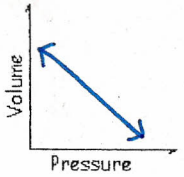
ANSWER KEY

Boyle's Law Homework: $P_1V_1 = P_2V_2$

1) What does a graph of pressure versus volume look like for an ideal gas? Sketch it here.



2) What is the equation that describes the function you drew?

$P_1V_1 = P_2V_2$

3) If you change the pressure or volume of a sample of gas at fixed temperature, what is the mathematical relationship of the starting pressure and volume to the final pressure and volume?

Inverse/Indirect Relationship → $\uparrow P = \downarrow V$

4) A sample of gas has an initial pressure of 2.00 atm and an initial volume of 1.50 L.
   a. What will happen to the volume if the pressure rises to 3.00 atm?
   INCREASE **DECREASE**
   b. Calculate the final volume.

$V_2 = \frac{P_1V_1}{P_2} \rightarrow V_2 = \frac{(2.00\,atm)(1.50\,L)}{(3.00\,atm)} \rightarrow V_2 = 1.00\,L$

5) A sample of gas has an initial pressure of 750 Torr and an initial volume of 800 mL.
   a. How will the pressure change if the volume is compressed to 600 mL?
   INCREASE DECREASE
   b. Calculate the final pressure.

$P_2 = \frac{P_1V_1}{V_2} \rightarrow P_2 = \frac{(750\,Torr)(800\,mL)}{(600\,mL)} \rightarrow P_2 = 1000\,Torr$

6) A sample of gas has an initial pressure of 200 kPa and an initial volume of 120 L.
   a. What will happen to the volume if the pressure is decreased to 60 kPa?
   INCREASE DECREASE
   b. Calculate the final volume.

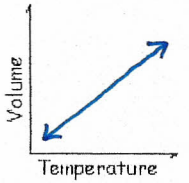
$V_2 = \frac{P_1V_1}{P_2} \rightarrow V_2 = \frac{(200\,kPa)(120\,L)}{(60\,kPa)} \rightarrow V_2 = 400\,L$

7) A sample of gas has an initial pressure of 25 mmHg and an initial volume of 75 mL.
   a. What will happen to the pressure if the volume is expanded to 250 mL?
   INCREASE **DECREASE**
   b. Calculate the final pressure.

$P_2 = \frac{P_1V_1}{V_2} \rightarrow P_2 = \frac{(25\,mmHg)(75\,mL)}{(250\,mL)} \rightarrow P_2 = 7.50\,mmHg$

Charles's Law Practice Problems $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

1) What does a graph of volume versus temperature look like for an ideal gas? Sketch it here.



2) What is the equation that describes the function you drew?

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

3) If you change the temperature or volume of a sample of gas at fixed pressure, what is the mathematical relationship of the starting temperature and volume to the final temperature and volume?

Direct Relationship → $\uparrow T = \uparrow V$

4) A sample of gas has a volume of 3.50 L at 25°C. What will its volume be at 100°C?
   a. Should the volume increase or decrease? Increase
   b. Express the temperatures in Kelvin 298 K and 373 K
   c. Calculate the final volume

$V_2 = \frac{V_1T_2}{T_1} \rightarrow V_2 = \frac{(3.50\,L)(373\,K)}{(298\,K)} \rightarrow V_2 = 4.38\,L$

5) A balloon is taken from a warm room (30°C) into the bitter cold winter air (-10°C). If its initial volume is 5.00 L, what will its volume be in the cold air?
   a. Should the volume increase or decrease? Decrease
   b. Express the temperatures in Kelvin 303 K and 263 K
   c. Calculate the final volume

$V_2 = \frac{V_1T_2}{T_1} \rightarrow V_2 = \frac{(5.00\,L)(263\,K)}{(303\,K)} \rightarrow V_2 = 4.34\,L$

6) A cylinder with a piston has a volume of 35.0 mL at 0°C. At what temperature will the volume increase to 70.0 mL?
   a. Should the temperature increase or decrease? Increase
   b. Express the initial temperature in Kelvin 0°C → 273 K
   c. Calculate the final temperature

$T_2 = \frac{V_2T_1}{V_1} \rightarrow T_2 = \frac{(70\,mL)(273\,K)}{(35\,mL)} \rightarrow T_2 = 546\,K$

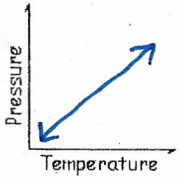
7) A balloon has a volume of 550 mL at 20°C. At what temperature will the balloon shrink to 400 mL?
   a. Should the temperature increase or decrease? Decrease
   b. Express the initial temperature in Kelvin 298 K
   c. Calculate the final temperature

$T_2 = \frac{V_2T_1}{V_1} \rightarrow T_2 = \frac{(400\,mL)(293\,K)}{(550\,mL)} \rightarrow T_2 = 213\,K$

Four Types of Gas Laws

Gay Lussac's Law Practice Problems: $\frac{P_1}{T_1} = \frac{P_2}{T_2}$

1) What does a graph of pressure versus temperature look like for an ideal gas? Sketch it here.



