Proportional Reasoning with Gases

CAeMis+ry: 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:

eagenest@madison.k12.wi.us

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?

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ $P_1V_1 = P_2V_2$ $\frac{P_1V_1}{V_2} = P_2$ $\frac{1 \cdot 1}{3} = P_2$

Answer: new pressure is $\frac{1}{3}$ of the original

2. What happens to temperature if you make the new volume ¼ of the original and the new pressure 1/3 of the original?

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \Rightarrow T_2 = \frac{P_2V_2T_1}{P_1V_1}$ $T_2 = \frac{\frac{1}{3} \cdot \frac{1}{4} \cdot 1}{1 \cdot 1}$ $T_2 = \frac{1}{12}$ the original

3. 300. mL of nitrogen gas is measured at the standard pressure (760 mmHg). What volume will the gas occupy at a pressure of 690 mm Hg? Temperature sounds like it stays the same.

$P_1V_1 = P_2V_2$ $\frac{P_1V_1}{P_2} = V_2$ $\frac{(760\text{mmHg})(300\text{L})}{(690\text{mmHg})} = V_2$

$330\text{L} = V_2$

4. A 71.6-mg sample of pentothenic acid (a vitamin B) gives off 3.84 mL of nitrogen gas at 23 °C (296K) and 785 mmHg. What is the volume of nitrogen at STP?

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

$V_2 = \frac{T_2P_1V_1}{P_2T_1}$

$V_2 = \frac{(273\text{K})(785\text{mmHg})(3.84\text{L})}{(760\text{mmHg})(296\text{K})} = 3.66\text{L}$

5. A bottle of nitrogen was collected at 0°C (273K). Assuming the pressure remains constant at what temperature would the volume be triple?

$V_1 = 1$ $T_1 = 273$ $V_2 = 3$ $T_2 = ?$

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$ $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $T_2 = \frac{V_2T_1}{V_1}$

$T_2 = \frac{(3)(273\text{K})}{(1)} = 819$

6. A 38.08 g sample of nitrogen is sealed in a 7.00L container and at a temperature of 327°C (600. K). What is the pressure of the gas?

Fix the units: $38.08\text{g}\,N_2 \times \left(\frac{1\text{ mol } N_2}{28.08\text{g}\,N_2}\right) = 1.356\text{ mol}\,N_2$

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

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

$P = 9.54\text{ atm}$

7. Calcium carbide reacts with water to produce acetylene gas, C_2H_2.

$$CaC_2(s) + 2H_2O(l) \rightarrow Ca(OH)_2(aq) + C_2H_2(g)$$

299K!

Calculate the volume (in liters) of acelytene produced at 26 °C and 684 mmHg 35.6 grams of water and plenty of CaC_2.

Step one

$$35.6\,g\,H_2O \times \left(\frac{1\ mol\ H_2O}{18.02\,g\,H_2O}\right) \times \left(\frac{1\ mol\ C_2H_2}{2\ mol\ H_2O}\right) = 0.9878\ mol\ C_2H_2$$

Step 2

$PV = nRT$

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

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

Answ

V = 26

8. Magnesium burns in air to produce magnesium oxide, MgO, and magnesium nitride, Mg_3N_2. Magnesium nitride reacts with water to give ammonia.

$$Mg_3N_2(s) + 6H_2O(l) \rightarrow 3Mg(OH)_2(s) + 2NH_3(g)$$

What volume of ammonia (NH_3) gas at 24 °C and 753 mmHg will be produced from 4.56 g of magnesium nitride?

Step ONE USE the periodic tab

$$4.56\,g\,Mg_3N_2 \times \left(\frac{1\ mol\ Mg_3N_2}{100.95\,g\,Mg_3N_2}\right) \left(\frac{2\ mol\ NH_3}{1\ mol\ Mg_3N_2}\right) = 0.0903\ mol\ NH_3$$

Step two

thanks to Daley for catching my mistake!

$PV = nRT$

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

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

9. How many moles of hydrochloric acid must react with excess calcium carbonate to form 18.0 L of CO_2 at STP?

$$CaCO_{3(s)} + 2HCl_{(aq)} \rightarrow H_2O_{(l)} + CO_{2(g)} + CaCl_{2(aq)}$$

Step one

$PV = nRT$

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

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

answer: $n = 0.803\ mol\ CO_2$

Step 2

$$0.803\,mol\,CO_2 \times \frac{2\ mol\ HCl}{1\ mol\ CO_2} = 1.61\ mol\ HCl$$

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?

$$Cl_{2(g)} + 2O_{3(g)} \rightarrow 2ClO_{(g)} + 2O_{2(g)}$$

Step One

$$250\,g\,Cl_2 \times \left(\frac{1\ mol\ Cl_2}{70.90\,g\,Cl_2}\right) \times \left(\frac{2\ mol\ O_3}{1\ mol\ Cl_2}\right) = 7.05\ mol\ O_3$$

Step 2

0.0495 atm !

$PV = nRT$

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

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

V = 2570 Liters of ozone