Inspiring Greatness
INDEPENDENCE SCHOOL DISTRICT

High School Science Virtual Learning

Chemistry
Behavior of Gases: The Gas Laws Practice

May 11th, 2020

Chemistry
Lesson: May 11th 2020

Objective/Learning Target:
The learner will be able to describe the relationships among the temperature, pressure, and volume of gases.

Bell Ringer

1. Describe the relationship between pressure and volume if temperature is held constant?

2. Describe the relationship between volume and temperature if pressure is held constant?

Bell Ringer Answers:

1. As pressure goes up, volume goes down.

2. As temperature goes up, volume goes up.

Lesson

In earlier lessons you learned about the different gas laws.

- Boyle's Law
- Charles' Law
- Gay-Lussac's Law
- Combined Gas Law

In this lesson we are going to focus on practicing calculations for these laws.

Gas Law Reminders

Boyle's Law: If the temperature is constant, when pressure increases, the volume decrease. (inversely proportional)

$P_1 x\ V_1 = P_2 x\ V_2$

Charles' Law: As the temperature of a gas increases the volume also increases when pressure is constant. (directly proportional)

$V_1 / T_1 = V_2 / T_2$

Gas Law

Gay-Lussac's Law: As the temperature of a gas increases the pressure also increases with a constant volume. (directly proportional) $P_1/T_1=P_2/T_2$

Combined Gas Law combines all three of the previous laws to handle changes in multiple variables at the same time. Mathematically it looks like $(P_1 x\ V_1)/T_1 = (P_2 x\ V_2)/T_2$

Rewatch this video if needed. The Gas Laws - The Science Classroom

Practice

1. <u>Boyle's Law:</u> A balloon contains 30.0 L of helium gas at 103 kPa. What is the volume of the helium when the balloon rises to an altitude where the pressure is only 25.0 kPa? (Assume the temperature remains constant.)

2. <u>Charles's Law:</u> A balloon inflated in a room at 24°C has a volume of 4.00 L. The balloon is then heated to a temperature of 58°C. What is the new volume if the pressure remains constant? (Remember to convert your temperatures to Kelvin
   K = °C + 273.15)

Practice

3. Gay-Lussac's Law: Aerosol cans carry warnings on their labels that say not to incinerate (burn) them or store the cans above a certain temperature. This problem will sho why it is dangerous to dispose of aerosol cans in a fire. The sa in a used aerosol can is at a pressure of 103 kPa at 25°C. If the can is thrown onto a fire, what will the pressure be when the temperature reaches 928°C? (Remember to convert your temperatures to Kelvin K = °C + 273.15)

Practice

4. The Combined Gas Law: The volume of a gas-filled balloon is 30.0 L at 313 K and 153 kPa pressure. What would the volume be at standard temperature and pressure (STP)?

Reminders:

- Make sure your temperatures are in Kelvin
- STP is 101.3 kPa at 0℃

Answers

1.

$$P_1 \, x \, V_1 = P_2 \, x \, V_2$$

$$103 \, kPa \, x \, 30.0 \, L = 25.0 \, kPa \, x \, V_2$$

$$\frac{103 \, kPa \, x \, 30.0 \, L}{25.0 \, kPa} = \frac{25.0 \, kPa \, x \, V_2}{25.0 \, kPa}$$

$$124 \, L = V_2$$

Answers

2.

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

$$K = 24°C + 273.15\,K = 297.15\,K$$

$$K = 58°C + 273.15\,K = 331.15\,K$$

$$\frac{4.00\,L}{297.15\,K} = \frac{V_2}{331.15\,K}$$

$$331.15\,\cancel{K}\,x\,\frac{103\ \ L}{297.15\,\cancel{K}} = \frac{P_2}{\cancel{331.15\,K}}\,x\,\cancel{331.15\,K}$$

$$4.46\,L = V_2$$

Answers

3.

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

$$K = 25°C + 273.15\,K = 298.15\,K$$

$$K = 928°C + 273.15\,K = 1201.15\,K$$

$$\frac{103\,kPa}{298.15\,K} = \frac{P_2}{1201.15\,K}$$

$$1201.15\,\cancel{K}\ x\ \frac{103\,kPa}{298.15\,\cancel{K}} = \frac{P_2}{\cancel{1201.15\,K}}\ x\ \cancel{1201.15\,K}$$

$$415\,kPa = P_2$$

Answers

4.

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

$$K = 0°C + 273.15\,K = 273.15\,K$$

$$\frac{153\,kPa \; x \; 30.0\,L}{313\,K} = \frac{101.3\,kPa \; x \; V_2}{273.15\,K}$$

$$\frac{273.15\,\cancel{K}}{101.3\,\cancel{kPa}} \; x \; \frac{153\,\cancel{kPa} \; x \; 30.0\,L}{313\,\cancel{K}} = \frac{\cancel{101.3\,kPa} \; x \; V_2}{\cancel{273.15\,K}} \; x \; \frac{\cancel{273.15\,K}}{\cancel{101.3\,kPa}}$$

$$39.5\,L = V_2$$

More Practice

This virtual lab from the University of Colorado: Colorado Springs will allow you to explore some of the gas laws.

This site from Mr. Carman will allow you to make quizzes to practice the different gas law calculations. Note: Make sure the Ideal Gas Law box is unchecked.

Type of problems (select at least one):

- [x] Boyle's Law (pressure & volume; temperature is constant)
- [x] Charles' Law (temperature & volume; pressure is constant)
- [x] Gay-Lussac's Law (pressure & temperature; volume is constant)
- [x] Combined Gas Law (pressure, volume & temperature; only moles are constant)
- [ ] Ideal Gas Law (pressure, volume, temperature & moles are constant)