PHYSICS

BOOKS - CHETANA PUBLICATION

Kinetic Theory of Gases and Radiation

Example

1. State Boyle's Law?

2. State Charle's Law.

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3. State Gay Lussac's Law.

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4. What is equation of state for a gas.

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5. What is Avogadro's number?

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6. What is a mole.

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7. How do you get ideal gas equation from the gas laws?

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8. 16 gm of oxygen occupy $0.025m^3$ at $27^\circ C$. If the universal gas constant is $8.4J/molK$, find the pressure exerted by it. (molecular weight of oxygen = 32).

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9. Using ideal gas equation, determine the value of R (Given that one gram of molecule of gas at N.T.P. occupies 22.4 litre).

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10. Determine the pressure of 4 gm of hydrogen occupying 16 litres of volume at $10^{\circ}C$ ($R = 8.315J/molK$, molecular weight of hydrogen = 2)

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11. Write ideal gas equation for a mass of 7g of nitrogen gas. (M = 28 for nitrogen)

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12. What is an ideal gas?

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13. Does an ideal gas exist in reality?

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14. What is a real gas.

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15. How is a real gas different from an ideal gas.

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16. State the conditions under which the real gas behaves like an ideal gas

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17. What is the effect of size of the molecule of a real gas, as against the ideal gas comprising point particles or the properties of the gas.

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18. What are the three main assumptions which explain the behaviour of gases?

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19. What are the properties of gases?

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20. State Avogadros hypothesis.

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21. State basic assumptions of kinetic theory of gases.

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22. Define:- Free path.

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23. Define:- Mean free path.

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24. How is mean free path related to density of the gas.

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25. How is mean free path related to the size of the molecule.

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26. State the expression of mean free path and state the terms involved.

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27. How does the pressure of the gas affect the mean free path.

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28. How are articles coated with metal films.

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29. Obtain the mean free path of nitrogen molecule at $0^{\circ}C$ and 1.0 atm pressure. The molecular diameter of nitrogen is 324 pm (assume that the gas is ideal).

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30. Derive an expression for pressure exerted by the gas on the basis of kinetic theory of gases.

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31. On the basis of kinetic theory of gases, derive an expression for the pressure exerted by the gas in an enclosed vessel.

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32. Define the following terms.- Mean velocity.

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33. Define the following terms:-Mean square velocity.

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34. Define the following terms.- Root mean square velocity.

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

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36. State and deduce Boyle's law on the basis of M kinetic theory of gases.

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37. Show that R.M.S. velocity of gas molecule is directly proportional to the square root of its absolute temperature.

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38. Derive an expression for KE and KE per unit volume of gas using the expression for pressure exerted by the gas.

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39. Show that average kinetic energy per unit volume of the gas is $\frac{3}{2}P$.

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40. Derive an expression for:- Kinetic energy per mole or kilomole

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41. Derive an expression for:- Kinetic energy per molecule

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42. Derive an expression for:- Kinetic energy per unit mass

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43. Show that kinetic energy per unit mass of a gas is $3\frac{P}{2_{\rho}}$.

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44. The velocities of five molecules are $2m/s$, $3m/s$, $4m/s$, $5m/s$ and $6m/s$, respectively, Find the mean velocity, mean square velocity and root mean square velocity of the molecule.

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45. Find r.m.s velocity of three molecules having velocities $10km/s$,$20km/s$, $30km/s$.

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46. Find R.M.S. velocity of H_2 molecules at N.T.P. (density of $H_2 = 0.09kg/m^3, P = 10^5 N/m^2$)

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47. Find number of molecules in $1cm^3$ of oxygen at N.T.P., if mass of oxygen molecules is $5.28 \times 10^{-28} kg$ and R.M.S. velocity of oxygen molecules at N.T.P. is $426m/s$. (Take pressure at N.T.P.=$10^5 N/m^2$)

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48. At what temperature will nitrogen molecules have same R.M.S. speed as oxygen molecules at 400 K (molecular weight of oxygen = 32, molecular weight of nitrogen = 28)

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49. If R.M.S. velocity of hydrogen molecule at N.T.P. is $1840 m / s$, determine the R.M.S.

velocity of oxygen molecule at N.T.P. (molecular weight of hydrogen and oxygen are 2 and 32, respectively).

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50. Calculate R.M.S. speed of oxygen molecules at $227^{\circ}C$ (density of oxygen at N.T.P. = $1.429kg/m^3$ and one atmospheric pressure = $1.013 \times 10^5 N/m^2$).

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51. Find the KE:- per cm3

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52. Find the KE :- per mole.

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53. Find the KE:- per gm,

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54. Find the KE:- per molecule of nitrogen at N.T.P.(molecular weight of N_2 = 28, Normal pressure = 76 cm of mercury, density of mercury $1.36gm/cm^2$, g = $980cm/s^2$, Avogadro's number 6.023×10^{23}, R = $8.314 \times 10^7 erg/mol^k$, molecular weight of nitrogen = 31).

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55. The kinetic energy of 1 kg of oxygen at 300 K is $1.356 \times 10^6 J$. Find kinetic energy of 4 kg of oxygen at 400 K.

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56. Calculate average molecular kinetic energy:- per kilomole.

