Find the change in volume of $V_0 = 1\ \mathrm{m}^3$ of water when subjected to pressure increase of $\Delta P = 35\ \mathrm{MPa}$. The bulk modulus of elasticity of water is $K = 2.2 \times 10^9\ \mathrm{Pa}$. Also estimate the volume of water after the pressure is applied.

Solution:

The bulk modulus of K of the liquid is given by

$$K = -V_0 \frac{\Delta P}{\Delta V},$$

where ΔV – is the increase in the volume of the fluid. Since $V_0 = 1\ \mathrm{m}^3$, $K = 2.2 \times 10^9\ \mathrm{Pa}$, and $\Delta P = 35\ \mathrm{MPa}$, we obtain

$$\Delta V = -\frac{V_0 \cdot \Delta P}{K} = -\frac{1\ \mathrm{m}^3 \cdot 35\ \mathrm{MPa}}{2.2 \times 10^9\ \mathrm{Pa}} = -15.9 \times 10^{-6}\ \mathrm{m}^3$$

The final volume is

$$V_f = V_0 + \Delta V = 1\ \mathrm{m}^3 - 15.9 \times 10^{-6}\ \mathrm{m}^3 = 0.9999841\ \mathrm{m}^3$$

Answer: $\Delta V = -15.9 \times 10^{-6}\ \mathrm{m}^3$, $V_f = 0.9999841\ \mathrm{m}^3$.