NeetPreparation

Behaviour of Perfect Gas and Kinetic Theory Important Questions With Answers

NEET Physics 2023

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1. In a certain region of space there are only 5 gaseous molecules per em" on an average. The temperature there is 3 K The pressure of this gas is
   (k_B = 1.38 X 10^{-23} J mol^{-1} K^{-1})
   a) 20.7 x 10^{-16} N m^{-2} **b) 20.7 x 10^{-17} N m^{-2}** c) 10.7 x 10^{-16} N m^{-2} d) 10.7 x 10^{-17} N m^{-2}

   Solution : -
   Let n be the number of molecules in the gas
   PV = nK_BT
   or $P = \frac{nk_BT}{V}$
   Here, $\frac{n}{V} = 5cm^{-3} = 5 \times 10^6 m^{-3}$
   k_B = l.38 x 10^{-23} J mol^{-1} K^{-1}
   ∴ P = 5 X 10^6 x l.38 x 10^{-23} x 3
   = 20.7 x 10^{-17} N m^{-2}

2. The temperature of a gas is raised from 27^0C to 927^0C. The root mean square speed:
   a) ($\sqrt{927/27}$) times the earlier value b) Gets halved c) Remains the same **d) Gets doubled**

   Solution : -
   v_{rms} is equal to $\sqrt{3RT/M}$
   Here T_l = 27 + 273 = 300 and T_2 = 927 + 273
   = 1200
   So, as temperature increases from 300 K to 1200 K which is four times, the v_{rms} will be doubled.

3. The kinetic theory of gases gives the formula $PV = \frac{1}{3}Nmv^{-2}$ for the pressure P exerted by a gas enclosed in a volume V. The term Nm represents
   a) the mass of a mole of the gas **b) the mass of the gas present in the volume V**
   c) the average mass of one molecule of the gas d) the total number of molecules present in volume V

4. The ratio of specific heats $C_p/C_v = \gamma$ in terms of degree of freedom (n) is given by:
   a) (1+n/3) **b) (1+2/n)** c) (1+n/2) d) (1+ 1/n)

   Solution : -
   Specific heat of gas at constant volume
   C_v = nR/2
   Also, C_p-C_v = R

$\therefore C_p = nR/2 + R = R(1 + n/2)$

$\therefore \gamma = C_p/C_v = [R(l + n/2)]/[nR/2] = (2/n) + 1$

5. From a certain apparatus, the diffusion rate of hydrogen has an average value of 28.7 $cm^3\ s^{-1}$. The diffusion of another gas under the same conditions is measured to have an average rate of 7.2 $cm^3\ s^{-1}$. The gas is

   a) Nitrogen b) Helium c) Argon **d) Oxygen**

   Solution : -

   According to Graham's law of diffusion, $\frac{r_1}{r_2} = \sqrt{\frac{\rho_2}{\rho_1}}$

   or $\frac{r_1}{r_2} = \sqrt{\frac{M_2}{2}}$

   Here, r_l = diffusion rate of hydrogen = 28.7 $cm^3 s^{-1}$

   r_2 = diffusion rate of unknown gas = 7.2 $cm^3\ s^{-1}$.

   M_1= molecular mass of hydrogen = 2 g

   $\therefore \frac{28.7}{7.2} = \sqrt{\frac{M_2}{2}}$ or $M_2 = \left(\frac{28.7}{7.2}\right) \times 2 \simeq 32g$

   32 g is molecular mass of oxygen.

6. 0.014 kg of nitrogen is enclosed in a vessel at a temperature of 27°C. At which temperature the rms velocity of nitrogen gas is twice its the rms velocity at 27°C?

   a) 1200 K b) 600 K c) 300 K d) 150 K

   Solution : -

   Using, $v_{rms} = \sqrt{\frac{3RT}{m}}$

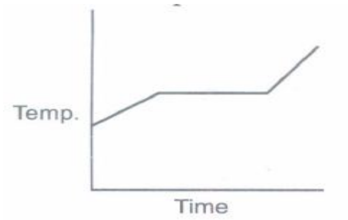
   or $\frac{(v_{rms})}{(v_{rms})} = \sqrt{\frac{T_1}{T_2}}$ (∵Ran m are constant)

