QUES 04:-

5.6 liter of helium gas at STP is adiabatically compressed to 0.7 liter. Taking the initial temperature to be T_1, the work done in the process is   [Main 2011]

(a) $\dfrac{9}{8}RT_1$ (b) $\dfrac{3}{2}RT_1$ (c) $\dfrac{15}{8}RT_1$ (d) $\dfrac{9}{2}RT_1$

(a) Initially, volume $V_1 = 5.6\ell$, temperature $= T_1$ and

$\gamma = \dfrac{5}{3}$ (for monoatomic gas)

The number of moles of gas, $n = \dfrac{5.6\ell}{22.4\ell} = \dfrac{1}{4}$

Finally (after adiabatic compression) $V_2 = 0.7\ell$

For adiabatic process $T_1 V_1^{\gamma-1} = T_2 V_2^{\gamma-1}$

$$\therefore\ T_2 = T_1\left(\dfrac{V_1}{V_2}\right)^{\gamma-1} = T_1\left(\dfrac{5.6}{0.7}\right)^{\frac{5}{3}-1} = T_1(8)^{2/3} = 4T_1$$

Work done in adiabatic process

$$W = \dfrac{nR\Delta T}{\gamma-1} = \dfrac{\dfrac{1}{4}R\left[T_1 - 4T_1\right]}{\left[\dfrac{5}{3}-1\right]} = \dfrac{9}{8}RT_1$$