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57. Calculate average molecular kinetic energy:- per kilogram of oxygen at $27^\circ C$ (R =

8320 J/k mole K, Avogadro s number 6.02×10^{27} molecule/K mole.

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58. Calculate kinetic energy of 10 gm of Argon molecule at $127^{\circ} C$. (R = $8320 J / K$ mole K, Atomic weight of Argon = 40)

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59. Determine the pressure of oxygen at $0^{\circ} C$ if the density of oxygen at N.T.P.=$1.44 kg / m^{3}$ and R.M.S. speed of the molecules at N.T.P. = $456.4 m / s$.

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60. If the R.M.S. velocity of oxygen molecules at N.T.P. is $460 m / s$, determine the R.M.S. velocity of hydrogen molecule at N.T.P. (molecular weight of O_2 = 32, molecular weight of hydrogen = 2).

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61. At what temperature can R.M.S. velocity of gas be doubled its value at N.T.P.?

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62. If the density of oxygen is $1.44 kg / m^3$ at a pressure of $10^5 N / m^2$, find the R.M.S. velocity of oxygen molecules.

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63. Calculate the ratio of mean square speeds of molecules of a gas at 30 k and 120 k.

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64. 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.

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65. Show that rms velocity of an oxygen molecule is $\sqrt{2}$ times that of a sulphur dioxide molecule at S.T.P.

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66. At what temperature will oxygen molecules have some rms speed as helium molecules at STP (molecular masses of oxygen and helium are 32 and 4 respectively)

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67. Compare the rms speed of hydrogen molecule at $127^{\circ}C$ with rms speed of oxygen molecules at $27^{\circ}C$ given that molecular masses of hydrogen and oxygen are 2 and 32 respectively.

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68. Find the KE of 5 litres of a gas at STP given standard pressure is $1.013 \times 10^5 N/m^2$.

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69. Calculate average molecular kinetic energy:- per kilomole.

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70. Calculate the average molecular kinetic energy : per kg molecule of oxygen at $127^{\circ} C$, given that the molecular weight of oxygen is 32, $R = 8.31 J mol^{-1} K^{-1}$, and Avogadros number N_A is 6.02×10^{23} molecules mol^{-1}.

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71. Calculate the average molecular K.E:- per molecule of oxygen at $127^{\circ}C$ given that molecular weight =32, $R = 8.31 J\,mol^{-1}\,K^{-1}$, $N_A = 6.02 \times 10^{23}, T = 127^{\circ}C$

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72. At 300 K, what is the rms speed of Helium atom? [mass of He atom is 4u, 1u = $1.66 \times 10^{-27} kg, k_B$= $1.38 \times 10^{-23} J/K$

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73. 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.

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74. Explain Maxwell distribution of molecular speeds with necessary graph.

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75. State and explain law of equipartition of energy.

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76. Define degree of freedom of a system.

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77. What do you mean by number of degrees of freedom?

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78. Name two monoatomic gases.

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79. Name two diatomic gases.

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80. Name a polyatomic gas.

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81. Discuss the number of degrees of freedom of:- Monoatomic gases

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82. Discuss the number of degrees of freedom of:- Diatomic gases

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83. Discuss the number of degrees of freedom of:- Polyatomic gases.

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84. Define Specific Heat Capacity.

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85. Define and explain specific heat.

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86. Why do we consider two specific heats heat for a gas?

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87. Why is $C_p > C_v$?

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88. State Mayer's Relation in terms of molar specific heats.

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89. Write Mayer's relation in terms of principal specific heats.

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90. Derive Mayer's relation.

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91. Given the values of the two principal specific heats, $S_P = 3400\ cal\ kg^{-1}K^{-1}$ and $S_v = 2400\ cal\ kg^{-1}K^{-1}$ for the hydrogen gas, find the value of J if the universal gas constant $R = 8300\ J\ kg^{-1}K^{-1}$.

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92. The difference between the two molar specific heats of a gas is $8000 J kg^{-1} K^{-1}$. If the ratio of the two specific heats is 1.65. Calculate the two molar specific heats.

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93. Explain the method to determine specific heat capacity of a monoatomic gas by using law of equipartition of energy.

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94. Determine specific heat capacity of diatomic gas by law of equipartition of energy.

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95. Determine specific heat capacity of polyatomic gas by the law of equipartition of energy.

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96. Determine specific heat capacity of solid by the law of equipartition of energy.

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97. Using law of equipartition of energy, determine specific heat capacity of water.

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98. Calculate the number of degree of freedom associate with 4 gm of helium at N.T.P.

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99. The ratio of specific heats of a gas is 1.4. If the specific heat at constant volume is 4.82 kcal/kmol K. Find universal gas constant.

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100. What is heat? Which are the three modes of transfer of heat? Explain.

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101. Define radiant energy and thermal radiation.

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102. Define coefficient of absorption. Give its S.I. unit and Dimension.

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103. Define coefficient of reflection. Give its S.I. unit and dimension.

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104. Define coefficient of transmission. Give its S.I. unit and dimension.

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105. Show that a + r +1=1 where symbols have their usual meaning.

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106. Define athermanous and substance diathermanous.

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107. A substances may be athermanous or diathermanous for certain wavelength, while good absorber for other wavelength. Explain.

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108. What is perfectly black body ?

