$P_1V_1 = P_2V_2$

Key

Boyles' Law

Use Boyles' Law to answer the following questions:

1) 1.00 L of a gas at standard temperature and pressure is compressed to 473 mL. What is the new pressure of the gas?

$(1atm)(1L) = P_2(.473L)$

$P_1 = 1\,atm$

$V_1 = 1.00\,L$

$P_2 = ?$

$V_2 = .473\,L$

$$\frac{(1atm)(1L)}{.473L} = 2.11\,atm$$

2) In a thermonuclear device, the pressure of 0.050 liters of gas within the bomb casing reaches 4.0×10^6 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?

$P_1 = 4 \times 10^6\,atm$

$V_1 = 0.050L$

$P_2 = 1\,atm$

$V_2 = ?$

$$\frac{(4. \times 10^6\,atm)(0.050L)}{1\,atm} = 200{,}000\,L$$

$2.0 \times 10^5\,L$

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

$P_1V_1 = P_2V_2$

$P_1 = 1.00\,atm$

$V_1 = 2.00\,L$

$P_2 = 6.00 \times 10^4\,atm$

$V_2 = ?$

$$\frac{(1.00atm)(2.00L)}{6.00 \times 10^4\,atm} = .0000333L$$

$3.33 \times 10^{-5}\,L$ OR $.0000333L$

4) The highest pressure ever produced in a laboratory setting was about 2.0×10^6 atm. If we have a 1.0×10^{-5} liter sample of a gas at that pressure, then release the pressure until it is equal to 0.275 atm, what would the new volume of that gas be?

$P_1 = 2.0 \times 10^6\,atm$

$V_1 = 1.0 \times 10^{-5}\,L$

$P_2 = 0.275\,atm$

$V_2 = ?$

$$\frac{(2.0 \times 10^6\,atm)(1.0 \times 10^{-5}\,L)}{0.275atm} = 72.73\,L$$

5) 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 3.04×10^4 mm Hg, what will be the volume of the gas when it is released from the tanks?

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

$$\frac{(3.04 \times 10^4 \text{ mm Hg})(10.0 \text{ L})}{150 \text{ mm Hg}} = 2026.66 \text{ L}$$

6) Part of the reason that conventional explosives cause so much damage is that their detonation produces a strong shock wave that can knock things down. While using explosives to knock down a building, the shock wave can be so strong that 12 liters of gas will reach a pressure of 3.8×10^4 mm Hg. When the shock wave passes and the gas returns to a pressure of 760 mm Hg, what will the volume of that gas be?

$P_1 = 3.8 \times 10^4$ mm Hg
$V_1 = 12$ L
$P_2 = 760$ mm Hg
$V_2 = ?$

$$\frac{(3.8 \times 10^4 \text{ mm Hg})(12 \text{ L})}{760 \text{ mm Hg}} = 600 \text{ L} = 6.0 \times 10^2 \text{ L}$$

7) 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 atm pushing on it, how big will that bubble be?

$P_1 = 1.2$ atm
$V_1 = 15{,}000$ L
$P_2 = 250$ atm
$V_2 = ?$

$$\frac{(1.2 \text{ atm})(15{,}000 \text{ L})}{250 \text{ atm}} = 72 \text{ L}$$

8) Divers get "the bends" if they come up too fast because gas in their blood expands, forming bubbles in their blood. If a diver has 0.05 L of gas in his blood under a pressure of 250 atm, then rises instantaneously to a depth where his blood has a pressure of 50.0 atm, what will the volume of gas in his blood be? Do you think this will harm the diver?

$P_1 = 250$ atm
$V_1 = 0.05$ L
$P_2 = 50.0$ atm
$V_2 = ?$

$$\frac{(250 \text{ atm})(0.05 \text{ L})}{50.0 \text{ atm}} = 0.25 \text{ L}$$

yes