Maharashtra Board Solutions Class 12

Physics

Chapter 3 Kinetic Theory of Gases and Radiations

1. Choose the correct option.

i) In an ideal gas, the molecules possess

A. Only kinetic energy

B. Both kinetic energy and potential energy

C. Only potential energy

D. Neither kinetic energy nor potential energy

Ans: The correct option is (A) only kinetic energy.

- If intermolecular force of any gas is zero then the gas is called ideal gas.
- There are two kinds of internal energy -internal kinetic energy and internal potential energy .
- Internal potential energy depends on the intermolecular forces.
- As intermolecular force of an ideal gas is zero therefore it possess no internal potential energy but only internal kinetic energy.

ii) The mean free path λ of molecules is given by

A. $\sqrt{\frac{2}{\pi n d^2}}$

B. $\frac{1}{\pi n d^2}$

C. $\frac{1}{\sqrt{2}\pi n d^2}$

D. $\frac{1}{\sqrt{2}\pi n d}$

where n is the number of molecules per unit volume and d is the diameter of the molecules.

Ans: The correct option is (C) $\frac{1}{\sqrt{2}\pi n d^2}$

Mean free path is the average distance travelled by gas molecules between two consecutive collisions . It is denoted by λ.

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

where, d= diameter of molecules and n=molecular density

iii) If pressure of an ideal gas is decreased by 10% isothermally, then its volume will

A. **Decrease by 9%**

B. **Increase by 9%**

C. **Decrease by 10%**

D. **Increase by 11.11%**

Ans: The correct answer is (D) 11.11%

Ideal Gas Equation,

PV=nRT

An isothermal process means the temperature is constant.

As T,n,R are constant then P α V .

$$\Rightarrow P_1V_1 = P_2V_2$$

$$\Rightarrow \frac{P_1}{P_2} = \frac{V_2}{V_1}$$

$$\Rightarrow P_2 = P_1 - \frac{10}{100}P_1$$

$$\Rightarrow P_2 = \frac{90}{100}P_1$$

$$\Rightarrow \frac{P_2}{P_1} = \frac{9}{10}$$

$$\Rightarrow \frac{P_2}{P_1} = \frac{V_1}{V_2} = \frac{9}{10}$$

The percent decrease in volume

$$= \left(\frac{V_2 - V_1}{V_1}\right) \times 100$$

$$= \left(\frac{V_2}{V_1} - 1\right) \times 100$$

$$= \left(\frac{10}{9} - 1\right) \times 100$$

$$= \frac{1}{9} \times 100 = 11.11\%$$

iv) If a = 0.72 and r = 0.24, then the value of t_r is

A. 0.02

B. 0.04

C. 0.4

D. 0.2

Ans: The correct answer is (B) 0.04

$\Rightarrow$a+r+t=1

Where a= absorptive coefficient

r= reflective coefficient

t=transmittive coefficient

given a=0.72 , r=0.24

then on applying,

a+r+t=1

$\Rightarrow 0.72 + 0.24 + t = 1$

$\Rightarrow 0.96 + t = 1$

$\Rightarrow t = 1 - 0.96$

$\Rightarrow t = 0.04$

v) The ratio of emissive power of perfectly blackbody at 1327°Cand 527°C is

A. 4:1

B. 16 : 1

C. 2 : 1

D. 8 : 1

Ans: The correct answer is (B) 16:1

The black body's temperature is

T_1=1357°C

The another black body's temperature is T_2=527°C

Emissive power of a perfect black body is given by:

$E_b = n\sigma T^4$

$$\Rightarrow \frac{E_1}{E_2} = \left(\frac{T_1}{T_2}\right)^4$$

$$\Rightarrow \frac{E_1}{E_2} = \left(\frac{1357+273}{527+273}\right)^4$$

$$\Rightarrow \frac{E_1}{E_2} = \left(\frac{1630}{800}\right)^4$$

$$\Rightarrow \frac{E_1}{E_2} = \frac{16}{1}$$

2. Answer in brief

i) What will happen to the mean square speed of the molecules of a gas if the temperature of the gas increases?

Ans: When the temperature is increased by n times, then the mean square speed also increases n times of its initial value .

