Substitution to solve for T_2:

$$T_2 = T_1 \times \text{volume ratio}$$
$$= 298.15\text{ K} \times \frac{25.0\ \cancel{\text{mL}}}{1.25 \times 10^2\ \cancel{\text{mL}}}$$
$$= 59.630\text{ K}$$

Final temperature conversion:

$$T_2 = \text{K} - 273.15$$
$$= 59.630\text{ K} - 273.15$$
$$= -213.52°\text{C}$$
$$= -214°\text{C}$$

The final temperature of the gas in degrees Celsius is –214°C.

Check Your Solution
The original volume decreased by a factor of 4 when the pressure was increased by a factor of 4. The decrease in volume would need a large decrease in temperature. The units have cancelled correctly and the answer seems reasonable. The answer is correctly expressed to three significant digits.

Section 11.3 Gases and Temperature Changes

Solutions for Practice Problems

Student Edition page 525

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

21. Practice Problem (page 525)

A gas is at 105 kPa and 300.0 K. What is the pressure of the gas at 120.0 K?

What Is Required?
You need to find the new pressure, P_2, on a gas.

What Is Given?
You know the initial pressure of the gas as well as the initial and final temperatures:
P_1 = 105 kPa
T_1 = 300.0 K
T_2 = 120.0 K

Plan Your Strategy
Temperature and pressure are changing at constant volume and amount of gas.
Use the equation for Gay-Lussac's law: $\frac{P_1}{T_1} = \frac{P_2}{T_2}$
Multiply each side of the equation by T_2 to isolate the variable P_2.
Substitute the numbers and units for the known variables in the formula and solve for P_2.

Act on Your Strategy
Isolation of the variable P_2:

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

$$\frac{P_1}{T_1}(T_2) = \frac{P_2}{\cancel{T_2}}(\cancel{T_2})$$

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

Substitution to solve for P_2:

$$\begin{aligned} P_2 &= \frac{P_1 T_2}{T_1} \\ &= \frac{(105\ \text{kPa})(120.0\ \cancel{\text{K}})}{300.0\ \cancel{\text{K}}} \\ &= 42.0\ \text{kPa} \end{aligned}$$

The pressure of the gas at 120.0 K is 42.0 kPa.

Alternative Solution

Plan Your Strategy
According to Gay-Lussac's law, a decrease in temperature will cause a decrease in pressure.
Determine the ratio of the initial temperature and the final temperature that is less than 1.
Multiply the initial pressure by the temperature ratio determined to obtain the final pressure.

Act on Your Strategy
Temperature ratio:
$T_1 = 300.0$ K
$T_2 = 120.0$ K

temperature ratio < 1 is $\frac{120.0\,\text{K}}{300.0\,\text{K}}$

Substitution to solve for P_2:

$$\begin{aligned} P_2 &= P_1 \times \text{temperature ratio} \\ &= 105\ \text{kPa} \times \frac{120.0\ \cancel{\text{K}}}{300.0\ \cancel{\text{K}}} \\ &= 42.0\ \text{kPa} \end{aligned}$$

The pressure of the gas at 120.0 K is 42.0 kPa.

Check Your Solution
According to Gay-Lussac's law, pressure is directly proportional to the Kelvin temperature. The answer shows that as the Kelvin temperature decreased the final pressure is less than the initial pressure. The answer correctly shows three significant digits.

22. Practice Problem (page 525)
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?

What Is Required?
You need to find the new pressure, P_2, of the gas inside the canister.

What Is Given?
You know the initial pressure of the gas in the canister as well as the initial and final air temperatures:
$P_1 = 350.0$ kPa
$T_1 = 298$ K
$T_2 = 278$ K

Plan Your Strategy
Temperature and pressure are changing at constant volume and amount of gas.
Use the equation for Gay-Lussac's law: $\frac{P_1}{T_1} = \frac{P_2}{T_2}$
Multiply each side of the equation by T_2 to isolate the variable P_2.
Substitute the numbers and units for the known variables in the formula and solve for P_2.

