What Goes Up...

ChemCatalyst:

Q: Why does the balloon pop?

A weather balloon is inflated to a volume of 12,500 L w/ He. When it is released from the ground the air pressure is 1.0 atm & the air temp. is 17°C. At a specific altitude the weather balloon pops.

Notes:

• Why did the weather balloon pop?

- Weather balloons are large balloons that are filled w/ He or H_2 that carry instruments to study the atmosphere.
  - He & H_2 float because they are less dense than air (mostly N & O & CO_2)
- as weather balloons are released & go up, the following variables change:
  1. outside P (pressure) decreases → causes the V (volume) of the balloon to increase
  2. outside T (temp) decreases → causes the V (volume) of the balloon to decrease
- the only thing that stays constant is the n, # of moles of gas (# of gas molecules)

*the change in pressure must be greater than temperature b/c the balloon pops

• What is the combined gas law?

- combines Charles', Boyles', & Gay-Lussac's laws:

Charles': $\frac{V_1}{T_1} = \frac{V_2}{T_2}$

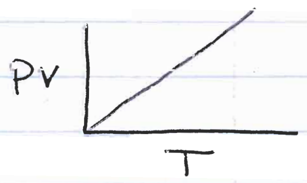
Gay-Lussac's: $\frac{P_1}{T_1} = \frac{P_2}{T_2}$

Boyles': $P_1V_1 = P_2V_2$

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

n is constant

*T in Kelvin!



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What Goes Up: Gas Law Problems

Charles' Law:

1. Calculate the decrease in temperature when 2.00 L at 20.0 °C is compressed to 1.00 L.

2. 600.0 mL of air is at 20.0 °C. What is the volume at 60.0 °C?

3. A gas occupies 900.0 mL at a temperature of 27.0 °C. What is the volume at 132.0 °C?

Gay-Lussac's Law:

1. Determine the pressure change when a constant volume of gas at 1.00 atm is heated from 20.0 °C to 30.0 °C.

2. A gas has a pressure of 0.370 atm at 50.0 °C. What is the pressure at 25.0 °C?

3. A gas has a pressure of 699.0 mm Hg at 40.0 °C. What is the temperature at 300 mm Hg?

Boyles' Law:

1. 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?

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?

3. 1.00 L of a gas at standard temperature and pressure is compressed to 473 mL. What is the new pressure of the gas?

Combined Gas Law:

1. A weather balloon is inflated to a volume of 12,500 L with helium. When it is released from the ground the air pressure is 1 atmosphere and the air temperature is 17°C. It travels to an altitude of 25,000 ft where the temperature is -35°C and the pressure is 0.4 atm. What is the volume of the balloon at this altitude?

2. A gas has a volume of 800.0 mL at -23.00 °C and 300.0 torr. What would the volume of the gas be at 227.0 °C and 600.0 torr of pressure?

3. 500.0 liters of a gas are prepared at 700.0 mm Hg and 200.0 °C. The gas is placed into a tank under high pressure. When the tank cools to 20.0 °C, the pressure of the gas is 30.0 atm. What is the volume of the gas?

4. What is the final volume of a 400.0 mL gas sample that is subjected to a temperature change from 22.0 °C to 30.0 °C and a pressure change from 760.0 mm Hg to 360.0 mm Hg?

5. What is the volume of gas at 2.00 atm and 200.0 K if its original volume was 300.0 L at 0.250 atm and 400.0 K?

Making Sense Notes:

- Combined Gas Law Examples:

① What is the final volume of a 400.0mL gas sample that is subjected to a temperature change from 22°C to 30.0°C & a pressure change from 760.0mmHg to 360.0mmHg?

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

K = °C + 273
= 22 + 273 = 295K
= 30 + 273 = 303K

$$\frac{760.0\text{mmHg}(400.0\text{mL})}{295\text{K}} = \frac{360.0\text{mmHg}(V_2)}{303\text{K}}$$

$$\frac{106{,}200 \times V_2}{106{,}200} = \frac{92{,}112{,}000}{106{,}200}$$

$$\boxed{V_2 = 867\text{mL}}$$

② What is the volume of gas @ 2.00 atm & 200.0K if its original volume was 300.0L @ 0.250 atm & 400.0K?

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}$$

$$\frac{(0.250)(300.0)}{400.0} = \frac{(2.00)\ V_2}{200.0}$$

$$\boxed{V_2 = 18.8\text{L}}$$