Inside the Canister

Trace how heating a trapped gas changes its pressure.

CHE.7.a "Qualitatively and quantitatively relate changes in the temperature and pressure of a gas to particle motion and number of collisions."

NAME _____ DATE _____

1 READ AND MARK

Read it twice

YOUR JOB Underline the two conditions held constant, circle the units used for temperature and pressure, and number three links in the text from heating the gas to increasing its pressure.

A Canister Under Pressure

1. Imagine a sealed metal canister of air with a pressure gauge on its lid. The canister cannot expand, and no air enters or leaves. Gas particles dart in all directions, striking the walls and rebounding. Each hit transfers momentum to a wall. The combined force of these hits across each unit of wall area is the gas pressure.

2. An electric heater warms the canister in stages. Temperature is recorded in kelvins, and pressure is recorded in kilopascals. In this model, the amount of gas and the canister's volume stay fixed. Warmer particles have greater average kinetic energy. They move faster, reach a given wall more often, and transfer more momentum in each collision.

PREDICTED CHANGES IN A SEALED CANISTER

Temperature (K)	Pressure (kPa)	Collisions on wall patch per microsecond
300	100	100
600	200	141
900	300	173

3. The table gives predicted values for one small patch of wall during equal time intervals. Its collision counts are rounded averages, not a record of individual hits. At fixed volume and particle number, pressure is proportional to temperature in kelvins. Collision rate rises too, but not as quickly as pressure, because each hit also transfers more momentum.

2 ANSWER WITH EVIDENCE

Use the passage

1. When the gas warms from 300 K to 600 K, how do its pressure and collision count change? Connect both changes to particle motion.

2. A student says that tripling the temperature from 300 K to 900 K must triple the collision count. Use the table and particle motion to evaluate the claim.

3. If the canister reaches 450 K, what pressure does the model predict? How would the collision rate compare with the rates at 300 K and 600 K?

4. The canister cools from 900 K to 600 K. State the pressure change and explain what happens to particle motion and wall collisions.

3 YOUR TURN

Your own words

A different sealed, rigid container holds gas at 200 K and 80 kPa. Predict its pressure at 400 K, then explain your prediction using particle speed, collision rate, and the momentum transferred in each hit.

Inside the Canister

PART 1 · READ AND MARK

Underline the two conditions held constant, circle the units used for temperature and pressure, and number three links in the text from heating the gas to increasing its pressure. Accept any marking that follows this job and points at the right text.

PART 2 · ANSWERS

#	QUESTION	ANSWER
1	When the gas warms from 300 K to 600 K, how do its pressure and collision count change? Connect both changes to particle motion.	**Pressure doubles from 100 to 200 kPa, while collisions on the wall patch rise from 100 to 141 per microsecond. Faster particles reach the wall more often and transfer more momentum per hit.**
2	A student says that tripling the temperature from 300 K to 900 K must triple the collision count. Use the table and particle motion to evaluate the claim.	**The claim is incorrect. Pressure triples from 100 to 300 kPa, but the collision count rises from 100 to 173 per microsecond, not 300. Faster particles transfer more momentum in each hit as well as hitting more often.**
3	If the canister reaches 450 K, what pressure does the model predict? How would the collision rate compare with the rates at 300 K and 600 K?	**The predicted pressure is 150 kPa. The collision rate would be higher than at 300 K but lower than at 600 K.**
4	The canister cools from 900 K to 600 K. State the pressure change and explain what happens to particle motion and wall collisions.	**Pressure falls from 300 to 200 kPa. Particles move more slowly, so collisions on the wall patch fall from 173 to 141 per microsecond, and each hit transfers less momentum.**

PART 3 · YOUR TURN (SAMPLE ANSWER)

The pressure would be 160 kPa because doubling the temperature in kelvins doubles the pressure when the amount of gas and volume stay fixed. The particles would move faster and hit the walls more often. Each hit would also transfer more momentum, so the collision rate would increase but would not need to double.

Accept equivalent explanations that distinguish collision rate from pressure. For Question 3, no exact collision count is required.