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109. Can a perfect blackbody be realized in practice ?

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110. What acts as a perfect black body in Fery's perfect, black body?

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111. Why is the double walled sphere in Fery's perfect black body evacuated?

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112. Which acts as a good absorber: Black polished surface or Black rough surface.

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113. Are good absorber of heat, good emitters?

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114. Why are the inner walls of vacuum bottles or thermoes flasks silvered?

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115. Name a substance that resembles a perfect black body.

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116. With a neat diagram, explain the construction Q and working of Fery's black body.

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117. The coefficient of absorption and coefficient of reflection of a thin uniform plate are 0.75 and 0.20, respectively. If 200 K cal of heat is incident on the surface of the plate, find the quantity of heat transmitted.

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118. The coefficient of absorption and reflection on the surface of the thin plate are 0.74 and 0.22, respectively. If 184 calories of radiant heat is incident on the surface of the plate, find the quantities of heat absorbed, reflected, and transmitted.

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119. The coefficient of absorption of heat surface of a body is 0.68. When 100 calories of heat is incident on the body, 27 calories are reflected from the surface. Find the coefficient of transmission of the body.

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120. If a = 0.72, r = 0.24 then what is the value of t.

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121. Which body radiates heat energy at higher rate? Hotter or cooler.

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122. Which coloured bodies reflect most of visible radiation? Lighter or darker.

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123. Which coloured bodies absorb most of visible radiation? Lighter or Darker coloured.

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124. What happens to temperature of the body if it radiates more heat than it absorbs.

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125. When is a body said to be in thermal equilibrium?

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126. Is there any heat transfer when the body is in thermal equilibrium with the surrounding ?

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127. Why does a body appear red hot where the temperature is around $800^{\circ}C$.

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128. What happens to tungsten filament when heated to about $3000^{\circ}C$?

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129. State the factor on which the heat radiated by a body depends upon.

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130. State and explain Prevost theory of heat exchanges.

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131. Define emissive power of a body. State its unit and dimension.

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132. State the factors on which emissive power of a body depends. What can you say about the emissive power of perfect black body?

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133. What is coefficient of emission (emissivity)?

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134. Define absorptive power, state its unit and dimension.

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135. State Kirchhoff's law of radiation and give its theoretical proof.

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136. Explain spectral distribution of black body radiation.

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

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138. The energy of 6000 J is radiated in 5 minutes by a body of surface area $100cm^2$. Find emissive power of a body.

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139. A metal cube of length 10 cm radiates heat at the rate of 60 watt. Find its emissive power of a perfectly black body at that temperature.

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140. Briefly explain Planck's Quantum Theory.

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141. What are red giants?

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142. State Wien's displacement law, State its significance.

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143. Calculate the value of $\lambda_{\max}$ for solar radiation assuming that surface temperature of Sun is 5800 K (b = $2.897 \times 10^{-3} mK$). In which part of the electromagnetic spectrum, does this value lie?

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144. What is the peak wavelength of radiation emitted by a black body at temperature $40^{\circ}C$ (b $=2.898 \times 10^{-3} mK$)

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145. Find the temperature of a black body if its spectrum has a peak at :- $\lambda_{\max}$ = 700 nm (visible)

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146. Find the temperature of a black body if its spectrum has a peak at :- $\lambda_{\max}$ = 3 cm (microwaves region)

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147. Find the temperature of a black body if its spectrum has a peak at :- $\lambda_{\max}$ = 3 cm (microwaves region)

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148. Earth's mean temperature can be assumed to be 280K. 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?

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149. State and expain Stefan-Boltzmann law of radiation.

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150. Using Stefan's law,obtain expression for the rate of loss of heat by a black body in cooler surroundings. How is this expression modified, if the body is not black?

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151. A body of surface area $10cm^2$ and temperature $727^\circ C$ emits 300 J of energy per minutes.Find the emissivity.

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152. Compare rates of loss of heat by the body at temperature $527^\circ C$ and $127^\circ C$. Temperatue of surrounding is $27^\circ C$.

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153. Find the surface area of black body maintained at $127^{\circ} C$ radiating energy at the rate of $1459.2 J / \sec.$

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154. A metal cube has each side of length 1 m losses all its energy at a rate of 3000 watt. If the emissity is 0.4, Find its temperature (Given:a=$5.767 \times 10^{-8} J / m^2 s k^{-1}$)

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155. Compare the ratio of radiation of metal sphere at $627^\circ C$ and $327^\circ C$.

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156. Calculate the energy radiated is one minutes by a black body of surface area $400cm^2$,when it is maintained at $127^\circ C$.

