm / mol$
Using ideal gas equation,
$PV = \frac{0.2}{2} \times R \times 200 \ldots\ldots (2)$
From (1) and (2), we get
$\frac{3}{M} \times R \times 300 = \frac{0.2}{2} \times 2 \times 200$
$\Rightarrow M = 45$

Question9

A rigid nitrogen tank stored inside a laboratory has a pressure of $30\,atm$ at $06:00\,am$ when the temperature is $27^{\circ}C$. At 03:00 pm, when the temperature is 45°, the pressure in the tank will be ____atm. [nearest integer]
[25-Jun-2022-Shift-2]

Answer: 32

Solution:

A nitrogen tank of fixed volume used where number of moles of nitrogen is fixed.
$\therefore V =$ constant
$n =$ constant
$R =$ constant
From ideal gas equation,
$PV = nRT$
$\Rightarrow P \propto T [\text{As } V, n, R =$ constant]
Here, initially $P_1 = 30$ atm, $T_1 = 300K$
Finally, $P_2 = ?, T_2 = 318K$
$\therefore \frac{P_1}{P_2} = \frac{T_1}{T_2}$
$\Rightarrow \frac{30}{P_2} = \frac{300}{318}$
$\Rightarrow P_2 = 31.8 \simeq 32$

Question10

An evacuated glass vessel weighs 40.0g when empty, 135.0g when filled with a liquid of density $0.95\,\mathrm{g\,mL}-1$ and 40.5g when filled with an ideal gas at 0.82 atm at 250K. The molar mass of the gas in gmol^{-1} is : (Given : $R = 0.082\,\mathrm{L\,atm\,K^{-1}\,mol^{-1}}$) [26-Jun-2022-Shift-1]

Options:

A. 35

B. 50

C. 75

D. 125

Answer: D

Solution:

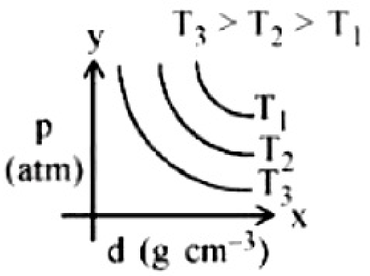
Solution:
Weight of empty glass vessel $= 40\,\mathrm{gm}$
Weight of glass vessel filled with liquid $= 135\,\mathrm{gm}$
$\therefore$ Weight of liquid $= 135 - 40 = 95\,\mathrm{gm}$
Given density of liquid $= 0.95\,\mathrm{gm\,ml^{-1}}$
$\therefore$ Volume of liquid $= \dfrac{95}{0.95} = 100\,\mathrm{ml}$
Weight of glass filled with ideal gas $= 40.5\,\mathrm{gm}$
$\therefore$ Weight of gas $= 40.5 - 40 = 0.5\mathrm{g}$
Let the Molar mass $= \mathrm{M}$
$\therefore$ Moles of gas $= \dfrac{0.5}{\mathrm{M}}$
$\therefore$ Now applying ideal gas equation,
$\mathrm{pV = nRT}$
$\Rightarrow 0.82 \times \dfrac{100}{1000} = \dfrac{0.5}{\mathrm{M}} \times 0.082 \times 250$
$\Rightarrow \mathrm{M} = 0.5 \times 250 = 125\mathrm{g / mol}$

Question11

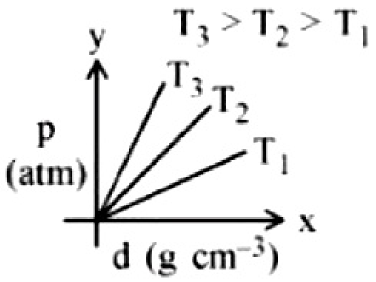
Which amongst the given plots is the correct plot for pressure (p) vs density (d) for an ideal gas? [27-Jun-2022-Shift-2]

Options:

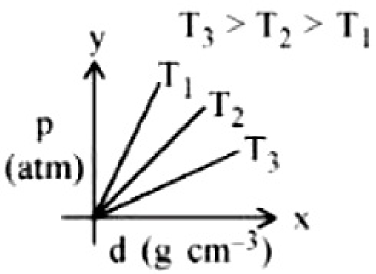
A.



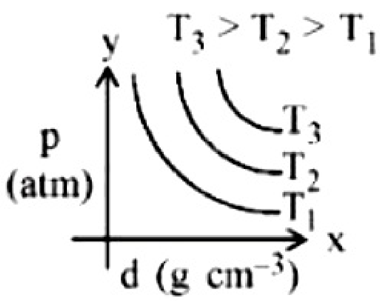
B.



C.



D.



Answer: B

Solution:

Solution:
From ideal gas equation we know,
$PV = nRT$
$\Rightarrow PV = \frac{W}{M}RT$
$\Rightarrow P = \frac{W}{V} \cdot \frac{RT}{M}$
$\Rightarrow P = d \cdot \frac{RT}{M} \left[\because d = \frac{W}{V} \right]$
For a fixed amount of gas at a fixed temperature, M and T is constant.
$\therefore P \propto d$
So graph between pressure (P) and density (d) is a straight line.
Also, $\frac{P}{d} = \frac{RT}{M}$
$\Rightarrow \frac{P}{d} \propto T$ [as R, M = constant]

$\therefore$ When temperature T increases then slope of graph between P and d increases.
As $T_3 > T_2 > T_1$ then slope of T_3 will be highest then T_2 and then T_1.
So, graph (B) is the right graph.

Question12

100g of an ideal gas is kept in a cylinder of 416L volume at 27°C under 1.5 bar pressure. The molar mass of the gas is _____$gmol^{-1}$. (Nearest integer)
(Given : $R = 0.083 L\, bar\, K^{-1}\, mol^{-1}$)
[28-Jun-2022-Shift-2]

Answer: 4

Solution:

Given, Mass of ideal gas $= 100\,gm$
Let the molar mass of ideal gas $= M$
$\therefore$ Number of moles of gas $(n) = \frac{100}{M}$
Volume of cylinder $(V) = 416L$
Temperature $(T) = (27 + 273)K = 300K$
Pressure $(P) = 1.5$ bar
$R = 0.083 L\, bar\, K^{-1}\, mol^{-1}$
Using ideal gas equation,
$PV = nRT$
$\Rightarrow 1.5 \times 416 = \frac{100}{M} \times 0.083 \times 300$
$\Rightarrow M = 4$

Question13

The pressure of a moist gas at 27°C is $4a \cdot m$. The volume of the container is doubled at the same temperature. The new pressure of the moist gas is $\times 10^{-1}$atm. (Nearest integer)
(Given : The vapour pressure of water at 27°C is 0.4atm.)
[25-Jul-2022-Shift-1]

Answer: 22

Solution:

From ideal gas equation,

$P \propto \frac{1}{V}$
$P_1V_1 = P_2V_2$
Pressure of the gas $= 4 - 0.4 = 3.6\,\text{atm}$
$3.6V_1 = P_2(2V_1)$
$P_2 = 1.8\,\text{atm}$
Hence, new pressure of moist gas is $1.8 + 0.4 = 2.2\,\text{atm} = 22 \times 10^{-1}\,\text{atm}$

Question14

A sealed flask with a capacity of $2\,dm^3$ contains 11g of propane gas. The flask is so weak that it will burst if the pressure becomes $2M\,Pa$. The minimum temperature at which the flask will burst is__________$^{\circ}C$. [Nearest integer]
(Given : $R = 8.3J\,K^{-1}mol^{-1}$, Atomic masses of C and H are 12u and 1u, respectively.) (Assume that propane behaves as an ideal gas.)
[25-Jul-2022-Shift-2]

Answer: 1655

Solution:

From ideal gas equation,
$PV = nRT$
$P = 2 \times 10^6\,\text{Pa}$
$V = 2\text{dm}^3 = 2 \times 10^{-3}\text{m}^3$
$R = 8.3\text{JK}^{-1}\text{mol}^{-1}$
$n = \frac{11}{44}\,\text{mol}$
$2 \times 10^6 \times 2 \times 10^{-3} = \frac{11}{44} \times 8.3 \times T$
$T = 1927.7\text{K}$
$T(\text{ in }^{\circ}C) = 1927.7 - 273 \simeq 1655^{\circ}C$

