PHYSICS

BOOKS - BHARATI BHAWAN PHYSICS (HINGLISH)

KINETIC THEORY OF GASES

Others

1. Caculate the root mean square velcity of molecules of a gas whose densilty is

$1.4kgm^{-3}$ at a pressure of $76cm$ of mercury (sp. gr. sp.of mercury $= 13.6$ and $g = 9.81ms^{-2}$)

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2. Calculate the root mean square velocity of the molecules of hydrogen at $0^{\circ}C$ and $100^{\circ}C$. Density of hydrogen at NTP $= 0.0896kgm^{-3}$ and density of mercury $= 13.6 \times 10^{3}kgm^{-3}$

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3. A certain mass of hydrogen occupies 100cc at a pressure of $10^5 Nm^{-2}$ at $27^\circ C$. What is the mass of hydrogen? Molecular weight of hydrogen is 2 and $R = 8.3 Jmol^{-1} K^{-1}$.

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4. The temperature at which the root mean square velocity of the gas molecules would becomes twice of its value at $0^\circ C$ is

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5. The molecular weight of a is 2. Calculate the root mean square velocity of its molecules at $0^\circ C$ and $100^\circ C$ givenn that $R = 8.3 Jmol^{-1} K^{-1}$

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6. Calculate the root mean square velocity of a nitrogen molecule at NTP if the density of hydrogen under the same conditiion is $9 \times 10^{-2} kgm^{-3}$

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7. If root mean sqauare velocity of the molecules of hydrogen at NTP is $1.84 kms^{-1}$, calculate the rms velocity of oxygen molecules at NTP. Molecular weights of hydrogen and oxygen are 2 and 32 respectively.

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8. Calculate the number of molecules per unit volume of a perfect gas at $27^{\circ} C$ and $10 mm$ of

mercury. Density of mercury $= 13.6 \times 10^3 kgm^{-3}$ and Boltzmann constant $= 1.38 \times 10^{-23} JK^{-1}$

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9. Calculate the molecular kinetic energyof hydrogen at $100^\circ C$. Molecular weights of hydrogne is 2 and $R = 8.3 Jmol^{-1} K^{-1}$. Is it the same for all gases.

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10. Calculate the kinetic energy per unit volume of a gas at a pressure of $10mm$ of Hg. (Density of $Hg = 13.6 \times 10^3 kgm^{-3}$ and $g = 9.8ms^{-2}$)

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11. An electric bulb of volume 250cc was sealed during manufacturing at a pressure of $10^{-3}mm$ of mercury at $27^\circ C$. Compute the number of air molecules contained in the bulb. Avogadro constant $= 6 \times 10^{23} mol^{-1}$,

density of mercury $= 13600 kgm^{-3}$ and $g = 10 ms^{-2}$.

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12. A vessel of water is put in a dry, sealed room of volume $50 m^3$ at a temperature $27^\circ C$. The saturated vapour pressure of water at $27^\circ C$ is $40 mm$ of mercury. How much water will evaporate before the water is in equilibrium with its vapour?

(Relative density of mercury

$= 13.6, g = 9.8ms^{-2}$ and

$= 8.3Jmol^{-1}K^{-1}$)

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13. A lamp of voume 50 cc was sealed off during manufacture at a pressure 0.1 newton per square metre at $27^{\circ}C$. Calculate the mass of the gas enclosed in the lamp. Molecular weight of the gas $= 10$ and $R = 8.3Jmol^{-1}K^{-1}$

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14. A cylinder of length $42cm$ is divided into chambers of equal volumes and each half contains a gas of equal mass at temperature $27^\circ C$. The separator is a frictionless piston of insulating material. Calculate the distance by which the piston will be displacement if the temperature of one half is increaded to $57^\circ C$.

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15. A column of mercury of 10cm length is contained in the middle of a narrow horizontal 1m long tube which is closed at both the ends. Both the halves of the tube contain air at a pressure of 76 cm of mercury. By what distance will the column of mercury be displaced if the tube is held vertically?

