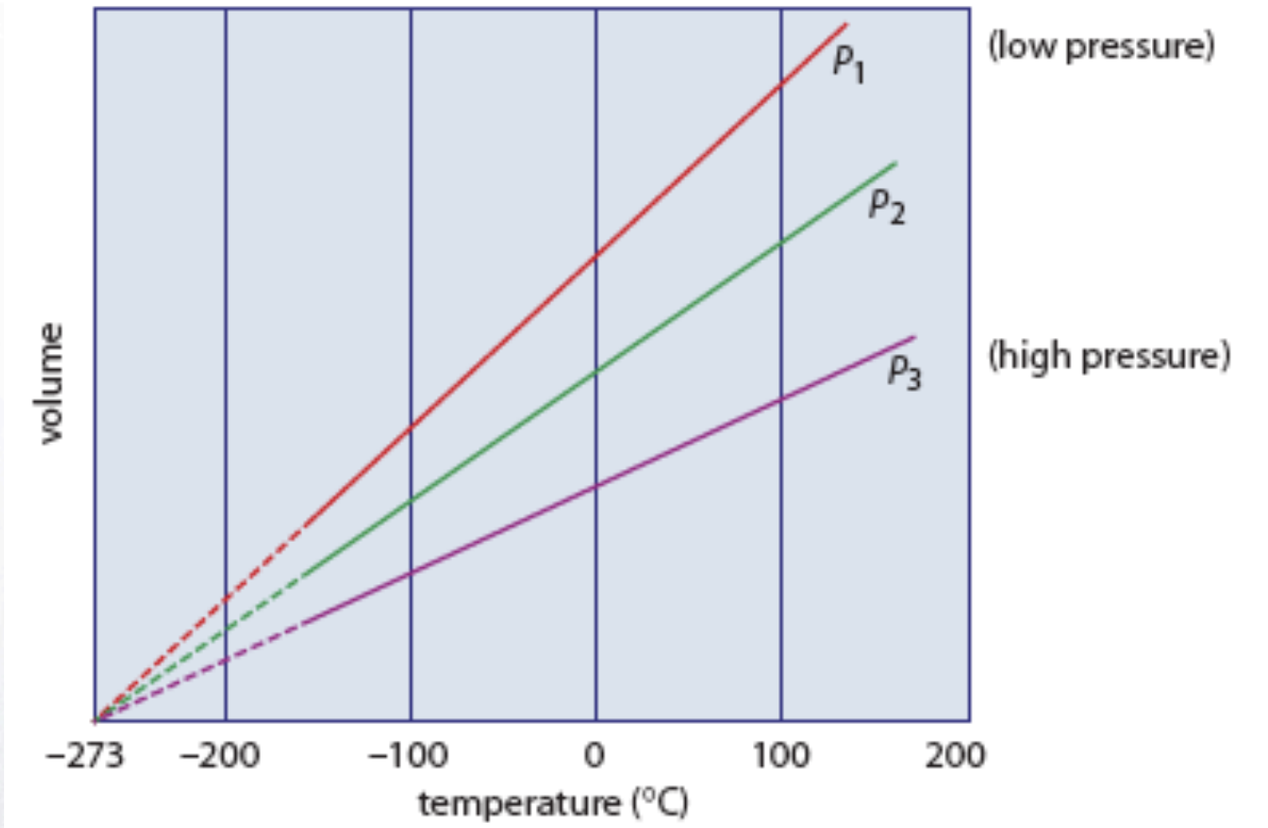
Last class...

- We introduced the variables that effect gases
- We learned Boyle's law, which relates pressure and volume
- Today: Charles's and Gay-Lusaac's law