Question15

A sample of 4.5mg of an unknown monohydric alcohol, R-OH was added to methylmagnesium iodide. A gas is evolved and is collected and its volume measured to be 3.1mL. The molecular weight of the unknown alcohol is _____g / mol . [Nearest integer]
[25-Jul-2022-Shift-2]

Answer: 33

Solution:

$R - OH + CH_3 MgI \Rightarrow R - OMgI + CH_4$
moles of alcohol $(ROH) \equiv$ moles of CH_4
At STP, [Assuming STP]
1 mole corresponds to $22.7L$
Hence, $3.1\,mL \equiv \frac{3.1}{22700}\,mol$
So, moles of alcohol $= \frac{3.1}{22700}$
$\Rightarrow \frac{3.1}{22700} = \frac{4.5 \times 10^{-3}}{M}$
$M \simeq 33g / mol$

Question16

A mixture of hydrogen and oxygen contains 40% hydrogen by mass when the pressure is 2.2 bar. The partial pressure of hydrogen is bar. (Nearest Integer)
[26-Jul-2022-Shift-1]

Answer: 2

Solution:

40%w / w hydrogen gas is given in mixture of H_2 and oxygen.
Wt. of $H_2 = 40g$
Wt. of $O_2 = 60g$

$$\chi_{H_2} = \frac{n_{H_2}}{n_{H_2} + n_{O_2}}$$
$$= \frac{\frac{40}{2}}{\frac{40}{2} + \frac{60}{32}}$$
$$= \frac{20}{20 + 1.875}$$
$$= \frac{20}{21.875} = 0.914$$
$$P_{H_2} = \chi_{H_2} \times P_T$$
$$= 0.914 \times 2.2$$
$$= 2.01 \simeq 2\,bar$$

Question17

A 10g mixture of hydrogen and helium is contained in a vessel of capacity $0.0125m^3$ at 6 bar and 27°C. The mass of helium in the mixture is _______ g. (nearest integer)
Given: $R = 8.3JK^{-1}mol^{-1}$
(Atomic masses of H and He are 1u and 4u, respectively)
[26-Jul-2022-Shift-2]

Answer: 8

Solution:

Number of moles of mixture of H_2 and He

$$= \frac{PV}{RT}$$

$$= \frac{6 \times 10^5 \times 0.0125}{8.3 \times 300} = 3$$

Let the mass of He in 10g mixture be xg

$$\therefore \frac{x}{4} + \frac{10 - x}{2} = 3$$

On solving $x = 8$g

$\therefore$ Mass of He in the mixture $= 8$g

Question18

Given below are two statements. One is labelled as Assertion A and the other is labelled as Reason R.
Assertion A : Activated charcoal adsorbs SO_2 more efficiently than CH_4.
Reason R: Gases with lower critical temperatures are readily adsorbed by activated charcoal.
In the light of the above statements, choose the correct answer from the options given below.
[27-Jul-2022-Shift-1]

Options:

A. Both A and R are correct and R is the correct explanation of A.

B. Both A and R are correct but R is NOT the correct explanation of A.

C. A is correct but R is not correct.

D. A is not correct but R is correct.

Answer: C

Solution:

Solution:
More polar gases easily adsorbs on activated charcoal.
And more polar gases has more (higher) critical temperature as compared to non-polar or less polar gases.
$\therefore$ Gases with higher critical temperature adsorbed more.

Question19

For a real gas at 25°C temperature and high pressure (99 bar) the

value of compressibility factor is 2 , so the value of Vander Waal's constant 'b' should be ________ $\times 10^{-2} Lmol^{-1}$ (Nearest integer) (Given $R = 0.083 L\ bar\ K^{-1} mol^{-1}$)
[27-Jul-2022-Shift-2]

Answer: 25

Solution:

Solution:
For real gas under high pressure
$Z = 1 + \frac{Pb}{RT} \Rightarrow b = \frac{RT}{P}$
$= \frac{0.083 \times 298}{99}$
$= 0.25 \times 10^{-2} Lmol^{-1}$

Question20

A certain gas obeys $p(V_m - b) = RT$. The value of $\left(\frac{\partial Z}{\partial p}\right)_T$ is $\frac{xb}{RT}$. The value of x is .... (Z = compressibility factor)
[26 Feb 2021 Shift 1]

Answer: 1

Solution:

For 1 mole of a real gas, the van der Waals' equation is,
$\left(p + \frac{a}{V_m^2}\right)(V_m - b) = RT$
At very high pressure, the equation becomes,
$p(V_m - b) = RT$
$\Rightarrow pV_m = RT + pb \Rightarrow \frac{pV_m}{RT} = 1 + \frac{pb}{RT}$
$\Rightarrow Z = 1 + \frac{pb}{RT} \left[\because Z = \frac{pV_m}{RT} = \text{compressibility}\right]$
$\therefore \left(\frac{\delta Z}{\delta p}\right)_T = 0 + \frac{b}{RT} = \frac{b}{RT} = \frac{xb}{RT}$
$\Rightarrow x = 1$

Question21

A car tyre is filled with nitrogen gas at 35 psi at 27°C. It will burst if

pressure exceeds 40 psi. The temperature in $^{\circ}C$ at which the car tyre will burst is .... (Rounded-off to the nearest integer).
[25 Feb 2021 Shift 1]

Answer: 70

Solution:

$p_1 = 35psi, T_1 = 27^{\circ}C = 300K$
$p_2 = 40psi, T_2 = ?$
According to Charle's law,
$p \propto T$
$\frac{p_2}{p_1} = \frac{T_2}{T_1} \Rightarrow \frac{40}{35} = \frac{T_2}{300}$
$T_2 = \frac{300 \times 40}{35} = 342.85K = 69.7^{\circ}C$
$T_2 \sim eq 70^{\circ}C$
Hence, answer is 70 .

Question22

The volume occupied by 4.75g of acetylene gas at $50^{\circ}C$ and 740mmHg pressure is ...... L (Rounded off to the nearest integer).
[Given, R = 0.0826L atm $K^{-1} mol^{-1}$]
[24 Feb 2021 Shift 2]

Answer: 5

Solution:

Solution:
Given, mass of $C_2H_2(g) = 4.75g$
Molecular weight $= 26g / mol$
Temperature $= 50 + 273 = 323K$
Pressure $= 740$ torr /mm of Hg
$\text{Pressure} = \frac{740}{760} atm$
$R = 0.0821 L atm mol^{-1} K^{-1}$
Hence, no. of mole $n = \frac{4.75}{26} mol$
Formula used, $pV = nRT$ (ideal gas)
$\Rightarrow V = \frac{nRT}{p} = \frac{4.75}{26} \times \frac{0.0821 \times 323}{(740 / 760)}$
$= \frac{96314.078}{19240} = 5.0059L = 5L$

Question23

The pressure exerted by a non-reactive gaseous mixture of 6.4g of methane and 8.8g of carbon dioxide in a 10L vessel at 27°C is ...... kPa (Round off to the nearest integer)
(Assume gases are ideal, $R = 8.314 \text{J mol}^{-1} \text{K}^{-1}$ Atomic mass, C: 12.0u, H : 1.0u, O : 16.0u)
[17 Mar 2021 Shift 1]

Answer: 150

Solution:

Solution:
Given, mass of methane $= 6.4\text{g}$
mass of $CO_2 = 8.8\text{g}$
volume of container $= 10\text{L}$
temperature $= 27^{\circ}\text{C}$
To find, p_{total} = Total pressure
Moles of $CH_4 = \dfrac{\text{Given mass}}{\text{Molar mass}}$
$= \dfrac{6.4}{16} = 0.4\text{mol}$
Moles of $CO_2 = \dfrac{8.8}{44} = 0.2\text{mol}$
$n_{\text{total}} = 0.4 + 0.2 = 0.6\text{mol}$
$p_{\text{total}} = \dfrac{n_{\text{total}} RT}{V} = \dfrac{0.6 \times 8.314 \times 300}{10}$
$= 149.652$
$= 150\text{kPa}$