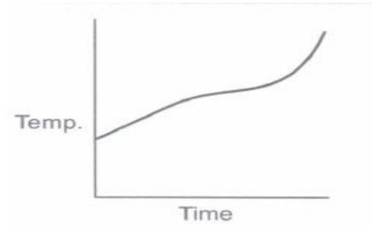
   According to question, $(v_{rms})_2 = 2(v_{rms})_1$

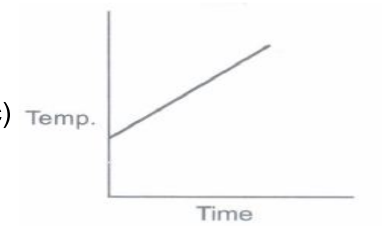
   $\therefore \frac{(v_{rms})_1}{(v_{rms})_2} = \sqrt{\frac{T_1}{T_2}} \Rightarrow \frac{1}{4} = \frac{300}{T_2}$

   T_2 = 300 x 4 = 1200 K.

7. Liquid oxygen at 50 K is heated to 300 K at constant pressure of 1 atm. The rate of heating is constant. Which one of the following graphs represents the variation of temperature with time?

a) 

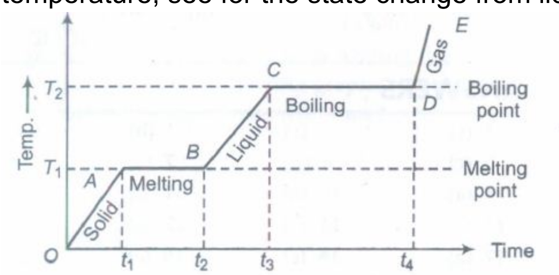
b) 

c) 

d) 

Solution : -

The graph below shows various change of state with temperature and time. On initially increasing the temperature, see for the state change from liquid to gas.



Hence, graph in option (a) will show variation of temperature with time where initially temperature increases which changes the state from liquid to boiling and to gas.

8. One mole of an ideal monatomic gas at temperature T_o expands slowly according to the law $\frac{P}{V}$ = constant. If the final temperature is 2 T_o heat supplied to the gas is

a) $\boldsymbol{2RT_0}$ b) RT_0 c) $\frac{3}{2}RT_0$ d) $\frac{1}{2}RT_0$

Solution : -

In a process pyx = constant, molar heat capacity

is given by $C = \frac{R}{\Upsilon - 1} + \frac{R}{1 - x}$

As the process is $\frac{P}{V}$ = constant,

i.e., PV^{-1} = constant, therefore, x = -1.

For an ideal monatomic gas, $\Upsilon = \frac{5}{3}$

$$\therefore C = \frac{R}{\frac{5}{3} - 1} + \frac{R}{1 - (-1)} = \frac{3}{2}R + \frac{R}{2} = 2R$$

$\Delta Q = nC(\Delta T) = 1(2R)(2T_o - T_o) = 2RT_o$.

9. N molecules each of mass m of gas A and 2N molecules each of mass 2m of gas B are contained in the vessel which is maintained at a temperature T. The mean square of velocity of the molecules of B type is denoted by v^2 and the mean square of the x-component of the velocity of A type is denoted by w^2. The ratio of $w^2: v^2$ is

a) 3: 2 b) 1: 3 **c) 2: 3** d) 1: 1

Solution : -

The mean square velocity of gas molecules is gIven by $v^2 = \frac{3kt}{m}$

For gas A, $v_A^2 = \frac{3kT}{m}$

For a gas molecule

$v^2 = v_x^2 + v_y^2 + v_z^2 = 3v_2^x \left(\because v_x^2 = v_y^2 = v_z^2 \right)$

or $v_x^2 = \frac{v^2}{3}$

From eqn. (i), we get

$$v_x^2 = \frac{v^2}{x} = \left[\frac{\frac{3kT}{m}}{3} \right] = \frac{kT}{m}$$

For gas B,$v_B^2 = v^2 = \frac{3kT}{2m}$

Dividing eqn. (ii) by eqn. (iii), we get

$$\frac{w^2}{v^2} = \frac{\frac{kT}{m}}{\frac{3KT}{2m}} = \frac{2}{3}$$

10. A vessel of volume V contains a mixture of 1 mole of hydrogen and 1 mole of oxygen (both considered as ideal). Let $f_1(v)dv$ denote the fraction of molecules with speed between *v* and (v + dv) with $f_2(v)dv$, similarly for oxygen. Then

