PHYSICS

BOOKS - CENGAGE PHYSICS (HINGLISH)

KINETIC THEORY

Question Bank

1. Air is filled at $60^{\circ}C$ in a vessel of open mouth. The vessel is heated to a temperature

T so that $\frac{1}{4}$ part of air escapes. The value of T(in $\overset{0}{C}$) is

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2. At a pressure of 24×10^5 dyne/cm^2, the volume of $(O)_2$ is 10 litre and its mass is $20g$. The rms veloçity (in m / s) is

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3. A vessel contains 1 mole of 0, 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 a temperature $2T$, has a pressure of nP. Find u.

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4. The given figure shows two flasks connected to each other. The volumo of flask 1 is twice that of flask 2 . The system is filled with an ideal gas at temperatare $100K$ and $200K$ respectively, in the flasks. If the mass of the gas in flask 1 be m, then the mass of the gas in flesk 2 in equilibriam is $\left(\frac{m}{x}\right)$. Find x.

'(##CEN_KSR_PHY_JEE_C13_E01_004_Q01##)'

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5. A closed vessel contains a mixture of two diatomic gases A and B, Molar mass of A is 16times than of B and mass of gas A contained in the vessel is 2 times that of B. If the pressure exerted by B is x times of that exerted by A, then find the value of x.

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6. The molar specific heat of the process $V \propto T^4$ for $(CH)_4$ gas at room temperature is yR. Find y. (Here $R =$ Universal gas constant)

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7. One mole. of an ideal gas undergoes a process $P = \frac{P_0}{1 + \left(\frac{V_0}{V}\right)^2}$. Here P_0 and V_0 are constants. The change in temperature of the gas when volume is changed from $V = V_0$ to $V = 2V_0$ is $\frac{xP_0V_0}{10R}$. Find x. (Here $R =$ Universal gas constant)

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8. The given figure shows a parabolic graph between T and $\frac{1}{V}$ for' a mixture of a.gas undergoing an adiabatic process. The ratio of $v_{(ms)}$ to the speed of sound in the mixture is k. Find $2k^2$.

'(##CEN_KSR_PHY_JEE_C13_E01_008_Q02##)'

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9. A gaseous mixture enclosed in a vessel of volume V consists of one gram mole of gas A with $\gamma = \frac{C_P}{C_F} = \frac{5}{3}$ and another gas B with $\gamma = \frac{7}{5}$ at a certain temperature T. The gram molecular weights of the gases A and B are 4 and 132 , respectively. The gases A and B do not react with cach other and are assumed to be ideal. The gaseous mixture follows the equation $PY^{\frac{19}{13}} =$ Constant, in adiabatic process. Find the inumber of gram moles of the gas B in the gaseous mixture.

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10. 2 moles of He are mixed with 2 moles of H_2 in a closed adiabatic container. Initially the mixture occupies 3 liters at $27\overset{o}{C}$. The volume is suddenly decreased to $\left(\frac{3}{2}\right)$ liters. Find γ for the mixture. (H_2). and He can be treted as ideal gases

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11. A vessel is partitioned in two equal halves by a fixed diathermic separator. Two different ideal gases are. filled in left (L) and right (R) halves. The rms speed of the molecules in L part is equal to the mean speed of molecules in the R part. If the ratio of the mass of a molecule in L part to that of a molecule in R part is $\frac{x^{\circ}\pi}{y}$. then find $|x-y|$.

'(##CEN_KSR_PHY_JEE_C13_E01_011_Q03##)'

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12. At pressure P and absolute temperature T_1 a mass M of an ideal gas fills a closed container of volume (V). An additional mass $2M$ of the same gas is added into the container and the volume is then reduced to

$\frac{V}{3}$ and the temperature to $\frac{T}{3}$. If now the pressure of the gas is nP, then find n.

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13. Assume a sample of an ideal gas in a vessel. The velocities of molecules in the sample are between $2\frac{m}{s}$ to $5\frac{m}{s}$. If the velocity of molecules (v) and the number of molecules (n) are related as $n = 7y - v^2 - 10$, then the most probable velocity (in $\frac{m}{s}$) in the sample is (Here v is measured in $\frac{m}{s}$).

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14. Pressure (P) versus temperature (T) graph of an ideal gas is shown in the figure. Density of the gas at point A is ρ_0 and at B is ρ. Find $\frac{\rho}{\rho_0}$.

'(##CEN_KSR_PHY_JEE_C13_E01_014_Q04##)'

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15. A $P-V$ graph for an ideal 'gas undergoing polytropic process $PY^m =$

Constant is sbown below. Find the value of m.

'(##CEN_KSR_PHY_JEE_C13_E01_015_Q05##)'

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16. A gas has molar heat capacity $C = 37.35 J mol^{-1} K^{-1}$ in the process $PT =$ Constant. Find the number of degree of freedom of molecules in the gas.

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17. A mixture of ideal gages N_2 and (He) are taken in the mass ratio of $14:1$, respectively. Molar heat capacity of the mixture at constant pressure is $\frac{xR}{6}$. What is the value of x?