Substitution to solve for P_2:

$$P_2 = P_1 \times \text{temperature ratio}$$
$$= 350.0 \text{ kPa} \times \frac{278 \cancel{\text{K}}}{298 \cancel{\text{K}}}$$
$$= 3.2651 \times 10^2 \text{ kPa}$$
$$= 3.26 \times 10^2 \text{ kPa}$$
$$= 327 \text{ kPa}$$

The new pressure of the gas in the canister is 327 kPa.

Check Your Solution

According to Gay-Lussac's law, pressure is directly proportional to the Kelvin temperature. The answer shows that as the Kelvin temperature decreased, the final pressure also decreased. The answer correctly shows three significant digits.

23. Practice Problem (page 525)

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?

What Is Required?

You need to find the new pressure, P_2, of the gas inside the propane tank.

What Is Given?

You know the initial pressure of the propane gas in the tank as well as the initial and final air temperatures:

$P_1 = 2500$ kPa

$T_1 = –15.0$°C

$T_2 = 20.0$°C

Plan Your Strategy

Temperature and pressure are changing at constant volume and amount of gas.

Use the equation for Gay-Lussac's law: $\frac{P_1}{T_1} = \frac{P_2}{T_2}$

Gay-Lussac's law expresses a direct relationship between Kelvin temperature and pressure.

Convert the temperatures from degrees Celsius to kelvin units:

K = °C + 273.15.

Multiply each side of the equation by T_2 to isolate the variable P_2.

Substitute the numbers and units for the known variables in the formula and solve for P_2.

Act on Your Strategy
Temperature conversions:

$$T_1 = -15°\text{C} + 273.15$$
$$= 258.15 \text{ K}$$
$$T_2 = 20.0°\text{C} + 273.15$$
$$= 293.15 \text{ K}$$

Isolation of the variable P_2:

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}$$
$$\frac{P_1}{T_1}(T_2) = \frac{P_2}{\cancel{T_2}}(\cancel{T_2})$$
$$P_2 = \frac{P_1T_2}{T_1}$$

Substitution to solve for P_2:

$$P_2 = \frac{P_1T_2}{T_1}$$
$$= \frac{(2500 \text{ kPa})(293.15 \cancel{\text{K}})}{258.15 \cancel{\text{K}}}$$
$$= 2.8389 \times 10^3 \text{ kPa}$$
$$= 2.8 \times 10^3 \text{ kPa}$$

The pressure of the propane in the tank will be 2.8×10^3 kPa.

Alternative Solution

Plan Your Strategy
According to Gay-Lussac's law, an increase in the Kelvin temperature will cause a proportional increase in the pressure.
Determine the ratio of the initial temperature and the final temperature that is greater than 1.
Multiply the initial pressure by the temperature ratio determined to obtain the final pressure.

Act on Your Strategy
Temperature ratio:

$$T_1 = 258.15 \text{ K}$$
$$T_2 = 293.15 \text{ K}$$

temperature ratio > 1 is $\frac{293.15 \text{ K}}{258.15 \text{ K}}$

Substitution to solve for P_2:

$$P_2 = P_1 \times \text{temperature ratio}$$

$$= 2500 \text{ kPa} \times \frac{293.15 \cancel{\text{K}}}{258.15 \cancel{\text{K}}}$$

$$= 2.8389 \times 10^3 \text{ kPa}$$

$$= 2.8 \times 10^3 \text{ kPa}$$

The new pressure on the gas in the propane tank is 2.8×10^3 kPa.

Check Your Solution

According to Gay-Lussac's law, pressure is directly proportional to the Kelvin temperature. The answer shows that as the Kelvin temperature increased the final pressure also increased. The answer correctly shows two significant digits.

24. Practice Problem (page 525)

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?

What Is Required?

You need to find the new pressure, P_2, of the air inside the tire.

What Is Given?

You know the initial pressure of the air in the tire as well as the initial and final air temperatures surrounding the tire:

$P_1 = 370$ kPa

$T_1 = 15°\text{C}$

$T_2 = 60.0°\text{C}$

Plan Your Strategy

Temperature and pressure are changing at constant volume and amount of gas.

Use the equation for Gay-Lussac's law: $\frac{P_1}{T_1} = \frac{P_2}{T_2}$

Gay-Lussac's law expresses a direct relationship between Kelvin temperature and pressure.

