Chapter 5: Gases

5.3: Gas Laws

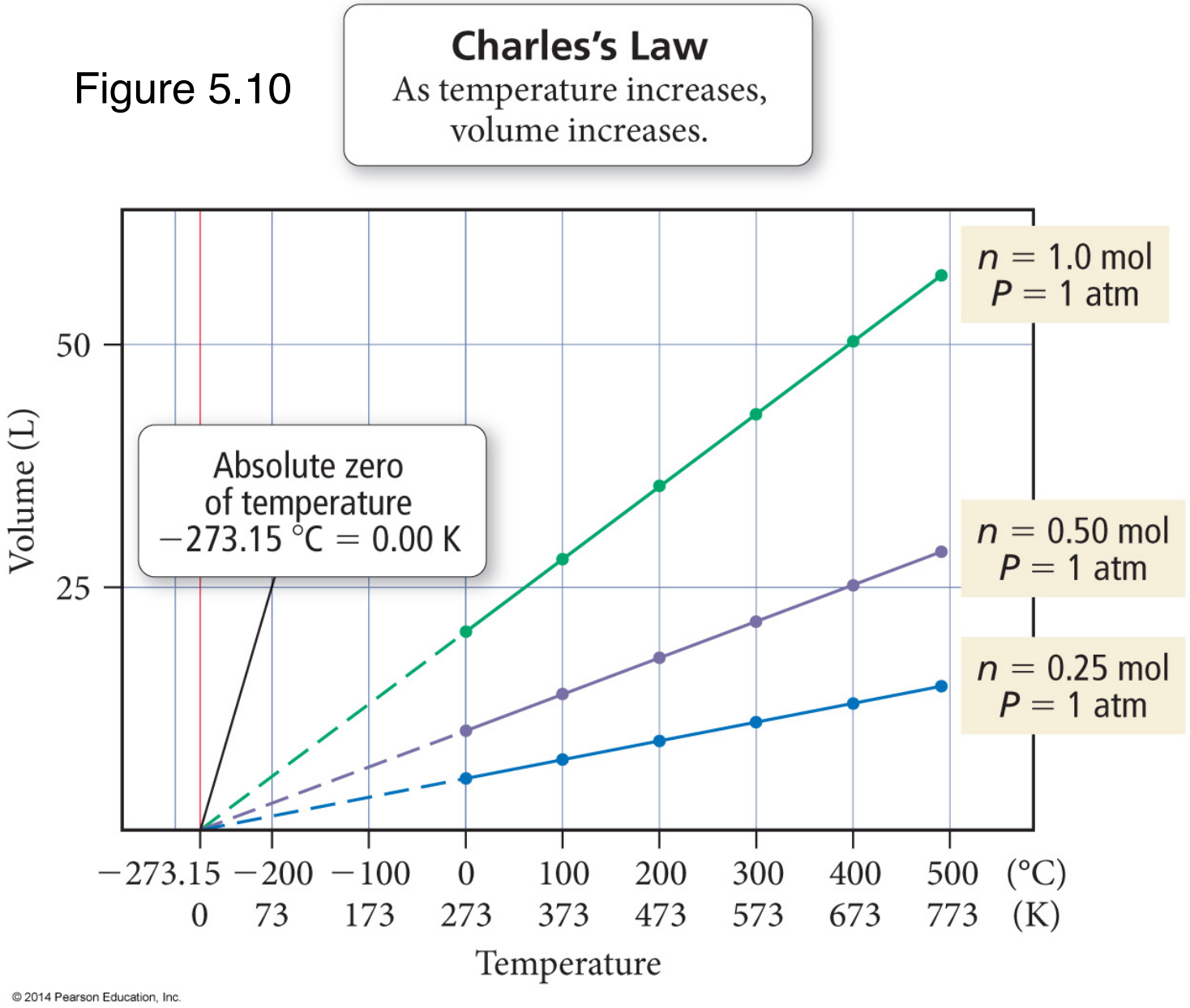
- The gas laws are a series of relationships between the different properties of gases.

1) **Boyle's Law**: The **volume** of a gas is inversely proportional to its **pressure** (at constant temperature).

For a change in volume or pressure at constant temperature:

$$P_1V_1 = P_2V_2$$

Figure 5.10



Gas Laws (contd.)

2) **Charles's Law**: The volume of a gas is directly proportional to its **absolute** temperature (in Kelvin).

For a change in temperature at constant pressure:

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

Gas Laws (contd.)

3) **Avogadro's Law**: The volume of a gas is directly proportional to the number of moles of gas (**n**) at constant temperature and pressure.

- The volume of a gas **does not depend on the identity of the gas**, but only on the number of moles present.

5.4: The Ideal Gas Law

- The three gas laws:

$$V \propto 1/P$$

$$V \propto T$$

$$V \propto n$$

- Combining these, we get: **$V \propto nT/P$**
- Rearranging:

$$PV = nRT$$

The Ideal Gas Equation

- R is the **ideal gas constant**.

