



CHEMISTRY

GAS LAWS - PART 2

Charles Law

In 1802, Charles' Law was stated as:

- *The volume of a fixed mass of gas is proportional to its temperature when the pressure is kept constant.*

→ As temperature **INCREASES**, volume **INCREASES**.

$$V \propto T$$

Algebra then leads to ...

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

T_1 – Initial Temperature

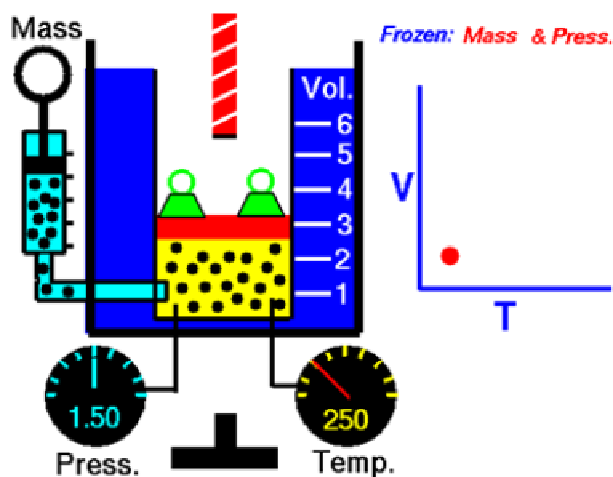
V_1 – Initial Volume

T_2 – Final Temperature

V_2 – Final Volume

must be in K

must be in K



**CHEMISTRY****GAS LAWS - PART 2**

Ex: Using a syringe, a chemist draws 25.5 cm³ of oxygen at 20°C and heats the syringe in an oven up to 65°C. Assuming the atmospheric pressure remains the same, what volume will the oxygen occupy?

Ex: A balloon is filled with 2.50 L of helium at 23.5°C. The balloon is placed in a freezer overnight and the final volume is observed to be 2.15 L. What was the temperature inside the freezer (in celcius)?



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GAY-LUSSAC'S LAW**Gay-Lussac's Law states that:**

- *The pressure of a fixed amount of gas, at constant volume, is directly proportional to its Kelvin temperature.*

→ As temperature **INCREASES**, pressure **INCREASES**.

$$P \propto T$$

Algebra then leads to ...

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

T_1 – Initial Temperature

P_1 – Initial Pressure

T_2 – Final Temperature

P_2 – Final Pressure

must be in K

must be in K

<http://phet.colorado.edu/en/simulation/gas-properties>

<http://www.youtube.com/watch?v=9bU-I2ZiML0>

**CHEMISTRY****GAS LAWS - PART 2**

Ex: A cylinder of chlorine gas is designed to withstand 50 atm of pressure. The pressure gauge reads 35.0 atm at 23.5°C. If one were to place this cylinder in a fire, raising its temperature to 87.5°C, what would the pressure gauge read?



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Pg. 522 #11 - 20

Pg. 525 #21 - 30

Practice Problems

Note: Assume that the pressure and amount of gas are constant in all of the problems except question 20.

- A gas has a volume of 6.0 L at a temperature of 250 K. What volume will the gas have at 450 K?
- 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?
- The temperature of a 2.25 L sample of gas decreases from 35.0°C to 20.0°C. What is the new volume?
- 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?
- At a summer outdoor air temperature of 30.0°C, a particular size of bicycle tire has an interior volume of 685 cm³. The bicycle has been left outside in the winter and the outdoor air temperature drops to -25.0°C. Assuming the tire had been filled with air in the summer, to what volume would the tire be reduced at the winter air temperature?
- At 275 K, a gas has a volume of 25.5 mL. What is its temperature if its volume increases to 50.0 mL?
- A sealed syringe contains 37.0 mL of trapped air. The temperature of the air in the syringe is 295 K. The sun shines on the syringe, causing the temperature of the air inside it to increase. If the volume increases to 38.6 mL, what is the new temperature of the air in the syringe?
- A beach ball is inflated to a volume of 25 L of air in the cool of the morning at 15°C. During the afternoon, the volume changes to 26 L. What was the Celsius air temperature in the afternoon?
- The volume of a 1.50 L balloon at room temperature increases by 25.0 percent when placed in a hot-water bath. How does the temperature of the water bath compare with room temperature?
- Compressed gases can be condensed when they are cooled. A 5.00×10^2 mL sample of carbon dioxide gas at room temperature (assume 25.0°C) is compressed by a factor of four, and then is cooled so that its volume is reduced to 25.0 mL. What must the final temperature be (in °C)? (**Hint:** Use both Boyle's law and Charles's law to answer the question.)

11. 11 L

12. 35.5 mL

13. 1.29 L

14. 95 L

15. 561 cm³

16. 539 K

17. 308 K

18. 27°C

19. 1.25 times room temperature

20. -214°C



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Pg. 525 #21 - 30

Practice Problems

Note: Assume that the volume and amount of gas are constant in all of the following problems.

21. A gas is at 105 kPa and 300.0 K. What is the pressure of the gas at 120.0 K?
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 ?
24. A rubber automobile tire contains air at a pressure of 370 kPa at 15.0°C . As the tire heats up, the temperature of the air inside the tire rises to 60.0°C . What would the new pressure in the tire be?
25. A partially filled aerosol can has an internal pressure of 14.8 psi when the temperature is 20.0°C .
 - a. What would the pressure in the can be, in kPa, if it were placed into an incinerator for disposal, which would have the effect of raising the temperature inside the can to 1800°C ?
 - b. Approximately how many times higher is that new pressure compared to standard atmospheric pressure?
26. A sealed can of gas is left near a heater, which causes the pressure of the gas to increase to 1.4 atm. What was the original pressure of the gas if its temperature change was from 20.0°C to 90.0°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 $^{\circ}\text{C}$.
29. A storage tank is designed to hold a fixed volume of butane gas at 2.00×10^2 kPa and 39.0°C . To prevent dangerous pressure buildup, the tank has a relief valve that opens at 3.50×10^2 kPa. At what Celsius temperature does the valve open?
30. If a gas sample has a pressure of 30.7 kPa at 0.00°C , by how many degrees Celsius does the temperature have to increase to cause the pressure to double?

21. 42.0 kPa

22. 327 kPa

23. 2800 kPa

24. 430 kPa

25. a. 720 kPa

b. about 7 times higher

26. 1.1 atm

27. 136 K

28. -150°C 29. 273°C 30. 273°C