- As mean square speed= $=\frac{3RT}{M_W}$

where R= gas constant, T= temperature in Kelvin scale and M_W =Molecular mass of the gas.

- In the formula we can see the mean square speed is directly proportional to T .
- So when the temperature increases by n factor, mean square speed also increases by n factor.

ii) On what factors do the degrees of freedom depend?

Ans: The degree of freedom depends on the following:-

- It depends on the number of atoms a molecule of the gas is composed of (atomicity) i.e. monoatomic, diatomic etc.
- It depends on the structure of the molecule of gas i.e. linear, tetrahedral etc.
- It also depends on the temperature of the gas.

iii) Write ideal gas equation for a mass of 7 g of nitrogen gas.

Ans:

The ideal gas equation is given by:

PV=nRT.

Where,

P= pressure, V=Volume, n= $\frac{m}{M_w}$ =moles, R= gas constant, T=kelvin temperature , m= mass of gas and M_W =Molecular mass of the gas .

Therefore the ideal gas equation for a mass of 7 g of nitrogen gas is:

$\Rightarrow PV = nRT$

$\Rightarrow PV = \frac{m}{M_w} RT$

$\Rightarrow PV = \frac{7}{28} RT$

$\Rightarrow PV = \frac{1}{4} RT$

iv) If the density of oxygen is $1.44 kgm^{-3}$ at a pressure of $10^5 N/m^2$ find the root mean square velocity of oxygen molecules.

Ans:

Given,

density $\rho = 1.44 kg/m^3$

Pressure (P)= $10^5 N/m^2$

Root mean square velocity of a gas= $\sqrt{\frac{3RT}{M_W}} = \sqrt{\frac{3P}{\rho}}$

The root mean square velocity of oxygen molecules = $\sqrt{\frac{3P}{\rho}}$

$= \sqrt{\frac{3 \times 10^5}{1.44}}$

$= \sqrt{2.083 \times 10^5}$

$= 4.564 \times 10^2 m/s$

v) Define athermanous substances and diathermanous substances.

Ans: Athermanous are those substances which don't allow any transmission of infrared radiation through them. Example:-water vapours, wood etc.

While diathermanous are those substances which allow transmission of infrared radiation through them . Example:- salt , glass etc.

3. When a gas is heated its temperature increases. Explain this phenomenon based on kinetic theory of gases.

Ans: When the gas is not heated the molecules of gas possess kinetic energy and they are in continuous state of motion in random direction. But when the gas is heated, the average kinetic energy per molecule of gas increases, so the temperature also increases. As internal kinetic energy is proportional to the temperature of gas.

4. Explain, on the basis of kinetic theory, how the pressure of gas changes if its volume is reduced at constant temperature.

Ans: At constant temperature, the average kinetic energy per molecule of a gas is constant. When the volume of a gas is reduced at a constant temperature, the rate of collisions of gas molecules with the walls of container increases. This causes an increase in momentum transferred per unit area per unit time. Hence the pressure of the gas increases.

5. Mention the conditions under which a real gas obeys ideal gas equation.

Ans: A real gas obeys ideal gas equation under the following conditions :-

- When pressure is very low.
- When temperature is very high.

6. State the law of equipartition of energy and hence calculate molar specific heat of mono- and di-atomic gases at constant volume and constant pressure.

Ans: The law of equipartition of energy states that :-

- For a dynamic system in thermal equilibrium the total energy of the system is shared equally between all the degree of freedom. The energy associated with each degree of freedom per molecule is $\frac{1}{2}K_BT$ here K_B is the Boltzmann's constant.
- Let's take an example of a monoatomic gas molecule, it has 3 degree of freedom, the mean kinetic energy of a molecule is $\frac{3}{2}K_BT$.

