Gas Law Stoichiometry

1. Potassium chlorate, $\text{KClO}_3$, decomposes under heating to produce potassium chloride and oxygen gas:

$$2\text{KClO}_3(\text{s}) \rightarrow 2\text{KCl}(\text{s}) + 3\text{O}_2(\text{g})$$

For a sample of $\text{O}_2$ collected over water, the total gas pressure is 761 torr, and the volume is 525 mL. At the gas temperature (23°C), the vapor pressure of water is 21 torr. How many grams of oxygen gas were collected? (10 pts)

2. A sample of nitrogen gas having a volume of 3.00 L at 25°C and 1.50 atm was mixed with a sample of hydrogen gas having a volume of 15.0 L at 35°C and 2.00 atm. The mixture was reacted to form ammonia gas, $\text{NH}_3(\text{g})$. Calculate the volume of $\text{NH}_3(\text{g})$ formed at a pressure of 2.00 atm and 105°C. (10 pts)
Gas Density

3. Calculate the density of methane, CH₄, at STP. (Report your answer to 3 significant figures.)

4. The density of a noble gas is 16.7 g/L at 2.00 atm and 50.0°C. Calculate the molecular weight of the gas, and use the periodic table to identify the gas.

Kinetic-Molecular Theory

5. Consider separate 1.0 liter gaseous samples of H₂, Xe, Cl₂, and O₂, all at 1 atm and 0°C. (a) Rank the gases in order of increasing average kinetic energy. (b) Rank the gases in order of increasing average velocity.

   a. increasing average kinetic energy: _______________________________________

   b. increasing average velocity: _________________________________________
6. Which gas effuses faster, and by how much: He or Ne? (10 pts)

Wavelength and Frequency

7. (a) How long (in minutes) does it take light to reach the Earth from the Sun? (Light travels at \(3.00 \times 10^8\) m/s. The distance from the Earth to the Sun is 93.0 million miles.) (b) A signal sent from the Earth would currently take 6.09618 hours to reach the NASA probe New Horizons, which recently passed Kupier Belt Object 2014 MU69 (“Ultima Thule”). What is the distance from Earth to New Horizons in astronomical units, AU, if 1 AU = \(1.495978707 \times 10^{11}\) m? (An Astronomical Unit, is the distance between the Sun and the Earth, and is a common unit of measurement in astronomy.) (10 pts)

8. An FM station broadcasts classical music at 93.5 MHz. Find the wavelength (in m) of these radio waves. (10 pts)
9. An atom emits a photon of light having a wavelength of 486 nm. What is the frequency of this light? (10 pts) 

10. When set to stun, the electromagnetic radiation emitted from a regulation Starfleet phaser emits radiation with a wavelength of 435 nm. What is the energy of this radiation in units of kJ/mol? (10 pts) 

11. **Bonus.** How many molecules of Cl₂ gas are present in 22.4 L of gas at STP conditions? (+4 pts)