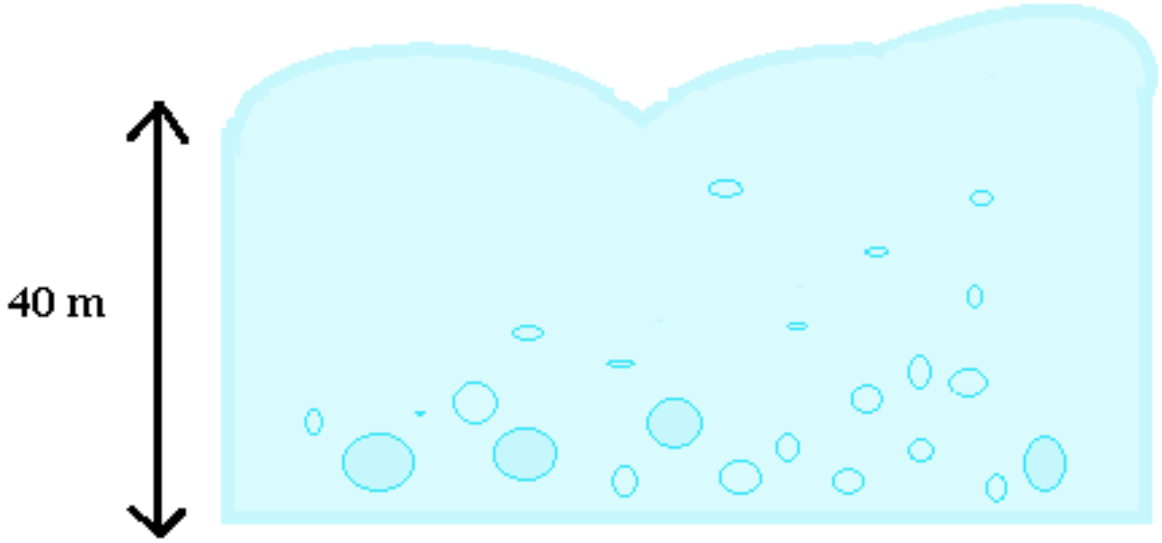
Problem
on
Kinetic theory of gases

Question

An air bubble of volume 1.0 cm^3 rises from the bottom of lake 40 m deep at a temperature of 12 °C. To what volume does it grow, when it reaches the surface, which is at a temperature of 35 °C? Given that 1 atm = 1.01$\times 10^5$Pa.

Here, temperature is 12 °C at the bottom of lake and bubbles starts rising to the surface.



Let us understand…

Here, temperature at 40 m depth,

$$T_1 = 12 + 273$$
$$= 285\ K$$

Volume of the bubble at 40 m depth,

$$V_1 = 1.0 cm^3$$
$$= 1.0 \times 10^{-6} m^3;$$

Pressure at 40 m depth,

$P_1 = 1$**atm + pressure exerted by 40 m of water column**

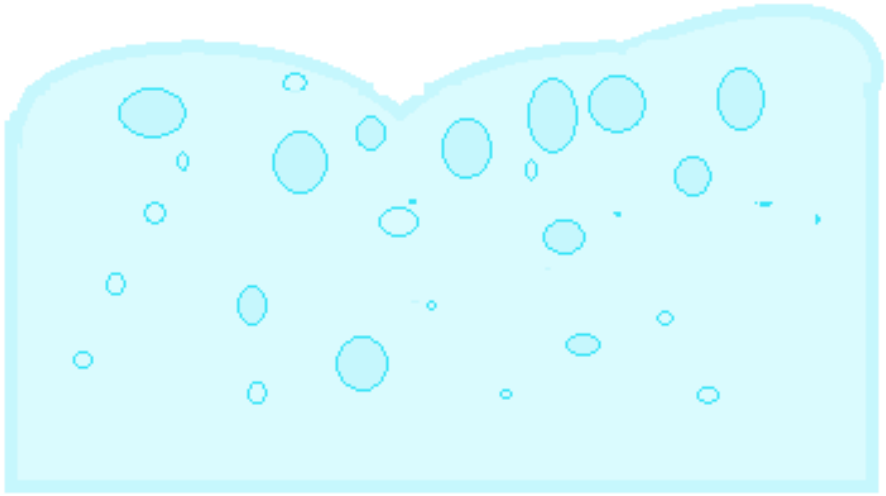
= 1 atm + hρg

Here, density of water, ρ = 1000 kg m^{-3}

$$= 1.01 \times 10^5 + 40 \times 10^3 \times 9.8$$

$$= 4.93 \times 10^5 Pa$$

Now, air bubble reaches to the surface of lake ,



Temperature at the surface of lake,

$$T_2 = 35 + 273 = 308\ K$$

Pressure at the surface of the lake,

$$P_2 = 1.01 \times 10^5 \text{Pa}$$

Let V_2 be the volume of air bubble at the surface of the lake. Then,

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

$$V_2 = \frac{P_1V_1}{T_1} \times \frac{T_2}{P_2}$$

$$= \frac{4.93\times10^5\times1.0\times10^{-6}\times308}{285\times1.01\times10^5}$$

$$= 5.275 \times 10^{-6} m^3$$

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