Chemistry
Gas Laws WS #1
Gay-Lussac's Law: Temperature & Pressure $\frac{P_1}{T_1} = \frac{P_2}{T_2}$

Name _____
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1. The relationship between temperature and pressure is:

   T↑ P↑ T↓ P↓

2. The formula for converting °C to K is:

   °C + 273

3. A gas with a pressure of 5.4 atm and at 25°C is raised to a new temperature of 78°C. What is the new pressure?

   $\frac{P_1 \times T_2}{T_1} = P_2$ ← $\frac{P_1}{T_1} = \frac{P_2}{T_2}$ $P_1 = 5.4\text{atm}$ $P_2 = ?$ $T_1 = 25°C + 273 = 298\text{K}$ $T_2 = 78°C + 273 = 351\text{K}$ $\frac{(5.4\text{atm})(351\text{K})}{(298\text{K})} =$ **6.4 atm**

4. A gas with a pressure of 550 torr and at 110°C is raised to a new pressure of 760 torr. What is the new temperature?

   $P_1 = 550\text{torr}$ $P_2 = 760\text{torr}$ $\frac{P_1}{T_1} = \frac{P_2}{T_2}$ → $\frac{P_1}{T_1 P_2} = \frac{1}{T_2}$ FLIP → $\frac{T_1 P_2}{P_1} = T_2$ $\frac{(383\text{K})(760\text{torr})}{(550\text{torr})} =$ **530 K**

   $T_1 = 110°C + 273 = 383\text{K}$ $T_2 = ?$

5. A gas with a pressure of 780 mmHg and at 55°C is lowered to a new pressure of 640 mmHg. What is the new temperature?

   $P_1 = 780\text{mmHg}$ $P_2 = 640\text{mmHg}$ $\frac{T_1 P_2}{P_1} = T_2$ $\frac{(328\text{K})(640\text{mmHg})}{(780\text{mmHg})} =$ **270K**

   $T_1 = 55°C + 273 = 328\text{K}$ $T_2 = ?$

6. A gas with a pressure of 5.6 atm and at –150°C is lowered to a new temperature of 20°C. What is the new pressure?

   $P_1 = 5.6\text{atm}$ $P_2 = ?$ $\frac{P_1}{T_1} = \frac{P_2}{T_2}$ → $\frac{P_1 T_2}{T_1} = P_2$ $\frac{(5.6\text{atm})(293\text{K})}{(123\text{K})} =$ **13 atm**

   $T_1 = -150°C + 273 = 123\text{K}$ $T_2 = 20°C + 273 = 293\text{K}$

Gas Laws WS #2
Boyle's Law: Pressure and Volume $P_1V_1 = P_2V_2$

1. What is the relationship between pressure and volume?

   P↑ V↓ P↓ V↑

2. A gas at 5.4 atm has a volume of 1.3 L. What volume would the gas have at 6.8 atm?

   $P_1 = 5.4\text{atm}$ $P_2 = 6.8\text{atm}$ $P_1V_1 = P_2V_2$ $V_2 = \frac{P_1V_1}{P_2}$ $\frac{(5.4\text{atm})(1.3\text{L})}{(6.8\text{atm})} =$ **1.0L**

   $V_1 = 1.3\text{L}$ $V_2 = ?$

3. A gas at 355 torr has a volume of 850 mL. What pressure would you need to decrease the volume to 550 mL?

   $P_1 = 355\text{torr}$ $P_2 = ?$ $P_1V_1 = P_2V_2$ $\frac{(355\text{torr})(850\text{mL})}{(550\text{mL})} =$ **550 torr**

   $V_1 = 850\text{mL}$ $V_2 = 550\text{mL}$ $\frac{P_1V_1}{V_2} = P_2$

   A gas at 67 L is reduced to 44L. If the original pressure was 330 torr, what is the new pressure?

   $P_1 = 330\text{torr}$ $P_2 = ?$ $P_1V_1 = P_2V_2$ $\frac{(330\text{torr})(67\text{L})}{(44\text{L})} = 502.5 \rightarrow$ **500 torr**

   $V_1 = 67\text{L}$ $V_2 = 44\text{L}$ $\frac{P_1V_1}{V_2} = P_2$

5. A quick review: Temperature must be in KELVIN!

$T_K - 273 = T_C$

$T_C + 273 = T_K$

56°C		329K
77°C		350 K
-45°C		228K
-269°C		4 K

Gas Laws WS #3

Charles Law: Temperature & Volume $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

1. The relationship between temperature and volume is: T↑V↑ T↓V↓

2. A gas at 5°C occupies a volume of 7.5 liters. What volume will the gas occupy at 100°C?

$V_1 = 7.5L$ $V_2 = ?$

$T_1 = 5°C + 273 = 278K$ $T_2 = 100°C + 273 = 373K$

$\frac{V_1}{T_1} = \frac{V_2}{T_2} \rightarrow \frac{V_1 T_2}{T_1} = V_2$ $\frac{(7.5L)(373K)}{(278K)} = 10.1L$

3. A gas at –20°C occupies a volume of 35.0 liters. What volume will the gas occupy at 20°C?

$V_1 = 35.0L$ $V_2 = ?$

$T_1 = -20°C + 273 = 253K$ $T_2 = 20°C + 273 = 293K$

$\frac{V_1}{T_1} = \frac{V_2}{T_2} \rightarrow \frac{V_1 T_2}{T_1} = V_2$ $\frac{(35.0L)(293K)}{(253K)} = 40.5L$

4. A gas fills a balloon and occupies a volume of 22.4 L at a temperature of 27°C. What would the new volume of the balloon be if the gas were heated to 127°C?