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16. One gram mole of oxygen at 27° and one atmospheric pressure is enclosed in vessel.

(i) Assuming the molecules to be moving the V_{rms}, Find the number of collisions per second which the molecules make with one square metre area of the vessel wall.

(ii) The vessel is next thermally insulated and moved with a constant speed V_0. It is then suddenly stopped. The process results in a rise of the temperature of the gas by $1^\circ C$. Calculate the speed V_0.

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17. A vessel containing one gram -mole of oxygen is enclosed in a thermally insulated vessel. The vessel is next moved with a constant speed v_0 and then suddenly stopped. The process results in a rise in the temperature of the gas by $1^\circ c$. Calculate the speed v_0.

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18. A thermally insulated vessel with gaseous nitrogen at a temperature of $27^{\circ}C$ moves with velocity $100m/s^{-1}$. How much (in percentage) and in what way will the gas pressrue change if the vessel is brought to rest suddenly ?

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19. A vessel of volume , $V = 5.0$ litre contains $1.4g$ of nitrogen at a temperature $T = 1800K$.

Find the pressure of the gas if $30\,\%$ of its molecules are dissociated into atoms at this temperature.

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20. A parallel beam of molecules moving with velocity v impinges on a wall at an angle θ to its normal. Find the pressure exerted by the beam on the wall assuming perfect elastic collisions. The concentration of the molecules in the beam is n.

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21. How many degrees of freedom have the gas molecules, if under standard conditions the gas density is $1.3kgm^{-3}$ and the velocity of sound propagation in it is $C = 330ms^{-1}$.

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22. A vessel of capacity $V = 101$ contains $m_0 = 2g$ of nitrogen molecules at $27^\circ C$. Calculate the time in which half of it will

escape into a vacuum through a hole of area $s = 1cm^2$. You may take $\bar{c} = c_{\text{rms}}$

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23. Find the minimum radius of a planet of mean density $5500kgm^{-3}$ and temperature $400^\circ C$ which has retained oxygen in its atmosphere. Density of oxygen at STP $= 1.424kgm^{-3}$. $G = 6.6 \times 10^{-11} Nm^2 kg^{-2}$

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24. A gaseous mixture enclosed in a vessel of volume V consists of one mole of a gas A with $\gamma = (C_p/C_v) = 5/3$ and another gas B with $\gamma = 7/5$ at a certain temperature T. The relative molar masses of the gasses A and B are 4 and 32, respectively. The gases A and B do not react with each other and are assumed to be ideal. The gaseous mixture follows the equation $PV^{19/13} = constant$, in adiabatic processes.

(a) Find the number of moles of the gas B in the gaseous mixture.

(b) Compute the speed of sound in the gaseous mixture at $T = 300K$.

(c) If T is raised by 1K from 300K, find the $\%$ change in the speed of sound in the gaseous mixture.

(d) The mixtrue is compressed adiabatically to $1/5$ of its initial volume V. Find the change in its adaibatic compressibility in terms of the given quantities.

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25. At constant volume the molar heat capacity of oxyhydrogen gas (mechanical mixture of hydrogen and oxygen) is n times greater than that of water produced by the chemical combination of the gases. Find n

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26. Calculate the kinetic energy of translation of the molecules of $20g$ of CO_2 at $27^\circ C$.

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27. Calculate the average momentum of a hydrogen molecule at $20^{\circ}C$. Boltzmann constant $= 1.38 \times 10^{-23} JK^{-1}$ and mass of a hydrogen molecule $= 3.2 \times 10^{-27} kg$.

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28. The maximum rarefaction produced by up-to-date laboratory methods is 10^{-11} mm of mercury. What is the density of the rarest air

at $17^{\circ}C$? Molecular weight of air $= 28$ and $760mm$ of mercury $= 1.013 \times 10^{5} Pa$.

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