.

🧪 Gas Laws: Complete Study Guide

⚠️ Foundational Concepts

◆ **Properties of Gases:**

- **Pressure (P)**: Force gas exerts per unit area (measured in atm, mmHg, torr, kPa)

- **Volume (V)**: Space a gas occupies (usually in liters, L)

- **Temperature (T)**: Always in **Kelvin** for gas laws
  $\text{K} = \text{°C} + 273$

- **Amount of gas (n)**: In **moles**
  $\text{moles} = \frac{\text{mass (g)}}{\text{molar mass}}$

⚙️ The Major Gas Laws

1. Boyle's Law — Pressure vs. Volume

- **Formula**: $P_1 V_1 = P_2 V_2$

- **Constant**: Temperature, number of moles

- **Relationship**: **Inverse**

  ○ When volume ↓, pressure ↑

- **Use when**: Temp is constant, P & V change

---

2. Charles's Law — Volume vs. Temperature

- **Formula**: $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

- **Constant**: Pressure, number of moles

- **Temperature in Kelvin**

- **Relationship**: **Direct**

    - Temp ↑ ⇒ Volume ↑

- **Use when**: Pressure is constant, V & T change

---

3. Gay-Lussac's Law — Pressure vs. Temperature

- **Formula**: $\frac{P_1}{T_1} = \frac{P_2}{T_2}$

- **Constant**: Volume, number of moles

- **Relationship**: **Direct**

    - Temp ↑ ⇒ Pressure ↑

- **Use when**: Volume is constant, P & T change

---

4. Combined Gas Law

- **Formula**:
  $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$
- **Use when**: P, V, and T all change

- **Must** use Kelvin and consistent units

---

5. Ideal Gas Law

- **Formula**:
  $PV = nRT$

- **R (Gas constant)**: 0.0821 L·atm/mol·K

- **Use when**:

  - Given or solving for **moles, pressure, temp, volume**

  - Can also be rearranged:

    - $P = \frac{nRT}{V}$

    - $V = \frac{nRT}{P}$

    - $n = \frac{PV}{RT}$

---

6. Avogadro's Law — Moles vs. Volume

- **Formula**:
  $\frac{V_1}{n_1} = \frac{V_2}{n_2}$
- **Relationship**: Direct

  - More moles = more volume (at same T & P)

🧰 Conversions You'll Need

Quantity	Convert to...	How
Temperature	Kelvin	°C + 273
Pressure	atm	1 atm = 760 mmHg = 101.3 kPa
Volume	Liters (L)	1000 mL = 1 L
Moles	from grams	mass / molar mass

🧠 How to Know Which Law to Use

Problem Mentions...	Use This Law
Pressure & Volume change, temp constant	**Boyle's Law**
Volume & Temp change, pressure constant	**Charles's Law**
Pressure & Temp change, volume constant	**Gay-Lussac's Law**
P, V, and T all changing	**Combined Gas Law**
Involves moles or gas amount	**Ideal Gas Law**

🧪 Problem-Solving Strategy

1. **Identify what's changing**: P, V, T, or n?

2. **Convert all units**:

   ○ Temp → **Kelvin**

   ○ Volume → **Liters**

   ○ Mass → **Moles** (if needed)

3. **Choose correct gas law**.

4. **Plug values into formula**.

5. **Solve for unknown**.

6. **Check units & logic** (volume shouldn't be negative, etc.)

📍 Example Problem

Q: A gas occupies 3.50 L at 1.00 atm and 300 K. What volume will it occupy at 2.00 atm and 400 K?

A: Use the **Combined Gas Law**

📚 Practice Topics to Master:

- Interpreting graphs of pressure vs. volume (inverse)

- Recognizing when to use **Kelvin**

- Identifying whether relationships are **direct or inverse**

- Using molar mass to convert grams to moles

- Recognizing when a gas law question is a **real-world scenario** (e.g., balloons rising)