

**Proportional Reasoning with Gases**

CleMistry: <http://genest.weebly.com>

Stop in for help every day at lunch and Tues, Wed., & Thurs after school!

After-hours question? Email me at home:

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Name \_\_\_\_\_

Period \_\_\_\_\_

1. What happens to pressure in a sample of gas if you make the new volume triple the original and keep temperature at 310K the whole time?

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \quad P_1 V_1 = P_2 V_2 \quad \frac{P_1 V_1}{V_2} = P_2 \quad \frac{1 \cdot 1}{3} = P_2$$

2. What happens to temperature if you make the new volume 1/3 of the original and the new pressure 1/3 of the original?

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \Rightarrow T_2 = \frac{P_2 V_2 T_1}{P_1 V_1} \quad T_2 = \frac{\frac{1}{3} \cdot \frac{1}{4} \cdot 1}{1 \cdot 1} \quad T_2 = \frac{1}{12} \text{ the original}$$

Answer new pressure is 1/3 of original

3. 300. mL of nitrogen gas is measured at the standard pressure. What volume will the gas occupy at a pressure of 690 mm Hg? Temperature sounds like it stays the same.

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \quad P_1 V_1 = P_2 V_2 \quad \frac{P_1 V_1}{P_2} = V_2 \quad \frac{(760 \text{ mmHg})(300 \text{ L})}{(690 \text{ mmHg})} = V_2$$

$$330 \text{ L} = V_2$$

4. A 71.6-mg sample of pantothenic acid (a vitamin B) gives off 3.84 mL of nitrogen gas at 23 °C and 785 mmHg. What is the volume of nitrogen at STP?

before	after
$V_1 = 3.84 \text{ L}$	$V_2 = ?$
$T_1 = 296 \text{ K}$	$T_2 = 273 \text{ K}$
$P_1 = 785 \text{ mmHg}$	$P_2 = 760 \text{ mmHg}$

$$V_2 = \frac{T_2 P_1 V_1}{P_2 T_1} \quad V_2 = \frac{(273 \text{ K})(785 \text{ mmHg})(3.84 \text{ L})}{(760 \text{ mmHg})(296 \text{ K})} = 3.66 \text{ L}$$

5. A bottle of nitrogen was collected at 0°C. Assuming the pressure remains constant at what temperature would the volume be triple?

$V_1 = "1"$	$V_2 = "3"$
$T_1 = 273 \text{ K}$	$T_2 = ?$

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2} \quad \frac{V_1}{T_1} = \frac{V_2}{T_2} \quad T_2 = \frac{V_2 T_1}{V_1} \quad T_2 = \frac{(3)(273 \text{ K})}{(1)} = 819 \text{ K}$$

6. A 38.08 g sample of nitrogen is sealed in a 7.00L container and at a temperature of 327°C. What is the pressure of the gas?

$$P = \frac{nRT}{V}$$

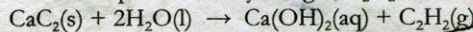
Fix the units

$$38.08 \text{ g N}_2 \times \left( \frac{1 \text{ mol N}_2}{28.08 \text{ g N}_2} \right) = 1.356 \text{ mol N}_2$$

$$P = \frac{(1.356 \text{ mol})(0.0821 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}})(600 \text{ K})}{(7.00 \text{ L})} \quad P = 9.54 \text{ atm}$$



7. Calcium carbide reacts with water to produce acetylene gas, C<sub>2</sub>H<sub>2</sub>.



Calculate the volume (in liters) of acetylene produced at 26 °C and 684 mmHg 35.6 grams of water and plenty of CaC<sub>2</sub>.

Step one

$$35.6 \text{ g H}_2\text{O} \times \left( \frac{1 \text{ mol H}_2\text{O}}{18.02 \text{ g H}_2\text{O}} \right) \times \left( \frac{1 \text{ mol C}_2\text{H}_2}{2 \text{ mol H}_2\text{O}} \right) = 0.9878 \text{ mol C}_2\text{H}_2$$

Step 2

$$PV = nRT$$

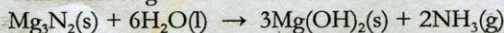
$$\downarrow$$

$$V = \frac{nRT}{P}$$

$$V = \frac{(0.9878)(0.0821)(299\text{K})}{(0.900 \text{ atm})}$$

Answer  
V = 26

8. Magnesium burns in air to produce magnesium oxide, MgO, and magnesium nitride, Mg<sub>3</sub>N<sub>2</sub>. Magnesium nitride reacts with water to give ammonia.



What volume of ammonia (NH<sub>3</sub>) gas at 24 °C and 753 mmHg will be produced from 4.56 g of magnesium nitride?

Step ONE

USE the periodic table

$$4.56 \text{ g Mg}_3\text{N}_2 \times \left( \frac{1 \text{ mol Mg}_3\text{N}_2}{100.95 \text{ g Mg}_3\text{N}_2} \right) \times \left( \frac{2 \text{ mol NH}_3}{1 \text{ mol Mg}_3\text{N}_2} \right) = 0.0903 \text{ mol NH}_3$$

Step two

$$PV = nRT$$

$$\downarrow$$

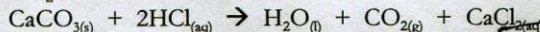
$$V = \frac{nRT}{P}$$

$$V = \frac{(0.0903 \text{ mol})(0.0821)(297\text{K})}{(0.991 \text{ atmospheres})}$$

thanks to Daley for catching my mistake!

Answer  
V =

9. How many moles of hydrochloric acid must react with excess calcium carbonate to form 18.0 L of CO<sub>2</sub> at STP?



Step one

$$PV = nRT$$

$$n = \frac{PV}{RT}$$

$$n = \frac{(1.00 \text{ atm})(18.0 \text{ L})}{(0.0821 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}})(273\text{K})}$$

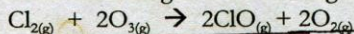
answer:

$$n = 0.803 \text{ mol CO}_2$$

Step 2

$$0.803 \text{ mol CO}_2 \times \frac{2 \text{ mol HCl}}{1 \text{ mol CO}_2} = 1.61 \text{ mol HCl}$$

10. How many liters of ozone can be destroyed at 220 K and 5.00 kPa if 250 g of chlorine reacts with ozone according to the following equation?



Step One

$$250 \text{ g Cl}_2 \times \left( \frac{1 \text{ mol Cl}_2}{70.90 \text{ g Cl}_2} \right) \times \left( \frac{2 \text{ mol O}_3}{1 \text{ mol Cl}_2} \right) = 7.05 \text{ mol O}_3$$

Step 2

$$PV = nRT$$

$$V = \frac{nRT}{P}$$

$$V = \frac{(7.05 \text{ mol})(0.0821 \frac{\text{L}\cdot\text{atm}}{\text{mol}\cdot\text{K}})(220\text{K})}{(0.0495 \text{ atm})}$$

$$V = 2570 \text{ Liters of ozone}$$

0.0495 atm!