a) $f_1(v) + f_2(v) = f(v)$ obeys the Maxwell's distribution law

b) f_1 (v),f_2(v) will obey the Maxwell's disribution law separately

c) Neither $f_1(v)$ nor $f_2(v)$ will obey the Maxwell's distribution law d) $f_2(v)$ and $f_1(v)$ will be the same

Solution : -

The Maxwell-Boltzmann speed distribution function $\left(N_v = \frac{dN}{dv} \right)$ depends on the mass of the gas molecule. [Here, dN is the number of molecules with speeds between *v* and (*v* + *dv*). The masses of hydrogen and oxygen molecules are different.

11. A gas has molar heat capacity C = 37.55 J mole^{-1}, K^{-1} in the process PT = constant. The number of degrees of freedom of the molecules of the gas.

a) 6 b) 3 c) 1 **d) 5**

Solution : -

Here, C = 37.55 J mole^{-1} K^{-1} ; and

PT = K (constant)

According to standard gas equation

PV= RT or P = RT/V

From (i) $\frac{RT}{V} \times T = K$ or $V = \frac{RT^2}{K}$

$\therefore \frac{dV}{dT} = \frac{2RT}{K}$

But $\frac{T}{K} = \frac{1}{P}$ from eqn. (i), therefore $\frac{dV}{dT} = \frac{2R}{P}$

As, $C = C_V + P\frac{dV}{dT}$ therefore,using(ii)

$C = C_V + P \times \frac{2R}{P} = C_V + 2R$ or $C_V = C - 2R$

As,$C_V = \frac{n}{2}R$

$\therefore \frac{n}{2}R = C - 2R$ or $n = \frac{2(C - 2R)}{2} = \frac{2(37.55 - 2 \times 8.3)}{8.3} = 5$

12. 22 gm of CO_2 at 27^0C is mixed with 16 gm of O_2 at 37^0C. The temperature of the mixture is :

a) 32^0C b) 27^0C c) 37^0C d) 30.5^0C

Solution : -

Let t is the temperature of mixture

Heat gained by CO_2 = Heat lost by O_2

Using $\mu_1 C_{v_1} \Delta T_1 = \mu_2 C_{v_2} \Delta T_2$

$$\frac{22}{44}(3R)(t - 27) = \frac{16}{32}\left(\frac{5}{2}R\right)(37 - t)$$

3(t-27)=$\frac{5}{2}$(37-t)

t = 32^0C

13. Boyle's law is applicable for an

a) adiabatic process **b) isothermal process** c) isobaric process d) isochoric process

Solution : -

Boyle's law is applicable to an isothermal process where temperature remains constant.

14. At what temperature is the rms velocity of hydrogen molecule equal to that of an oxygen molecule at 47°C?

a) 10 K **b) 20 K** c) 30 K d) 40 K

Solution : -

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

Now, rms velocity of H_2 molecule = rms velocity of O_2 molecule

$$\sqrt{\frac{3R \times T}{2}} = \sqrt{\frac{3R \times (47 + 273)}{32}}$$

$$T = \frac{2 \times 320}{32} = 20k$$

15. A cylinder of fixed capacity 44.8 litres contains helium gas at standard temperature and pressure. What is the amount of heat needed to raise the temperature of the gas in the cylinder by 15°C ? (R = 8.31 J mol^{-1} K^{-l})

a) 265 J b) 310.10 J **c) 373.95 J** d) 387.97 J

Solution : -

Since one mole of any ideal gas at STP occupies a volume of 22.4 litre.

Therefore, cylinder offixed capacity 44.8 litre must contain 2 moles of helium at STP.

