Name: _____

Class: _____

Due Date: _____

B.3 Gas Laws

Understandings

o Pressure is given by $P = \frac{F}{A}$ where F is the force exerted perpendicular to the surface.

o The amount of substance n as given by $n = \frac{N}{N_A}$ where N is the number of molecules and N_A is the Avogadro constant.

o Ideal gases are described in terms of the kinetic energy and constitute a modeled system used to approximate the behavior of real gases.

o The ideal gas law equation can be derived from the empirical gas laws for constant pressure, constant volume, and constant temperature as given by $\frac{PV}{T} = $ constant.

o The equations governing the behavior of ideal gases as given by $PV = nk_\mathrm{B}T$ and $PV = nRT$.

o The change in momentum of particles due to collisions with a given surface gives rise to pressure in gases and, from that analysis, pressure is related to the average translational speed of molecules as given by $P = \frac{1}{3}\rho v^2$.

o The relationship between the internal energy U of an ideal monatomic gas and the number of molecules or amount of substance as given by $U = \frac{3}{2}Nk_\mathrm{B}T$ or $U = \frac{3}{2}RnT$.

o The temperature, pressure, and density conditions under which an ideal gas is a good approximation of a real gas.

Equations

$$P = \frac{F}{A}$$

$$N = \frac{N}{N_\text{A}}$$

$$\frac{PV}{T} = \text{constant}$$

$$PV = nRT = Nk_\text{B}T$$

$$P = \frac{1}{3}\rho v^2$$

$$U = \frac{3}{2}nRT = \frac{3}{2}Nk_\text{B}T$$

The solutions can be found on the YouTube channel Go Physics Go:

Part 1: Use your favorite sources to answer the following questions

1. Define and give the units for each variable for *pressure* $P = \frac{F}{A}$. Is it a scalar or vector? Do not confuse pressure P with power P or momentum $\vec{p}$ or density ρ!

2. Define *Avogadro's constant* N_A.

3. Define and give the units for each variable for a *mole* $n = N/N_A$.

4. Define and give the units of *atomic mass unit u.*

5. State some characteristics of an *ideal gas.*

6. What are some differences between an *ideal gas* and a *real gas*?

7. Define and draw a graph showing *Boyle's Law.*

8. Define and draw a graph showing *Charles' Law.*

9. Define and draw a graph showing *Gay-Lussac's Law.*

10. Take *Boyle's Law*, *Charles' Law*, and *Gay-Lussac's Law* to obtain a general equation for an ideal gas.

11. Define and give the units of each variable for the *Ideal Gas Law* $PV = nRT$.

12. Define and give the units of each variable for the *Ideal Gas Law* $PV = Nk_BT$.

13. Define and give the units for each variable for the equation for the kinetic theory of an ideal gas $P = \frac{1}{3}\rho v^2$.

14. Define and give the units for each variable for the equation for the internal energy of an ideal monatomic gas $U = \frac{3}{2}nRT = \frac{3}{2}Nk_BT$.

15. What is the average kinetic energy and speed of O_2 at room temperature 20°C? Assume O_2 is an ideal gas.

16. What is the molar mass of H_2O?

17. How many moles are in 50 grams of H_2O?

18. How many grams are in 20 moles of H_2O?

19. What is the number of moles of an ideal gas in 80 cm^3 at room temperature of 20°C and a pressure of 10^5 Pa?

20. Three moles of an ideal gas originally occupies a volume of 120 cm^3 with a pressure of 10^5 Pa at a temperature of 23℃. What will be its new volume if its pressure is held constant and its temperature increases to 35℃?