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157. A body having surface area $5cm^2$ and temperature of $727^\circ C$ radiates 300 J of energy per minutes. What is its emissivity? (Stefan's constanta $\sigma = 5.7 \times 10^{-8} J/mk^4$)

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158. A filament of an evacuated light blue has length 10 cm, diameter 0.2mm and emissivity 0.2. Calculate the power it radiates at 2000 K ($\sigma = 5.67 \times 10^{-8} \frac{J}{m^2} k^4$)

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159. A 100 watt filament loses all its power by radiation, when it is heated to a temperature 2500 K. If the diameter of the filament is 0.2mm and emissivity of the filament is 0.5, find the length of the filament to ($\sigma = 5.67 \times 10^{-8} J/m^2 s K^4$)

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160. Calculate the energy radiated in one minute by a black body of surface area $100cm^2$ when it is maintained at $227^\circ C$ ($\sigma = 5.67 \times 10^{-8} \frac{J}{m^2} sK^4$)

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161. Calculate the energy radiated is one minute by a blackbody of surface area $200cm^2$ at $127^\circ C$ ($\sigma = 5.7 \times 10^{-8} Jm^{-2} s^{-1} K^{-4}$)

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162. A 60 watt filament lamp loses all its energy by radiation from its surface. The emissivity of the surface is 0.5. The area of the surface is $5 \times 10^{-5} m^3$. Find the temperature of the filament ($\sigma = 5.67 \times 10^{-8} m^2 s^{-4} K^{-4}$)

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163. Compare the rate of loss of heat from a metal sphere at $827^\circ C$ with the rate of loss of heat from the same sphere at $427^\circ C$, if the temperature of the surrounding is $27^\circ C$.

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164. Assuming that the temperature at the surface of the Sun is 6000 K, find out the size of a virtual star (in terms of the size of Sun) whose surface temperature is 3000 K and the power radiated by the virtual star is 25 times the power radiated by the Sun. Treat both, the Sun and virtual star as a blackbody.

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165. Energy is emitted from a hole in an electric furnace at the rate of 20W when that temperature of the furnace is $727^{\circ}C$. What is the area of the hole ($\sigma = 5.7 \times 10^{-8} Js^{-1} m^{-2} K^{-4}$)

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166. Compare the rates of emission of heat by a black body maintained at $727^{\circ}C$ and at

$227^{\circ}C$, if the black bodies are surrounded by an enclosure (black) at $27^{\circ}C$. What would be the ratio of their rates of loss of heat.

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167. A small blackened solid copper sphere of radius 2.5cm is placed in an evaculated chamber. The temperature of the chamber is maintained at $100^{\circ}C$. At what rate energy must be supplied to the copper sphere to maintain its temperature at $110^{\circ}C$. (

$\sigma = 5.76 \times 10^{-8} Js^{-1} m^{-2} K^{-4}$) Treat sphere as black body.

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Exercise

1. 16 gm of oxygen occupied $0.025 m^3$ at $27^\circ C$. It the universal gas constant is $8.311 J / mol K$. Find the pressure exerted by it. (molecular weight of oxygen = 32)

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2. A cylinder filled with hydrogen gas at 500 K exerts a pressure of 4 atoms. If hydrogen is replaced by equal mass of helium, at same temperature, what will be pressure exerted by helium and relative number of molecules of hydrogen and helium.

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3. The velocities of three molecules of a gas are $2m/s$,$3m/s$ and $4m/s$, respectively. Find the mean velocity and R.M.S. velocity of the molecule.

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4. Calculate the R.M.S. velocity of helium at temperature $0^\circ C$ (density of helium $0.1785kg/m^3$, p = $1.013 \times 10^5 N/m^2$)

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5. At what temperature can the R.M.S. velocity of gas be three times its value at N.T.P.?

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6. Calculate the number of molecules in one litre of gas at N.T.P., if mass of each molecule is $4.55 \times 10^{-25} kg$ and its R.M.S. velocity at N.T.P. is $350 m/s$ (P = $10^5 N/m^2$).

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7. Find the mass of 10c.c of gas at N.T.P. if RMS.velocity of gas molecules is $400m/s$(p = $1 \times 10^5 N/m^2$)

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8. Find the KE per kg of nitrogen molecule at $127^\circ C$ (molecular weight of nitrogen = 28, R = $8320J/Kmo \leq K$).

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9. Calculate the R.M.S. velocity of oxygen molecule at N.T.P., if the density of oxygen at N.T.P. is $1.44kg/m^3$ (Given: atmospheric pressure at N.T.P. = $1.013 \times 10^5 N/m^2$).

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10. If the R.M.S. velocity of oxygen molecules at N.T.P. is $460m/s$, determine the R.M.S. velocity of hydrogen molecules at N.T.P. (molecular weight of oxygen = 32, molecular weight of hydrogen = 2).

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11. The ratio of molar specific heats of certain gas is 1.4, if molar specific heat of gas at constant volume is $4.965 Kcal / Kmo \leq K$, find universal gas constant.

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12. Compare the R.M.S. velocity of hydrogen molecules at 400 K with R.M.S. velocity of oxygen molecules at 900 K. (Molecular weight

of hydrogen = 2, molecular weight of oxygen = 32)

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13. Radiant energy is incident on the body at a rate of $1500J / \min$. If coefficient of emission of a body is 0.9 and coefficient of reflection is 0.06. Find the radiant energy:- absorbed.

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14. Radiant energy is incident on the body at a rate of $1500J/\min$. If coefficient of emission of a body is 0.9 and coefficient of reflection is 0.06. Find the radiant energy:- reflected.

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15. Radiant energy is incident on the body at a rate of $1500J/\min$. If coefficient of emission of a body is 0.9 and coefficient of reflection is

0.06. Find the radiant energy:- the radiant energy transmitted by the body in 7minutes.

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16. A metal cube of each side 0.05 m long emits 0.6k cal in 80 seconds, Calculate the emissive power of its surface.