Convert the temperatures from degrees Celsius to kelvin units:

K = °C + 273.15

Act on Your Strategy

Temperature conversions:

$$T_1 = 15°\text{C} + 273.15$$
$$= 288.15 \text{ K}$$
$$T_2 = 60.0°\text{C} + 273.15$$
$$= 333.15 \text{ K}$$

Temperature ratio:

$$T_1 = 288.15 \text{ K}$$
$$T_2 = 333.15 \text{ K}$$

temperature ratio > 1 is $\dfrac{333.15 \text{ K}}{288.15 \text{ K}}$

Substitution to solve for P_2:

$$P_2 = P_1 \times \text{temperature ratio}$$
$$= 370 \text{ kPa} \times \frac{333.15 \cancel{\text{K}}}{288.15 \cancel{\text{K}}}$$
$$= 4.2778 \times 10^2 \text{ kPa}$$
$$= 4.3 \times 10^2 \text{ kPa}$$

The new pressure in the tire would be 4.3×10^2 kPa.

Check Your Solution

According to Gay-Lussac's law, pressure is directly proportional to the Kelvin temperature. The answer shows that as the Kelvin temperature increased, the final pressure increased by a proportional amount. The answer correctly shows two significant digits.

25. Practice Problem (page 525)

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?

a. pressure

What Is Required?

You need to find the new pressure, P_2, of the gas inside the aerosol can.

What Is Given?

You know the initial pressure of the gas in the can as well as the initial and final temperatures:

P_1 = 14.8 psi
T_1 = 20.0°C
T_2 = 1800°C

Plan Your Strategy

Temperature and pressure are changing at constant volume and amount of gas.

Use the equation for Gay-Lussac's law: $\frac{P_1}{T_1} = \frac{P_2}{T_2}$

Gay-Lussac's law expresses a direct relationship between Kelvin temperature and pressure.

Convert the temperatures from degrees Celsius to kelvin units:

K = °C + 273.15

Multiply each side of the equation by T_2 to isolate the variable P_2.

Substitute the numbers and units for the known variables in the formula and solve for P_2.

Convert the final pressure to from psi to kPa: 14.7 psi = 101.325 kPa

Act on Your Strategy

Temperature conversions:

$$\begin{aligned} T_1 &= 20°\text{C} + 273.15 \\ &= 293.15 \text{ K} \\ T_2 &= 1800°\text{C} + 273.15 \\ &= 2073.15 \text{ K} \end{aligned}$$

Isolation of the variable P_2:

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

$$\frac{P_1}{T_1}(T_2) = \frac{P_2}{\cancel{T_2}}(\cancel{T_2})$$

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

Substitution to solve for P_2:

$$P_2 = \frac{P_1T_2}{T_1}$$
$$= \frac{(14.8 \text{ psi})(2073.15 \cancel{\text{K}})}{293.15 \cancel{\text{K}}}$$
$$= 1.0466 \times 10^2 \text{ psi}$$

Final pressure conversion:

$$P_2 = 1.0466 \times 10^2 \text{ psi}$$
$$= 1.0466 \times 10^2 \cancel{\text{psi}} \times \frac{101.325 \text{ kPa}}{14.7 \cancel{\text{psi}}}$$
$$= 7.2140 \times 10^2 \text{ kPa}$$
$$= 7.2 \times 10^2 \text{ kPa}$$

The pressure (in kPa) on the gas in the aerosol can would be 7.2×10^2 kPa.

Alternative Solution

Plan Your Strategy

According to Gay-Lussac's law, an increase in the Kelvin temperature will cause a proportional increase in the pressure.
Convert the temperatures from degrees Celsius to kelvin units:
K = °C + 273.15
Determine the ratio of the initial temperature and the final temperature that is greater than 1.
Multiply the initial pressure by the temperature ratio determined to obtain the final pressure.
Convert the final pressure from psi to kPa: 14.7 psi = 101.325 kPa

Act on Your Strategy

Temperature conversions:

$$T_1 = 20°\text{C} + 273.15$$
$$= 293.15 \text{ K}$$
$$T_2 = 1800°\text{C} + 273.15$$
$$= 2073.15 \text{ K}$$