Question24

An LPG cylinder contains gas at a pressure of 300 kPa at 27°C. The cylinder can withstand the pressure of 1.2×10^6Pa. The room in which the cylinder is kept catches fire. The minimum temperature at which the bursting of cylinder will take place is __________ °C. (Nearest integer)
[25 Jul 2021 Shift 2]

Answer: 927

Solution:

$$\frac{P_1}{T_1} = \frac{P_2}{T_2} \Rightarrow \frac{300 \times 10^3}{300} = \frac{1.2 \times 10^6}{T_2}$$
$\Rightarrow T_2 = 1200\text{K}$

$T_2 = 927°\text{C}$

Question25

A home owner uses $4.00 \times 10^3 m^3$ of methane (CH_4) gas, (assume CH_4 is an ideal gas) in a year to heat his home. Under the pressure of 1.0 atm and 300K, mass of gas used is $x \times 10^5$g. The value of x is _______ .
(Nearest integer)
(Given R = 0.083LatmK^{-1}mol^{-1})
[25 Jul 2021 Shift 1]

Answer: 26

Solution:

$n(CH_4) = \frac{PV}{RT}$

$= \frac{1 \times 4 \times 10^3 \times 1000}{0.083 \times 300}$

Weight of CH_4

$= \frac{40 \times 16 \times 10^5}{0.083 \times 300}\text{gm}$

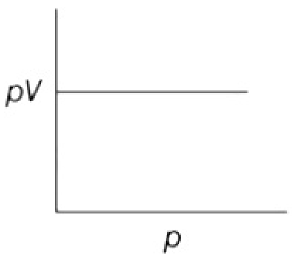
$= 25.7 \times 10^5\text{gm}$

Question26

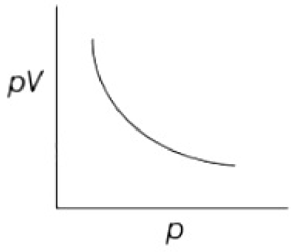
Which one of the following is the correct pV vs p plot at constant temperature for an ideal gas ?
(p and V stand for pressure and volume of the gas respectively)
[31 Aug 2021 Shift 1]

Options:

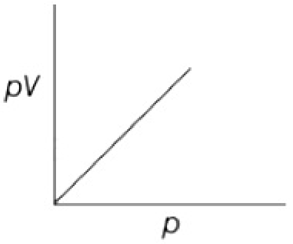
A.



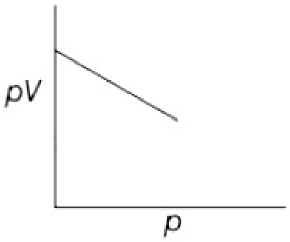
B.



C.



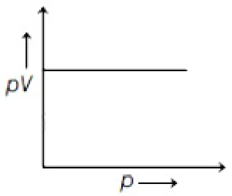
D.



Answer: A

Solution:

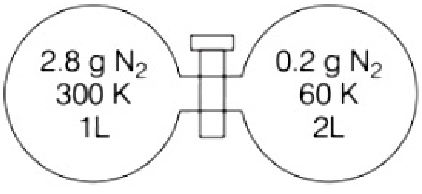
Solution:
From ideal gas equation, pV = nRT
Given that, pV = constant, since temperature is constant.
Hence, graph for pV vs p will be



Hence, correct option is (a).

Question27

Two flasks I and II shown below are connected by a valve of negligible volume.



When the valve is opened, the final pressure of the system in bar is $x \times 10^{-2}$. The value of x is ....(Integer answer)
[Assume, Ideal gas, 1 bar = 10^5 Pa, molar mass of

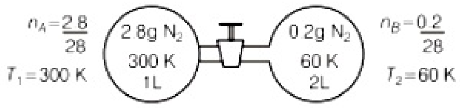
$N_2 = 28.0 g mol^{-1}$; $R = 8.31 J mol^{-1} K^{-1}$]

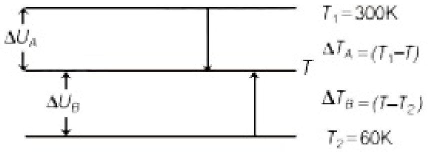
[27 Aug 2021 Shift 2]

Answer: 84

Solution:

Solution:





On mixing the temperature of gas becomes T. Internal energy lost by gas A is the internal energy gained by gas B.

$\Delta U_A = \Delta U_B$

$\frac{f}{2} n_A R \Delta T_A = \frac{f}{2} n_B R \Delta T_B$ (As both gases are diatomic, f is same on both sides)

$n_A \Delta T_A = n_B \Delta T_B$

$\frac{2.8}{28} \times (T_1 - T) = \frac{0.2}{28}(T - T_2)$

$\frac{1}{10}(300 - T) = \frac{1}{140}(T - 60)$

$T = 284K$

On mixing the temperature becomes $284K$ and volume becomes $3L$ and total number of moles becomes $(n_A + n_B) = 0.10$ moles.

$pV = (n_A + n_B) RT$

$= \frac{0.10 \times 8.3 \times 284}{3}$

$= 84.18 \text{ atm}$ or 84.18 bar

This is final pressure of gas.

Question28

The unit of the van der Waals' gas equation parameter 'a' in $\left(p + \frac{an^2}{V^2}\right)(V - nb) = nRT$ is

[27 Aug 2021 Shift 1]

Options:

A. $kg\, ms^{-2}$

B. $dm^3 mol^{-1}$

C. $kg\, ms^{-1}$

D. $atm\, dm^6 mol^{-2}$

Answer: D

Solution:

Solution:
van der Waals' gas equation,
$$\left(p+\frac{an^2}{V^2}\right)(V-nb)=n\,RT$$
For dimensionally correct equation, $\frac{an^2}{V}$ should have the same dimension of pressure i.e. atm.
Unit of parameter 'a' is as follows
$= \text{atm}\,\frac{L^2}{\text{mol}^2} = \text{atm}\,L^2\,\text{mol}^{-2}$
$= \text{atm}\,\text{dm}^6\,\text{mol}^{-2}$.

Question29

An empty LPG cylinder weight 14.8 kg. When full, it weight 29.0 kg and shows a pressure of 3.47 atm. In the course of use at ambient temperature, the mass of the cylinder is reduced to 23.0 kg . The final pressure inside of the cylinder is ....atm. (Nearest integer) (Assume LPG of be an ideal gas)
[1 Sep 2021 Shift 2]

Answer: 2

Solution:

Solution:
Weight of empty LPG cylinder = 14.8 kg
Weight of full LPG cylinder = 29 kg
∴ Weight of gas = 29 − 14.8 = 14.2 kg
If weight of full LPG cylinder = 23 kg
then weight of gas used = 29 − 23 = 6 kg at ambient temperature.
From ideal gas equaiton, pV = nRT
or $pV = \frac{\text{Weight of solute}}{\text{Molecular mass of solute}} \times RT$
or$pV = \frac{W}{M} \times RT$
Applying ideal gas to LPG cylinder when gas is full,
$pV = nRT$
$3.47\,\text{atm} \times V = \frac{14.2\,\text{kg}}{M} \times RT$ ...(i)
Applying ideal gas to LPG cylinder when gas is reduced to 23 kg at ambient temperature,
$pV = nRT$
$p \times V = \frac{8.2\,\text{kg}}{M} \times RT$ ...(ii)
Divide Eq. (i) by (ii)
$$\frac{3.47 \times V}{p \times V} = \frac{\frac{14.2\,\text{kg}\,RT}{M}}{\frac{8.2\,\text{kg} \times RT}{M}}$$
$$\frac{3.47}{p} = \frac{14.2}{8.2}$$
$$\Rightarrow p = \frac{3.47 \times 41}{71} = 2.003\,\text{atm}$$
Hence, answer is 2.

