KINETIC THEORY OF GAS

01 DEGREES OF FREEDOM

- For monoatomic gas, $f = 3$
- For diatomic gas,
  - (a) at room temperature, $f = 5$
  - (b) at high temperature, $f = 7$
- For triatomic gas,
  - (a) Linear $f = 5$
  - (b) Non-linear $f = 6$
  - 1 Vibrational mode $f = 2$

Q1 Ideal gas is composed of polyatomic molecule that has 4 vibrational modes. Total degree of freedom is
a) 12 b) 14 c) 8 d) 6

02 SPECIFIC HEAT CAPACITY

a) $C_P - C_V = R$ (MSH)

b) $C_P - C_V = \frac{R}{M}$ (GSH)

c) $C_V = \frac{R}{\gamma - 1} = \frac{f}{2}R$

d) $C_P = \frac{\gamma R}{\gamma - 1} = 1 + \frac{f}{2}$

e) $\gamma = \frac{C_P}{C_V} = 1 + \frac{2}{f}$

Mono-$\gamma = \frac{5}{3}$

Dia $\gamma = \frac{7}{5}$

Tri $\gamma = \frac{4}{3}$

Q2 If C_p and C_v denoted the specific heats of unit mass of nitrogen at constant pressure and volume respectively, then
a) $C_p - C_v = \frac{R}{28}$ b) $C_p - C_v = \frac{R}{14}$ c) $C_p - C_v = \frac{R}{7}$ d) $C_p - C_v = R$

03 MIXING OF GASES

$$C_{V mix} = \frac{n_1 C_{V1} + n_2 C_{V2}}{n_1 + n_2}$$

$$C_{P mix} = \frac{n_1 C_{P1} + n_2 C_{P2}}{n_1 + n_2}$$

$$\gamma_{mix} = \frac{C_{P\ mix}}{C_{V\ mix}}$$

Q3 Consider a mixture of n moles of helium gas and 2n moles of oxygen gas (molecules taken to be rigid) as an ideal gas. It's C_p/C_V value will be:
a) 19/13 b) 67/45 c) 40/27 d) 23/15

04 LAW OF EQUIPARTITION OF ENERGY

1 Molecule per f = $\frac{1}{2}KT$

Total for a molecule = $\frac{f}{2}KT$

Monoatomic Molecule = $\frac{3}{2}KT$

Total for a mole = $\frac{f}{2}RT$

Monoatomic (mole) = $\frac{3}{2}RT$

Diatomic (mole) = $\frac{5}{2}RT$

Translatory Kinetic energy = $\frac{3}{2}RT$ (mole f= 3)

Q4 A gas mixture consists of 2 moles of O_2 and 4 moles of Ar at temparature T. Neglecting all vibrational modes, the total internal energy of the system is
a) $4RT$ b) $15RT$ c) $9RT$ d) $11RT$

05 FIRST LAW OF THERMODYNAMICS

$\Delta Q_P = \Delta U + \Delta W$

$\Delta U = nC_V \Delta T$

$\Delta W = \int P dv$

$\frac{\Delta U}{\Delta Q_P} = \frac{1}{\gamma}$

$\frac{\Delta W}{\Delta Q_P} = 1 - \frac{1}{\gamma}$

06 VELOCITY OF GAS

$V_{mps} : V_{avg} : V_{rms} = 1 : 1.14 : 1.228$

Root Mean square speed:

Square root of mean of square of speed of different molecules,

$V_{rms} = \sqrt{\frac{v_1^2 + v_2^2 + \ldots\ldots\ldots + v_n^2}{n}}$

$V_{rms} = \sqrt{\frac{3RT}{M}} = \sqrt{\frac{3P}{d}} = \sqrt{\frac{3k_BT}{m}}$

Average Speed:

Arithmetic mean of speed of molecules of gas at given temperature.

$v_{avg} = \frac{|\vec{v_1}| + |\vec{v_2}| + \ldots\ldots + |\vec{v_n}|}{n}$

$v_{avg} = \sqrt{\frac{8RT}{\pi M}} = \sqrt{\frac{8P}{\pi d}}$

Most probable speed:

Speed possessed by maximum number of molecules of gas.

$V_{mp} = \sqrt{\frac{2RT}{M_0}} = \sqrt{\frac{2P}{d}}$

07 MEAN FREE PATH

Average distance travelled by molecules between two successive collision

$\lambda_{mean} = \frac{1}{\sqrt{2}\pi d^2 n}$

d = diameter of molecules.

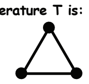
n = no. of molecules per unit volume

$\lambda \propto \frac{1}{d^2}$

$\lambda \propto \frac{1}{r^2}$

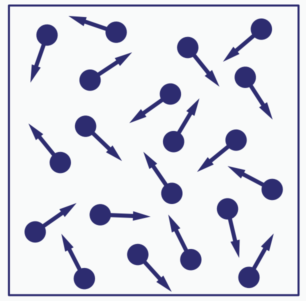
$\lambda \propto \frac{T}{P}$

Q5 Consider a gas of triatomic molecules. The molecules are assumed to be triangular made up of massless rigid rods whose vertices are occupied by atoms. The internal energy of a mole of the gas at temperature T is:
a) $\frac{5}{2}RT$ b) $\frac{3}{2}RT$ c) $\frac{9}{2}RT$ d) $3RT$

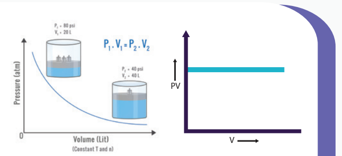


Q6 The rms speeds of the molecules of Hydrogen, Oxygen & Carbondioxide at the same temparature are V_H, V_O and V_C respectively then:
a) $V_H > V_O > V_C$ b) $V_C > V_O > V_H$
c) $V_H = V_O > V_C$ d) $V_H = V_O = V_C$

Q7 The mean free path of molecules of gas, (radius r) is inversely proportional to
a) r^3 b) r^2
c) r d) $\sqrt{r}$

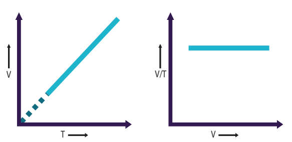


BOYLE'S LAW



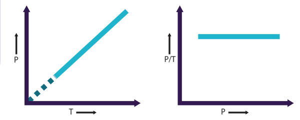
- PV = constant, if T = Cosntant
- $P_1V_1 = P_2V_2$, When gas changes it's state under constant temperature.

CHARLE'S LAW



- $V \propto T$; $\frac{V}{T}$ = constant; P = constant.
- $\frac{V_1}{T_1} = \frac{V_2}{T_2}$, When gas change its state under constant pressure.

GAY LUSSAC'S LAW



- $P \propto T$; $\frac{P}{T}$ = constant; V = constant.
- $\frac{P_1}{T_1} = \frac{P_2}{T_2}$, When gas change its state under constant Volume.

PRESSURE OF GAS

$PV = \frac{1}{3}mnV_{rms}^2 = \frac{1}{3}mn\overline{V^2}$

Relation between pressure and Kinetic Energy.

$E = \frac{3}{2}PV$

IDEAL GAS LAW

$PV = nRT$

R=8.314 JK-1mol-1

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

Specific heat of Solid = 3R
WATER = 9R