

Answer on Question 62232, Physics, Molecular Physics, Thermodynamics

Question:

Calculate the volume contraction of 100 mL of water when subjected to a pressure of 1.5 MPa. The bulk modulus of water is 2.1 GPa.

Solution:

Let's recall the definition of the bulk modulus. The bulk modulus, K , is a material property characterizing the compressibility of the fluid. The bulk modulus can be calculated as follows:

$$K = -\frac{dp}{dV/V_0},$$

here, $K = 2.1 \text{ GPa}$ is the bulk modulus of water, $dp = 1.5 \text{ MPa}$ is the pressure change that is required in order to change the volume of water by dV , $V_0 = 100 \text{ mL}$ is the initial volume of water.

From this formula we can find the volume contraction dV :

$$dV = -V_0 \frac{dp}{K} = -100 \text{ mL} \cdot \frac{1.5 \cdot 10^6 \text{ Pa}}{2.1 \cdot 10^9 \text{ Pa}} = -0.071 \text{ mL}.$$

The sign minus indicates that an increase in pressure is accompanied by a decrease in volume.

Answer:

$$dV = -0.071 \text{ mL}.$$