$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $K = {}^\circ C + 273$

Charles' Law Worksheet

1) The temperature inside my refrigerator is about 4^0 Celsius. If I place a balloon in my fridge that initially has a temperature of 22^0 C and a volume of 0.5 liters, what will be the volume of the balloon when it is fully cooled by my refrigerator?

$V_1 = 0.5$ $T_1 = 295$ $V_2 = X$ $T_2 = 277$

$\frac{0.5}{295} \times \frac{X}{277}$ $295x = 138.5$

$V_2 = 0.47\ L$

2) A man heats a balloon in the oven. If the balloon initially has a volume of 0.4 liters and a temperature of 20 ^{0}C, what will the volume of the balloon be after he heats it to a temperature of 250 ^{0}C?

$V_1 = 0.4$ $T_1 = 293$ $V_2 = X$ $T_2 = 523$

$\frac{0.4}{293} = \frac{X}{523}$ $293x = 209.2$

$V_2 = 0.71\ L$

3) 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 C, what will the new volume of the bag be?

$V_1 = 250$ $T_1 = 292$ $V_2 = X$ $T_2 = 333$

$\frac{250}{292} = \frac{X}{333}$ $292x = 83{,}250$

$x = 285\ mL$

4) 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 L) at room temperature (25 ^{0}C), what will the new volume be if you put it in your freezer (-4 ^{0}C)?

$V_1 = 2$ $T_1 = 298$ $V_2 = X$ $T_2 = 269$

$\frac{2}{298} = \frac{x}{269}$ $298x = 538$

$V_2 = 1.8\ L$

5) Some students believe that teachers are full of hot air. If I inhale 2.2 liters of gas at a temperature of 18^0 C and it heats to a temperature of 38^0 C in my lungs, what is the new volume of the gas?

$V_1 = 2.2 \quad T_1 = 291 \quad V_2 = X \quad T_2 = 311$

$\frac{2.2}{291} = \frac{X}{311}$

$291x = 684.2$

$V_2 = 2.35\ L$

6) How hot will a 2.3 L balloon have to get to expand to a volume of 400 L? Assume that the initial temperature of the balloon is 25 ^{0}C.

$V_1 = 2.3 \quad T_1 = 298 \quad V_2 = 400 \quad T_2 = y$

$\frac{2.3}{298} = \frac{400}{X}$

$2.3x = 114,200$

$51,826\ K$

7) I have made a thermometer which measures temperature by the compressing and expanding of gas in a piston. I have measured that at 100^0 C the volume of the piston is 20 L. What is the temperature outside if the piston has a volume of 15 L? What would be appropriate clothing for the weather?

$V_1 = 20 \quad T_1 = 373 \quad V_2 = 15 \quad T_2 = X$

$\frac{20}{373} = \frac{15}{X}$

$20x = 5,595$

$T_2 = 279.75\ K$

$P_1 V_1 = P_2 V_2$ Boyle's Law

1. Four liters of carbon dioxide have a pressure of 1.5 atmospheres. If the original pressure was .9 atmospheres, what was the original volume?

$P_1 = .9$ $V_1 = X$ $P_2 = 1.5$ $V_2 = 4$

$.9 V_1 = (1.5)(4)$

$.9 V_1 = 6$

$V_1 = 6.67$ L

2. 8 liters of a gas have a pressure of 760 torr. If the volume was originally 6 liters, what was the original pressure?

$P_1 = X$ $V_1 = 6$ $P_2 = 760$ $V_2 = 8$

$6X = (760)(8)$

$6X = 6,080$

$P_1 = 1,013.33$ torr

3. 1,000 cubic inches of air are under a pressure of 50 kilopascals. What is the volume if the pressure is increased to 130 kilopascals?

$P_1 = 50$ $V_1 = 1,000$ $P_2 = 130$ $V_2 = X$

$(50)(1,000) = 130 V_2$

$50,000 = 130 V_2$

$V_2 = 384.62$ cubic inches

4. 3 gallons of argon were at a pressure of 14 pounds per square inch. A pressure change then reduces the volume to 2.2 gallons. What is the new pressure?

$P_1 = 14$ $V_1 = 3$ $P_2 = X$ $V_2 = 2.2$

$(14)(3) = P_2 (2.2)$

42

$P_2 = 19.09$ PSI

5. A gas occupies 12.3 liters at a pressure of 40.0 mm Hg. What is the volume when the pressure is increased to 60.0 mm Hg?

$P_1 = 40$ $V_1 = 12.3$ $P_2 = 60$ $V_2 = X$

$(40)(12.3) = (60)(V_2)$

492

$V_2 = 8.2$ L

6. If a gas at 25.0 °C occupies 3.60 liters at a pressure of 1.00 atm, what will be its volume at a pressure of 2.50 atm?

$P_1 = 1$ $V_1 = 3.60$ $P_2 = 2.50$ $V_2 = X$

$(1)(3.60) = 2.50 (V_2)$

$V_2 = 1.44$ L

7. A gas occupies 1.56 L at 1.00 atm. What will be the volume of this gas if the pressure becomes 3.00 atm?

$P_1 = 1.00 \quad V_1 = 1.56 \quad P_2 = 3.00 \quad V_2 = X$

$(1)(1.56) = (3)(V_2)$

$V_2 = 0.52\ L$

8. A gas occupies 11.2 liters at 0.860 atm. What is the pressure if the volume becomes 15.0 L.

$P_1 = 0.860 \quad V_1 = 11.2 \quad P_2 = X \quad V_2 = 15.0$

$(0.860)(11.2) = (P_2)(15.0)$

9.632

$P_2 = 0.6[illegible]\ atm$

9. 13. A gas occupies 4.31 liters at a pressure of 0.755 atm. Determine the volume if the pressure is increased to 1.25 atm.