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17. The emissive power of sphere of area $0.02m^2$ is $0.5kcal/s-m^2$. What is the amount of heat radiated by the spherical surface in 20 seconds?

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18. The coefficient of absorption of a surface is 0.6. When radiant energy is incident on the surface at $1500J/\min$, the energy reflected in 5 minutes is 450 J. Find the coefficient of reflection and transmission of the surface.

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19. Assuming that the sun radiates as a black body, calculate the energy radiated per minute by unit area of its surface. Surface temperature of the sun = $5727^{\circ} C$ and Stefan's constant = $5.7 \times 10^{-8} Jm^{-2}K^{-4}s^{-1}$.

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20. The temperature of the filaments of a 100W electric lamp is $2727^{\circ} C$. The emissivity of the surface of the filament is 0.086 and its radius is 0.5 mm. Find the length of the filament. $\sigma = 5.7 \times 10^{-8} S.I.$ units.

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21. A black body of mass 32g, specific heat = $0.1 cal^{\circ} c$ and area $8 cm^2$ at a temperature of 300^{C} is kept in an enclosure maintained at 0^{C}.

If the body cools at the rate of $0.35^{\circ} C / s$, calculate Stefan's constant. J = 4.18 joule/cal.

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22. If the surface temperature of the sun is assumed to be 6150 K, find the wave length of maximum intensity in the sun's radiation taking Wien's constant $2.88 \times 10^{-3} mk$.

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23. The coefficients of reflection and transmission of the surface of a thin plate are 0.22 and 0.04 respectively. If 250 calories of radiant heat is incident on the surface of the plate, how much heat is absorbed by the surface?

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24. A metal cube of each side 2 cm long emits 0.16 kcal of heat in 100s. Calculate the emissive power of the cube in joule at that temperature. $J = 4200 J/kcal$.

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25. Energy is emitted from a hole in an electric furnace at the rate of 20 watt when furnace is at $227^{\circ} C$. Find the area of the hole, $\sigma = 5.7 \times 10^{-8} S.I.$ units.

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26. A copper sphere has a surface area of $3.142 \times 10^{-2} m^2$ and its emissivity is 0.018. Find the energy lost by the sphere per second when its temperature is $100^{\circ} C$. ($\sigma = 5.67 \times 10^{-8} \frac{W}{m^2} k^4$.)

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27. A metal cube has each side 2.5 cm long and radiates $0.36 kcal / \min$. What is the emissive power of its surface? If the emissivity of its surface is 0.4, what would be the emissive power of the cube if it were perfectly black?

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28. If λm for solar radiation is $4753A^{\circ}$, estimate the surface temperature of the sun. Wien's constant, b = 0.2893 cmk.

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29. Analysis of the sun's spectrum shows that the wave length of maximum intensity is $4750 A^{\circ}$. Taking Wien's constant as $2.9 \times 10^{-3} mk$, find the surface temperature of the sun.

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30. The coefficient of absorption and coefficient of reflection of a thin uniform plate are 0.75 and 0.20, respectively. If 200 K cal of

heat is incident on the surface of the plate, find the quantity of heat transmitted.

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31. Heat is incident at the rate of 10 W on an opaque body having an emissivity of 0.8. Find the quantity of radiant heat reflected by it in 1 minute.

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32. A 100 watt filament loses all its power by radiation when it is heated to a temperature of 2500 K. If the diameter of the filament is 0.2 mm and the surface emissivity of the filament is 0.5, find the length of the filament. (Stefan's constant $\sigma = 5.67 \times 10^{-8} \frac{W}{m^2} k^4$)

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33. In an ideal gas, the molecules possess

A. only kinetic energy

B. both kinetic energy and potential energy

C. onlt potential energy

D. neither kinetic energy nor potential energy

Answer:

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34. The mean free path X of molecules is given by where n is the number of molecules per unit volume and d is the diameter of the molecules.

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

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

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

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

Answer:

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35. 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%

Answer:

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36. If a = 0.72, r = 0.24, then the value of t is.......

A. 0.02

B. 0.04

C. 0.4

D. 0.2

Answer:

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37. Theratioof emissive powerof perfectly blackbody at $1327^{\circ} C$ and $527^{\circ} C$ is

A. $4:1$

B. $16:1$

C. $2:1$

D. $8:1$

Answer:

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38. The average distance covered by a moleculebetween two successive collision is..........

A. free path

B. constant path

C. mean free path

D. free path per unit time

Answer:

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39. According to the Law of equipartition of energy, the average K.E. of one molecule of diatomic gas will be......

A. $\dfrac{3K_bT}{2}$

B. $\dfrac{5K_bT}{2}$

C. $3R\dfrac{T}{2}$

D. $5R\dfrac{T}{2}$

Answer:

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40. K.E. per unit volume is given by........

A. $E=\frac{3}{2_p}$

B. $E=\frac{1}{2}mv^2$

C. $E=\frac{1}{2}mv2$

D. $E=\frac{1}{2}mNC^2$

Answer:

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41. How is a real gas different from an ideal gas.

A. high temperature, low pressure

B. low temperature, hight pressure

C. high temperature, high pressure

D. low temperature, low pressure

Answer:

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42. Mean square velocity of five molecules of velocities $2m/s$, $3m/s$, $4m/s$, $5m/s$, and $6m/s$ is.......

