Answer on Question #50112, Chemistry, Physical Chemistry

Two vanderwaals gases A and B are at corresponding state. The critical temperature and pressure of gases are

Pc/atm. Tc/K

A. 48. 150

B. 33. 12.

Find the volume of B at this corresponding state if the volume of A is 1.5L.

Solution:

Van der Waals equation uses the following state variables: the pressure of the gas **p**, total volume of the gas **V**, number of moles **n**, and absolute temperature of the system **T**.

$$\left(p + \frac{n^2 a}{V^2}\right)(V - nb) = nRT$$

$$a = \frac{27 \times T_c^2 \times R^2}{64 \times p_c}$$

$$b = \frac{T_c \times R}{8 \times p_c}$$

$$V_c = 3 \times b = \frac{p_c + 3 \times R \times T_c}{3 \times p_c}$$

The gas constant (also known as the molar, universal, or ideal gas constant, denoted by the symbol R or R) is a physical constant which is featured in many fundamental equations in the physical sciences, such as the ideal gas law and the Nernst equation.

R = 8.31 J $K^{-1}mol^{-1}$ = 0.082 L atm $K^{-1}mol^{-1}$

Different gases have the same equation of state if each gas is described by the dimensionless reduced variables:

$$T_r = \frac{T}{T_c}$$

$$p_r = \frac{p}{p_c}$$

$$V_r = \frac{V}{V_c}$$

If two gases have the same values of T_r, P_r, and V_r, they are in corresponding states. The values of P, V, and T can be very different for two gases that are in corresponding states.

Gas A:

$$V_c = \frac{48 + 3 \times 0.082 \times 150}{3 \times 48} = \frac{84.9}{144} = 0.5896\ L$$

Gas B:

$$V_c = \frac{33 + 3 \times 0.082 \times 12}{3 \times 33} = \frac{35.952}{99} = 0.3632\ L$$

Gas	**p_c, atm**	**T_c, K**	**V_c, L**
A	*48*	*150*	*0.5896*
B	*33*	*12*	*0.3632*

$$V_{rA} = V_{rB}$$

$$\frac{V_A}{V_{cA}} = \frac{V_B}{V_{cB}}$$

$$V_B = \frac{V_A \times V_{cB}}{V_{cA}} = \frac{1.5 \times 0.3632}{0.5896} = 0.924\ L$$

Answer:

volume of B at this corresponding state is 0.924 L