$P_1 = 0.755 \quad V_1 = 4.31 \quad P_2 = 1.25 \quad V_2 = X$

$(0.755)(4.31) = (1.25)(V_2)$

$V_2 = 2.60\ L$

10. A sample of gas has a volume of 12.0 L and a pressure of 1.00 atm. If the pressure of gas is increased to 2.00 atm, what is the new volume of the gas?

$P_1 = 1.00 \quad V_1 = 12.0 \quad P_2 = 2.00 \quad V_2 = X$

$(1)(12) = (2.00)(V_2)$

$V_2 = 6\ L$

$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$ $K = {}^{\circ}C + 273$

Combined Gas Law Problems

Use the combined gas law to solve the following problems:

1) If I initially have a gas at a pressure of 12 atm, a volume of 23 liters, and a temperature of 200 K, and then I raise the pressure to 14 atm and increase the temperature to 300 K, what is the new volume of the gas?

$P_1 = 12$ $V_1 = 23$ $T_1 = 200$ $P_2 = 14$ $V_2 = x$ $T_2 = 300$

$\frac{(12)(23)}{200} = \frac{(14)(V_2)}{300}$

$1.38 = 0.046667\ V_2$

$V_2 = 29.6\ L$

2) A gas takes up a volume of 17 liters, has a pressure of 2.3 atm, and a temperature of 299 K. If I raise the temperature to 350 K and lower the pressure to 1.5 atm, what is the new volume of the gas?

$P_1 = 2.3$ $V_1 = 17$ $T_1 = 299$ $P_2 = 1.5$ $V_2 = X$ $T_2 = 350$

$\frac{(2.3)(17)}{299} = \frac{(1.5)(V_2)}{350}$

$0.13076923 = V_2\ 0.00428571$

$V_2 = 30.5\ L$

3) A gas that has a volume of 28 liters, a temperature of 45 ^{0}C, and an unknown pressure has its volume increased to 34 liters and its temperature decreased to 35 ^{0}C. If I measure the pressure after the change to be 2.0 atm, what was the original pressure of the gas?

$P_1 = X$ $V_1 = 28$ $T_1 = 318$ $P_2 = 2.0$ $V_2 = 34$ $T_2 = 308$

$\frac{(P_1)(28)}{318} = \frac{(2.0)(34)}{308}$

$0.08805031\ P_1 = 0.2207792$

$P_1 = 2.51\ atm$

4) A gas has a temperature of 14 ^{0}C, and a volume of 4.5 liters. If the temperature is raised to 29 ^{0}C and the pressure is not changed, what is the new volume of the gas?

$P_1 = 1$ $V_1 = 4.5$ $T_1 = 287$ $P_2 = 1$ $V_2 = X$ $T_2 = 302$

$\frac{4.5}{287} = \frac{X}{302}$

$287\ x = 1359$

$X = 4.74\ L$

5) If I have 17 liters of gas at a temperature of 67 ^{0}C and a pressure of 88.89 atm, what will be the pressure of the gas if I raise the temperature to 94 ^{0}C and decrease the volume to 12 liters?

$P_1 = 88.89$ $V_1 = 17$ $T_1 = 340$ $P_2 = X$ $V_2 = 12$ $T_2 = 367$

$$\frac{(88.89)(17)}{340} = \frac{(P_2)(12)}{367}$$

$4.4445 = (P_2)(0.032693)$

$P_2 = 136$ atm

6) I have an unknown volume of gas at a pressure of 0.5 atm and a temperature of 325 K. If I raise the pressure to 1.2 atm, decrease the temperature to 320 K, and measure the final volume to be 48 liters, what was the initial volume of the gas?

$P_1 = 0.5$ $V_1 = X$ $T_1 = 325$ $P_2 = 1.2$ $V_2 = 48$ $T_2 = 320$

$$\frac{(0.5)(V_1)}{325} = \frac{(1.2)(48)}{320}$$

$0.00153846\,V_1 = .18$

$V_1 = 117$ L

7) If I have 21 liters of gas held at a pressure of 78 atm and ~~a temperature of~~ 900 K, what will be the volume of the gas if I decrease the pressure to 45 atm and decrease the temperature to 750 K?

$P_1 = 78$ $V_1 = 21$ $T_1 = 900$ $P_2 = 45$ $V_2 = X$ $T_2 = 750$

$$\frac{(78)(21)}{900} = \frac{(45)(V_2)}{750}$$

$0.06\,V_2 = 1.82$

$V_2 = 30.3$ L

8) If I have 2.9 L of gas at a pressure of 5 atm and a temperature of 50 ^{0}C, what will be the temperature of the gas if I decrease the volume of the gas to 2.4 L and decrease the pressure to 3 atm?

$P_1 = 5$ $V_1 = 2.9$ $T_1 = 323$ $P_2 = 3$ $V_2 = 2.4$ $T_2 = X$

$$\frac{(5)(2.9)}{323} = \frac{(3)(2.4)}{T_2}$$

$14.5\,T_2 = 2,325.6$

$T_2 = 160.38$ K

9) I have an unknown volume of gas held at a temperature of ~~115 K in a~~ container with a pressure of 60 atm. If by increasing the temperature to 225 K and decreasing the pressure to 30 atm causes the volume of the gas to be 29 liters, how many liters of gas did I start with?

$P_1 = 60$ $V_1 = X$ $T_1 = 115$ $P_2 = 30$ $V_2 = 29$ $T_2 = 225$

$$\frac{(60)(V_1)}{115} = \frac{(30)(29)}{225}$$

$0.5217391\,V_1 = 3.867$

$V_1 = 7.41$ L