Question30

The predominant intermolecular forces present in ethyl acetate, a liquid, are:
[Jan. 08, 2020 (I)]

Options:

A. London dispersion and dipole-dipole

B. hydrogen bonding and London dispersion

C. Dipole-dipole and hydrogen bonding

D. London dispersion, dipole-dipole and hydrogen bonding

Answer: A

Solution:

Solution:
Ethyl acetate is polar molecule so dipole-dipole interaction and London dispersion will be present in its liquid statc.

Question31

The relative strength of interionic/ intermolecular forces in decreasing order is:
[Jan. 07, 2020 (I)]

Options:

A. dipole-dipole > ion-dipole > ion-ion

B. ion-dipole > ion-ion > dipole-dipole

C. ion-dipole > dipole-dipole > ion-ion

D. ion-ion > ion-dipole > dipole-dipole

Answer: D

Solution:

Solution:
Among given intermolecular forces, ionic interactions are stronger as compared to van der Waal interaction Thus, correct order is ion-ion > ion-dipole > dipole-dipole

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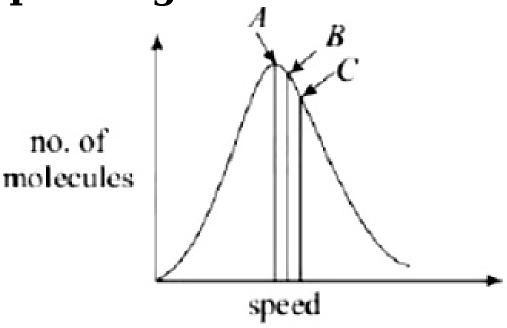
Question32

Identify the correct labels of A, B and C in the following graph from the

options given below:



Root mean square speed (V_{mss}); most probable speed (V_{mp}); average speed (V_{av})
[Jan. 07, 2020 (II)]

Options:

A. $A - V_{m}$; $B - V_{rm}$; $C - V_{av}$

B. $A - V_{av}$; $B - V_{ms}$; $C - V_{t}$

C. $A - V_{ms}$; $B - V_{mp}$; $C - V_{av}$

D. $A - V_{mp}$; $B - V_{av}$; $C - V_{mss}$

Answer: D

Solution:

Solution:
$V_{ms} > V_{average} > V_{mps}$
$\sqrt{\frac{3RT}{M}} > \sqrt{\frac{8RT}{\pi M}} > \sqrt{\frac{2RT}{M}}$

Question33

A spherical balloon of radius 3cm containing helium gas has a pressure of 48×10^{-3} bar. At the same temperature, the pressure, of a spherical balloon of radius 12cm containing the same amount of gas will be _____ $\times 10^{-6}$ bar.
[NV, Sep. 06,2020(I)]

Answer: 750

Solution:

At constant temperature and number of moles
$P_1 V_1 = P_2 V_2$

$P_1 = 48 \times 10^{-3}$ bar; $V_1 = \frac{4}{3}\pi(3)^3$

$V_2 = \frac{4}{3}\pi(12)^3$

$$P_2 = \frac{P_1 V_1}{V_2} = \frac{48 \times 10^{-3} \times (3)^3}{(12)^3}$$

$$= \frac{48 \times 10^{-3}}{64} = 7.5 \times 10^{-4} = 750 \times 10^{-6}\text{bar}$$

Question34

A mixture of one mole each of H_2, He and O_2 each are enclosed in a cylinder of volume V at temperature T. If the partial pressure of H_2 is 2atm, the total pressure of the gases in the cylinder is:
[Sep. 03, 2020(II)]

Options:

A. 6atm

B. 38atm

C. 14atm

D. 22atm

Answer: A

Solution:

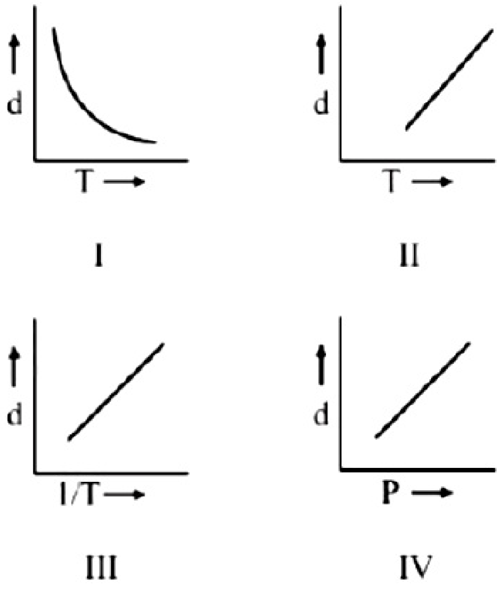
$$P_{gas} = \frac{n_{gas} RT}{V}$$

As n, T and V constant so $P_{H_2} = P_{O_2} = P_{He} = 2\text{atm}$

So, $P_{Total} = P_{H_2} + P_{O_2} + P_{He} = 6\text{atm}$

Question35

Which one of the following graphs is not correct for ideal gas?



d = Density, P = Pressure, T = Temperature
[Sep. 02,2020(I)]

Options:

A. I

B. II

C. IV

D. III

Answer: B

Solution:

For ideal gas $PV = nRT$

$PV = \frac{m}{M}RT \left(\because n = \frac{m}{M}\right)$

$PM = \frac{m}{V}RT; \quad PM = d\,RT; \quad d = \left[\frac{PM}{R}\right]\frac{1}{T}$

$\Rightarrow d \propto \frac{1}{T}; \quad d \propto P$

So, graph between $d\ V s T$ is not straight line.

Question36

Match the type of interaction in column A with the distance dependence of their interaction energy in column B:

(I) ion-ion
(A) $\frac{1}{r}$
(II) dipole-dipole
(B) $\frac{1}{r^2}$
(III) London dispersion
(C) $\frac{1}{r^3}$
(D) $\frac{1}{r^6}$
[Sep. 02, 2020(II)]

Options:

A. $(I) - (B), (II) - (D), (III) - (C)$

B. $(I) - (A), (II) - (B), (III) - (D)$

C. $(I) - (A), (II) - (B), (III) - (C)$

D. $(I) - (A), (II) - (C), (III) - (D)$

Answer: D

Solution:

(I) Ion-ion interaction encrgy $\propto \left(\frac{1}{r}\right)$.

(II) Dipole-dipole interaction energy $\propto \left(\frac{1}{r^3}\right)$.

(III) London dispersion $\propto \left(\frac{1}{r^6}\right)$.

Question37

0.5 moles of gas A and x moles of gas B exert a pressure of 200Pa in a container of volume $10 m^3$ at 1000K. Given R is the gas constant in $J K^{-1} mol^{-1}$, x is:
[Jan. 9, 2019(I)]

Options:

A. $\frac{2R}{4+R}$

B. $\frac{2R}{4-R}$

C. $\frac{4+R}{2R}$

D. $\frac{4-R}{2R}$

Answer: D

Solution:

Ideal gas equation: $PV = nRT$
After putting the values, we get
$200 \times 10 = (0.5 + x) \times R \times 1000$
$(\text{ total no. of moles } = 0.5 + x)$

$\frac{2000}{1000} = 0.5R + xR$; $2 - 0.5R = xR$; $\frac{20.5R}{R}$

$\therefore\ x = \frac{4 - R}{R}$

Question38

An open vessel at 27˚C is heated until two fifth of the air (assumed as an ideal gas) in it has escaped from the vessel. Assuming that the volume of the vessel remains constant, the temperature at which the vessel has been heated is:
[Jan. 12, 2019 (II)]

Options:

A. 500˚C

B. 500K

C. 750˚C

D. 750K

Answer: B

Solution:

At 27˚C or 300K number of moles of an ideal gas $= n_1$
At T_2K number of moles of the ideal gas $= n_2$

Number of moles escaped $= \frac{2n_1}{5}$

$n_2 = n_1 - \frac{2n_1}{5} = \frac{3n_1}{5}$

$PV = nRT$ (Ideal gas equation)
At constant volume and pressure.