To calculate molar specific heat of monoatomic gas:

It has 3 degree of freedom

Average kinetic energy of a molecule = $\frac{3}{2}K_BT$

Total internal energy of a mole is $=\frac{3}{2}N_AK_BT$

Here N_A = Avogadro number

Molar specific heat at constant volume (C_V)= $\frac{dE}{dT}=\frac{3}{2}R$

We know that, $C_P - C_V = R$

Molar specific heat at constant pressure (C_P)=R+C_V

$\Rightarrow C_P = C_V + R$

$\Rightarrow C_P = \frac{3}{2}R + R$

$\Rightarrow C_P = \frac{5}{2}R$

To calculate molar specific heat of a diatomic gas:

It has 5 degree of freedom

Average kinetic energy of a molecule = $\frac{5}{2}K_BT$

Total internal energy of a mole is $=\frac{5}{2}N_AK_BT$

Here N_A = Avogadro number

Molar specific heat at constant volume $(C_V) = \frac{dE}{dT} = \frac{5}{2}R$

We know that, $C_P - C_V = R$

Molar specific heat at constant pressure (C_P)=R+C_V

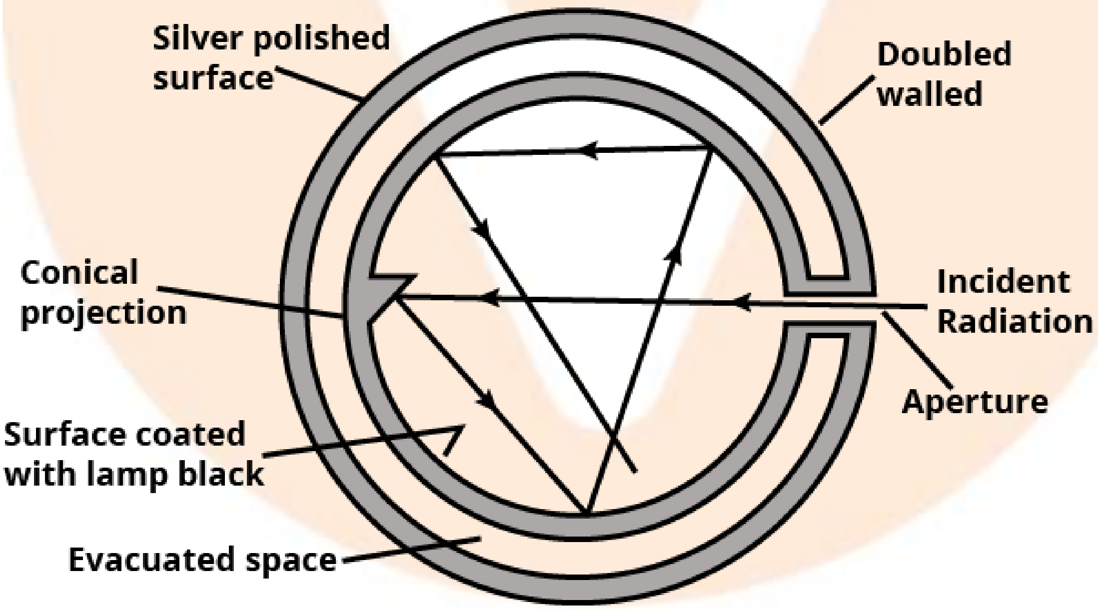
$\Rightarrow C_P = C_V + R$

$\Rightarrow C_P = \frac{5}{2}R + R$

$\Rightarrow C_P = \frac{7}{2}R$

7. What is a perfect blackbody? How can it be realized in practice?

Ans: A body that completely absorbs all incident radiant radiation is referred to as a perfect blackbody.



Using a hollow, double-walled sphere with a tiny hole or aperture through which radiant heat can enter, Ferry produced a spherical blackbody. The sphere's exterior is silver plated, while its inside wall has been lampblack-blackened. The area between the two walls is evacuated to lessen the loss of heat by conduction and convection.

Any radiation that enters the sphere through the opening is reflected many times, with the lampblack coating absorbing around 97% of it at each incident. The radiation is almost completely absorbed after a sequence of internal reflections.

An internal wall projection on the side opposite the aperture has a conical shape that lowers the likelihood of incident radiation escaping.

The hole serves as a source of black-body radiation when the sphere is submerged in the right mixture of fused salts to maintain the optimum temperature. The temperature of the walls alone determines the radiation's strength and type.

By definition, a blackbody has an absorption coefficient of 1. Its coefficients of reflection and transmission are therefore equal to zero.

Blackbody radiation, or the radiation emitted by a blackbody, spans the entire electromagnetic spectrum. A blackbody is therefore sometimes referred to as a full radiator.

