Lighter Than Air

18T

CST:

Chem 2a, 3d, 3e, 4e, 4h

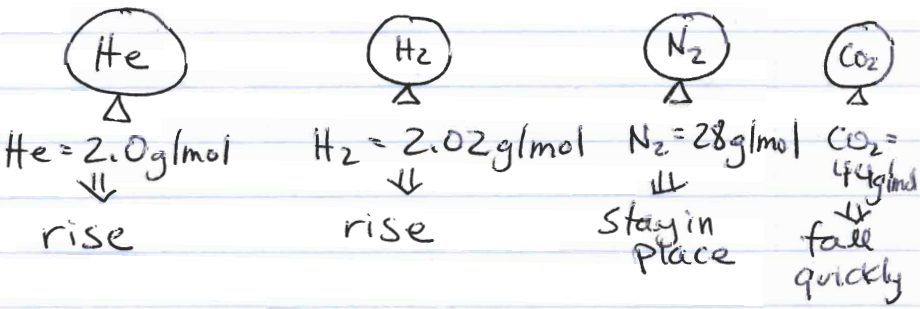
ChemCatalyst:

Q: Why do meteorologists use He & H_2 for weather balloons?

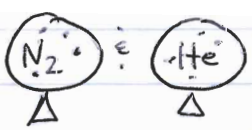
Q: Which gas would cause the balloon to rise faster?

Notes:

- How do weather balloons work?
  - Air is made up of 78% N_2, 21% O_2 & 1% trace gases (~28.56 g/mol for air)
  - Weather balloons are filled w/ He or H_2 which is less dense than air



- What was Avogadro's gas hypothesis?
  - Avogadro's Gas Law: equal volumes of gases @ the same temp & pressure contain equal # of particles



have equal V, so the # of N_2 molecules = # of He atoms

Student Worksheet

Lighter Than Air

Name: _____

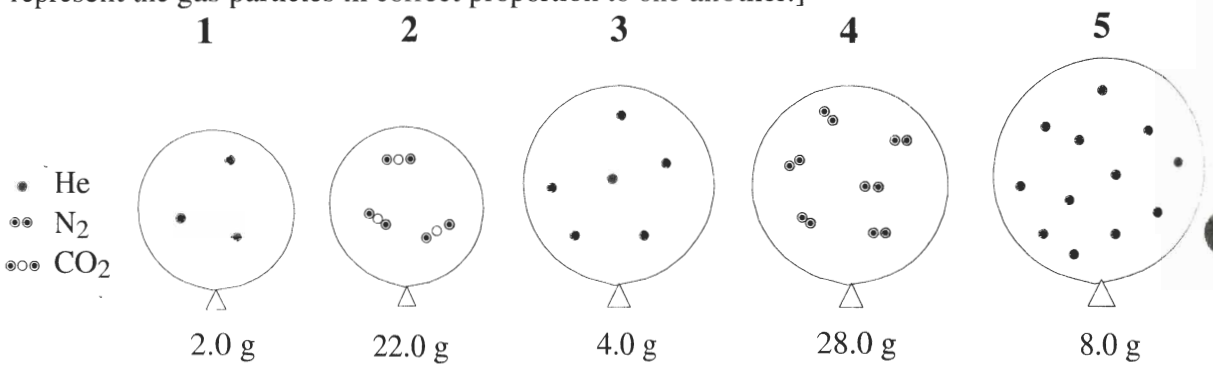
Period:_____ Date: _____

Purpose: The purpose of today's lesson is to explore the number of gas particles in a specified volume of gas. You will need Avogadro's Hypothesis to help you answer the questions.

Avogadro's Hypothesis: Equal volumes of gases at the same temperature and pressure contain equal numbers of gas particles. A gas particle refers to either a single atom or a single molecule that is separated from other molecules or atoms.

Consider these 5 balloons. They are filled with helium (He), nitrogen (N_2), and carbon dioxide (CO_2). The pressure for all 5 balloons is 1.0 atm and the temperature is 273 K.

[Note: These drawings do not show the exact number of gas particles, they simply represent the gas particles in correct proportion to one another.]



1. Which balloon(s) has/have the most gas particles? 5
2. Which balloon(s) has/have the most total atoms? 4 & 4
3. The volumes of Balloon 3 and Balloon 4 are the same. Explain why.