For helium, $C_V = \frac{3}{2}R$ (monatomic)

∴ Heat needed to raise the temperature,

Q = number of moles x molar specific heat x raise in temperature

$= 2 \times \frac{3}{2}R \times 15 = 45R = 45 \times 8.31J = 373.95J$

16. A sample of an ideal gas occupies a volume V at pressure P and absolute temperature T. The mass of each molecule is m, then the density of the gas is

a) mKT **b) $\frac{pm}{KT}$** c) $\frac{P}{Km}$ d) $\frac{P}{KT}$

Solution : -

The equation which relates the pressure (P), volume (V) and temperature (n of the given state of an ideal gas is known as ideal gas equation

PV = KTN, where Nis the number of molecules

$$P\left(\frac{Nm}{\rho}\right) = KTN \left[\because V = \frac{m}{\rho} \right]$$

Density of gas, $\rho = \frac{Pm}{KT}$

17. The internal energy of one gram of helium at 100 K and one atmospheric pressure is:

a) 100 J b) 1200 J **c) 300 J** d) 500 J

Solution : -

The helium molecule is monoatomic and hence its internal energy per molecule is $\frac{3}{2}k_BT$ (where k_B is the Boltzmann, constant).The internal energy per mole is therefore is $\frac{3}{2}RT$ .One gram of helium is one fourth mole and hence its internal energy is $\frac{1}{4} \times \frac{3}{2}R \times 100 = 300J$ taking the value of R to be approximately 8 J mol^{-1} K^{-1}.

18. A real gas behaves like an ideal gas if its
 a) both pressure and temperature are high b) both pressure and temperature are low
 c) pressure is high and temperature is low **d) pressure is low and temperature is high**

 Solution : -

 At high temperature and low pressure the real gas behaves as an ideal gas.

19. A gas is taken in a sealed container at 300K it is heated at constant volume to a temperature 600 K the mean KE. of its molecules is :
 a) Halved **b) Doubled** c) Tripled d) Quadrupled

 Solution : -

 The mean K.E. of gas molecules $E_k = \frac{3}{2}kT$

 So, $\frac{(E_k)'}{(E_k)} = \left(\frac{T'}{T}\right) = \frac{600k}{300k}$

 E'_k=2Ek.

20. The mean free path for a gas, with molecular diameter d and number density n can be expressed as:
 a) $\frac{1}{\sqrt{2}n^2\pi^2d^2}$ b) $\frac{1}{\sqrt{2}n\pi d}$ **c)** $\boldsymbol{\frac{1}{\sqrt{2}n\pi d^2}}$ d) $\frac{1}{\sqrt{2}n^2\pi d^2}$

 Solution : -

 Mean free path for a gas sample

 $\lambda_m = \frac{1}{\sqrt{2}\pi r^2 n} \quad \therefore r = d$

 where d is diameter of a gas molecule and n is molecular deñity.

21. If a given mass of gas occupies a volume of 10 cc at 1 atmospheric pressure and temperature of 100°C (373.15K). What will be its volume at 4 atmospheric pressure the temperature being the same?
 a) 100 cc b) 400 cc **c) 2.5 cc** d) 104 cc

 Solution : -

 From Boyle's Law $P \propto \frac{1}{V}$

 $\therefore \frac{V_2}{V_1} = \frac{P_1}{P_2} \Rightarrow V_2 = 10 \times \left(\frac{1}{4}\right) = 2.5$ cc

22. A litre of an ideal gas at 27°C is heated at a constant pressure to 297^0C. Then the final volume is approximately:
 a) 1.2 litres **b) 1.9 litres** c) 19 litres d) 2.4 litres

 Solution : -

$V_1/V_2 = T_1/T_2$
$V_2 = V_1 \times (T_2/T_1)$
$V_2 = 1 \times [(297 + 273)/(27 + 273)]$
$V_2 = 570/300 = 1.9$ L

23. The molecules of a given mass of a gas have r.m.s velocity of 200 m/s at 27^0C and 1.0×10^5 N/m^2 pressure. When the temperature and pressure of the gas are respectively 127°C and $0.05 \times 10^5 Nm^{-2}$, the rms velocity of its molecules in ms^{-1} is
a) 100/3 b) $100\sqrt{2}$ **c) $400\sqrt{3}$** d) $100\sqrt{2/3}$

Solution : -
It is observed that the rms velocity of molecule is directly proportional to temperature, so
$v_{rms} \propto \sqrt{T}$
or, $v'_{rms} = v_{rms}\sqrt{\frac{T'}{T}}$

Hence, $v'_{rms} = 200 \times \sqrt{\frac{400}{300}} = 400/\sqrt{3}$.

