Explanation of gas laws involving pressure, volume and temperature

Boyle' law says that pressure and volume are inversely related at a constant temperature for a fixed volume of gas.

PV=k When Pressure is doubled, volume is reduced by half. This is only true when the temperature is constant.

Charles' Law is a special case of the ideal gas law. It states that the volume of a fixed mass of a gas is directly proportional to the temperature. This law applies to ideal gases held at a constant pressure, where only the volume and temperature are allowed to change. When the gas pressure is increased in a confined space, temperature rises. Conversely when pressure is reduced, the temperature falls. You might have noticed that the air coming out of a high pressure tank or compressor feels cool. Also you may have noted that the storage tank of an air compressor gets warmer as it increases the pressure as the tank fills.

These two laws are the basis for a more complete law known as **the Ideal Gas Law.**

PV = nRT Where n is the quantity of gas in moles, R is the gas constant and T is degrees kelvin or absolute temperature. For a system where the quantity gas remains constant PV/T is a constant

This law relates pressure, volume and temperature (absolute temperature, **deg K**). Temperature is in degrees Kelvin °K = °C + 273°. Mole is the quantity of gas of one gram molecular equivalents which for an ideal gas is 22.4 liters. R is short for Regnault and = **0.08206** L atm / mol K

Applications

A. How much oxygen is in a Mountain High Oxygen Tank (AL-415-540) when the pressure is down to 500 PSI. The Mfgr says the tank holds 415 ltr. (14.6 cu.ft.) @ 139 bar (2015 psi). We will use the equation V2 = V1 * P2 / P1 noting that the residual volume is a direct function of the pressure V2 = 14.5 x 500 / 2015 V2 = 3.6 cu.ft. This should be more than enough for a single flight.

B. What will be the pressure of a cylinder of gas which is 2,000 psi at standard temperature (73°F) when it is heated to 150°F (a possible temperature when the aircraft is in the sun for a while)? We will use the P1/T1 = P2/T2 with the temperatures in absolute degrees (K).

   P1 = 2,000 psi, T1 = 73°F, 23°C, and 296°K, T2 = 150°F, 65°C and 338°K, P2 = 2,000 x 338/296 =2,284 psi

C. You took off with your oxygen tank showing 500 psi. What will be the pressure when the temperature drops to -20°F at 17,900 feet? Assume you used very little oxygen getting to that altitude. We will use the P1/T1 = P2/T2 with the temperatures in absolute degrees (K).
   P1 = 500 psi, T1 = 73°F, 23°C, and 296°K, T2 = -20°F, -29°C and 244°K, P2 = 500 x 244/296 = 446 psi.