Temperature ratio:

$$T_1 = 293.15 \text{ K}$$
$$T_2 = 2073.15 \text{ K}$$

temperature ratio > 1 is $\dfrac{2073.15\text{ K}}{293.15\text{ K}}$

Substitution to solve for P_2:

$$P_2 = P_1 \times \text{temperature ratio}$$
$$= 14.8\text{ psi} \times \frac{2073.15\text{ }\cancel{\text{K}}}{293.15\text{ }\cancel{\text{K}}}$$
$$= 1.0466 \times 10^2\text{ psi}$$

Final pressure conversion:

$$P_2 = 1.0466 \times 10^2\text{ psi}$$
$$= 1.0466 \times 10^2\text{ }\cancel{\text{psi}} \times \frac{101.325\text{ kPa}}{14.7\text{ }\cancel{\text{psi}}}$$
$$= 7.2140 \times 10^2\text{ kPa}$$
$$= 7.2 \times 10^2\text{ kPa}$$

The pressure (in kPa) on the gas in the aerosol can would be 7.2×10^2 kPa.

Check Your Solution
According to Gay-Lussac's law, pressure is directly proportional to the Kelvin temperature. The answer shows that as the Kelvin temperature increased the final pressure is increased proportionally. The answer is reasonable for such a large increase in pressure and the answer correctly shows two significant digits.

b. pressure compared with SAP
What Is Required?
You must approximate how many times higher the new pressure is compared with standard atmospheric pressure?

What Is Given?
You know the pressure inside the aerosol can: 7.2×10^2 kPa
You know that standard atmospheric pressure is 101.325 kPa.

Plan Your Strategy.
Round the values for pressure inside the aerosol can and standard atmospheric pressure to estimate how many times higher the pressure is inside the can.

Act on Your Strategy
pressure inside can ≈ 7×10^2 kPa
standard atmospheric pressure ≈ 1×10^2 kPa

$$\text{Estimating: } \frac{\text{pressure inside can}}{\text{standard pressure}} = \frac{7 \times \cancel{10^2}}{1 \times \cancel{10^2}} = 7$$

The pressure inside the can is about 7 times greater than standard atmospheric pressure.

Check Your Solution
The answer seems reasonable for this increase in temperature.

26. Practice Problem (page 525)

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?

What Is Required?
You need to find the initial pressure, P_1, of the air inside the can.

What Is Given?
You know the final pressure of gas in the can as well as the initial and final air temperatures:
$P_2 = 1.4$ atm
$T_1 = 20.0$°C
$T_2 = 90.0$°C

Plan Your Strategy
Temperature and pressure are changing at constant volume and amount of gas.
Use the equation for Gay-Lussac's law: $\frac{P_1}{T_1} = \frac{P_2}{T_2}$
Gay-Lussac's law expresses a direct relationship between Kelvin temperature and pressure.
Convert the temperatures from degrees Celsius to kelvin units:
K = °C + 273.15
Multiply each side of the equation by T_1 to isolate the variable P_1.
Substitute the numbers and units for the known variables in the formula and solve for P_1.

Act on Your Strategy
Temperature conversions:

$$T_1 = 20°\text{C} + 273.15$$
$$= 293.15 \text{ K}$$
$$T_2 = 90°\text{C} + 273.15$$
$$= 363.15 \text{ K}$$

Temperature ratio:

$$T_1 = 293.15 \text{ K}$$
$$T_2 = 363.15 \text{ K}$$

temperature ratio < 1 is $\dfrac{293.15 \text{ K}}{363.15 \text{ K}}$

Substitution to solve for P_1:

$$P_1 = P_2 \times \text{temperature ratio}$$
$$= 1.4 \text{ atm} \times \frac{293.15 \cancel{\text{K}}}{263.15 \cancel{\text{K}}}$$
$$= 1.1301 \text{ atm}$$
$$= 1.1 \text{ atm}$$

The original pressure inside the can was 1.1 atm.

Check Your Solution
According to Gay-Lussac's law, pressure is directly proportional to the Kelvin temperature. The answer shows that as the Kelvin temperature increased, the final pressure increased by a proportional amount. The answer correctly shows two significant digits.