8. State

a) Stefan-Boltmann law

b) Wein's displacement law.

Ans: (a) Stefan-Boltzmann law states that the emissive power of an ideal black body is directly proportional to the fourth power of absolute temperature.

Stefan's law:-

$$E \alpha T^4$$

Where E=emissive power , T= temperature in kelvin scale .

(b) Wein's displacement law states that the wavelength corresponding to maximum emission is inversely proportional to the temperature.

Wein's law :-

$$\lambda_m \alpha \frac{1}{T}$$

$$\lambda_m = \frac{b}{T}$$

Where b=Wein's constant $=2.89\times10^{-3}mK$

9. Explain spectral distribution of blackbody radiation.

Ans: The spectral distribution of the thermal energy radiated by a black body depends on temperature. It is the curve between spectral emissive power (E_λ) and its respective wavelength (λ).

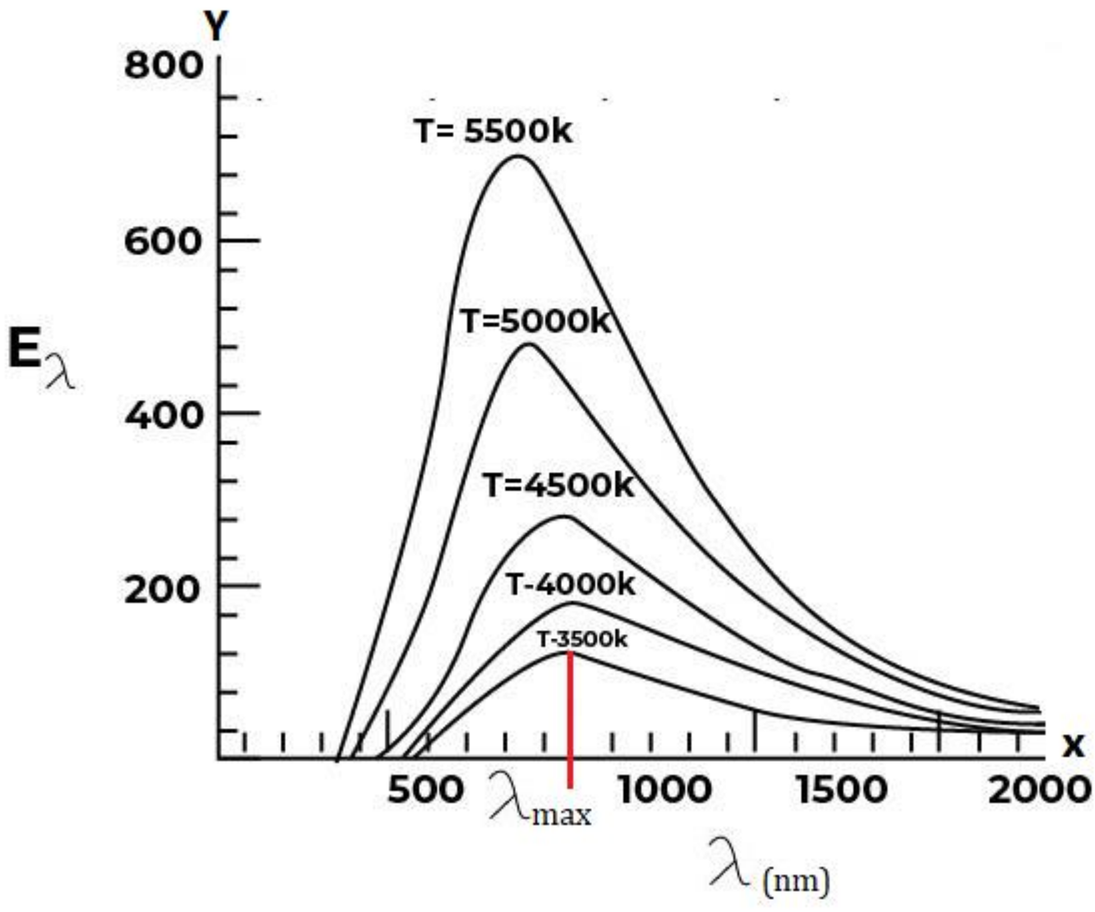


Image: spectral distribution of blackbody radiation

10. State and prove Kirchoff's law of heat radiation.

Ans: Kirchhoff's law of heat radiation states that the emissivity of radiating bodies is equal to their absorptivity.