24. A cubic vessel (with faces horizontal + vertical) contains an ideal gas at NTP. The vessel is being carried by a rocket which is moving at a speed of 500 m/s in vertical direction. The pressure of the gas inside the vessel as observed by us on the ground.
a) remains the same because 500 m/s is very much smaller than V_{rms} of the gas
b)
remains the same because motion of the vessel as a whole does not affect the relative motion of the gas molecules and the walls
c)
will increase by a factor equal to $\left[V_{rms}^2 + (500)^2\right]/V_{rms}^2$,where V_{rms} was the original rms mean square velocity of the gas
d) will be different on the top wall and bottom wall of the vessel.

Solution : -
As $P = \frac{nRT}{V}$,It (i.e., P) remains unaffected as n, R, Tand V.

25. For hydrogen gas $C_p - C_v = a$, and for oxygen gas $C_p - C_v = b$, so that relation between a and b given by:
a) a=16 b b) 16a=b c) a=b d) a=4b

Solution : -
For Hydrogen
$C_p - C_v = a = R/2$
For oxygen,
$C_p - C_v = b = R/32$
$\therefore a = 16\ b$

26. The pressure and temperature of two different gases is P and T having the volume V for each. They are mixed keeping the same volume and temperature, the pressure of the mixture will be :
a) P/2 b) P **c) 2P** d) 4P

Solution : -

$$P \propto \frac{M}{V}T$$

So, if V and T are same, then pressure $P \propto M$

Hence, if M becomes 2M, then P becomes 2P

27. The molecules of a given mass of a gas have root mean square speeds of 100 ms^{-1} at 27°C and 1 atmospheric pressure. The root mean square speeds of the molecules of the gas at 127°C and 2 atmospheric pressure is

a) $\mathbf{\frac{200}{\sqrt{3}}}$ b) $\frac{100}{\sqrt{3}}$ c) $\frac{400}{3}$ d) $\frac{200}{3}$

Solution : -

Here, v_{rms_1} =100 m s^{-1}, T_1 = 27°C = (27 + 273) K =300K

P_1 = 1 atm, v =?, T_2 = 127°C = (127 + 273) K = 400 K

P_2 = 2 atm

From $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}; \frac{V_1}{V_2} = \frac{P_2}{P_1} \cdot \frac{T_1}{T_2} = 2 \times \frac{300}{400} = \frac{3}{2}$

Again $P_1 = \frac{1}{3}\frac{M}{V_1}v_{rms_1}^2$ and $P_2 = \frac{1}{3}\frac{M}{V_2}v_{rms_2}^2$

$$\therefore \frac{v_{rms_2}^2}{v_{rm_1}^2} \times \frac{V_1}{V_2} = \frac{P_2}{P_1}$$

$$v_{rms_1}^2 = v_{rms_1}^2 \times \frac{P_2}{P_1} \times \frac{V_2}{V_1} = (100)^2 \times 2 \times \frac{2}{3}$$

$$v_{rms_2} = \frac{200}{\sqrt{3}} ms^{-1}$$

28. The pressure of a gas is raised from 27^{o}C to 927^{o}C. The root mean square speed is:

a) $\sqrt{(927/27)}$ times the earlier value b) Remain the same c) Get halved **d) Get doubled**

Solution : -

$c_{rms} \propto \sqrt{T}$

As temperature increases from 300 K to 1200 K i.e. four times, so, c_{rms} will be doubled.

