Chemistry 20 - Unit 2 - Understanding the Kinetic Molecular Theory

Name: ____

You may find the following formulas and constants useful:

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

760.000 mmHg = 101.325 kPa = 1.00000 atm
1000 mL = 1.000 L
STP = 0.00 °C, 101.325 kPa
SATP = 25.00 °C, 100.00 kPa
$T_K = T_{°C} + 273.15$

1. What is internal pressure? Provide an example of internal pressure. The pressure inside a container, exerted by the gas. ↳ air in a ball ↳ air in a tire. } Keeps them full.	2. What is external pressure? Provide an example of external pressure. The pressure being exerted on an object from outside. ↳ atmospheric pressure ↳ water pressure (diving)

3. A cylinder of gas with a movable piston has an internal pressure of 1000.0 kPa. If this cylinder is moved into an environment with an external pressure of 0.1000 kPa, what should happen to the cylinder? Bearing this in mind, why is it important for compressed gas containers to be made of rigid materials?

↑P to ↓P V↑ by A LOT.
Cylinder may explode.
Rigid materials prevent failure due to pressure change.

4. Gases have indefinite shapes and volumes compared to solids (in an open system). Why do gases behave this way? Gases don't have strong attractions and will move away from each other from collisions. Solids are bonded to each other.	5. Gases fill and assume the shape of their container. Why do they behave this way? Gases will move away from each other due to collisions, and will then collide with the container.

6. Gases are compressible (liquids and solids generally are not). Why is this the case?

Gases have space between molecules, liquids and solids are bonded to each other reducing space.

7. The pressure exerted by a gas increases when its temperature is increased. Why does this happen?

The temperature increase causes the molecules to move quicker, causing more collisions with the container, increasing pressure.

8. Solids retain their shapes while liquids and gases do not. Why do they behave this way?

Solids have molecules that can't move, only vibrate, so the shape can't change.

9. Liquids assume the shapes of their containers but solids do not. Why do they behave this way?

Liquids can "slide" across each other but still stay loosely bonded.

10. A sample of fluorine gas with a volume of 67.5 L at STP is changed to 146 kPa and 42.0 K. What is the new volume of the gas in kL?

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

$$V_2 = \frac{P_1V_1T_2}{T_1P_2} = \frac{(101.325\text{ kPa})(67.5\text{ L})(273.15\text{ K})}{(42.0\text{ K})(146\text{ kPa})}$$

$$= \boxed{305\text{ L}}$$

11. A sample of oxygen gas with a volume of 32.6 L at SATP expands to a volume of 69.8 L with a final temperature of 100.0 K. What is the new gas pressure in atm?

$$P_2 = \frac{P_1V_1T_2}{T_1V_2} = \frac{(100.00\text{ kPa})(32.6\text{ L})(298.15\text{ K})}{(100.0\text{ K})(69.8\text{ L})}$$

$$\boxed{= 139\text{ kPa}}$$

12. A sample of nitrogen dioxide gas with a volume of 68.5 L at STP is changed to 116 kPa and has a final volume of 9.87 x 10^4 mL. What is the new temperature of the gas in degrees Celsius?

$$T_2 = \frac{T_1 P_2 V_2}{P_1 V_1} = \frac{(273.15K)(116kPa)(98.7L)}{(101.325kPa)(68.5L)}$$

$$= 451K - 273.15 = \boxed{177°C}$$

13. Swimming pools make use of small quantities of chlorine gas as a disinfecting agent. If 10.0 L of chlorine at 25.00 degrees Celsius and 101.325 kPa is pumped into a pool with a temperature of 15.00 degrees Celsius and a pressure of 800.00 mmHg, what is the new volume of chlorine?

$$V_2 = \frac{P_1 V_1 T_2}{T_1 P_2} = \frac{(760.00mmHg)(10.0L)(288.15K)}{(298.15K)(800.00mmHg)}$$

$$\boxed{= 9.18L}$$

14. Sulfur dioxide gas is a highly toxic substance that Mr. Pruden's lab partner once cooked up by mistake (it was terrifying). If this gas has a volume of 15.0 L at STP, what is its volume at SATP in mL?

$$V_2 = \frac{P_1 V_1 T_2}{T_1 P_2} = \frac{(101.325kPa)(15.0L)(298.15K)}{(273.15K)(100.00kPa)}$$

$$= 16.6L = \boxed{1.66 \times 10^4 mL}$$

15. Sulfur hexafluoride gas is similar to helium in that it can temporarily alter the pitch of a person's voice when inhaled. If this gas occupies a volume of 1.65 L at 37.0 degrees Celsius at 98.6 kPa, to what temperature in degrees Celsius must the subject be heated for the gas to double in volume? You may safely assume that the pressure remains constant

$$\frac{V_1}{T_1} = \frac{V_2}{T_2} \rightarrow T_2 = \frac{V_2 T_1}{V_1} = \frac{(3.30L)(310.2K)}{(1.65L)}$$

$$= 620K$$