Theoretical proof: - consider a normal body B and an ideal black body IBB of same dimensions . Both present in uniform temperature enclosures.

Let us take,

- E= emissive power of body B
- E_{IBB} =Emissive power of body IBB
- A=absorptive coefficient of B
- e= emissivity of B
- Q=radiant energy incident per unit time per unit area on each body.
- Quantity of heat absorbed per unit area per unit time by body B=aQ
- Quantity of heat emitted per unit area per unit time by body B=E

Since the temperature is constant $E = aQ$

$\Rightarrow E = aQ$

$\Rightarrow Q = \frac{E}{a} ...(1)$

Quantity of heat absorbed per unit area per unit time by body IBB=Q

The radiant heat emitted per unit time per unit area by body IBB= E_b

Since the temperature is constant Q= E_b ...(2)

From equation (1) and (2) we get:-

$\Rightarrow \frac{E}{a} = E_b$

$\Rightarrow \frac{E}{E_b} = a$

We know that $\frac{E}{E_b} = e$

$\therefore a = e$

11. Calculate the ratio of mean square speeds of molecules of a gas at 30K and 120K.

Ans: The temperature's of the gas, $T_1 = 30K$ and $T_2 = 120K$

The formula for root mean square is given as:

Mean square speed(V) $=\frac{3RT}{M_W}$ where R= gas constant, T= temperature in Kelvin scale and M_W =Molecular mass of the gas.

$$v \propto T$$

$$\Rightarrow \frac{v_1}{v_2} = \frac{T_1}{T_2}$$

$$\Rightarrow \frac{v_1}{v_2} = \frac{30K}{120K}$$

$$\Rightarrow \frac{v_1}{v_2} = \frac{1}{4}$$

Is the required ratio.

12. Two vessels A and B are filled with same gas where volume, temperature and pressure in vessel A is twice the volume, temperature and pressure in vessel B. Calculate the ratio of number of molecules of gas in vessel A to that in vessel B.

Ans: Given data :- $T_A = 2T_B$

$$\Rightarrow V_A = 2V_B$$

$$\Rightarrow P_A = 2P_B$$

$$PV = nRT$$

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

$$\Rightarrow n_A = \frac{P_A V_A}{RT_A}$$

And $\Rightarrow n_B = \frac{P_B V_B}{RT_B}$

$$\Rightarrow \frac{n_A}{n_B} = \left(\frac{P_A}{P_B}\right)\left(\frac{V_A}{V_B}\right)\left(\frac{T_B}{T_A}\right)$$

$$\Rightarrow \frac{n_A}{n_B} = \left(\frac{2P_B}{P_B}\right)\left(\frac{2V_B}{V_B}\right)\left(\frac{T_B}{2T_B}\right)$$

$$\Rightarrow \frac{n_A}{n_B} = 2\times 2\times \frac{1}{2}$$

$$\Rightarrow \frac{n_A}{n_B} = \frac{2}{1}$$

Is the required ratio.

13. A gas in a cylinder is at pressure P. If the masses of all the molecules are made one third of their original value and their speeds are doubled, then find the resultant pressure.

Ans: Given -Masses are made one-third $\Rightarrow m_2 = \frac{1}{3}m_1$

And speeds are doubled $\Rightarrow v_{rms2} = 2v_{rms1}$

We know that, $P = \frac{1}{3}\frac{Nm}{V}v^2{}_{rms}$

$$\Rightarrow P_1 = \frac{1}{3}\frac{Nm_1}{V}v^2{}_{rms1}$$

and

$\Rightarrow P_2 = \frac{1}{3}$\dfrac{{N{m_{_2}}}}$Vv^2{}_{rms2}$

$$\Rightarrow \frac{P_2}{P_1} = \frac{m_2}{m_1}\frac{v^2{}_{rms2}}{v^2{}_{rms1}}$$

$$\Rightarrow \frac{P_2}{P_1} = \frac{1}{3}\frac{m_1\left(2^2\right)v_{rms1}{}^2}{m_1 v_{rms1}{}^2}$$

$$\Rightarrow \frac{P_2}{P_1} = \frac{4}{3}$$

$$\Rightarrow P_2 = \frac{4}{3}P_1$$

14. Show that rms velocity of an oxygen molecule is 2 times that of a sulphur dioxide molecule at S.T.P.

Ans: Root mean square velocity of a gas= $\sqrt{\frac{3RT}{M_W}}$ where R= gas constant, T= temperature in Kelvin scale and M_W =Molecular mass of the gas.

