HPS Gas Laws Calcs 2021 Name: Key Per:

Objective 4: Demonstrate the relationships between pressure, moles, volume, and temperature of a confined gas.

	Boyle's Law	Gay-Lussac's Law	Charles's Law
Equation	$P_1V_1 = P_2V_2$	$\frac{P_1}{T_1} = \frac{P_2}{T_2}$	$\frac{V_1}{T_1} = \frac{V_2}{T_2}$
Relationship	Inverse	Direct	Direct
Units	Volume: cm^3, m^3, L Pressure: atm, kPa, mm Hg	Temperature: Kelvin *C + 273 = K Pressure: atm, kPa, mm Hg	Temperature: Kelvin *C + 273 = K Volume: cm^3, m^3, L

Combined Gas Law: $\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2}$

(This law combines the three laws above. It can be helpful to memorize just one equation rather than three separate ones. Use when the mass of the gas is fixed.)

Ideal Gas Law: PV = nRT

where n is moles and R is a constant:

8.314 (L*kPa)/(mol*K) or
0.0821 (L*atm)/(mol*K)

A **mole** is **defined** as $6.02214076 \times 10^{23}$ of some **chemical** unit, be it atoms, molecules, ions, or others. The **mole** is a convenient unit to use because of the great number of atoms, molecules, or others in any substance.

B

1. In a thermonuclear device, the pressure of 0.050 liters of gas within the bomb casing reaches 4.0 $\times 10^6$ atm. When the bomb casing is destroyed by the explosion, the gas is released into the atmosphere where it reaches a pressure of 1.00 atm. What is the volume of the gas after the explosion?

$\frac{(4.0 \times 10^6 atm)(.050 L)}{(1.00)} = \frac{(1.00 atm)(V_2)}{(1.00)}$

$V_2 = 2.0 \times 10^5 L$

B

2. Synthetic diamonds can be manufactured at pressures of 6.00 x 10^4 atm. If we took 2.00 liters of gas at 1.00 atm and compressed it to a pressure of 6.00 x 10^4 atm, what would the volume of that gas be?

$\frac{(1.00 atm)(2.00 L)}{6.00 \times 10^4} = \frac{(6.00 \times 10^4 atm)(V_2)}{6.00 \times 10^4}$

$V_2 = 3.33 \times 10^{-5} L$

C

3. The temperature inside my refrigerator is about 4.0^0 Celsius. If I place a balloon in my fridge that initially has a temperature of 22^0 C and a volume of 0.50 liters, what will be the volume of the balloon when it is fully cooled by my refrigerator?

$\frac{.50 L}{295 K} = \frac{V_2}{277.0 K}$

$\frac{138.5}{295} = \frac{(295)(V_2)}{295}$

$V_2 = .47 L$

C 4. How hot will a 2.3 L balloon have to get to expand to a volume of 400.0 L? Assume that the initial temperature of the balloon is 25 ^{0}C.

T_2, $V_1 = 2.3$ L, $V_2 = 400.0$ L, $T_1 = 25\ ^0C = 298$ K

$\frac{2.3 L}{298 K} = \frac{400.0 L}{T_2}$ $\quad \frac{119200}{2.3} = \frac{(2.3 L)(T_2)}{2.3}$

$T_2 = 5.2 \times 10^4$ K or 52000 K

I 5. If I have an unknown quantity of gas at a pressure of 1.2 atm, a volume of 31.0 liters, and a temperature of 87 ^{0}C, how many moles of gas do I have?

$PV = nRT$ $\quad$ 360. K

$(1.2 atm)(31.0 L) = n(.0821)(360. K)$

$n = 1.3$ moles

B 6. Atmospheric pressure on the peak of Mt. Everest can be as low as 150 mm Hg, which is why climbers need to bring oxygen tanks for the last part of the climb. If the climbers carry 10.0 liter tanks with an internal gas pressure of 3.04 x 10^4 mm Hg, what will be the volume of the gas when it is released from the tanks?

$P_2 = 150$ mm Hg, $V_1 = 10.0$ L, $P_1 = 3.04 \times 10^4$ mm Hg, V_2

$\frac{(3.04 \times 10^4 mmHg)(10.0 L)}{150} = \frac{(150 mm Hg)(V_2)}{150}$

$V_2 = 2.0 \times 10^3$ L

I 7. If I have 7.7 moles of gas at a pressure of 0.09 atm and at a temperature of 56 ^{0}C, what is the volume of the container that the gas is in?

n, P, T = 329 K ?

$PV = nRT$ $\quad (.09 atm)(V) = (7.7 moles)(.0821)(329 K)$

$V = 2000 L$

C 8. On hot days, you may have noticed that potato chip bags seem to "inflate", even though they have not been opened. If I have a 250 mL bag at a temperature of 19 ^{0}C, and I leave it in my car which has a temperature of 60.0^0 C, what will the new volume of the bag be?

V_1, $T_1 = 292$ K, $T_2 = 333.0$ K, V_2

$\frac{250 mL}{292 K} = \frac{V_2}{333.0}$

$\frac{(250 mL)(333.0 K)}{292 K} = \frac{(292 K)(V_2)}{292 K}$

$V_2 = 290$ mL

I 9. If I contain 3.0 moles of gas in a container with a volume of 60.0 liters and at a temperature of 400.0 K, what is the pressure inside the container?

$PV = nRT$ $\quad (P)(60.0 L) = (3.0 mol)(8.314)(400.0 K)$ $\quad$ .0821

$P = 170$ kPa or 1.6 atm

C 10. A soda bottle is flexible enough that the volume of the bottle can change even without opening it. If you have an empty soda bottle (volume of 2.0 L) at room temperature (25 ^{0}C), what will the new volume be if you put it in your freezer (-4.0 ^{0}C)?

V_1, 298 K, V_2, 269 K

$\frac{2 L}{298 K} = \frac{V_2}{269 K}$

$\frac{(2 L)(269 K)}{298 K} = \frac{(298 K)(V_2)}{298 K}$

$V_2 = 1.8$ L

I 11. If I have 4.0 moles of a gas at a pressure of 5.6 atm and a volume of 12 liters, what is the temperature?

$PV = nRT$

$\frac{(5.6 atm)(12 L)}{(4.0)(.0821)} = \frac{(4.0 moles)(.0821)(T)}{(4.0)(.0821)}$

$T = 2.0 \times 10^2$ K

B 12. Submarines need to be extremely strong to withstand the extremely high pressure of water pushing down on them. An experimental research submarine with a volume of 15,000 liters has an internal pressure of 1.2 atm. If the pressure of the ocean breaks the submarine forming a bubble with a pressure of 250.0 atm pushing on it, how big will that bubble be?

V_1, P_1, P_2, V_2

$\frac{(1.2 atm)(15,000 L)}{250} = \frac{(250 atm)(V_2)}{250}$

$V_2 = 72$ L