Answer on Question #83474 - physics - thermodynamics

1. At what temperature the root mean square velocity will be half of that standard pressure and temperature, the pressure being kept constant.

Solution.

Calculate the root mean square velocity by relation as follows.

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

Here, R is the gas constant , T is the standard temperature and M is the mass of mole.

Here , V_{rms} is directly propotional to the square root of temperature.

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

Substitute 273 K for T.

Calculate the temperature at half root mean square velocity by the relation as follows.

$$V_{rms}' \propto \sqrt{T}'$$

Here , V_{rms}' half mean square velocity.

By the proportionality relation

$$\frac{V_{rms}}{V_{rms}'} = \sqrt{\frac{273\ K}{T'}}$$

$$2 = \sqrt{\frac{273\ K}{T'}}$$

$$T' = \frac{273\ K}{4}$$

$$T' = 68.25\ K$$

Answer : 68.25 K

2. For an ideal gas $= 1.4$, calculate the values of molar specific heats of the gas .(R=8.31 J/mol K)

Solution.

Calculate the molar specific heats by the relation as follows.

$$\gamma = \frac{C_P}{C_V}$$

$$C_P = \gamma C_V$$

Here, C_P is the molar specific heat at the constant pressure and C_V is the molar specific heat at constant volume.

Calculate the values of molar specific heats by the relation as follows.

$$C_P - C_V = R$$

$$\gamma C_V - C_V = R$$

Substitute $\gamma = 1.4$ and R=8.31 J/mol K.

$$1.4C_V - C_V = 8.31$$

$$C_V = \frac{8.31 \ \ J/molK}{0.4}$$

$$C_V = 20.775 \ \ J/molK$$

Calculate C_P by the relation

$$C_P = \gamma C_V$$

$$C_P = (1.4)\left(20.775 \ \frac{J}{molK}\right)$$

$$C_P = 29.085 \ \ J/molK$$

Answer.

$$C_V = 20.775 \ \ J/molK$$

$$C_P = 29.085 \frac{J}{mol} K$$

3.How much heat is required to raise the temperature by 40 of 14g nitrogen gas at constant pressure?[Molar mass of nitrogen=28 g, R=8.31J/Kmol for diatomic gas =5/2R]

Solution.

Calculate the heat required by the relation as follows.

$$Q = nC_V\Delta T$$

Here, n is the mole of gas, C_V is the molar specific heat of gas and ΔT is the temperature difference.

$$Q = (14/28)(5R/2)(40)$$

$$Q = (0.5)\left(2.5 \times 8.31 \frac{J}{mol} K\right)(40\ K)$$

$$Q = 415.7\ J$$

Answer. 415.7 J

4. In Young's experiment separation between two slits is 3.5×10^{-4} m and the distance of the
screen from the plane of the slit is .73m. What is the distance from the central bright
point to the first bright point in the screen? [$\lambda=550\times10^{-10}$ m]

Solution.

Calculate the distance of first bright point from the central bright point by the relation as follows.

$$x = \left(\frac{D}{d}\right) n\lambda$$

Substitute 0.73 m for D and 3.5×10 -4 m for d and 550×10 -10 m for λ and 1 for n.

$$x = \left(\frac{0.73\ \text{m}}{3.5\times10^{-4}\ \text{m}}\right)(1)(\ 550\times10^{-10}\ \text{m})$$

$$x = 114.71 \times 10^{-6}\ m$$

Answer. $114.71 \times 10^{-6}\ m$

5.The phase difference between two points in a wave is π/2. What is the path difference
between those two points?

Solution.

Calculate the path difference by the relation as follows.

$$\Delta X = \frac{\lambda \cdot \Delta\phi}{2\pi}$$

Here, λ is the wavelength, $\Delta\phi$ is the phase difference.

Substitute $\frac{\pi}{2}$ for phase difference.

$$\Delta X = \frac{\lambda \cdot (\frac{\pi}{2})}{2\pi}$$

$$\Delta X = \frac{\lambda}{4}$$

Answer. $\frac{\lambda}{4}$

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