27. Practice Problem (page 525)
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?

What Is Required?
You need to find the initial temperature, T_1, of helium gas inside a cylinder.

What Is Given?
You know the initial pressure and the final pressure of helium in the cylinder as well as the final air temperature:
$P_1 = 1.12$ atm
$P_2 = 2.56$ atm
$T_2 = 310.0$ K

Plan Your Strategy
Temperature and pressure are changing at constant volume and amount of gas.

Use the equation for Gay-Lussac's law: $\frac{P_1}{T_1} = \frac{P_2}{T_2}$

Multiply each side of the equation first by T_1 and then by $\frac{T_2}{P_2}$ to isolate the variable T_1.
Substitute the numbers and units for the known variables in the formula and solve for T_1.

Act on Your Strategy
Isolation of the variable T_1:

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

$$\left(\frac{P_1}{\cancel{T_1}}\right)(\cancel{T_1}) = \left(\frac{P_2}{T_2}\right)(T_1)$$

$$\left(\frac{T_2}{P_2}\right)(P_1) = \left(\frac{\cancel{P_2}}{\cancel{T_2}}\right)\left(\frac{\cancel{T_2}}{\cancel{P_2}}\right)(T_1)$$

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

Substitution to solve for T_1:

$$\begin{aligned} T_1 &= \frac{T_2 P_1}{P_2} \\ &= \frac{(310.0 \text{ K})(1.12 \ \cancel{\text{atm}})}{2.56 \ \cancel{\text{atm}}} \\ &= 1.356 \times 10^2 \text{ K} \\ &= 136 \text{ K} \end{aligned}$$

The initial temperature of the helium gas in the cylinder was 136 K.

Alternative Solution

Plan Your Strategy
According to Gay-Lussac's law, an increase in Kelvin temperature will cause a proportional increase in pressure. The initial temperature must be less than the final temperature.

Determine the ratio of the initial pressure and the final pressure that is less than 1. Multiply the final temperature by the pressure ratio determined to obtain the initial temperature.

Act on Your Strategy
Pressure ratio:
$P_1 = 1.12$ atm
$P_2 = 2.56$ atm
pressure ratio < 1 is $\dfrac{1.12 \text{ atm}}{2.56 \text{ atm}}$

Substitution to solve for T_1:

$$\begin{aligned} T_1 &= T_2 \times \text{pressure ratio} \\ &= 310.0 \text{ K} \times \frac{1.12 \cancel{\text{atm}}}{2.56 \cancel{\text{atm}}} \\ &= 1.356 \times 10^2 \text{ K} \\ &= 136 \text{ K} \end{aligned}$$

The initial temperature of the helium gas in the cylinder was 136 K.

Check Your Solution
According to Gay-Lussac's law, pressure is directly proportional to the Kelvin temperature. The answer shows that as the pressure approximately doubled, the Kelvin temperature changed by approximately the same factor. The answer correctly shows three significant digits.

28. Practice Problem (page 525)
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.

What Is Required?
You need to find the final temperature, T_2, of neon gas inside a bulb.

What Is Given?
You know the initial pressure and the final pressure of the neon gas in the bulb as well as the initial temperature:
$P_1 = 350$ kPa
$P_2 = 103$ kPa
$T_1 = 150$°C

Check Your Solution
According to Gay-Lussac's law, pressure is directly proportional to the Kelvin temperature. The answer shows that as the pressure decreased, the final temperature decreased proportionally. The answer seems reasonable and the answer correctly shows two significant digits.

29. Practice Problem (page 525)
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 build-up, the tank has a relief valve that opens at 3.50×10^2 kPa.
At what Celsius temperature does the valve open?

What Is Required?
You need to find the temperature, T_2, at which a relief valve opens.