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18. P-V diagram of an ideal diatomic gas is a straight line passing through origin. The molar heat capacity of the gas in the process is xR. Find x (Here R - Universal gas constant)

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19. One mole of a diatomic gas undergoes 'a process $P = \dfrac{P_0}{1 + \left(\frac{V}{V_0}\right)^s},$ where P_0, V_0 are constants. The translational kinetic energy of the gas when $V = V_0$ is given by $\dfrac{\alpha P_0 V_0}{\beta}$, Find $(\alpha + \beta)$.

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20. A container has an ideal gas at pressure P in thermal equilibrium. Assuming the mass of a molecule is m and all the molecules are moving with same speed v in random directions, the expression for number of collisions per second which the molecules make with unit area of container's wall is $\frac{\sqrt{x}P}{mv}$, Find $(x+y)$.

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21. A diatomic gas of molecular weight $30\frac{g}{m}ol$ is filled in a container at $300K$. It is moving with a velocity of $100\frac{m}{s}$. If it is suddenly stopped, the rise in temperature of gas is $\left(\frac{10x}{R}\right)K$, where R is universal gas constant

Find the value of x in J/mol.

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22. A cubical box of side of $1m$ contains helium gas (atomic weight 4) at a pressure of $100\frac{N}{m^2}$.

During" an observation time of $1s$, an atom traveling with the root-mean-square speed parallel to one of the edges of the cube, was found to make 500 hits with a particular wall, without any collision with other atoms. Evaluate the temperature (in K) of the gas, (Take $R = \frac{25}{3} Jmo^{-1} K^{-1}$ and $k = 1.38 \times 10^{-23} \frac{J}{K}$)

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23. The ratio of translational to rotational kinetic energies at $100K$ temperature is $3:2$. The internal energy (in J) of one mole gas at that temperature is $\left(R = 8.3 J mol^{-1} K^{-1}\right)$

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24. Two containers are filled with ideal gases at the same temperature. In the container on the left is a gas of molar mass $2M$, volume $2V$, and number of moles $\cdot 2n$. In the container on the right is a gas of molar mass M, voluine V, arid moles n. The ratio of the pressure of the gas on the left to- the pressure of the gas on the right container is

'(##CEN_KSR_PHY_JEE_C13_E01_024_Q06##)'

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25. Two conducting movable smooth pistons are kept inside a tion-conducting, ediabatic. container with initial positions as shown. Gas is present in the three parts A, B and C having initial pressures as shown. Now.the pistons are released. The final equilibrium position length of part A is found to be $\frac{L}{x}$.

Find x.

'(##CEN_KSR_PHY_JEE_C13_E01_025_Q07##)'

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26. A closed container of volume $0.02m^3$ contains a mixture of neon and argon gases at a temperature of $27\overset{o}{C}$ and pressure of $I \times 10^5 Nm^2$. The total mass of the mixture is

$28g$. If the gram molecular weights of neon and argon are 20 and 40 , respectively, then find the mass ($\in p$) of argon gas in the container. Assume gases to be ideal. $(GivenR = 8.314Jmol^{-1}K^{-1})$

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27. An air bubble doubles in radius on rising from the bottom of a lake to its surface. If the atmospheric pressure is equal to that due to a column of $10m$ of water, then what will be the depth (in m) of the lake? (Assume that surface tension is negligible.)

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28. $5g$ of helium having rms speed of molecules us $1000\frac{m}{s}$ and 24 g of oxygen having rms speed of molecules as $1000\frac{m}{s}$, are introduced into a thermally isolated vessel. The rms speed (in m / s) of oxygen when thermal equilibrium is attained is (Neglect the heat capacity of the vessel.)

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29. One mole of diatomic gas is being heated in a closed tank from $300'(K)$ up to $1000(\sim K)$. During the process, part of the molecules dissociate. Aț $1000(\sim K)$, the energy of the diatomic molecules are only half of that of the whole gas. The ratio of gas pressure $\left(\frac{P_{\text{final}}}{P_{\text{initial}}}\right)$ is $\frac{m}{n}$. Find $(m-n)$. (The oscillation of the molecules are not to be taken in account.)

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30. An ideal gas is present in a massive metal cylinder of height $h = 1m$, closed on top by a moving piston. A weight is gently put on the top of the piston. The piston immediately drops by $x = 2.5cm$, Over a long time it was seen that the piston comes down another $x^{t} = 1cm.$ Determine the degree of freedom for the molecules of the gas. Room temperature is constant, gas does not leak out. Use binomial approximation.

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31. Three insulated vessels of equal volumes V are connected by thin tubes that can transfer gas but do not transfer heat. Initially all the vessels are filled with the same type of gas at a temperature T_0 and pressure P_0. Then the temperature in the first vessel is doubled and the temperature in the second vessel is tripled. The temperature in the thin vessel remains unchanged. If initial pressure is $77 cm$ of Hg, then find the final pressure (in cm of Hg) in the system.

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