PHYSICS

BOOKS - BHARATI BHAWAN PHYSICS (HINGLISH)

SPECIFIC HEAT CAPACITY OF GASES

Others

1. If the density of air ate NTP is $1.293 kgm^{-3}$ and its sp. heat capacity at constant volume is

$169 cal kg^{-1} K^{-1}$, calculate specific heat capacity at constant pressure. (Density of mercury $= 13.6 \times 10^3 kg m^{-3}$ at $0^\circ C$ and $J = 4.2$ joule cal^{-1})

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2. In an experiment using Regnault's method of determining specific heat capacity of a gas at constant pressue, a gas was stored in a reservoir of 50- litre capacity at $10^\circ C$ and 6 atmosphere pressure. The gas was heated to

$100^{\circ}C$ and passed through a calorimeter at $10^{\circ}C$. When the temperature rose to $30^{\circ}C$ the calorimeter was detached from the heating bath. The pressure of the reservoir was found to fall to 4 atmosheric pressure in the mean time. Calculate the specific heat capacity of the gas at constant pressure if the water equivalent of the calorimeter and its contents was $50g$. Mass of 1 liter of gas at NTP $= 1.25 \times 10^{-3}kg$

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3. In a Jolly's differential calorimeter one of the spheres of volume 1 litre was filled with experiemental gas at 10 atmospheric pressure. When steady state was attained, the excess of steam that condensed on this sphere was $0.378g$. Calculate the specific heat capacity of the gas at constant volume. (Initial temperature of gas $= 15^\circ C, L$ of steam of $100^\circ C = 540 \times 10^3 calkg^{-1}, J = 4.2Jcal^{-1}$ and density of gas at 1 atmospheric pressure $= 0.8kgm^{-3}$)

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4. Find the number of degrees of freedom of molecules in a gas. Whose molar heat capacity

(a) at constant pressure $C_p = 29 J mol^{-1} K^{-1}$

(b) $C = 29 J mol^{-1} K^{-1}$ in the precess (pT) = constant.

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5. A vessel of volume $V = 7.5$ litres contains a mixture of ideal gases at temperature $T = 300K$. There are $n_1 = 0.1$ mole of oxygen

$(M_1 = 32)$, $n_2 = 0.2$ mole of nitorgen $(M_2 = 28)$ and $n_3 = 0.3$ mole of carbon dioxide $(M_3 = 44)$. Assuming the gases to be ideal, find (a) the pressure of the mixture, (b) the man molar mass M of the mixture.

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6. A vessel contains a mixture consisting of $m_1 = 7g$ of nitrogen $(M_1 = 28)$ and $m_2 = 11g$ of carbon dioxide $(M_2 = 44)$ at temperature $T = 300K$ and pressure $p_0 = 1$ atm. Find the density of the mixture.

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7. The volume of each sphere of a Jolly's differential steam caloriment is 500 cc and the excess of steam condensed is $0.1g$. Find the specific heat capacity of the gas at constant volume. The initial temperature of the gas is $15^\circ C$ and density of gas $6kgm^{-3}$. The latent heat capacity of steam $= 540 \times 10^3 calkg^{-1}$.

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8. Find the value of Joule's mechanical equivalent of heat from the following data: density of hydrogen at NTP is $0.09kgm^{-3}$, its specific heat capacity at constant pressure $= 3400calkg^{-1}K^{-1}$ and ratio of specific heat capacities $(\gamma) = 1.4$.

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9. The specific heat capacity of helium at constant pressure is $1250 cal kg^{-1} K^{-1}$. Assuming that the gas is monatomic, calculate the mechanical equivalennt of heat. Densityy of gas at NTP $= 0.1785 kg m^{-3}$

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10. The difference in the two molar specific heat capacities of a gas is 2 calories. Calculate the mechaical equivalent of heat assuming that the molar volume of a gas a NTP is $0.0244 m^3$. ($g = 9.81 ms^{-2}$ and density of mercury $= 13.6 \times 10^3 kgm^{-3}$)

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11. The velocity of sound thorugh CO_2 at $0^\circ C$ is $259 ms^{-1}$. The specific heat capacity of CO_2 at constant pressure is $220 cal kg^{-1} K^{-1}$ and $\gamma = 1.31$. Calculate the value of J.