$n \propto \frac{1}{T}; n_1T_1 = n_2T_2$

$T_2 = \frac{n_1}{n_2}T_1; T_2 = \frac{n_1}{\frac{3n_1}{5}} \times T_1$

$= \frac{5}{3} \times 300 = 500K$

Question39

The volume of gas A is twice than that of gas B. The compressibility factor of gas A thrice than that of gas B at same temperature. The pressures of the gases for equal number of moles are:
[Jan. 12, 2019 (I)]

Options:

A. $3P_A = 2P_B$

B. $2P_A = 3P_B$

C. $P_A = 3P_B$

D. $P_A = 2P_B$

Answer: B

Solution:

Compressibility factor is given by,

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

$$\frac{Z_A}{Z_B} = \frac{P_A V_A}{P_B V_B}$$

Given $Z_A = 3Z_B$; $V_A = 2V_B$

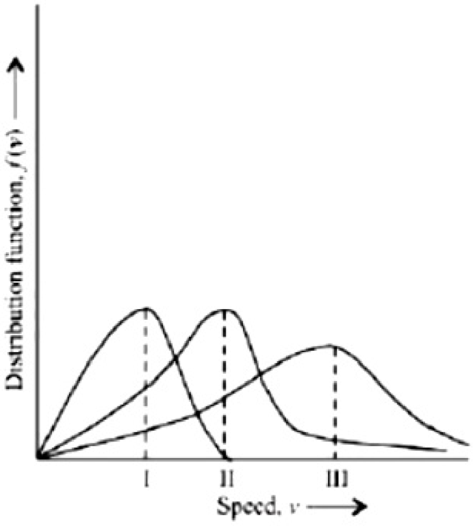
$$\frac{3Z_B}{Z_B} = \frac{P_A \times 2V_B}{P_B \times V_B}$$

$$3 = \frac{P_A}{P_B} \times 2$$

$$2P_A = 3P_B$$

Question40

Points I II and III in the following plot respectively correspond to (V_{mp}: most probable velocity)



[April 10, 2019(II)]

Options:

A. V_m of $N_2(300K)$; V_m of $O_2(400K)$; V_{mp} of $H_2(300K)$

B. V_m of $O_2(400K)$; V_{mp} of T of $H_2(300K)$

C. V_{m0} of $N_2(300K)$; V_m of $H_2(300K)$; V_{mg} of $O_2(400K)$

D. V_{mo} of $H_2(300K)$; V_{mo} of $N_2(300K)$; V_{mr} of $O_2(400K)$

Answer: A

Solution:

Solution:

$V_{mp} = \sqrt{\frac{2RT}{M}} \quad \therefore \left(\frac{T}{M}\right)^{\frac{1}{2}} \propto V_{mp}$

From curve,

$(V_{mp})_{I} < (V_{mp})_{II} < (V_{mp})_{III}$

$(V_{mp})_{N_2} \propto \sqrt{\frac{300}{28}}; (V_{mp})_{O_2} \propto \sqrt{\frac{400}{32}}; (V_{mp})_{H_2} \propto \sqrt{\frac{300}{2}}$

$\therefore (V_{mp})_{N_2} < (V_{mp})_{O_2} < (V_{mp})_{H_2}$ (under given condition)

Question41

Consider the following table :

Gas	$a/(kPa\,dm^6 mol^{-1})$	$b/(dm^3 mol^{-1})$m
A	642.32	0.05196
B	155.21	0.04136
C	431.91	0.05196
D	155.21	0.4382

a and b are van der waals constants. The correct statement about the gases is :
[April 10,2019 (I)]

Options:

A. Gas C will occupy more volume than gas A; gas B will be more compressible than gas D

B. Gas C will occupy lesser volume than gas A; gas B will be lesser compressible than gas D

C. Gas C will occupy morc volume than gas A; gas B will be lesser compressible than gas D

D. Gas C will occupy lesser volume than gas A; gas B will be more compressible than gas D

Answer: A

Solution:

Solution:
If values of ' b ' for two gases are same but values of 'a' are different, then the gas having a larger value of 'a" will occupy lesser volume. Since, it, will have larger force of attraction and, therefore, lesser distance between its moleucles. If values of ' a ' for two gases are same but values of ' b ', are different then the smaller value of ' b ' will occupy lesser volume and, therefore, will be more compressible.

Question42

Consider the van der Waals constants, a and b, for the following gases,

Gas	Ar	Ne	Kr	Xe
$a/(atm\,dm^6 mol^{-2})$	1.3	0.2	5.1	4.1
$b/(10^{-2} dm^3 mol^{-1})$	3.2	1.7	1.0	5.0

Which gas is expected to have the highest critical temperature?
[April 9, 2019 (I)]

Options:

A. Kr

B. Ne

C. Xe

D. Ar

Answer: A

Solution:

Solution:

Critical temperature $= \frac{8a}{27Rb}$

$Ar \Rightarrow \frac{a}{b} = 0.4$; $Ne \Rightarrow \frac{a}{b} = 0.12$

$Kr \Rightarrow \frac{a}{b} = 5.1$; $Xe \Rightarrow \frac{a}{b} = 0.82$

Value of $\frac{a}{b}$ is highest for Kr.

Therefore, Kr has highest value of critical temperature.

Question43

At a given temperature T, gases Ne, Ar, Xe and Kr are found to deviate from ideal gas behaviour. Their equation of state is given as
$P = \frac{RT}{V-b}$ at T .
Here, b is the van der Waals constant. Which gas will exhibit steepest increase in the plot of Z (compression factor) vs P ?
[April 9, 2019 (II)]

Options:

A. Xe

B. Kr

C. Ne

D. Ar

Answer: A

Solution:

$P = \frac{RT}{V - b}$
$PV - Pb = RT$
$\Rightarrow \frac{PV}{RT} - \frac{Pb}{RT} = \frac{RT}{RT}$
$\Rightarrow \frac{PV}{RT} = 1 + \frac{Pb}{RT} Z = 1 + \frac{Pb}{RT}$
[Where Z (compressibility factor) $= PV / RT$]
Slope of Z vs P curve (straight line) $= \frac{b}{RT}$
∴ Higher the value of b, more steep will be the curve. Constant 'b' value depends on size of atoms or molecules.

Question44

Assuming ideal gas behaviour, the ratio of density of ammonia to that of hydrogen chloride at same temperature and pressure is: (Atomic wt. of $Cl = 35.5u$) [Online April 16, 2018]

Options:

A. 1.46

B. 1.64

C. 0.46

D. 0.64

Answer: C

Solution:

Solution:
From ideal gas equation
$PV = nRT$
where $n = m / M$
So, $PV = mRT / M$
$P = mRT / MV$
$P = dRT / M$
∵ At constant temperature and pressure, $d \propto M$
∴ $d_1 / d_2 = M_1 / M_2$
(Here d_1 and M_1 aredensity and molecular mass of ammonia whereas d_2 and M_2 are density and molecular mass of hydrogen chloride)
$d_1 / d_2 = 17 / 36.5 : d_1 / d_2 = 0.46$

Question45

Among the following, the incorrect statement is: [Online April 8,2017]

Options:

A. At low pressure, real gases show ideal behaviour.

B. At very low temperature, real gases show ideal behaviour.

C. At very large volume, real gases show ideal behaviour.

D. At Boyle's temperature, real gases show ideal behaviour.

Answer: B

Solution:

Solution:
The real gases show deviation from ideality at low temperature high pressure and low volume. Thus, at very low temperature real gases do not show ideal behaviour.

