Absolute Zero

Chem Catalyst:

Q: Do you think CO_2 would be a solid, liquid or gas? Q: What happens to the motion of molecules as temp. decreases?	The lowest recorded temp. in the solar system was on Triton, a moon of Neptune, & was recorded to be -235°C.

Notes:

• What is the relationship btwn temp & volume?	• as temperature decreases, molecules slow down & start to condense, so volume decreases • temp ↓ = volume ↓
• What is Absolute Zero?	• Absolute Zero: lowest temp. possible – @ absolute zero, there is NO motion of molecules & the volume is zero – only found on the Kelvin scale
• What temperature scales do we use in Science?	• traditionally use °C (or °F in America) • scientists use the Kelvin Scale when working w/ gases – NO negative #'s! – lowest temp is 0 Kelvin = -273°C • don't use the "degree" symbol in kelvin – K = °C + 273 – °C = K - 273
• Fun Facts about Temp:	– lowest recorded temps: • in lab = 0.00001 K • on Earth (Antartica) = 184 K (-89°C) • in solar system = 38 K (-235°C)

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Absolute Zero

Name: ______________________

Period _____ Date: ___________

Purpose: This lesson allows you to examine the relationship between volume and temperature in gases and introduces you to the Kelvin scale.

Part I: A quantity of gas was heated to various temperatures. Each time the temperature changed, the volume of the gas was measured in milliliters. The temperature was sometimes measured in degrees Celsius and sometimes in degrees Kelvin. Note that V represents volume and T represents temperature.

Fill in the remainder of the table:

Trial	Temperature (°C)	Temperature (K)	Volume (ml)	Ratio: V/T (for T in °C)	Ratio: V/T (for T in K)
1	10.0	283	500.	50.0	1.77
2	50.0	323	570	11.4	1.76
3	100.0	373	660	6.6	1.77
4	200.0	473	840	4.2	1.78
5	283	556	1000.	3.53	1.80
6	838	1111	2000.	2.39	1.80

1. What do you notice about the ratio of volume to temperature for the different trials? Constant if in Kelvin
2. When the temperature was doubled in degrees Celsius, did the volume also double? NO
3. When the temperature was doubled in degrees Kelvin, did the volume also double? Yes
4. Whenever the volume doubled, did the temperature also double? What appears to be the difference between using the Kelvin scale and the Celsius scale in this situation? Kelvin scale the V & T are directly proportion

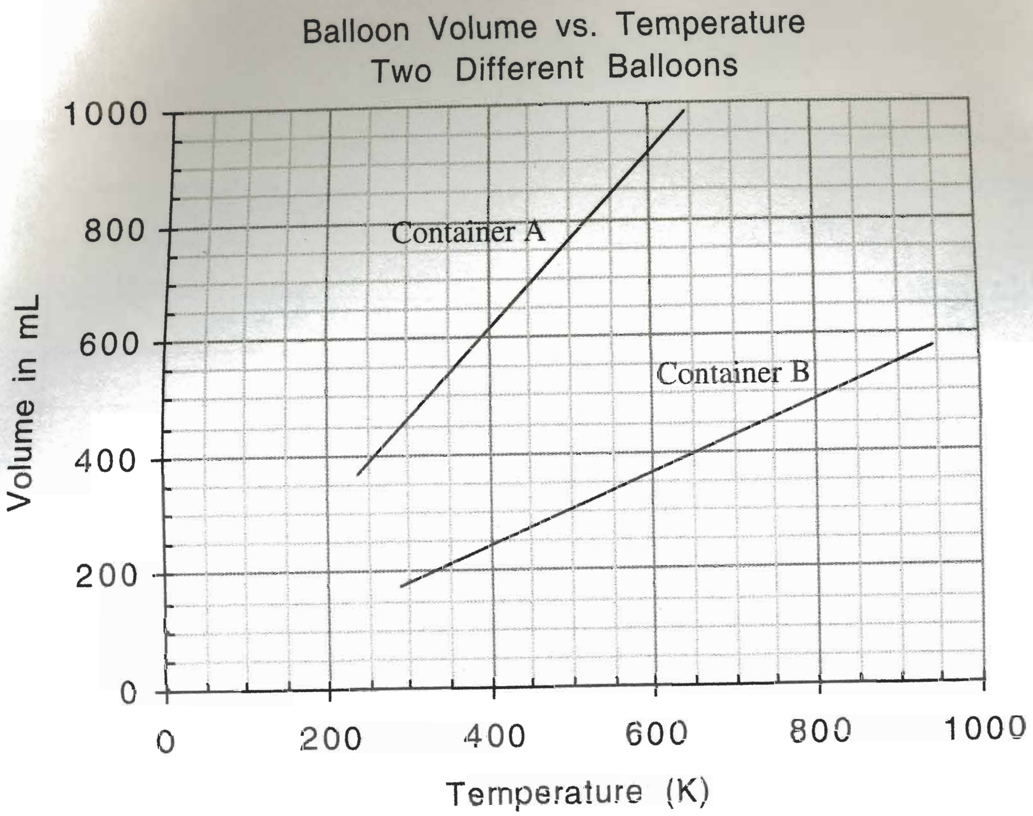
Part II: Imagine there are two hot air balloons ready for launch. One hot air balloon (balloon A) is large and the other (balloon B) is small. The air in each balloon is heated and the temperature and volume of the gas is recorded. The following graph shows the data for each balloon.