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12. One cubic metre of air at $27^{\circ} C$ and $10^{5} Nm^{-2}$ pressure weighs $1.18 kg$. Calculate the value of the gas constant for $1 kg$ of the gas and calculate c_p of air if $168 cal kg^{-1} K^{-1}$ and $J = 4.2 J cal^{-1}$

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13. The density of gas at NTP $= 2.468 kg m^{-3}$ and $c_p = 156 cal kg^{-} K^{-1}$. Find the ratio of specific heat capacities of the gas. Is it diatomic or tiratomic?

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14. In the determination of the sp heat capacity of a gas at constant pressure by Regnaults, method $0.03m^3$ of the gas was supplied from a reservoir at $10^\circ C$ and 16 atmospheric pressure. The pressure of the gas was reduce to 2 atmospheres at te end of the experiment, the temperature remaiing constant at $10^\circ C$. The temperature of the oil bath of the apparatus was maintained at $150^\circ C$. The hot gas was led into a calorimeter at $10^\circ C$. The final temperature of the calorimeter and its contents was $31.5^\circ C$ and its water equivalent was $210g$. If the density of the gas was $0.089kg$ per cubic metre at NTP, calculate the specific heat capacity of the gas at constant pressure.

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15. One cubic metre of hydrogen at $0^\circ C$ and $76cm$ and of Hg weighs $0.0896kg$. The specific heat capacities of hydrogen at constant pressure volume are 3409 and 2411 cal per kg per kelvin, respectively. Calculate the value of J. $(g = 9.81, ms^{-2}$ density of mercury $= 13.6 \times 10^3$ kg per cubic metre)

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16. The gran -molecular sp heat capacity of hydrogen at constant pressure $= 6.865$ cal and volume $= 0.0224$ cubic metre and coefficient of expansioin of hydrogen at constant pressure $\alpha = \dfrac{1}{273.3}$ per kelvink.

Calculate the value of J. (1 atmospheric pressure $= 1.013 \times 10^5$ newtons per square metre.)

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17. Two thermally insulated vessels 1 and 2 are filled with air and connected by a short tube equipped with a valve. The volumes of the vessels, the pressures and temperatues of air in them are V_1, p_1, T_1 and $V_2, p_2, T_2,$

respectively. Find the air temperature and pressure after the opening of the valve.

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18. If the kinetic energy of the molecules in 5 litre of helium at 2 atm is (E). What is the kinetic energy of molecules in 15 litre of oxygen at 3 atm in terms of (E) ?

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19. One mole of oxygen is mixed withone mole of helium. What is γ of the mixture?

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20. Under standard conditions the density of a helium (atomic weight $= m_1$) and nitrogen (atomic weight m_2) mixture is ρ. Find the concentration of the helium atoms in the mixture.

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21. A gas consisting of $N -$ atomic molecules has the temperature T at which all degrees of freedom (translational, rotational, and vibrational) are excited. Find the mean energy of molecules in such a gas. What fraction of this energy corresponds to that of translational motion ?

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22. Find the molar mass and the number of degrees of freedom of a gas if its heat capacities are as $c_v = 650 J kg^{-1} K^{-1}$ and $c_p = 910 J kg^{-1} K$.

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23. Find the rate v with which helium flows out of a thermally insulated vessel into vacuum through a small hole. The flow rate of the gas inside the vessel is assumed to be negligible under these conditions. The temperature of helium in the vessel is $T = 1.000K$.

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24. Find the specific heat capacities c_v and c_p for a gaseous mixture consisting of $7.0g$ of nitrogen and $20g$ of argon. The gases are assumed to be ideal.

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25. Calculate the values of the molecular mass and gamma for a gaseous mixture consisting of $n_1 = m$ moles of oxygen and $n_2 = 3$ moles of carbon dioxide. The gases are assumed to be ideal.

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26. How many atoms do the molecules of a gas consist of if its γ increases 1.2 times when the vibrational degrees of freedom are frozen? Assume the atoms to hbe linearly arranged.

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