

Mastering Physics Solutions 4th Edition

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Physics With Mastering Physics 4th Edition Textbook Solutions

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Pressure of helium inside the balloon $P = 2.4 \times 10^5 \text{ Pa}$

Temperature of the balloon $T = 18^\circ\text{C}$

$$= 273 + 18$$

$$= 291 \text{ K}$$

Radius of the balloon $r = 0.25 \text{ m}$

Boltzmann constant $k = 1.38 \times 10^{-23} \text{ J/K}$.

(a)

Let the number of atoms in the balloon be N

Apply an ideal gas equation.

$$PV = NkT$$

$$N = \frac{PV}{kT}$$

Volume of helium inside the balloon $V = \frac{4}{3}\pi r^3$

$$= \frac{4}{3}\pi(0.25 \text{ m})^3$$

$$= 0.065 \text{ m}^3$$

Therefore

$$\begin{aligned}\text{Number of atoms in the balloon } N &= \frac{(2.4 \times 10^5 \text{ Pa})(0.065 \text{ m}^3)}{(1.38 \times 10^{-23} \text{ J/K})(291 \text{ K})} \\ &= 3.88 \times 10^{24} \text{ atoms} \\ &= \boxed{3.9 \times 10^{24} \text{ atoms}}\end{aligned}$$

(b)

If the number of helium atoms are doubled, keeping the pressure and temperature constant.

Then by the equation of state

$$PV = NkT$$

The volume of helium doubles.

Let this volume be V'

$$\therefore V' = 2V$$