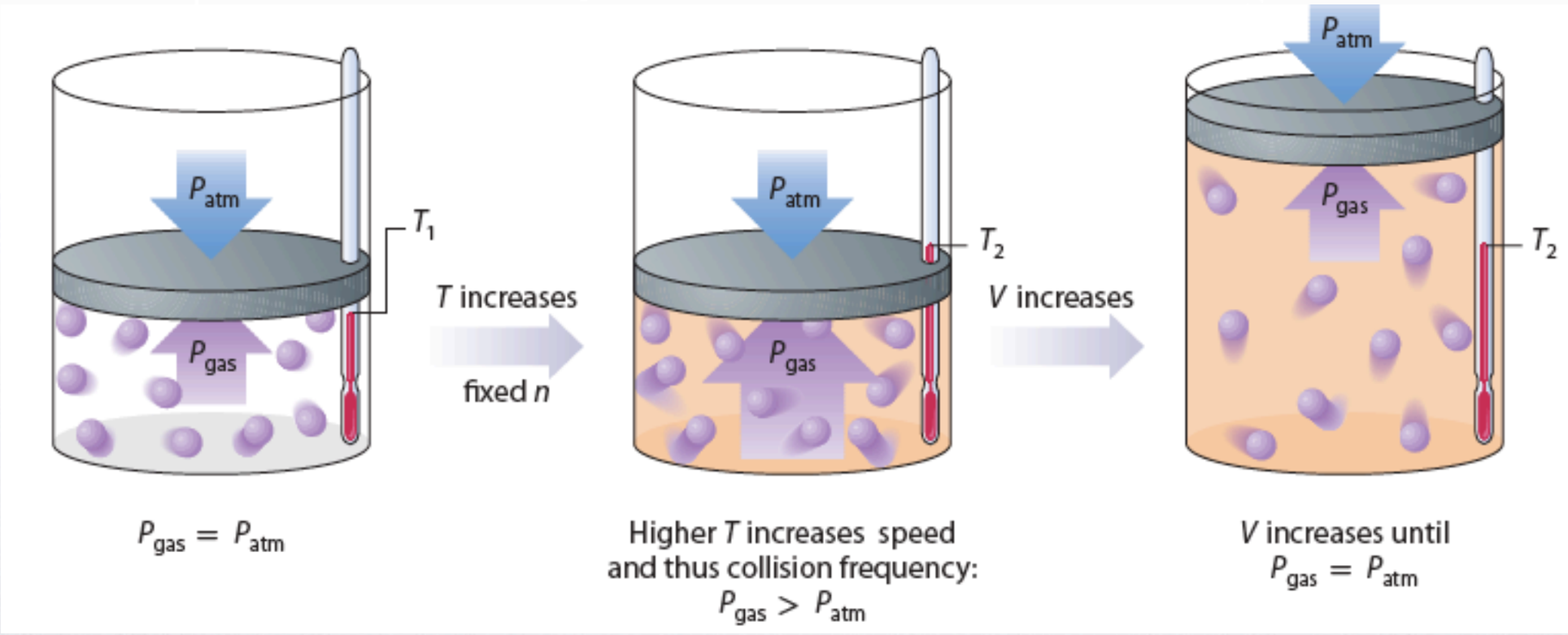
Charles's Law

- At constant pressure, the volume of a given mass of gas is directly proportional to its <u>absolute</u> temperature
- Graphically:



- V/T = constant
- **$V_1/T_1 = V_2/T_2$**
- *Where T is in* ***Kelvin***

As temperature increases, so does volume



Charles's Law

Try it!

Problem

A balloon inflated with air in a room in which the temperature of the air is 295 K has a volume of 650 mL. The balloon is put into a refrigerator at 277 K and left long enough for the air in the balloon to reach the same temperature as the air in the refrigerator. Predict the volume of the balloon, assuming that the amount of air has not changed and the air pressure in the room and in the refrigerator are the same.

Given:

$V_1 = 650\ \text{mL}$

$T_1 = 295\ \text{K}$

$T_2 = 277\ \text{K}$

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

$$V_2 = \frac{V_1 T_2}{T_1} = \frac{(650\ \text{mL})(277\ \cancel{\text{K}})}{(295\ \cancel{\text{K}})} = 610\ \text{mL}$$

Try it!

1. A balloon is filled with Helium gas to a volume of 1.2 L at a pressure of 105 kPa and a temperature of 15 degrees Celsius. If the pressure remains constant and the temperature rises to 30 degrees Celsius, calculate the new volume.

