Gas Laws Practice Problems

(Standard Atmospheric Pressure = 101.325 kPa) (Kelvin = ℃ + 273)

I. Charle's Law

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

V_1 = Volume before change (L)

T_1 = Temperature before change (K)

V_2 = Volume after change (L)

T_2 = Temperature after change (K)

1. A gas has a volume of 6.3 L at a temperature of 200 K. When the temperature is increased to 320 K, what is the resulting volume?

$$V_2 = \frac{V_1 T_2}{T_1} = \frac{(6.3\,L)(320\,k)}{200\,k} = 10.08\,L$$

2. A gas has a volume of 6.5 L at a temperature of 126 K. What is the temperature when the volume is reduced to 1.3 L?

$$T_2 = \frac{T_1 V_2}{V_1} = \frac{(126\,K)(1.3\,L)}{(6.5\,L)} = 25.2\,K$$

II. Boyle's Law

$$P_1V_1 = P_2V_2$$

P_1 = Pressure before change (kPa)

V_1 = Volume before change (L)

P_2 = Pressure after change (kPa)

V_2 = Volume after change (L)

3. A gas has a pressure of 235 kPa and a volume of 5.0 L. When the volume changes to 1.25 L, what is the resulting pressure?

$$P_2 = \frac{P_1 V_1}{V_2} = \frac{(235\,kPa)(5.0\,L)}{1.25\,L} = 940\,kPa$$

4. **A gas has a pressure of 356 kPa and a volume of 3.8 L. What is the <u>volume</u> when the pressure changes to 406 kPa?**

$$V_2 = \frac{P_1 V_1}{P_2} = \frac{(356 \text{ kPa})(3.8 \text{ L})}{406 \text{ kPa}} = 3.3 \text{ L}$$

<u>III. Combined Gas Law</u>

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

P_1 = Pressure before change (kPa)

V_1 = Volume before change (L)

T_1 = Temperature before change (K)

P_2 = Pressure after change (kPa)

V_2 = Volume after change (L)

T_2 = Temperature after change (K)

5. **A gas has pressure of 340 kPa at a volume of 3.2 L. What is the new <u>pressure</u> when the volume is increased to 5.44 L?** *<u>The temperature does not change</u>.*

$$P_2 = \frac{P_1 V_1}{V_2} = \frac{(340 \text{ kPa})(3.2 \text{ L})}{5.44 \text{ L}} = 200 \text{ kPa}$$

6. **A gas has a pressure of 180 kPa at a temperature of 300 K. At what <u>temperature</u> will the gas have a pressure of 276 kPa?** *<u>The volume does not change</u>.*

$$T_2 = \frac{T_1 P_2}{P_1} = \frac{(300 \text{ K})(276 \text{ kPa})}{180 \text{ kPa}} = 460 \text{ K}$$

7. **At 47 °C, a gas has a pressure of 140 kPa. The gas is cooled until the pressure decreases to 105 kPa. If the <u>volume remains constant</u>, what will the final <u>temperature</u> be in Kelvin? Celsius?**

1. $K = 47°C + 273 = 320 \text{ K}$
2. $T_2 = \frac{T_1 P_2}{P_1} = \frac{(320 \text{ K})(105 \text{ kPa})}{140 \text{ kPa}} = 240 \text{ K}$
3. $240 \text{ K} - 273 = -33°C$

8. A tank of helium gas used to inflate toy balloons is at a pressure of 1,550 kPa and a temperature of 293 K. The tank's volume is 20.0 L. How large a balloon would it fill at standard atmosphere pressure and 323 K?

$$V_2 = \frac{T_2 P_1 V_1}{P_2 T_1} = \frac{(323\ K)(1{,}550\ kPa)(20.0\ L)}{(101.325\ kPa)(293\ K)} = 337.3\ L$$

9. A tank containing 200.0 L of hydrogen gas at 0.0 °C is kept at 156 kPa. The temperature is raised to 95 °C, and the volume is decreased to 175 L. What is the new pressure of the gas?

$T_1 = 273\ K$
$T_2 = 95° + 273 = 368\ K$

$$P_2 = \frac{T_2 P_1 V_1}{V_2 T_1} = \frac{(368\ K)(156\ kPa)(200.0\ L)}{(175\ L)(273\ K)} = 240\ kPa$$

10. In a certain internal combustion engine, 2.1 L of air at standard atmospheric pressure and 303 K is rapidly compressed to a pressure of 2,010 kPa and a volume of 0.3 L. What is the final temperature of the compressed gas?

$$T_2 = \frac{T_1 P_2 V_2}{P_1 V_1} = \frac{(303\ K)(2{,}010\ kPa)(0.3\ L)}{(101.325\ kPa)(2.1\ L)} = 858.7\ K$$

11. A piston with an area of 0.015 m² encloses a constant amount of gas in a cylinder with a volume of 230 L. The initial pressure of the gas is 150 kPa. A 150-kg mass is then placed on the piston, and the piston moves downward to a new position. If the <u>temperature is constant</u>, what is the new volume of the gas in the cylinder?

$$V_2 = \frac{P_1 V_1}{P_2} = \frac{P_1 V_1}{\left(P_1 + \frac{mg}{A}\right)} = \frac{(150\ kPa)(230\ L)}{(150\ kPa) + \left(\frac{(150\ kg)(9.8\ m/s^2)}{0.015\ m^2}\right)}$$

$$= \text{[scribbled out]} = 0.351\ L$$