$$\Rightarrow v_{rms} \alpha \frac{1}{\sqrt{M_W}}$$

$$\Rightarrow \frac{v_{rmsO_2}}{v_{rmsSO_2}} = \sqrt{\frac{M_{W_{SO_2}}}{M_{W_{O_2}}}}$$

$$\Rightarrow \frac{v_{rmsO_2}}{v_{rmsSO_2}} = \sqrt{\frac{64}{32}} = \sqrt{2}$$

$$\Rightarrow \frac{v_{rmsO_2}}{v_{rmsSO_2}} = \sqrt{2}$$

$$\Rightarrow v_{rmsO_2} = \sqrt{2} v_{rmsSO_2}$$

15. At what temperature will oxygen molecules have same rms speed as helium molecules at S.T.P.? (Molecular masses of oxygen and helium are 32 and 4 respectively)

Ans: Given $T_{He} = 273K$

$M_{WO_2} = 32$

$M_{WHe} = 4$

Root mean square velocity of a gas= $\sqrt{\frac{3RT}{M_W}}$ where R= gas constant, T= temperature in Kelvin scale and M_W =Molecular mass of the gas.

Given, $v_{O_2} = v_{He}$

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

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

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

$$\Rightarrow T_{O_2} = \frac{273\times 32}{4}$$

$$\Rightarrow T_{O_2} = 2184K$$

16. Compare the rms speed of hydrogen molecules at 127°C with rms speed of oxygen molecules at 27°C given that molecular masses of hydrogen and oxygen are 2 and 32 respectively.

Ans: $M_{O_2} = 32$

$M_{H_2} = 2$

$T_{O_2} = 273 + 27 = 300K$

$T_{H_2} = 273 + 127 = 400K$

Root mean square velocity of a gas= $\sqrt{\frac{3RT}{M_W}}$ where R= gas constant, T= temperature in Kelvin scale and M_W =Molecular mass of the gas.

$$\Rightarrow \frac{v_{rmsO_2}}{v_{rmsH_2}} = \sqrt{\frac{T_{O_2}\times M_{H_2}}{T_{H_2}\times M_{O_2}}}$$

$$\Rightarrow \frac{v_{rmsO_2}}{v_{rmsH_2}} = \sqrt{\frac{300\times 2}{400\times 32}}$$

$$\Rightarrow \frac{v_{rmsO_2}}{v_{rmsH_2}} = \frac{\sqrt{3}}{8}$$

$$\Rightarrow \frac{v_{rmsO_2}}{v_{rmsH_2}} = \frac{8}{\sqrt{3}}$$

17. Find kinetic energy of 5 litre of a gas at S.T.P. given standard pressure is $1.013\times10^{5} N/m^{2}$

Ans: Given: - V= 5 litres =$5\times10^{-3}m^{3}$, P= $1.013\times10^{5} N/m^{2}$

We know that $E=\frac{3}{2}PV$

$\Rightarrow E=\frac{3}{2}\times1.013\times10^{5} N/m^{2}\times5\times10^{-3}m^{3}$

$\Rightarrow E=7.597\times10^{2} J$

$\Rightarrow E=0.7597IJ$

Is the required energy.