A. $10m^2/s^2$

B. $18m^2/s^2$

C. $20m^2/s^2$

D. $15m^2/s^2$

Answer:

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43. Temperature of a gas is $0^{\circ} C$. Its root mean square velocity will be double at..........

A. $273^{\circ} C$

B. $1092^{\circ} C$

C. $819^{\circ} C$

D. $103^{\circ} C$

Answer:

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44. If K.E. is doubled, then the change in temperature from $27^\circ C$ is.........

A. $54^\circ C$

B. $327^\circ C$

C. $273^\circ C$

D. $-232^\circ C$

Answer:

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45. The ratio of pressure of two gases is $3:2$ and ratio of densities of two gases is.........

A. 3 : 2

B. 2 : 3

C. 1 : 3

D. 3 : 1

A. $3:2$

B. $2:3$

C. $1:3$

D. $3:1$

Answer:

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46. The average KE of a gas molecules at $27^{\circ}C$ is $6.21\times10^{-21}J$. The average K.E. at $227^{\circ}C$ will be.........

A. $9.35\times10^{-21}J$

B. $10.35\times10^{-21}J$

C. $11.35\times10^{-21}J$

D. $12.35\times10^{-21}J$

Answer:

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47. Which statement is true?

A. $R = (\gamma - 1)C_v$

B. $R = (\gamma - 1)C_p$

C. $C_v = R(\gamma - 1)$

D. $C_p = \dfrac{R}{(\gamma - 1)}$

Answer:

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48. The R.M.S. velocity of nitrogen molecules at N.T.P is.....

A. $493m / s$

B. $532m / s$

C. $546m / s$

D. $33m / s$

Answer:

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49. The temperature of gas is increased from $0^\circ C$ to $273^\circ C$. The average KE of molecule changes in the ratio of.....

A. $1:4$

B. $4:1$

C. $1:2$

D. $2:1$

Answer:

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50. The specific heat of ice at $0^{\circ} C$ is

A. $C_p + C_v = \frac{R}{J}$

B. $C_p + C_v = 0$

C. $C_p - C_v = R$

D. $C_p - C_v = \frac{R}{J}$

Answer:

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51. Which of the following properties of gas molecule is same for all ideal gases at a particular temperature.

A. mass

B. velocity

C. momentum

D. kinetic energy

Answer:

Watch Video Solution

52. Meankineticenergyof perfectgasisproportional to

A. T

B. T^2

C. $\frac{1}{T}$

D. $\frac{1}{T^2}$

Answer:

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53. The kinetic energy per molecule of hydrogen gas at N.T.P. is........

A. $6.657 \times 10^{-21} J / mo \leq c\underline{e}s$

B. $5.657 \times 10^{-21} J / mo \leq c\underline{e}s$

C. $6.657 \times 10^{-21} J / mo \leq c\underline{e}s$

D. $8.657 \times 10^{-21} J / mo \leq c\underline{e}s$

Answer:

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54. The ratio of specific heats (y) for monoatomic gas is.......

A. $\frac{3}{5}$

B. $\frac{9}{7}$

C. $\frac{7}{9}$

D. $\frac{5}{3}$

Answer:

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55. The specific heat capacity of water is..........

A. 6R

B. 3R

C. 9R

D. 12R

Answer:

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56. What is the sum of coefficients of absorption, reflection, and transmission of the body is.......

A. 0.1

B. 7

C. 1.1

D. 1

Answer:

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57. When coefficient of transmission (t) = 0, what type of the body is..........

A. perfect absorber

B. perfect reflector

C. opaque body

D. perfect transparent

Answer:

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58. According to Kirchhoff's law of radiation at

a temperature.........

A. a=e

B. $\frac{E}{E_b} = e$

C. $\frac{E}{a} = E_b$

D. Both (a) and (c)

A. a=e

B. $\frac{E}{E_b} = e$

C. $\frac{E}{a} = E_b$

D. both (a) and (c)

Answer:

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59. If a = 0.72, r = 0.24, then the value of t is.......

A. 0.02

B. 0.04

C. 0.4

D. 0.2

Answer:

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60. The S.I. unit of Wien's constant is........

A. $cal / m^2 \sec$

B. $J / m^2 \sec$

C. $\frac{m}{K}$

D. m / K

A. $cal / m^2 \sec$

B. $J / m^2 \sec$

C. mK

D. m / K

Answer:

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61. If the gas pressure is 6×10^5 dyne $/cm^2$, then its K.E. per cubic cm will be........

A. $6 \times 10^5 erg$

B. $4 \times 10^5 erg$

C. $9 \times 10^5 erg$

D. $12 \times 10^5 erg$

A. $6 \times 10^5 erg$

B. $4 \times 10^5 erg$

C. $9 \times 10^5 erg$

D. $12 \times 10^5 erg$

Answer:

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62. The temperature of a certain gas increased from $27^\circ C$ to $127^\circ C$, the increase in energy is........