Question46

At 300K , the density of a certain gaseous molecule at 2 bar is double to that of dinitrogen (N_2) at 4 bar. The molar mass of gaseous molecule is : [Online April 9, 2017]

Options:

A. $28 \mathrm{gmol}^{-1}$

B. $56 \mathrm{gmol}^{-1}$

C. $112 \mathrm{gmol}^{-1}$

D. $224 \mathrm{gmol}^{-1}$

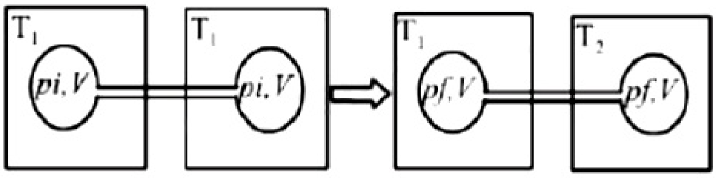
Answer: C

Solution:

Solution:
Density$(\rho) = \frac{PM}{RT}(1\mathrm{bar} = 0.987\mathrm{atm})$
$\rho_{N_2} = \frac{4 \times 0.987\mathrm{atm} \times 28\mathrm{g} / \mathrm{mol}}{R \times 300K}$
Let the molar mass of gas be x
$\rho_{gas} = \frac{2 \times 0.987\mathrm{atm} \times x}{R \times 300K}$
Given $\rho_{gas} = \rho_{N_2} \times 2$
$\frac{2 \times 0.987\mathrm{atm} \times x}{R \times 300K} = \frac{4 \times 0.987\mathrm{atm} \times 28\mathrm{g} / \mathrm{mol}}{R \times 300} \times 2$
$\therefore x = 112\mathrm{g} / \mathrm{mol}$.

Question47

Two closed bulbs of equal volume (V) containing an ideal gas initially at pressure p_i and temperature T_1 are connected through a narrow tube of negligible volume. The temperature of one of the bulbs is then raised to T_2. The final pressure p_f is :



[2016]

Options:

A. $2p_i\left(\frac{T_2}{T_1+T_2}\right)$

B. $2p_i\left(\frac{T_1T_2}{T_1+T_2}\right)$

C. $p_i\left(\frac{T_1T_2}{T_1+T_2}\right)$

D. $2p_i\left(\frac{T_1}{T_1+T_2}\right)$

Answer: A

Solution:

Solution:
For a given mass of an ideal gas, the volume and amount (moles) of the gas are directly proportional, if the temperature and pressure are constant. i.e $V \mu n$ Hence in the given case.
Initial moles and final moles are equal $(n_T)_i = (n_T)_f$

$$\frac{P_iV}{RT_i}+\frac{P_iV}{RT_i}=\frac{P_fV}{RT_1}+\frac{P_fV}{RT_2}$$

$$2\frac{P_i}{T_i}=\frac{P_f}{T_1}+\frac{P_f}{T_2}\ ;\ \ P_f=2P_i\left(\frac{T_2}{T_1+T_2}\right)$$

Question48

Initially, the root mean square (rms) velocity of N_2 molecules at certain temperature is u. If this temperature is doubled and all the nitrogen molecules dissociate into nitrogen atoms, then the rms velocity will be: [Online April 10, 2016]

Options:

A. 2u

B. 14u

C. 4u

D. u / 2

Answer: A

Solution:

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

rms for N_2 = $\sqrt{\frac{3RT}{28}}$

After dissociation, $u' = \sqrt{\frac{3R \times 2T}{14}}$

$\frac{u}{u'} = \sqrt{\frac{1}{4}}$

$\frac{u}{u'} = \frac{1}{2}$

$u' = 2u$

Question49

At very high pressures, the compressibility factor of one mole of a gas is given by:
[Online April 9, 2016]

Options:

A. $1 + \frac{Pb}{RT}$

B. $\frac{Pb}{RT}z$

C. $1 - \frac{Pb}{RT}$

D. $1 - \frac{b}{(V RT)}$

Answer: A

Solution:

According to van der Waals equation for one mole of gas

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

At very high pressure $P >> \frac{a}{V^2}$

So, $\frac{a}{V^2}$ is negligible.

$P(V - b) = RT$; $PV - Pb = RT$

on dividing RT on both sides.

$\therefore Z = 1 + \frac{Pb}{RT}$ compressibility factor.

Question50

When does a gas deviate the most from its ideal behaviour?
[Online April 11, 2015]

Options:

A. At low pressure and low temperature

B. At low pressure and high temperature

C. At high pressure and low temperature

D. At high pressure and high temperature

Answer: C

Solution:

Solution:
At high pressure and low temperature, gaseous atoms or molecules get closer to cach other and van der Waal forces operates. So molecules or atoms start attracting each other. Hence a gas deviate the most from its ideal behaviour. While in ideal behaviour we consider that gases donot attract each, i.c., there is no intermolecular forces of attraction.

Question51

The intermolecular interaction that is dependent on the inverse cube of distance between the molecules is : [2015]

Options:

A. London force

B. hydrogen bond

C. ion - ion interaction

D. ion - dipole interaction

Answer: B

Solution:

Solution:
Hydrogen bond is a type of strong electrostatic dipole-dipole interaction and dependent on the inverse cube of distance between the molecules.

Question52

Which of the following is not an assumption of the kinetic theory of gases? [Online April 10, 2015]

Options:

A. Gas particles have negligible volume.

B. A gas consists of many identical particles which are in continual motion.

C. At high pressure, gas particles are difficult to compress.

D. Collisions of gas particles are perfectly elastic.

Answer: C

Solution:

Solution:
At high pressure real gas particles are easily compressed.

Question53

The initial volume of a gas cylinder is 750.0mL. If the pressure of gas inside the cylinder changes from 840.0mm H g to 360.0mmH g, the final volume the gas will be:
[Online April 11, 2014]

Options:

A. 1.750L

B. 3.60L

C. 4.032L

D. 7.50L

Answer: A

Solution:

Solution:
According to Boyle's law

$\frac{V_1}{V_2} = \frac{P_2}{P_1}; \frac{750}{V_2} = \frac{360}{840}$

$V_2 = 1750\text{mL} = 1.750\text{L}$

Question54

Sulphur dioxide and oxygen were allowed to diffuse through a porous partition. $20\,dm^3$ of SO_2 diffuses through the porous partition in 60 seconds. The volume of O_2 in dm^3 which diffuses under the similar condition in 30 seconds will be (atomic mass of sulphur $= 32u$):
[Online April 19, 2014]

Options:

A. 7.09

B. 14.1

C. 10.0

D. 28.2

Answer: B

Solution:

Solution:
According to Graham's Law Diffusion:

$$\frac{r_1}{r_2} = \sqrt{\frac{d_2}{d_1}} \text{ or } \frac{r_1}{r_2} = \sqrt{\frac{m_2}{m_1}} \left[\because d = \frac{\text{Mol.wt}}{2}\right]$$

$$\text{Since rate of diffusion} = \frac{\text{Vol. of gas diffused (V)}}{\text{Time taken for diffusion (t)}}$$

$$\therefore \frac{r_1}{r_2} = \frac{V_1 / t_1}{V_2 / t_2}$$

$$\text{or } \frac{r_1}{r_2} = \frac{V_1 / t_1}{V_2 / t_2} = \sqrt{\frac{m_2}{m_1}}$$

$$= \frac{20 / 60}{V_2 / 30} = \sqrt{\frac{32}{64}} = \sqrt{\frac{1}{2}}$$

$$\frac{10}{V_2} = \sqrt{\frac{1}{2}}; V_2 = 10\sqrt{2}$$

$$V_2 = 14.1$$

Question55

The ratio of masses of oxygen and nitrogen in a particular gaseous mixture is 1 : 4. The ratio of number of their molecules is: [2014]

Options:

A. 1 : 4

B. 7 : 32

C. 1 : 8

D. 3 : 16

Answer: B

Solution:

Solution:

Number of moles of $O_2 = \frac{m}{32}$

Number of moles of $N_2 = \frac{4m}{28} = \frac{m}{7}$

$\therefore$ Ratio $= \frac{m}{32} : \frac{m}{7} = 7 : 32$

Question56

The temperature at which oxygen molecules have the same root mean

square speed as helium atoms have at 300K is:
(Atomic masses: He = 4u, O = 16u)
[Online April 9, 2014]

Options:

A. 300K

B. 600K

C. 1200K

D. 2400K

Answer: D

Solution:

Solution:

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

$V_{ms}(O_2) = V_{mss}(He)$

$\sqrt{\frac{3RT_{O_2}}{M_{O_2}}} = \sqrt{\frac{3RT_{He}}{M_{He}}}$

or $\frac{T_{O_2}}{M_{O_2}} = \frac{T_{He}}{M_{He}}$

$\therefore T_{O_2} = \frac{300 \times 32}{4} = 2400K$

Question57

If Z is a compressibility factor, van der Waals equation at low pressure can be written as:
[2014]

