Answer on Question #50647-Physics-Molecular Physics-Thermodynamics

A block of copper whose expansivity, β, is $48.0 \cdot 10^{-6}\ k^{-1}$ and isothermal elasticity, E_T , is $1.30 \cdot 10^{11} Nm^{-2}$ is at atmospheric pressure and a temperature of 0°C. Its temperature is raised to 10°C. Calculate the final pressure when volume is kept constant. Express your answer in units of atmospheric pressure (atm).

Solution

For an isochoric process, we have

$$p_2 - p_1 = \beta E_T (T_2 - T_1).$$

On substituting the values of $\beta, E_T, (T_2 - T_1)$, we get

$$p_2 - p_1 = 48.0 \cdot 10^{-6}\ k^{-1} \cdot 1.30 \cdot 10^{11} Nm^{-2}(10K) = 624 \cdot 10^5 Nm^{-2} = 624\ atm.$$

so that final pressure p_2 is

$$p_2 = (624 + 1)\ atm = 625\ atm.$$

That is, to keep the volume of the copper block constant when its temperature is raised from 0°C to 10°C, one must increase the pressure to $625\ atm$.

Answer: $625\ atm$.