1. What is the ratio of volume to temperature for the gas in Balloon A? Show your work.

$$\frac{Y_2-Y_1}{X_2-X_1} = \frac{850-600}{550-375} = \frac{250}{175} = 1.4$$

2. What is the ratio of volume to temperature for the gas in Balloon B? Show your work.

$$\frac{Y_2-Y_1}{X_2-X_1} = \frac{400-300}{650-500} = \frac{100}{150} = 0.67$$



3. Compare the ratio of volume to temperature.
   a) *Is the ratio V/T always the same for Balloon A?* Yes
   b) Is the ratio V/T always the same for Balloon B? yes
   c) Is the ratio V/T the same for both balloons?

4. *Predict the volume of the gas in Balloon A if the temperature is 500 K. Predict the* volume of the gas in Balloon B if the temperature is 500 K. A = 750L B = 300L

5. At what temperature do the two balloons have the same volume? OK

Part III: Imagine that you are getting ready to go up in one of these hot air balloons. Around noon you fill a balloon to a volume of 50,000 L at 100.0°C. Later the day becomes cloudy and chilly, and the temperature inside the balloon drops to 50.0°C.

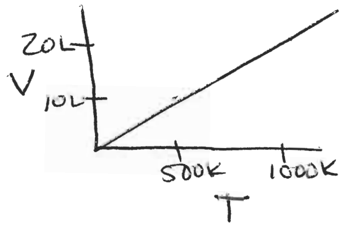
1. Do you predict that the balloon will get bigger or smaller? Explain your reasoning. Smaller

2. What is the ratio V/T at the beginning of the day? (Be sure to use Kelvin). $\frac{50,000}{100° + 273} = \frac{50,000}{373} = 134\ L/K$

3. What is the ratio V/T when the temperature drops to 50.0°C? 134 L/K

Making sense question:
What is the volume of the balloon described in Part III when the temperature is 50°C? (Be sure to use Kelvin.)

Making Sense Notes:

• what is the relationship btwn volume & temp of gases?	• as temp ↑, volume ↑ or as temp ↓, volume ↓ • graph of V vs. T gives a straight line going through the origin - $\frac{V}{T}$ is constant when T is in Kelvin  only need to measure <u>one</u> point (V or T) to predict the other
• What is <u>Charles' Law</u> for gases?	• <u>Charles Law</u>: Volume is directly proportional to temperature ($V \propto T$) - as temp ↑, volume ↑ or as temp ↓, volume ↓ - $\boxed{\frac{V_1}{T_1} = \frac{V_1}{T_2}}$ ✱ Always convert temp. to <u>Kelvin</u> • ex: A sample of air occupies 450.0 mL @ 20.0°C. What is the volume of air @ 60.0°C? K = °C + 273 = 20.0 + 273 = 293K = 60.0 + 273 = 333K $\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\frac{450.0\text{mL}}{293\text{K}} = \frac{V_2}{333\text{K}}$ $\boxed{V_2 = 511\text{mL}}$
Check-In: Q: What change in volume results if 60.0mL is cooled from 27.0°C to 2.0°C?	$\frac{V_1}{T_1} = \frac{V_2}{T_2}$ $\frac{60.0\text{mL}}{300\text{K}} = \frac{V_2}{275\text{K}}$ $V_2 = 55\text{mL}$