   Same # of particles
4. The masses of Balloon 3 and Balloon 4 are different. Explain why.

   different masses
5. The volume of Balloon 2 is the same as Balloon 1, but smaller than Balloon 5. Explain why.

   1 & 2 have same # of particles & less than 5
6. The mass of Balloon 2 is larger than both Balloon 1 and Balloon 5. Explain why.

   CO_2 has more mass than He
7. Imagine you want to create a helium balloon with the same mass as Balloon 2. How would you do that? What would a drawing of the balloon look like?

Use Avogadro's Hypothesis to complete the table below:

gas	# of particles	mass	volume	pressure	temperature	~~#~~ mol
He	6.02×10^{23}	4.0 g	22.4 L	1.0 atm	273 K	1.0
He	12.04×10^{23}	8.0 g	44.8 L	1.0 atm	273 K	2.0
He	3.01×10^{23}	2.0g	11.2 L	1.0 atm	273 K	0.5
N_2	6.02×10^{23}	28.0 g	22.4 L	1.0 atm	273 K	1.0
N_2	3.01×10^{23}	14.0g	11.2L	1.0 atm	273 K	0.5
N_2	6.02×10^{23}	28.0 g	11.2 L	2.0atm	273 K	0.5
CO_2	6.02×10^{23}	44.0 g	22.4	1.0 atm	273 K	1.0
CO_2	3.01×10^{23}	22.0 g	11.2L	1.0 atm	273 K	0.5

8. When you have a balloon that has a volume of 22.4 L at 1.0 atm and 273 K, how many particles does it have? 6.02×10^{23}

9. What is the relationship between the volume of a particular gas and its mass?
When one doubles the other doubles

10. What is the relationship between the mass of a particular gas and the number of gas particles?
When one doubles the other doubles

11. Does the identity of the gas change the number of particles in 22.4 liters? Explain. NO

12. How would you write 6.02×10^{23} as a whole number instead of in scientific notation?

13. Three balloons have the same volume, pressure, and temperature. A helium (He) balloon has a mass of 4.0 g, a nitrogen (N_2) balloon has a mass of 28.0 g, and a carbon dioxide (CO_2) balloon has a mass of 44.0 g. How do these masses relate to the atomic masses given on the periodic table?

14. Suppose you want to make an air mixture that has 4 nitrogen (N_2) molecules for every 1 oxygen (O_2) molecule. Answer the following:

    a) If you have 6.02×10^{23} O_2 molecules, how many N_2 molecules do you need?

    b) If you have 100 L of N_2, how many liters of O_2 do you need?

Making sense question:
You have: 5.0 L of methane (CH_4) at 30°C and 1.0 atm, and
5.0 L of oxygen (O_2) at 30°C and 1.0 atm.

List at least three things that are the same.
List at least three things that are different.
(Consider the volume, temperature, pressure, number of gas particles, identities of the gas particles, mass, and density.)

If you finish early…
Suppose you have 100 L of humid air at 30°C, and 100 L of dry air at 30°C. Which is denser? Explain your reasoning.

Making Sense Notes:

- How can we relate Avogadro's # to gases?
  - If 2 gases have the same volume, pressure & temp. they will have the same # of gas particles
  - In chemistry most gas experiments are performed @ STP = Standard Temp & Pressure
    - STP = T = 0°C (273 K)
      P = 1.0 atm
  - @ STP, the volume of gas is 22.4L which contains 6.02×10^{23} particles (1 mole!)
    - **1 mol = 22.4 L**

- How can we use gas volume in stoichiometry?
  - * we use the conversion ratio: 1mol = 22.4L
  - ex:

$$2Na + 2H_2O \rightarrow 2NaOH + H_2$$

what volume (L) of H_2 will be produced if 5.0g of Na is used?

$$5.0\,g\,Na \left|\frac{1\ mol\ Na}{22.9\ g\ Na}\right| \frac{1\ mol\ H_2}{2\ mol\ Na} \left|\frac{22.4\ L\ H_2}{1\ mol\ H_2}\right| = \boxed{2.4\ L\ H_2}$$

Check-In:

Q: One balloon has 22.4L of Ar; another has 22.4L of Ne. Both are @ STP.

- same V? Yes
- same mass? NO
- same # particles? Yes