29. The temperature of an ideal gas is increased from 27°C to 127°C, then percentage increase in v_{rms} is

a) 37% b) 11% c) 33% **d) 15.5%**

Solution : -

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

$$\%increase \quad in \quad v_{rms} = \frac{\sqrt{\frac{3RT_2}{M}} - \sqrt{\frac{3RT_1}{M}}}{\sqrt{\frac{3RT_1}{M}}} \times 100$$

$$= \frac{\sqrt{T_2} - \sqrt{T_1}}{\sqrt{T_1}} \times 100 = \frac{\sqrt{400} - \sqrt{300}}{\sqrt{300}} \times 100$$

$$= \frac{20 - 17.32}{17.32} \times 100 = 15.5\%$$

30. The root mean square speed of smoke particles each of mass 5 x 10^{-17} kg in their Brownian motion in air at N.T.P is:

a) 3 x 10^{-2} ms^{-1} **b) 1.5 x 10^{-2} m s^{-1}** c) 3 x 10^{-3} m s^{-1} d) 1.5 x 10^{-3} m s^{-1}

Solution : -

According to Kinetic theory,

average K.E. of a gas molecule = $\frac{1}{2}mv_{rms}^2 = \frac{3}{2}k_bT$

$$\therefore v_{rms} = \sqrt{\frac{3K_BT}{m}} = \sqrt{\frac{3 \times 1.38 \times 10^{-23} \times 273}{5 \times 10^{-17}}}$$

= 1.5 x 10^{-2} m s^{-1}

31. If pressure of a gas contained in a closed vessel is increased by 0.4% when heated by 1^0C, the initial temperature must be:

a) 250 K b) 250^0C c) 2500 K d) 25^0C

Solution : -

P_1 = P, T_1 = T

P_2=P+ (0.4% of P) =$p + \frac{0.4}{100}p = p + \frac{p}{250} = \frac{251p}{250}$

T_2=T+1

From Gay Lussac's law

$$\frac{P_1}{P_2} = \frac{T_1}{T_2}$$

$$\frac{P}{\frac{251P}{250}} = \frac{T}{T+1}$$

[As V = constant for closed vessel]

By solving we get T = 250 K

32. 1 mole of a gas with $\gamma = \frac{7}{5}$ is mixed with 1 mole of gas with $\gamma = \frac{5}{3}$ the value of y of the resulting mixture of.

a) $\frac{7}{5}$ b) $\frac{2}{5}$ **c) $\frac{3}{2}$** d) $\frac{12}{7}$

33. A balloon contains 1500 m^3 of helium at 27°C and 4 atmospheric pressure. The volume of helium at -3 °C temperature and 2 atmospheric pressure will be

a) 1500 m^3 b) 1700 m^3 c) 1900 m^3 **d) 2700 m^3**

Solution : -

Here, VI = 1500 m^{3}', T_1 = 27°C = 300 K

P_1 = 4 atm, T_2= -3°C = 270 K

P_2 = 2 atm

According to ideal gas equation

$$\frac{P_1V_1}{T_1} \times \frac{P_2V_2}{T_2}$$

$$\therefore V_2 = \frac{P_1V_1}{T_1} \times \frac{T_2}{P_2} = \frac{4 \times 1500 \times 270}{300 \times 2} = 2700m^3$$

34. Ratio specific heats of monoatomic molecule is:

a) γ=5/3 b) γ=3/5 c) γ=4/3 d) γ=2/3

Solution : -

Ratio of specific heats γ is given by γ = 1+2/n, where n is the degree of freedom

We know that the degree of freedom of a molecule is number of independent ways in which it can have energy. Also, a mono atomic molecule can move linearly but can't rotate, so it can have energy along three directions viz. x, y and z axes only.

For a monoatomic gas, n = 3, so γ = 1+(2/n)

γ = 1+(2/3)= 5/3

35. Molecular motion shows itself as

a) temperature b) internal energy c) friction d) viscosity

36. **Assertion:** The ratio of specific heat of a gas at constant pressure and specific heat at constant volume for a diatomic gas is more than that for a monoatomic gas.

Reason : The molecules of a mono atomic gas have more degree of freedom than those of a diatomic gas.

a) If both assertion and reason are true and reason is the correct explanation of assertion.

b) If both assertion and reason are true but reason is not the correct explanation of assertion.

c) If assertion is true but reason is false. **d) If both assertion and reason are false.**

Solution : -

For a monatomic gas, number of degree of freedom, n = 3, and for a diatomic gas, n = 5.