Options:

A. $Z = 1 + \frac{RT}{Pb}$

B. $Z = 1 - \frac{a}{VRT}$

C. $Z = 1 - \frac{Pb}{RT}$

D. $Z = 1 + \frac{Pb}{RT}$

Answer: B

Solution:

Solution:

Compressibility factor $(Z) = \frac{PV}{RT}$

(For one mole of real gas)

van der Waals equation

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

At low pressure, volume is very large and hence correction term b can be neglected in comparison to very large volume of V. i.e. $V - b \approx V$

$\left(P + \frac{a}{V^2}\right)V = RT$; $PV + \frac{a}{V} = RT$

$PV = RT - \frac{a}{V}$; $\frac{PV}{RT} = 1 - \frac{a}{VRT}$

Hence, $Z = 1 - \frac{a}{VRT}$

Question58

van der Waals equation for a gas is stated as,

$$P = \frac{nRT}{V - nb} - a\left(\frac{n}{V}\right)^2$$

This equation reduces to the perfect gas equation, $P = \frac{nRT}{V}$ when,

[Online April 9, 2014]

Options:

A. temperature is sufficient high and pressure is low.

B. temperature is sufficient low and pressure is high.

C. both temperature and pressure are very high.

D. both temperature and pressure are very low.

Answer: A

Solution:

Solution:

Given $P = \frac{nRT}{V - nb} - a\left(\frac{n}{V}\right)^2$

Which can also be written as

$\left[P + \frac{n^2a}{V^2}\right](V - nb) = nRT$ At low pressure and high temperature the effect of $\frac{a}{V^2}$ and b is negligible hence $PV = nRT$.

Question59

For gaseous state, if most probable speed is denoted by C^*, average speed by $\overline{C}$ and mean square speed by C, then for a large number of molecules the ratios of these speeds are :

[2013]

Options:

A. $C^* : \overline{C} : C = 1.225 : 1.128 : 1$

B. $C^* : \overline{C} : C = 1.128 : 1.225 : 1$

C. $C^* : \overline{C} : C = 1 : 1.128 : 1.225$

D. $C^* : \overline{C} : C = 1 : 1.225 : 1.128$

Answer: C

Solution:

Solution:

Most probable speed $(C^*) = \sqrt{\frac{2RT}{M}}$

Average Speed $(\overline{C}) = \sqrt{\frac{8RT}{\pi M}}$

Root mean square velocity $(C) = \sqrt{\frac{3RT}{M}}$

$C^* : \overline{C} : C = \sqrt{\frac{2RT}{M}} : \sqrt{\frac{8RT}{\pi M}} : \sqrt{\frac{3RT}{M}}$

$= 1 : \sqrt{\frac{4}{\pi}} : \sqrt{\frac{3}{2}} = 1 : 1.128 : 1.225$

Question60

By how many folds the temperature of a gas would increase when the root mean square velocity of the gas molecules in a container of fixed volume is increased from 5×10^4cm / s to 10×10^4cm / s?
[Online April 9, 2013]

Options:

A. Two

B. Three

C. Six

D. Four

Answer: D

Solution:

Solution:

r.m.s. velocity $V_{rms} = \sqrt{\frac{3RT}{M}}$

i.e., $\frac{V_1}{V_2} = \sqrt{\frac{T_1}{T_2}}$

$\frac{5 \times 10^4}{10 \times 10^4} = \frac{1}{2} = \sqrt{\frac{T_1}{T_2}}$

$\therefore \ T_2 = 4T_1$

Question61

Which one of the following is the wrong assumption of kinetic theory of gases?
[Online April 25, 2013]

Options:

A. Momentum and energy always remain conserved.

B. Pressure is the result of elastic collision of molecules with the container's wall.

C. Molecules are separated by great distances compared to their sizes.

D. All the molecules move in straight line between collision and with same velocity.

Answer: D

Solution:

Solution:
Molecules move very fast in all directions in a straight line by colliding with each other but with different velocity.

Question62

For 1mol of an ideal gas at a constant temperature T, the plot of $(\log P)$ against $(\log V)$ is a (P: Pressure, V : Volume)
[Online May 7, 2012]

Options:

A. Straight line parallel to x -axis.

B. Straight line with a negative slope.

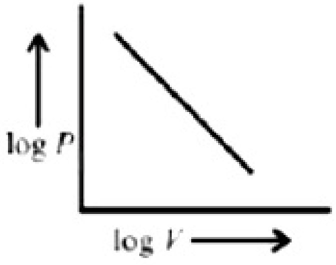
C. Curve starting at origin.

D. Straight line passing through origin.

Answer: B

Solution:

According to Boyle's law, $PV = $ constant
$\therefore \log P + \log V = $ constant
$\log P = -\log V + $ constant
Hence, the plot of $\log P$ us $\log V$ is straight line with negative slope.



Question63

When $CO_2(g)$ is passed over red hot coke it partially gets reduced to $CO(g)$. Upon passing 0.5L of $CO_2(g)$ over red hot coke, the total volume of the gases increased to 700mL. The composition of the gaseous mixture at STP is
[Online May 19, 2012]

Options:

A. $CO_2 = 300mL; CO = 400mL$

B. $CO_2 = 0.0mL; CO = 700mL$

C. $CO_2 = 200mL; CO = 500mL$

D. $CO_2 = 350mL; CO = 350mL$

Answer: A

Solution:

Solution:
The balanced chemical equation for this reaction can be written as
$CO_2 + C \longrightarrow 2CO$
$\text{Initial} \;\; 0.5L \;\; 0$
$\text{Final} \;\; (0.5 - x)L \;\; 2xL$
Since volumes are measured at constant T and P. Hence according to Avogadro's law volume ∝ mole
∵ Total volume $= 0.5 - x + 2x = 0.7$
$x = 0.2L$
∵ Volume of $CO = 2x = 2 \times 0.2 = 0.4L \approx 400mL$
∵ Volume of $CO_2 = 0.7 - 0.4 = 0.3L \approx 300mL$

Question64

An open vessel at 300K is heated till $2/5^{th}$ of the air in it is cxpelled. Assuming that the volume of the vessel remains constant, the temperature to which the vessel is heated, is
[Online May 19, 2012]

Options:

A. 1500K

B. 400K

C. 500K

D. 750K

Answer: C

Solution:

For open system where volume is constant, the pressure will also be constant, thus two general gas equation can be written as fellows.
$PV = n_1RT_1$ and $PV = n_2RT_1$
Thus, $n_1RT_1 = n_2RT_2$
or $n_1T_1 = n_2T_2$ . . . (i)
Let the initial number of moles be 1.0mol
Number of moles remaining $= 1 - \frac{2}{5} = \frac{3}{5} = 0.6\text{mol}$
Putting the values in above equation (i), we get
$1 \times 300 = 0.6 \times T_2$
$T_2 = \frac{300 \times 1}{0.6} = 500\text{K}$
Thus, the required temperature is 500K

Question65

α, v and u represent most probable velocity, average velocity and root mean square velocity respectively of a gas at a particular temperature. The correct order among the following is
[Online May 12, 2012]

Options:

A. $u > v > \alpha$

B. $v > u > \alpha$

C. $\alpha > u > v$

D. $u > \alpha > v$

Answer: A

Solution:

Solution:
$u : v : \alpha = \sqrt{\frac{3RT}{M}} : \sqrt{\frac{8RT}{\pi M}} : \sqrt{\frac{2RT}{M}}$
$= \sqrt{3} : \sqrt{\frac{8}{\pi}} : \sqrt{2}$
$= 1.732 > 1.597 > 1.414$
Thus, correct order is $u > v > \alpha$

Question66

The relationship among most probable velocity, average velocity and root mean square velocity is respectively
[Online May 26, 2012]

Options:

