INTEGRATION OF PHYSICS AND CHEMISTRY IN TEACHING DALTON’S AND AVOGADRO‘S LAWS

Vazirova Ezoza To‘xtaboyevna
PhD student, Department of Physics, Namangan State University

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Abstract: This article discusses the significance of integrating physics and chemistry in teaching Dalton’s and Avogadro‘s laws. The physical and chemical essence of these gas laws is elucidated, and the effectiveness of using interdisciplinary connections to explain them to students is substantiated. The paper also highlights how an integrated approach can foster students’ scientific thinking and logical reasoning skills.

Keywords: Dalton’s law, Avogadro‘s law, interdisciplinary integration, physics, chemistry, gases, ideal gas model, chemical reactions, molar volume.

Introduction.

In the modern education system, interdisciplinary integration is regarded as one of the key pedagogical approaches. In particular, integrating closely related subjects such as physics and chemistry helps students develop a holistic understanding of natural phenomena. Dalton’s and Avogadro‘s gas laws are well-suited topics for such integration, as they require the harmonization of molecular-physical and chemical concepts [1].

When teaching Dalton's law, disciplinary integration plays an important role: in physics, it is used to explain the pressure of gas mixtures, while in chemistry it helps clarify the properties of gases participating in chemical reactions. This law shows how the total pressure of a gas mixture is determined. Suppose a mixture of non-reacting gases in thermal equilibrium is contained in a vessel of fixed volume. If the numbers of molecules of each gas component in the mixture are $N_1, N_2, \dots, N_i$, then for such a mixture the generalized equation of state can be written as

$$PV = (N_1 + N_2 + \dots\dots + N_i)kT \qquad (1)$$

This equation can also be expressed in the form

$$P = \frac{N_1}{V}kT + \frac{N_2}{V}kT + \dots + \frac{N_i}{V}kT \qquad (2)$$

Taking into account that $\frac{N_1}{V}kT = P_1, \frac{N_2}{V}kT = P_2, \dots, \frac{N_i}{V}kT = P_i$ we obtain

$$P = P_1 + P_2 + \dots + P_i \qquad (3)$$

Expression (3) represents the mathematical formulation of Dalton's law. As seen from this formula, the pressure exerted by a gas mixture on the vessel walls is equal to the sum of the partial pressures of its components. Since this law is strictly valid for ideal gases, certain deviations may be observed for real gases at high pressures [3]. In practice, Dalton's law is applied to determine the molar mass of gas mixtures. For example, consider a mixture of two gases with masses m_1 and m_2 in a vessel of volume V. Let the molar masses of these gases be μ_1 and μ_2, respectively, and let the temperature be T. Then the partial pressures are

$$P_1 = \frac{m_1}{\mu_1}\frac{RT}{V} \quad \text{va} \quad P_2 = \frac{m_2}{\mu_2}\frac{RT}{V}$$

According to Dalton’s law

$$P = P_1 + P_2 = \left(\frac{m_1}{\mu_1} + \frac{m_2}{\mu_2}\right)\frac{RT}{V} = \frac{m_{ar}}{\mu_{ar}}\frac{RT}{V} \qquad (4)$$

and for the gas mixture we obtain

$$\mu_{ar} = \frac{m_{ar}}{\frac{m_1}{\mu_1} + \frac{m_2}{\mu_2}} \qquad (5)$$

Avogadro‘s Law. From the ideal gas equation of state, it follows that under the same pressure and temperature, equal volumes of any gases contain the same number of molecules. Indeed, if $P_1 = P_2, T_1 = T_2$, and $V_1 = V_2$, then,

$$P_1V_1 = N_1kT_1 \text{ va } P_2V_2 = N_2kT_2$$

From these equations it follows that $N_1 = N_2$ [4]. This is the mathematical expression of Avogadro‘s law.

The pedagogical significance of teaching Dalton's and Avogadro‘s laws through the integration of physics and chemistry lies in shaping students' scientific worldview, strengthening the stability of knowledge, linking theoretical concepts with practice, and increasing interest in the sciences. With such an approach, students do not merely memorize the laws; instead, they understand their underlying meaning.

Conclusion

In conclusion, integrating physics and chemistry in teaching Dalton’s and Avogadro‘s laws substantially improves the effectiveness of instruction. An interdisciplinary approach develops students’ logical thinking, analytical abilities, and skills in drawing conclusions, thereby preparing them to master more complex scientific concepts in the future.

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