$V_1 = 22.4L$ $V_2 = ?$

$T_1 = 27°C + 273 = 300K$ $T_2 = 127°C + 273 = 400K$

$\frac{(22.4L)(400K)}{(300K)} = 29.9L$

5. A gas occupies a volume of 30.0 cm^3 at 73.5°C. If the pressure is held constant and the temperature is changed to 22.5°C, what will the new volume be?

$V_1 = 30.0 cm^3$ $V_2 = ?$

$T_1 = 73.5°C + 273 = 346.5K$ $T_2 = 22.5°C + 273 = 295.5K$

$\frac{(30.0 cm^3)(295.5K)}{(346.5K)} = 25.6 cm^3$

6. A sample of argon gas is cooled and its volume went from 3.8 L to 2.3 L. If its final temperature was 45°C, what as the original temperature?

Hint, I need to FLIP!

$V_1 = 3.8L$ $V_2 = 2.3L$

$T_1 = ?$ $T_2 = 45°C + 273 = 318K$

$\frac{V_1}{T_1} = \frac{V_2}{T_2} \rightarrow \frac{1}{T_1} = \frac{V_2}{T_2 V_1}$ FLIP! $\rightarrow T_1 = \frac{T_2 V_1}{V_2} \rightarrow \frac{(318K)(3.8L)}{(2.3L)} = 530K$

Chemistry
Gas Laws WS #4:
Combined Gas Law

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$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$$

Combined Gas Law

1. 4.5 L of Carbon dioxide at 23°C has a pressure of 3.2 atm. What is the pressure of the carbon dioxide at 95°C and 3.4 L?

$V_1 = 4.5\,L$ $V_2 = 3.4\,L$
$T_1 = 296\,K$ $T_2 = 368\,K$
$P_1 = 3.2\,atm$ $P_2 = ?$

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \rightarrow \frac{P_1V_1T_2}{T_1V_2} = P_2$

$\frac{(3.2\,atm)(4.5\,L)(368\,K)}{(296\,K)(3.4\,L)} = 5.3\,atm$

2. 7.6 L of nitrogen at 146°C has a pressure of 755 torr. What is the pressure of the nitrogen at 57°C and 10.5 L?

$V_1 = 7.6\,L$ $V_2 = 10.5\,L$
$T_1 = 419\,K$ $T_2 = 330\,K$
$P_1 = 755\,torr$ $P_2 = ?$

$\frac{(755\,torr)(7.6\,L)(330\,K)}{(419\,K)(10.5\,L)} = 430\,torr$

3. Oxygen at 25°C and 760 torr pressure occupies a volume of 21.2 L. What is the volume of oxygen gas at 133°C and 830 torr?

$T_1 = 298\,K$ $T_2 = 406\,K$
$P_1 = 760\,torr$ $P_2 = 830\,torr$
$V_1 = 21.2\,L$ $V_2 = ?$

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \rightarrow \frac{P_1V_1T_2}{T_1P_2} = V_2$

$\frac{(760\,torr)(21.2\,L)(406\,K)}{(298\,K)(830\,torr)} = 26\,L$

4. 4.3 L of methane at 5.4 kPa has a temperature of 46°C. What is the temperature of methane at 5.4 L at 6.6 kPa?

$V_1 = 4.3\,L$ $V_2 = 5.4\,L$
$P_1 = 5.4\,kPa$ $P_2 = 6.6\,kPa$
$T_1 = 319\,K$ $T_2 = ?$ *catch out!

$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \rightarrow \frac{P_1V_1}{P_2V_2T_1} = \frac{1}{T_2}$ FLIP! $\frac{P_2V_2T_1}{P_1V_1} = T_2$

$\frac{(6.6\,kPa)(5.4\,L)(319\,K)}{(5.4\,kPa)(4.3\,L)} = 490\,K$

$R = 0.0821 \frac{L \cdot atm}{K \cdot mol}$

$R = 8.31 \frac{L \cdot kPa}{K \cdot mol}$

Chemistry
Gas Laws WS #5:
Ideal Gas Law

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Ideal Gas Law $PV = nRT$

I did not write R's units to save space

1. What pressure (in atm) is exerted by 0.622 moles of gas contained in a 9.22 L vessel at 16.0°C?

P= ?
V= 9.22L
n= .622mol
R= 0.0821
T= 289K

$PV = nRT$

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

$\frac{(.622mol)(.0821)(289K)}{9.22L} = 1.60atm$

2. How many moles of gas occupy a 4.86 L flask at 11°C and 66.7 kPa pressure?

P= 66.7kPa
V= 4.86L
n= ?
R= 8.31
T= 284K

$PV = nRT$

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

$\frac{(66.7kPa)(4.86L)}{(8.31)(284K)} = .137mol$

3. What volume is occupied by .684 mol of gas at 800 mmHg and 9.0°C?

*must convert

$800mmHg \left| \frac{1atm}{760mmHg} \right. = 1.05atm$

P= 1.05atm
V= ?
n= .684mol
R= .0821
T= 282K

$PV = nRT$

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

$\frac{(.684mol)(.0821)(282K)}{1.05atm} = 15.08 \rightarrow 20L$

4. At what temperature is a gas if 8.51 mol of it is contained in a .604-L vessel at 25 atm?

P= 25atm
V= .604L
n= 8.51
R= .0821
T= ?

$PV = nRT$

$T = \frac{PV}{nR}$

$\frac{(25atm)(.604L)}{(.0821)(8.51)} = 22K$

5. What pressure (in kPa) is exerted by 0.00306 mol of gas in a 25.9-cm^3 container at –25°C?

must convert! → $25.9mL \left| \frac{1L}{1000mL} \right. = .0259L$

P= ?
V= .0259L
n= .00306mol
R= 8.31
T= 248K

$PV = nRT$

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

$\frac{(.00306mol)(8.31)(248K)}{.0259L} = 243kPa$