A. $\sqrt{2} : \sqrt{3} : \sqrt{8 / \pi}$

B. $\sqrt{2} : \sqrt{8 / \pi} : \sqrt{3}$

C. $\sqrt{8/\pi} : \sqrt{3} : \sqrt{2}$

D. $\sqrt{3} : \sqrt{8/\pi} : \sqrt{2}$

Answer: B

Solution:

Solution:

Most probable speed (C^*) = $\sqrt{\frac{2RT}{M}}$

Average speed ($\overline{C}$) = $\sqrt{\frac{8RT}{\pi M}}$

Root mean square velocity (C) = $\sqrt{\frac{3RT}{M}}$

$C^* : \overline{C} : C = \sqrt{2} : \sqrt{\frac{8}{\pi}} : \sqrt{3}$

Question67

The compressibility factor for a real gas at high pressure is: [2012]

Options:

A. $1 + \frac{RT}{Pb}$

B. 1

C. $1 + \frac{Pb}{RT}$

D. $1 - \frac{Pb}{RT}$

Answer: C

Solution:

Solution:

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

At high pressure $\frac{a}{V^2}$ can be neglected

$\therefore PV - Pb = RT$ or $PV = RT + Pb$

$\frac{PV}{RT} = 1 + \frac{Pb}{RT}$

$Z = 1 + \frac{Pb}{RT}$; $Z > 1$ at high pressure.

Question68

When r, P and M represent rate of diffusion, pressure and molecular mass, respectively, then the ratio of the rates of diffusion (r_A / r_B) of two

gases A and B, is given as
[2011 RS]

Options:

A. $(P_A / P_B)(M_B / M_A)^{1/2}$

B. $(P_A / P_B)^{1/2}(M_B / M_A)$

C. $(P_A / P_B)(M_A / M_B)^{1/2}$

D. $(P_A / P_B)^{1/2}(M_A / M_B)$

Answer: A

Solution:

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

$\frac{r_A}{r_B} = \frac{P_A}{P_B}\sqrt{\frac{M_B}{M_A}}$

Question69

The molecular velocity of any gas is:
[2011 RS]

Options:

A. inversely proportional to absolute temperature.

B. directly proportional to square of temperature.

C. directly proportional to square root of temperature.

D. inversely proportional to the square root of temperature.

Answer: C

Solution:

Solution:
The different type of molecular velocities possessed by gas molecules are
(i) Most probable velocity (v_{mp}) = $\sqrt{\frac{2RT}{M}}$
(ii) Average velocity ($\bar{v}$) = $\sqrt{\frac{8RT}{\pi M}}$
(iii) Root mean square velocity (v_{rms}) = $\sqrt{\frac{3RT}{M}}$
In all the above cases, velocity $\propto \sqrt{T}$

Question70

If $10^{-4} dm^3$ of water is introduced into a $1.0 dm^3$ flask at 300 K, how many moles of water are in the vapour phase when equilibrium is established? [2010] (Given: Vapour pressure of H_2O at 300K is 3170Pa; R = $8.314 J K^{-1} mol^{-1}$) [2010]

Options:

A. 5.56×10^{-3}mol

B. 1.53×10^{-2}mol

C. 4.46×10^{-2}mol

D. 1.27×10^{-3}mol

Answer: D

Solution:

Solution:
From the ideal gas cquation:
$PV = nRT$
The volume occupied by H_2O molecule in vapour phase
is $(1 - 10^{-4}) dm^3$ i.e., $1 dm^3 \approx 1L$
Given, $P = 3170Pa \approx 3170 \times 10^{-5}atm$
$R = 8.314 J K^{-1} mol^{-1}$
or $\frac{8.314 J K^{-1} mol^{-1} \times 1.02 atm}{101.3 J}$
$R = 0.0821 LatmK^{-1} mol^{-1}$
Thus, $T = 300K$
$n = \frac{PV}{RT} = \frac{3170 \times 10^{-5} atm \times 0.99}{0.0821 LatmK^{-1} mol^{-1} \times 300K}$
$= 1.27 \times 10^{-3}$mol

Question71

Which one of the following statements is NOT true about the effect of an increase in temperature on the distribution of molecular speeds in a gas? [2005]

Options:

A. The area under the distribution curve remains the same as under the lower temperature

B. The distribution becomes broader

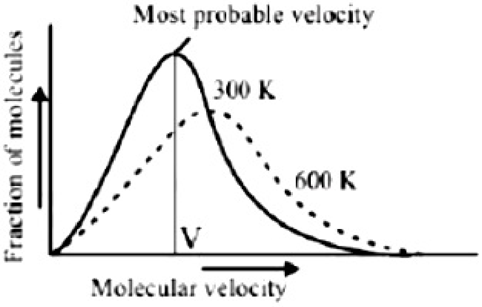
C. The fraction of the molecules with the most probable speed increases

D. The most probable speed increases

Answer: C

Solution:

Solution:
Distribution of molecular velocities at two different temperatures is shown below.



Note: At higher temperature more molecules have higher velocities and less molecules have lower velocities. As evident from fig., it is clear that with the increase in temperature the most probable velocity increases but the fraction of such molecules decreases.

Question72

As the temperature is raised from 20˚C to 40˚C, the average kinetic energy of neon atoms changes by which factor
[2004]

Options:

A. 313 / 293

B. $\sqrt{(313 / 293)}$

C. 1 / 2

D. 2

Answer: A

Solution:

Solution:

$$\frac{\text{K.E of neon at } 40^{\circ}\text{C}}{\text{K.E of neon at } 20^{\circ}\text{C}} = \frac{\frac{3}{2}\text{K} \times 313}{\frac{3}{2}\text{K} \times 293} = \frac{313}{293}$$

Question73

In van der Waals equation of state of the gas law, the constant ' b ' is a measure of
[2004]

Options:

A. volume occupied by the molecules

B. intermolecular attractions

C. intermolecular repulsions

D. intermolecular collisions per unit volume

Answer: A

Solution:

Solution:
In van der Waals equation, 'b' is for volume correction.

Question74

According to the kinetic theory of gases, in an ideal gas, between two successive collisions a gas molecule travels [2003]

Options:

A. in a wavy path

B. in a straight line path

C. with an accelerated velocity

D. in a circular path

Answer: B

Solution:

Solution:
According to kinetic theory of gases, gas molecules are in a state of constant rapid motion in all possible directions, colloiding in a random manner with one another and with the walls of the container and between two successive collisions, molecules travel in a straight line path but show haphazard motion due to collisions.

Question75

For an ideal gas, number of moles per litre in terms of its pressure P, gas constant R and temperature T is [2002]

Options:

A. PT / R

B. PRT

C. P / RT

D. RT / P.

Answer: C

Solution:

$PV = nRT$
Number of moles $= n / V \quad \therefore n / V = P / RT$

Question76

Value of gas constant R is [2002]

Options:

A. 0.082 litreatm

B. $0.987 \mathrm{cal\,mol}^{-1} \mathrm{K}^{-1}$

C. $8.3 \mathrm{J\,mol}^{-1} \mathrm{K}^{-1}$

D. 83 erg $\mathrm{mol}^{-1} \mathrm{K}^{-1}$.

Answer: C

Solution:

Value of gas constant
$(R) = 0.08205 \mathrm{LatmK}^{-1} \mathrm{mol}^{-1}$
$= 8.314 \times 10^7 \mathrm{ergsK}^{-1} \mathrm{mol}^{-1}$
$= 8.314 \mathrm{J\,K}^{-1} \mathrm{mo}^{-1} = 1.987 \mathrm{cal\,K}^{-1} \mathrm{mol}^{-1}$
[For conversion, these terms can be used
$1.0 \quad \mathrm{L\,atm} = 101.3 \mathrm{J}$; $1 \mathrm{J} = 10^7$ ergs; $1 \mathrm{J} = 0.239 \mathrm{cal}$;
or $1 \mathrm{cal} = 4.184 \mathrm{J}$]

Question77

Kinetic theory of gases proves [2002]

Options:

A. only Boyle's law

B. only Charles' law

C. only Avogadro's law

D. all of these.

Answer: D

Solution:

Kinetic theory of gases proves all the given gas laws.