1.3 L

2. If a sample of gas occupies 100 L at 200 K, what volume would it occupy at a temperature of 150 K?

75 L

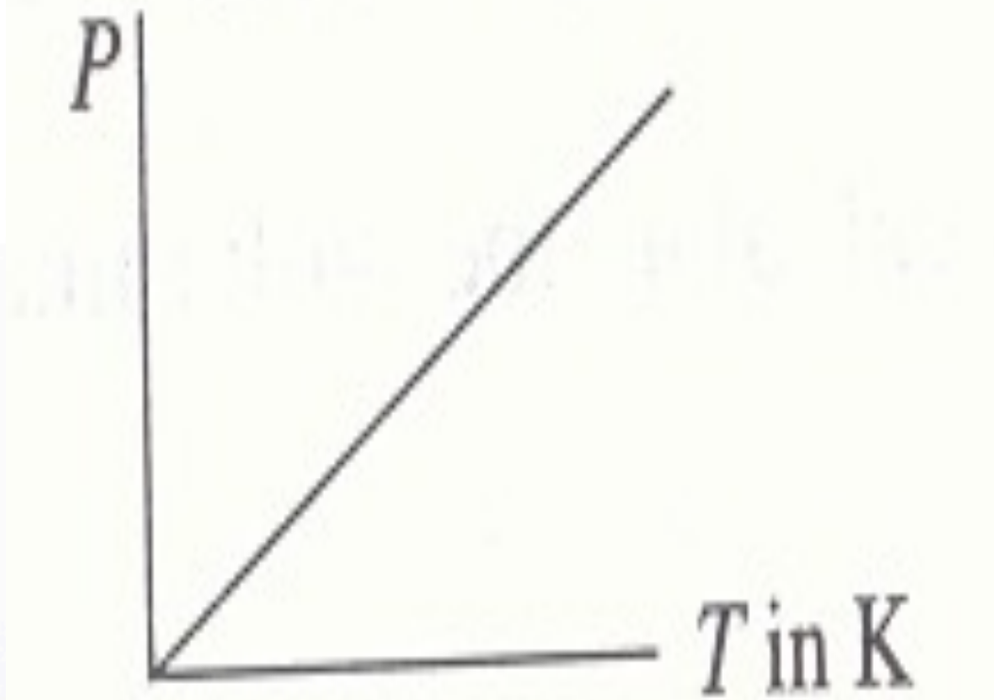
3. A balloon contains 5.0 L of air at 25 degrees Celsius. At what temperature would the balloon shrink to half the volume? Assume the pressure is held constant.

149 K

Gay-Lussac's Law

The relationship between the pressure and temperature at constant volume

Gas pressure is directly proportional to temperature if the volume and number of particles is constant.



$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$

Example

- About 10.0 L of $H_{2(g)}$ is found to exert 97.0 kPa at 25.0 °C. What would be the required temperature (°C) to change the pressure to standard pressure?

V1 = 10.0 L

T1 = 25.0 °C

P1 = 97.0 kPa

T2 = ? °C

P2 = 101.325 kPa

$$P_1 / T_1 = P_2 / T_2$$

$$T_2 = P_2 T_1 / P_1$$

$$= (101.325)(298)/97.0$$

$$= 311 \text{ K}$$

Try it!

The pressure of oxygen gas inside a canister with a fixed volume is 5.00 atm at 298 K. What is the pressure of the oxygen gas inside the canister if the temperature changes to 263 K?

4.41 atm

Try it!

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11. A gas has a volume of 6.0 L at a temperature of 250 K. What volume will the gas have at 450 K?

12. A syringe is filled with 30.0 mL of air at 298.15 K. If the temperature is raised to 353.25 K, what volume will the syringe indicate?

13. The temperature of a 2.25 L sample of gas decreases from 35.0°C to 20.0°C. What is the new volume?

14. A balloon is inflated with air in a room in which the air temperature is 27°C. When the balloon is placed in a freezer at −20.0°C, the volume is 80.0 L. What was the original volume of the balloon?

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22. The pressure of a gas in a sealed canister is 350.0 kPa at a room temperature of 298 K. The canister is placed in a refrigerator and the temperature of the gas is reduced to 278 K. What is the new pressure of the gas in the canister?

23. A propane barbeque tank is filled in the winter at −15.0°C to a pressure of 2500 kPa. What will the pressure of the propane become in the summer when the air temperature rises to 20.0°C?

27. Helium gas in a 2.00 L cylinder has a pressure of 1.12 atm. When the temperature is changed to 310.0 K, that same gas sample has a pressure of 2.56 atm. What was the initial temperature of the gas in the cylinder?

28. A sample of neon gas is contained in a bulb at 150°C and 350 kPa. If the pressure drops to 103 kPa, find the new temperature, in °C.