18. Calculate the average molecular kinetic energy (i) per kmol (ii) per kg (iii) per molecule of oxygen at 127°C, given that molecular weight of oxygen is 32, R is 8.31 $Jmol^{-1}K^{-1}$ **and Avogadro's number NA is 6.02 x 1023 molecules** mol^{-1}**.**

Ans: Given T=273+127=400K

R=8.31_ $Jmol^{-1}K^{-1}$

$M_W=32$

(i) The average molecular kinetic energy per kmol of oxygen

=the average molecular kinetic energy per mole of oxygen $\times1000$

$=\frac{3}{2}RT\times1000$

$=\frac{3}{2}\times8.31\times400\times1000$

$=4.986\times10^{6} JKmol^{-1}$

(ii)The average molecular kinetic energy per kg of oxygen

$=\frac{3}{2}\frac{RT}{M_W}=\frac{3}{2}\times8.31\times400\times\frac{1000}{32}=1.558\times10^{5} Jkg^{-1}$

(iii)The average molecular kinetic energy per molecule of oxygen

$$=\frac{3}{2}\frac{RT}{N_A}$$

$$=\frac{3}{2}\times 8.31\times 400\times 1000\times\frac{1}{6.022\times 10^{23}}$$

$$=8.282\times 10^{-21}J-molecule^{-1}$$

19. Calculate the energy radiated in one minute by a blackbody of surface area 100 cm^2 when it is maintained at 227°C.

Ans: Given data

Time (t) =1 min = 60 secs

Area (A) = 100 $cm^2 = 10^{-2}m^2$

T=273+227=500K

$\sigma = 5.67\times 10^{-8}Wm^{-2}K^{-4}$

The energy radiated by the blackbody Q=σAT^4t

$\Rightarrow Q=\sigma AT^4t$

$\Rightarrow Q=5.67\times 10^{-8}\times 10^{-2}\times 500^4\times 60$

$\Rightarrow Q=2126.25J$

20. Energy is emitted from a hole in an electric furnace at the rate of 20 W, when the temperature of the furnace is 727°C. What is the area of the hole? (Take Stefan's constant σ to be $5.7\times 10^{-8}Js^{-1}m^{-2}K^{-4}$)

Ans: Given data:-

$$\frac{Q}{t}=20W$$

T=273+727=1000K

$\sigma = 5.7\times 10^{-8}Js^{-1}m^{-2}K^{-4}$

We know that,

$$\frac{Q}{t}=\sigma AT^4$$

$$\Rightarrow A = \frac{\frac{Q}{t}}{\sigma T^4}$$

$$\Rightarrow A = \frac{20}{5.7 \times 10^{-8} \times (10^3)^4}$$

$$\Rightarrow A = 3.5 \times 10^{-4} m^2$$

21. The emissive power of a sphere of area 0.02 m^2 is 0.5 $kcal - s^{-1}m^{-2}$. What is the amount of heat radiated by the spherical surface in 20 second?

Ans: Given data

Area (A) =0.02 m^2

Emissive power (E) = is 0.5 $kcal - s^{-1}m^{-2}$

Time (t) =20s

We know that,

$\Rightarrow$Q=Eat

$$\Rightarrow Q = 0.5 \times 0.02 \times 20$$

$$\Rightarrow Q = 0.2 kcal$$

22. Compare the rates of emission of heat by a blackbody maintained at 727°Cand at 227°C, if the blackbodies are surrounded by an enclosure (black) at 27°C. What would be the ratio of their rates of loss of heat?

Ans: Given data:-

$$T_1 = 273 + 727 = 1000K$$

$$T_2 = 273 + 227 = 500K$$

$$T_0 = 273 + 27 = 300K$$

The rate of loss of heat $= \frac{dQ}{dt} = \sigma A\left(T^4 - T_0^4\right)$

Let us assume both bodies have same area A

Ratio of rate of loss of heats both the bodies:-

$$\Rightarrow \frac{\left(\frac{dQ}{dt}\right)_1}{\left(\frac{dQ}{dt}\right)_2} = \frac{T_1^4 - T_0^4}{T_2^4 - T_0^4}$$

$$\Rightarrow \frac{\left(\frac{dQ}{dt}\right)_1}{\left(\frac{dQ}{dt}\right)_2} = \frac{1000^4 - 300^4}{500^4 - 300^4}$$

$$\Rightarrow \frac{\left(\frac{dQ}{dt}\right)_1}{\left(\frac{dQ}{dt}\right)_2} = \frac{9919}{544} = 18.23$$

$$\Rightarrow \frac{\left(\frac{dQ}{dt}\right)_1}{\left(\frac{dQ}{dt}\right)_2} = \frac{18.23}{1}$$

Is the required ratio

23. Earth's mean temperature can be assumed to be 280 K. How will the curve of blackbody radiation look like for this temperature? Find out $\lambda_{\max}$. In which part of the electromagnetic spectrum, does this value lie?