As, $\frac{C_p}{C_v} = \gamma = 1 + \frac{2}{n}$,

For monatomic gas, $\frac{C_p}{C_v} = \frac{5}{3} = 1.67$ and

For diatomic gas, $\frac{C_p}{C_v} = \frac{7}{5} = 1.4$

$$\left(\frac{C_P}{C_v}\right)_{monatomic} > \left(\frac{C_p}{C_v}\right)_{diatomic}$$

37. Two containers A and B are partly filled with water and closed. The volume of A is twice that of B and it contains half the amount of water in B. If both are at the same temperature, the water vapour in the containers will have pressure in the ratio of:

a) 1: 2 **b) 1: 1** c) 2: 1 d) 4: 1

Solution : -

Vapour pressure depends on the temperature alone and not on the amount of substances.

38. If C_p and C_v denote the specific heats (per unit mass) of an ideal gas of molecular weight M, then: where R is the molar gas constant

a) C_p-C_v = R/M^2 **b) C_p-C_v = R** **c) C_p-C_v = R/M** d) C_p-C_v = M/R

Solution : -

C_v = molar specific heat of the ideal gas at constant volume

C_p = molar specific heat of the ideal gas at constant pressure,

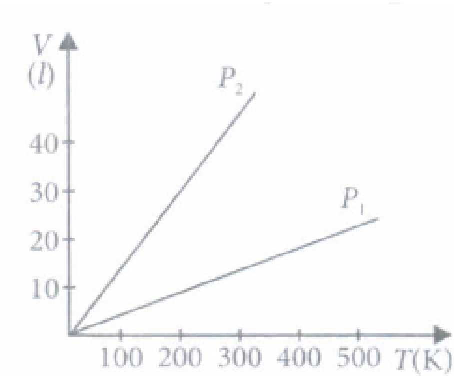
$C'_p=MC_p$ and $C'_v=MC_v$

Also $C'_p - C'_v = R$

$MC_p - MC_v = R$

$C_p-C_v=R/M$

39. Volume versus temperature graphs for a given mass of an ideal gas are shown in figure at two different values of constant pressure. What can be inferred about relation between P_1 and P_2?



a) $P_1 > P_2$ b) $P_1=P_2$ c) $P_1 2$ d) data is insufficient

Solution : -

According to Charle's law

$V \propto T$ or $\frac{V}{T}=$ Constant = $\frac{1}{P}$

As in graph, slope at P_2 is more than slope at P_1,

$\therefore$ $P_1 > P_2$

40. The number of translational degrees of freedom for a diatomic gas is:

a) 2 **b) 3** c) 5 d) 6

Solution : -

For all kinds of gases number of translational degrees of freedom is same.

41. The average kinetic energy of O_2 at a particular temperatures is 0.768 eV. The average kinetic energy of N_2 molecules in eV at the same temperature is

a) 0.0015 b) 0.0030 c) 0.048 **d) 0.768**

Solution : -

Average kinetic energy per molecular of a gas = $\frac{3}{2}KT$ = a constant at a given temperature.

42. A vessel containing 1 mole of 0_2 gas (molar mass 32) at a temperature T. The pressure of the gas is P. An identical vessel containing one mole of He gas (molar mass 4) at temperature 2T has a pressure of:

a) $\frac{P}{8}$ b) P **c) 2P** d) 8P

Solution : -

$P_1V=n_1RT_1$ and $P_2V=n_2RT_2$

$$\therefore \frac{P_2}{P_1} = \frac{n_2}{n_1} \times \frac{T_2}{T_1} = \frac{1}{1} \times \frac{2T}{T} = 2$$

43. The temperature of 5 mole of a gas which was held at constant volume was changed from 100°C to 120^0C. The change in internal energy was found to be 80 J. The total heat capacity of the gas at constant volume will be equal to:

a) 8 JK^{-1} b) 0.8 JK^{-1} **c) 4 JK^{-1}** d) 0.4 JK^{-1}

Solution : -

At constant volume, total energy utilized in increasing the temperature of gas is:

$(\Delta Q)_v = \mu C_v \Delta T$

$80 = \mu C_v (120 - 100)$

Now $\mu C_v = \frac{80}{20}$ = 4 Joule/Kelvin

This is the heat capacity of 5 mole gas.