A. $\frac{3}{4}$times initial value

B. $\frac{4}{3}$times initial value

C. 100 times initial value

D. 27 times initial value

Answer:

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63. The light from the sun is found to have a maximum intensity near the wavelength of

470 nm. Assuming the surface of the sun as a black body, the temperature of the sun is

A. 5800 K

B. 6050 K

C. 6166 K

D. 6500 K

Answer:

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64. The temperature of an ideal gas is increased from $27^{\circ} C$ to $927^{\circ} C$. The root mean square velocity of its molecules becomes

A. twice

B. half

C. four times

D. one third

Answer:

Watch Video Solution

65. The velocities of 4 molecules are $2m/s$, $4m/s$, $5m/s$ and $6m/s$ respectively. What is their mean square velocity?

A. $\frac{51}{4}\frac{m^2}{s^2}$

B. $\frac{61}{4}\frac{m^2}{s^2}$

C. $\frac{71}{4}\frac{m^2}{s^2}$

D. 81/4m^2/s^2`

Answer:

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66. The root mean square speed of hydrogen molecules at 300 K is $1930 m / s$. Then the root mean square speed of oxygen molecules having the same mass at 900 K will be

A. $643 \frac{m}{s}$

B. $836 \frac{m}{s}$

C. $\frac{1930}{\sqrt{3}}$

D. $1930\sqrt{3}$

Answer:

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67. A vessel contains one mole of oxygen and one mole of hydrogen at N.T.P. What is the ratio of the values of rms velocities of hydrogen and oxygen molecules?

A. $1:16$

B. $16:1$

C. $4:1$

D. $1:4$

Answer:

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68. The number of molecules in a gram molecule of a gas is called

A. Universal gas constant

B. Planck's constant

C. Avogadro's number

D. Boltzmann constant

Answer:

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69. The temperature of an ideal gas is increased from $27^\circ C$ to $327^\circ C$. It the r.m.s speed of its molecules at $27^\circ C$ is $200m/s$, then the new r.m.s speed at 600 K will be

A. $200\frac{m}{s}$

B. $200\sqrt{5}\frac{m}{s}$

C. $200\sqrt{2}\frac{m}{s}$

D. $400\frac{m}{s}$

Answer:

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70. The speed of four gas molecules are $1km/s$, $3km/s$, $5km/s$ and $7km/s$ respectively. The difference between their r.m.s. speed and average speed is

A. $0.583km/s$

B. $0.438km/s$

C. $0.358k\frac{m}{s}$

D. $0.638k\frac{m}{s}$

Answer:

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71. What is the density of a gas at N.T.P. if the rms velocity of the gas molecules is $400m/s$? (Take atmospheric pressure P= $1 \times 10^5 N/m^2$)

A. $\frac{5}{8}kg/m^3$

B. $\frac{11}{8}kg/m^3$

C. $\frac{15}{8}kg/m^3$

D. $\frac{25}{8}kg/m^2$

Answer:

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72. The r.m.s. speed of the molecules of an enclosed gas is x. What will be the r.m.s. speed, if the pressure of the gasis doubled but the tmeperature is kept constant?

A. x

B. $\frac{x}{2}$

C. 2x

D. $\sqrt{x}$

Answer:

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73. If the masses of all the molecules of a gas are doubled and their speed are havled, then the ratio of the final and initial pressures will be

A. $2:1$

B. $1:2$

C. $1:4$

D. $4:1$

Answer:

Watch Video Solution

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74. At what temperature the K.E. of gas molecules is half of that of its value at $27^{\circ}C$?

A. $135^{\circ}C$

B. $150^{\circ}C$

C. 150 K

D. 300 K

Answer:

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75. At what temperature will the average K.E. of the hydrogen molecules be half of its value at N.T.P.?

A. 136.5 K

B. 273 k

C. 1052 k

D. 546 k

Answer:

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76. What is the value of $\gamma = \frac{C_p}{C_v}$, if the gas has f degrees of freedom?

A. $1 + \frac{2}{f}$

B. $\frac{1}{2} + f$

C. $1 + \frac{f}{2}$

D. $1 + \frac{f}{2}$

Answer:

Watch Video Solution

77. Which one of the following molecules does not possess vibrational energy?

A. Oxygen

B. Nitrogen

C. Argon

D. CO_2

Answer:

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78. What is the mean energy per molecule for a polyatomic gas with n degrees of freedom?

A. $nK\frac{T}{N}$

B. $3K\frac{T}{2}$

C. $nK\frac{T}{2}N$

D. $nK\frac{T}{2}$

Answer:

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79. For an ideal gas______

A. > 1

B. < 1

C. $= 1$

D. ≥ 1

Answer:

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80. When a black body is heated, it emits heat radiations of

A. Infrared wavelengths

B. Ultraviolet wavelengths

C. All wavelengths

D. A particular wavelength

Answer:

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81. A black body at a temperature of $227^{\circ} C$ radiates heat at a rate of $5 cal / cm^2 s$. At a temperature of $727^{\circ} C$, the rate of heat radiated per unit area will be

A. $80 cal / cm^2 s$

B. $500 cal / cm^2 s$

C. $100 cal / cm^2 s$

D. $250 cal / cm^2 s$

Answer:

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82. If the temperature of the sun is doubled, the rate of energy received on earth will be increased by a factor

A. 2

B. 4

C. 16

D. 8

Answer:

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83. The dimensional formula for Stefan's constant is

A. $M^0L^0T^{-2}K^{-4}$

B. $M^1L^1T^{-2}K^{-2}$

C. $M^1L^0T^{-3}K^{-4}$

D. $M^0L^2T^{-3}K^{-3}$

Answer:

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84. A sphere, a cube and a thin circular plate all made of the same material and having the same mass are initially heated to a temperature of $300^\circ C$. Which one of these cools faster?

