Chemistry 20 - Unit 2 - Absolute Temperature and Charles' Law

Name: ______________________________

Complete all of the following problems to the best of your ability. Ensure that you write legibly and that your name is on this assignment. Show all of your work, including the formulas used and the substitution of numerical values. If you have any questions, please refer to your textbooks and notes. Good luck!

You may find the following formulas useful:

$$T_K = T_{°C} + 273.15$$
$$T_{°C} = T_K - 273.15$$
$$V_1/T_1 = V_2/T_2$$

1. Convert each of the following Celsius temperatures to Kelvin.	2. Convert each of the following Kelvin temperatures to Celsius.
a. 18.65 °C. $18.65 + 273.15 = 291.80\,K$	a. 0.00 K. $0 - 273.15 = -273.15\,°C$
b. 200.18 °C. $200.18 + 273.15 = 473.33\,K$	b. 45.0 K. $45.0 - 273.15 = -228.2\,°C$
c. 88.96 °C. $362.11\,K$	c. 32.68 K. $= -240.47\,°C$
d. -44.23 °C. $228.92\,K$	d. 114.592 K. $= -158.56\,°C$
e. -16.98 °C. $256.17\,K$	e. 345.678 K. $= 72.53\,°C$
f. -10.0 °C. $263.2\,K$	f. 890.12 K. $= 616.97\,°C$

3. In a test of Charles' Law, a gas inside a cylinder with a moveable piston is heated. The initial volume of gas in the cylinder is 0.30 L at 25 °C. What will be the final gas volume (*in mL*) when the temperature is increased to 315 °C?

$V_1 = 0.30\,L \times \frac{1000\,mL}{1\,L} = 300\,mL = 3.0 \times 10^2\,mL$

$T_1 = 25°C + 273.15 = 298\,K$ $\quad T_2 = 315 + 273.15 = 588\,K$

$\frac{V_1}{T_1} = \frac{V_2}{T_2} \rightarrow \frac{3.0 \times 10^2\,mL}{298\,K} = \frac{V_2}{588\,K}$

$V_2 = 5.9 \times 10^2\,mL$

4. If 15 mL of butane gas at ~~0 °C~~ 273K is warmed to ~~25 °C~~, calculate its final volume *in kL*.

$V_1 = 15\,mL$
$T_1 = 273K$
$T_2 = 298K$
$V_2 = ?$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \rightarrow \frac{15\,mL}{273K} = \frac{V_2}{298K} \rightarrow V_2 = 16\,mL$$

$$V_{2(kL)} = 16\,mL \times \frac{1L}{1000\,mL} \times \frac{1kL}{1000L} = \boxed{1.6 \times 10^{-5}\,kL}$$

5. A gas sample with a volume of 2.05 L is removed from a refrigerator at ~~5.0 °C~~ and allowed to warm up to ~~21.0 °C~~ 294.2K on a kitchen counter. What volume *in litres* will the gas occupy at 21.0 °C? 278.2K

$V_1 = 2.05L$
$T_1 = 278.2K$
$T_2 = 294.2K$
$V_2 = ?$

$$V_2 = \frac{V_1}{T_1} \times T_2 = \frac{2.05L}{278K} \times 294K = \boxed{2.17L}$$

6. If 1.5 L of gas in a saucepan is heated from ~~22.0 °C~~ to 100.0 °C, what is its final volume *in nL*?

295.2 373.2

$V_1 = 1.5L$
$T_1 = 295.2K$
$T_2 = 373.2K$
$V_2 = ??$

$$V_2 = \frac{V_1}{T_1} \times T_2 = \frac{1.5L}{295.2K} \times 373.2K = 1.9L$$

$$V_{2(nL)} = 1.9L \times \frac{1 \times 10^9\,nL}{1L} = \boxed{1.9 \times 10^9\,nL}$$

7. A balloon containing helium gas at ~~20.00 °C~~ has a volume of 7.50 L. Calculate the volume of the balloon after it rises 10 km into the upper atmosphere, where the temperature is ~~-36.00 °C~~. Do you believe this gas volume is accurate? Why or why not? 237.15K

293.15K

$T_1 = 293.15K$
$V_1 = 7.50L$
$T_2 = 237.15K$
$V_2 = ?$

$$V_2 = \frac{V_1}{T_1} \times T_2 = \frac{7.50L}{293.15K} \times 237.15K = 6.07L$$

Not accurate... pressure is NOT constant!

8. Carbon dioxide produced by yeast in bread dough causes the dough to rise, even before it is baked. During baking, the carbon dioxide gas expands. Predict the final volume of 0.10 L of carbon dioxide in bread dough that is heated from ~~25 °C~~ to ~~190 °C~~ at a constant pressure.

298°K 463K

$V_1 = 0.10L$
$T_1 = 298K$
$T_2 = 463K$
$V_2 = ?$

$$V_2 = \frac{V_1}{T_1} \times T_2 = \frac{0.10L}{298K} \times 463K$$

$$= \boxed{0.16L}$$