44. If a gas has n degrees of freedom ratio of specific heats of gas is

a) $\frac{1+n}{2}$ b) $1 + \frac{1}{n}$ c) $1 + \frac{n}{2}$ **d) $1 + \frac{2}{n}$**

Solution : -

$Y = 1 + \frac{2}{n}$

45. If three molecules have velocities 0.5 km s^{-1}, 1 km s^{-1} and 2 km s^{-1}, the ratio of the rms speed and average speed is:

a) 2.15 **b) 1.13** c) 0.53 d) 3.96

Solution : -

rms speed, $v_{rms} = \sqrt{\frac{v_1^2 + v_2^2 + v_3^2}{3}}$

$= \sqrt{\frac{(0.5)^2 + (1)^2 + (2)^2}{3}}$

= 1.32 km s^{-1}.

Average speed, $v_{av} = \frac{v_1 + v_2 + v_3}{3} = \frac{0.5 + 1 + 2}{3} = 1.17 kms^{-1}$

$= \frac{v_{rms}}{v_{av}} = \frac{1.32}{1.17} = 1.13$

46. The average thermal energy for a mono-atomic gas is : (k_B is Boltzmann constant and T, absolute temperature)

a) $\frac{7}{2}k_BT$ b) $\frac{1}{2}k_BT$ **c) $\frac{3}{2}k_BT$** d) $\frac{5}{2}k_BT$

Solution : -

Average thermal energy $= \frac{3}{2} K_BT$

where 3 is translational degree of freedom for monoatomic gas total degree of freedom f=3 (translational degree of freedom)

47. The degree of freedom of a molecule of a triatomic gas is:

a) 2 b) 4 **c) 6** d) 8

Solution : -

Number of degrees of freedom $= 3\,K - N$

Where K is no. of atom and N is the number of relations between atoms. For triatomic gas, $K = 3, N = {}^3C_2 = 3$

No. of degree of freedom =3(3)-3=6

48. N molecules, each of mass m, of gas A and 2 N molecules, each of mass 2 m, of gas B are contained in the same vessel which maintained at a temperature T. the mean square of the velocity of molecules of B type is denoted by v^2 and the mean square of the X component of the velocity of A type is denoted by ω^2, then (ω^2/ v^2) is:

a) 2 b) 1 c) 1/3 **d) 2/3**

Solution : -

Mean square velocity of gas molecules is

v^2= 3kT/m

Now for gas B:

v_B^2 = v2 = 3kT/2m

Since the molecule has equal probability of motion in all directions, so:

$v_x^2 = v_y^2 = v_z^2 = \omega^2$

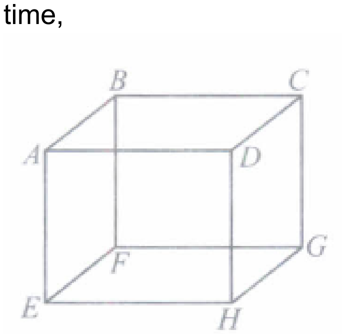
Now, $v^2 = v_x^2 + v_y^2 + v_z^2 = 3v_x^2$

$v_x^2 = \frac{v^2}{3}$

ω^2 = 1/3 x 3kT/m = (kT/m)

$\frac{\omega^2}{v^2}$ = [(kT/m) / (3kT/2m)] = 2/3

49. 1 mole of an ideal gas iscontained in a cubical volume V, A BCDEFGH at 300 K as shown in figure. One face of the cube (EFGH) is made up of a material which totally absorbs any gas molecule incident on it. At any given time,



a) the pressure on EFGH would be zero b) the pressure on all the faces will be equal

c) the pressure of EFGH would be double the pressure on ABCD

d) the pressure on EFGH would be half that on ABCD.

50. The volume of vessel A is twice the volume of another vessel B, and both of them are filled with the same gas. If the gas in A is at twice the temperature and twice the pressure in comparison to the gas in B, then the ratio of the gas molecules in A to that of B is

a) $\frac{1}{2}$ **b) $\frac{2}{1}$** c) $\frac{3}{2}$ d) $\frac{2}{3}$

Solution : -

$PV = nRT$

$\therefore n_B = \frac{PV}{RT}$ and $n_A = \frac{2P \times 2V}{R \times 2T}$

or $n_A = \frac{2PV}{RT}$

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