- A gas that obeys the ideal gas law is called an **ideal gas**.

5.5: Applications of The Ideal Gas Law

- At **standard temperature and pressure, STP** (0 °C, 1 atm), the volume of 1 mol of an ideal gas is **22.4 L.**

5.5: Applications of The Ideal Gas Law (contd.)

- Calculating molar mass:

  Molar mass = g/mol = **g/n**

- Calculating density:

  Density = mass / volume = n × molar mass / V

5.6: Mixtures of Gases

Dalton's Law of Partial Pressures:

- Each gas in a mixture exerts a partial pressure.
- The total pressure of a gas is the sum of the partial pressures of each component of the mixture:

$$\mathbf{P_{total} = P_A + P_B + P_C + \ldots}$$

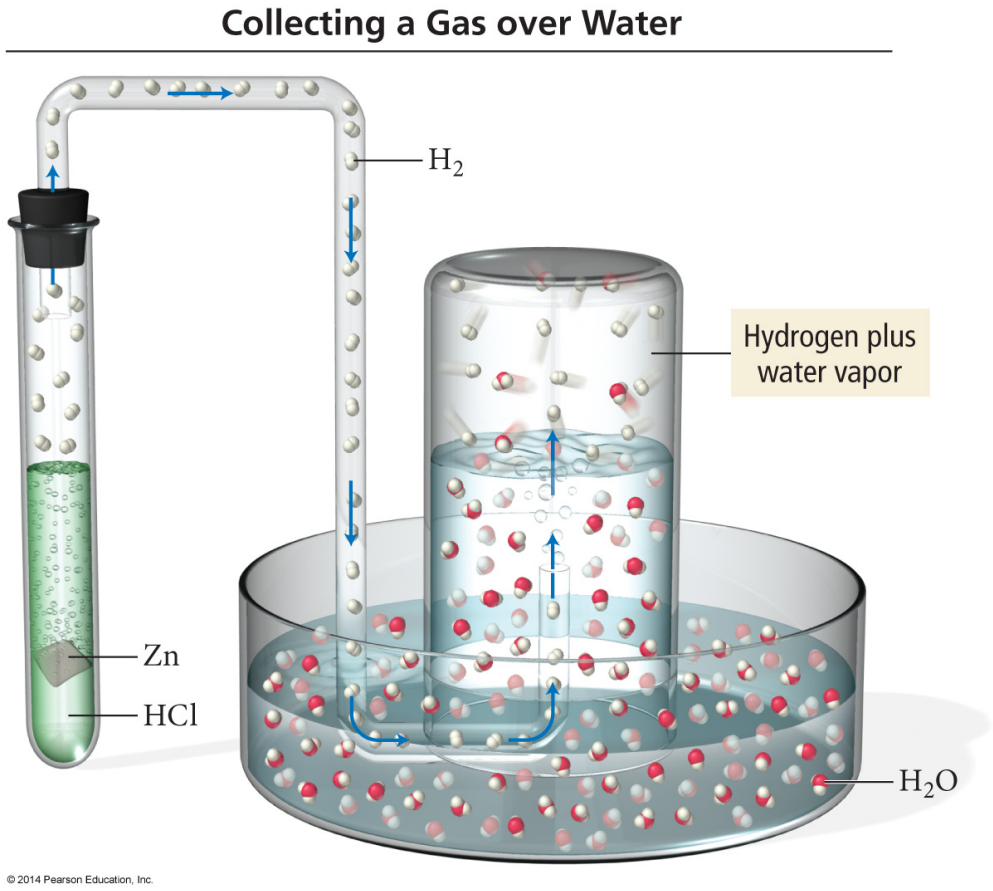
- The partial pressure of an individual gas depends on the amount of that gas present:

$$\mathbf{P_A = \frac{n_A RT}{V}}$$

- or, $P_A = X_A \times P_{total}$

Collecting Gases Over Water

- Gases are often isolated by having them displace water from a container. The collected gas will also contain water vapor.



Collecting Gases Over Water

- The partial pressure of the water vapor is called the **vapor pressure**, and it depends only on the temperature.
- You must look up the vapor pressure of water at a certain T, and subtract this from the total pressure:

$$\mathbf{P_{gas} = P_{total} - \text{vapor pressure of water}}$$

TABLE 5.4 Vapor Pressure of Water versus Temperature

Temperature (°C)	Pressure (mmHg)	Temperature (°C)	Pressure (mmHg)
0	4.58	55	118.2
5	6.54	60	149.6
10	9.21	65	187.5
15	12.79	70	233.7
20	17.55	75	289.1
25	23.78	80	355.1
30	31.86	85	433.6
35	42.23	90	525.8
40	55.40	95	633.9
45	71.97	100	760.0
50	92.6		