Ans: Given data

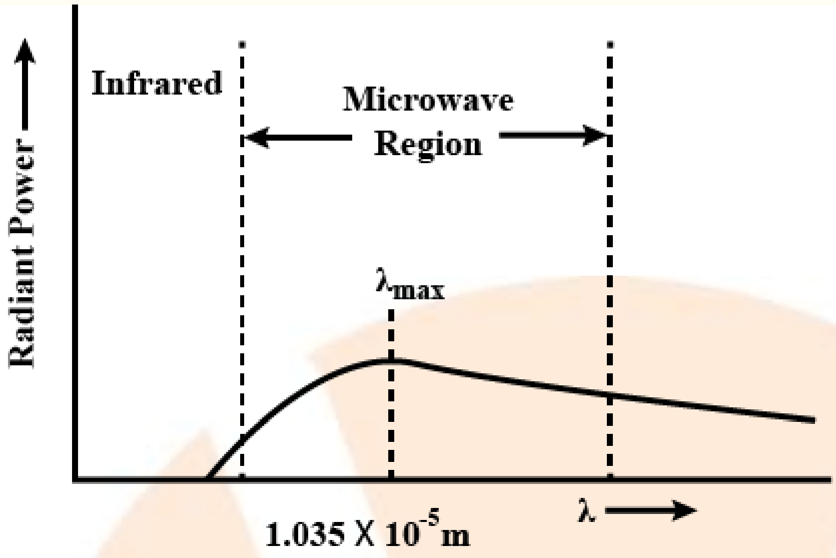
T=280K, b=Wien's constant $= 2.89 \times 10^{-3} mK$

We know that,

$$\lambda_{\max} = \frac{b}{T}$$

$$\therefore \lambda_{\max} = \frac{b}{T} = \frac{2.897 \times 10^{-3}}{280} = 1.035 \times 10^{-5} m$$

This value of λ lies in the microwave region of the electromagnetic spectrum.



24. A small-blackened solid copper sphere of radius 2.5 cm is placed in an evacuated chamber. The temperature of the chamber is maintained at 100°C. At what rate energy must be supplied to the copper sphere to maintain its temperature at 110°C? (Take Stefan's constant σ to be $5.67\times10^{-8}\,Js^{-1}m^{-2}K^{-4}$ **and treat the sphere as blackbody.)**

Ans: Given data

Radius of solid copper sphere (r)=2.5cm=0.025m

T=273+110=383K

T_0 =273+100=373K

$\sigma = 5.67\times10^{-8}\,Js^{-1}m^{-2}K^{-4}$

The rate at which energy should be supplies to it $=\sigma A\left(T^4-T_0^4\right)$

$=\sigma\pi r^2\left(T^4-T_0^4\right)$

$=5.67\times10^{-8}\times4\times3.142\times\left(2.5\times10^{-2}\right)^2\left(383^4-373^4\right)=0.9624W$

25. Find the temperature of a blackbody if its spectrum has a peak at

a) λ_{max} **= 700 nm (visible)**

b) λ_{max} **= 3 cm (microwave region)**

c) = 3 m $\lambda_{\max}$ (FM radio Waves) (Take Wien's constant b = 2.897×10^{-3} **m K).**

Ans: We know that

$$\lambda_{\max}=\frac{b}{T}$$

(a) $T=\frac{b}{\lambda_{\max}}=\frac{2.897\times10^{-3}}{700\times10^{-9}}$

$T=4138K$

Is the required temperature.

(b) $T=\frac{b}{\lambda_{\max}}=\frac{2.897\times10^{-3}}{3\times10^{-2}}$

$T=9.66\times10^{-2}=0.0966K$

Is the required temperature.

(c) $T=\frac{b}{\lambda_{\max}}=\frac{2.897\times10^{-3}}{3}$

$T=9.66\times10^{-4}=0.966\times10^{-3}K$

Is the required temperature .