A. Circular plate

B. Sphere

C. Cube

D. All will cool at the same rate

Answer:

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85. If a black body is heated from $27^\circ C$ to $927^\circ C$, then the ratio of the radiation emitted by the body at the two temperatures will be

A. $1:4$

B. $1:16$

C. $1:256$

D. $1:64$

Answer:

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86. The ratio of the wavelength of emission corresponding to the maximum emission in the spectrum of a black body heated to temperatures 1000 K and 2000 K respectively is

A. $\frac{1}{4}$

B. $\frac{1}{2}$

C. $4:1$

D. $2:1$

Answer:

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87. If the temperature of a black body is doubled, the frequency at which the spectral intensity becomes maximum will be

A. doubled

B. halved

C. unchanged

D. quadrupled

Answer:

Watch Video Solution

88. The phenomenon of black body radiation was explained satisfactorily by

A. kinetic theory

B. classical theory

C. quantum theory

D. theory of relativity

Answer:

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89. The maximum wavelength of radiation emitted at 1500K is $5\mu m$. The maximum wavelength of radiation emitted at 2500 K will be

A. $2\mu m$

B. $3\mu m$

C. $4\mu m$

D. $10\mu m$

Answer:

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90. The maximum wavelength of radiation emitted by a black body at $1227^{\circ}C$ is Am. What is its maximum wavelength at $2227^{\circ}C$?

A. $\lambda \frac{m}{2}$

B. $\lambda \frac{m}{3}$

C. $\frac{3}{5} \lambda m$

D. $\frac{9}{25} \lambda m$

Answer:

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91. The temperature of a black body is gradually increased. The colour of the body will change from

A. White-green-red

B. Red-yellow-blue

C. Red-violet-yellow

D. Yellow-green-red

Answer:

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92. The surface temperature of a black body is 1200 K. What is the wavelength corresponding to maximum intensity of emission of radiation

if Wien's constant b = $2.892 \times 10^{-3} mk$?

A. $2.41 \times 10^{-4} m$

B. $2.41 A$

C. $2.41 \mu m$

D. $2.41 cm$

Answer:

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93. The earth radiates in the infrared region of the spectrum. The wavelength of the maximum intensity of the spectrum is correctly given by

A. Stefan's law of radiation

B. Wien's lavy

C. Rayleigh Jeans law

D. Planck's law of radiation

Answer:

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94. Select and write the most appropriate answer from the given alternatives for each sub-questions:- The kinetic energy of one gram molecule of a gas at normal temperature and pressure is (R = $8.31 J/mol.\ k$)

A. $0.56 \times 10^4 J$

B. $1.3 \times 10^2 J$

C. $2.7 \times 10^2 J$

D. $3.4 \times 10^3 J$

Answer:

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95. Select and write the most appropriate answer from the given alternatives for each sub-questions:- Diathermanous surface has

A. $r = 1$

B. $a = 1$

C. $t = 1$

D. $t = 0$

Answer:

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96. Select and write the most appropriate answer from the given alternatives for each sub-questions:- If the absolute temperature of a gas is increased 3 times, the root mean square velocity of the molecules of the gas will be

A. 3 times

B. 9 times

C. $\sqrt{3}\times$

D. $1\sqrt{3}\times$

Answer:

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97. How many degrees of freedom are there for a monoatomic gas?

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98. State Mayer's Relation in terms of molar specific heats.

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99. What is the value of coefficient of absorption for a perfect black body?

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100. State Wien's displacement law. Give S.I. unit and dimension of Wien's constant.

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101. Calculate R.M.S. velocity of helium at temperature $0^{\circ} C$. (density of helium is $0.1785 kg / m^3$, atmospheric pressure = $1.013 \times K^5 N / m^2$).

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102. The coefficient of absorption and reflection of thin uniform plate are 0.75 and 0.20, respectively. If 200 kcal of heat is incident on the surface of plate, find the quantity of heat transmitted.

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103. Calculate the energy radiated in 30 seconds by perfectly black sphere of radius5cm maintained at $127^\circ C$. (Stefan's constant $s = 5.7 \times 10^{-8} J/m^2 sk^4$)

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104. Define co-efficient of emission state kirchoff's law of radiation.

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105. The energy of 6000 J is radiated in 5 minutes by a body of surface area $100cm^2$. Find emissive power of a body.

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106. What is perfectly black body? Explain construction and working of Fery's black body.

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107. Derive an expression for KE and KE per unit volume of gas using the expression for pressure exerted by the gas.

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108. At what temperature can R.M.S. velocity of gas be doubled its value at N.T.P.?

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109. Determine the specific heat capacity ratio for a diatomic gas for:- rigid molecule

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110. Show that R.M.S. velocity of a gas molecule is directly proportional to the square roof of its absolute temperature. Show that average kinetic energy per unit volume of the gas is $\frac{3}{2}P$

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