2) What is the equation that describes the function you drew?

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

3) If you change the temperature or pressure of a sample of gas at fixed volume, what is the mathematical relationship of the starting temperature and pressure to the final temperature and pressure?

Direct Relationship → ↑T = ↑P

4) A sample of a gas in a rigid container has an initial temperature of 373 K and an initial pressure of 550 kPa. It is cooled to 298 K.
   a. Will the pressure **INCREASE** or **DECREASE**?
   b. What will the final pressure be?

$P_2 = \frac{P_1 T_2}{T_1} \rightarrow P_2 = \frac{(550\ kPa)(298\ K)}{(373\ K)} \rightarrow P_2 = 439\ kPa$

5) A sample of gas in a rigid container has a pressure of 350 Torr at 25 °C. At what temperature will it have a pressure of 760 Torr?
   a. Will the temperature have to **INCREASE** or **DECREASE**?
   b. What will the final temperature be?

$T_2 = \frac{P_2 T_1}{P_1} \rightarrow T_2 = \frac{(760\ Torr)(298\ K)}{(350\ Torr)} \rightarrow T_2 = 647\ K$

6) A canister of gas is heated from 23°C to 110°C. Its final pressure turns out to be 5.25 atm.
   a. Was the initial pressure **HIGHER** or **LOWER**?
   b. What was its initial pressure?

$P_1 = \frac{P_2 T_1}{T_2} \rightarrow P_1 = \frac{(5.25\ atm)(296\ K)}{(383\ K)} \rightarrow P_1 = 4.06\ atm$

7) A sample of gas at 250 kPa is cooled until its pressure is 180 kPa. Its final temperature is -8°C.
   a. Was its initial temperature **HIGHER** or **LOWER**?
   b. What was its initial temperature?

$T_1 = \frac{P_1 T_2}{P_2} \rightarrow T_1 = \frac{(250\ kPa)(265\ K)}{(180\ kPa)} \rightarrow T_1 = 368\ K$

Four Types of Gas Laws

Combined Gas Law Problems: $\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

1) Boyle's Law, Charles's Law, and Gay Lussac's Law can be written as an expression equal to a constant ($PV = k$, $\frac{V}{T} = k$, and $\frac{P}{T} = k$). Write one expression that combines all three but keeps the mathematical relations the same.

$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

2) If you have a beginning temperature, volume, and pressure (P_1, V_1, and T_1) as well as an ending temperature, volume, and pressure (P_2, V_2, and T_2) what equation can you write that relates the two sets of conditions?

$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$

3) A 2.50-liter sample of gas at 300 Kelvin and 0.950 atm is heated until its temperature is 373 Kelvin. Its final volume is 2.80 liters. What is the final pressure of the gas?

$P_2 = \frac{P_1 V_1 T_2}{V_2 T_1} \rightarrow P_2 = \frac{(0.950\ atm)(2.50\ L)(373\ K)}{(2.80\ L)(300\ K)} \rightarrow P_2 = 1.05\ atm$

4) A 3.65 L balloon at 30°C and 108 kPa is taken to a pressure of 3.25 atm and a temperature of 5°C. What is its final volume?

$V_2 = \frac{P_1 V_1 T_2}{P_2 T_1} \rightarrow V_2 = \frac{(108\ kPa)(3.65\ L)(278\ K)}{(329\ kPa)(303\ K)} \rightarrow V_2 = 1.10\ L$

5) A 35 L sample of gas at 760 mm Hg and 20°C is compressed to 20 L and 800 mm Hg. What must its final temperature be?

$T_2 = \frac{P_2 V_2 T_1}{P_1 V_1} \rightarrow T_2 = \frac{(800\ mmHg)(20\ L)(293\ K)}{(760\ mmHg)(35\ L)} \rightarrow T_2 = 176\ K$