What Is Given?
You know the initial pressure and the final pressure in the storage tank as well as the initial temperature:
$P_1 = 2.00 \times 10^2$ kPa
$P_2 = 3.50 \times 10^2$ kPa
$T_1 = 39$°C

Plan Your Strategy
Temperature and pressure are changing at constant volume and amount of gas.
Use the equation for Gay-Lussac's law: $\frac{P_1}{T_1} = \frac{P_2}{T_2}$
Gay-Lussac's law expresses a direct relationship between Kelvin temperature and pressure.
Convert the initial temperature from degrees Celsius to kelvin units:
K = °C + 273.15
Multiply each side of the equation by T_2 and then by $\frac{T_1}{P_1}$ to isolate the variable T_2.
Substitute the numbers and units for the known variables in the formula and solve for T_2.
Convert the final temperature from kelvin units to degrees Celsius:
°C = K – 273.15

Act on Your Strategy
Initial temperature conversion:
$$\begin{aligned} T_1 &= 39.0°\text{C} + 273.15 \\ &= 312.15 \text{ K} \end{aligned}$$

Isolation of the variable T_2:

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

$$\left(\frac{P_1}{T_1}\right)(T_2) = \left(\frac{P_2}{\cancel{T_2}}\right)(\cancel{T_2})$$

$$\left(\frac{\cancel{P_1}}{\cancel{T_1}}\right)\left(\frac{\cancel{T_1}}{\cancel{P_1}}\right)(T_2) = (P_2)\left(\frac{T_1}{P_1}\right)$$

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

Substitution to solve for T_2:

$$\begin{aligned} T_2 &= \frac{T_1 P_2}{P_1} \\ &= \frac{(312.15\ \text{K})(3.50 \times 10^2\ \cancel{\text{kPa}})}{2.00 \times 10^2\ \cancel{\text{kPa}}} \\ &= 5.4626 \times 10^2\ \text{K} \end{aligned}$$

Final temperature conversion:

$$\begin{aligned} T_2 &= 5.4626 \times 10^2\ \text{K} \\ &= 5.4626 \times 10^2\ \text{K} - 273.15 \\ &= 2.7311 \times 10^2\ ^\circ\text{C} \\ &= 273^\circ\text{C} \end{aligned}$$

The relief valve will open at a temperature of 273°C.

Alternative Solution

Plan Your Strategy

According to Gay-Lussac's law, an increase in the pressure will cause a proportional increase in the Kelvin temperature.

Determine the ratio of the initial pressure and the final pressure that is greater than 1.

Gay-Lussac's law expresses a direct relationship between Kelvin temperature and pressure.

Convert the initial temperature from degrees Celsius to kelvin units:

K = °C + 273.15

Multiply the initial temperature by the pressure ratio determined to obtain the final temperature.

Convert the final temperature from kelvin units to degrees Celsius:
°C = K – 273.15

Act on Your Strategy
Initial temperature conversion:

$$\begin{aligned} T_1 &= 39.0°\text{C} + 273.15 \\ &= 312.15 \text{ K} \end{aligned}$$

Pressure ratio:
$P_1 = 2.00 \times 10^2$ kPa
$P_2 = 3.50 \times 10^2$ kPa

$$\text{pressure ratio} > 1 \text{ is } \frac{3.50 \times 10^2 \text{ kPa}}{2.00 \times 10^2 \text{ kPa}}$$

Substitution to solve for T_2:

$$\begin{aligned} T_2 &= T_1 \times \text{pressure ratio} \\ &= 312.15 \text{ K} \times \frac{3.50 \times 10^2 \ \cancel{\text{kPa}}}{2.00 \times 10^2 \ \cancel{\text{kPa}}} \\ &= 5.4626 \times 10^2 \text{ K} \end{aligned}$$

Final temperature conversion:

$$\begin{aligned} T_2 &= 5.4626 \times 10^2 \text{ K} \\ &= 5.4626 \times 10^2 \text{ K} - 273.15 \\ &= 2.7311 \times 10^2 °\text{C} \\ &= 273°\text{C} \end{aligned}$$

The pressure relief valve will open at a temperature of 273°C.

Check Your Solution
According to Gay-Lussac's law, pressure is directly proportional to the Kelvin temperature. The answer shows that as the pressure increased, the final temperature increased proportionally. The answer seems reasonable and correctly shows three significant digits.

30. Practice Problem (page 525)
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?

What Is Required?
You need to find by how many degrees Celsius the temperature of a sample must increase to cause the pressure to double.