Chapter 9: Gaseous State

Nov 28, 2022

Chemistry Department, Cypress College

Class Announcements

Lab

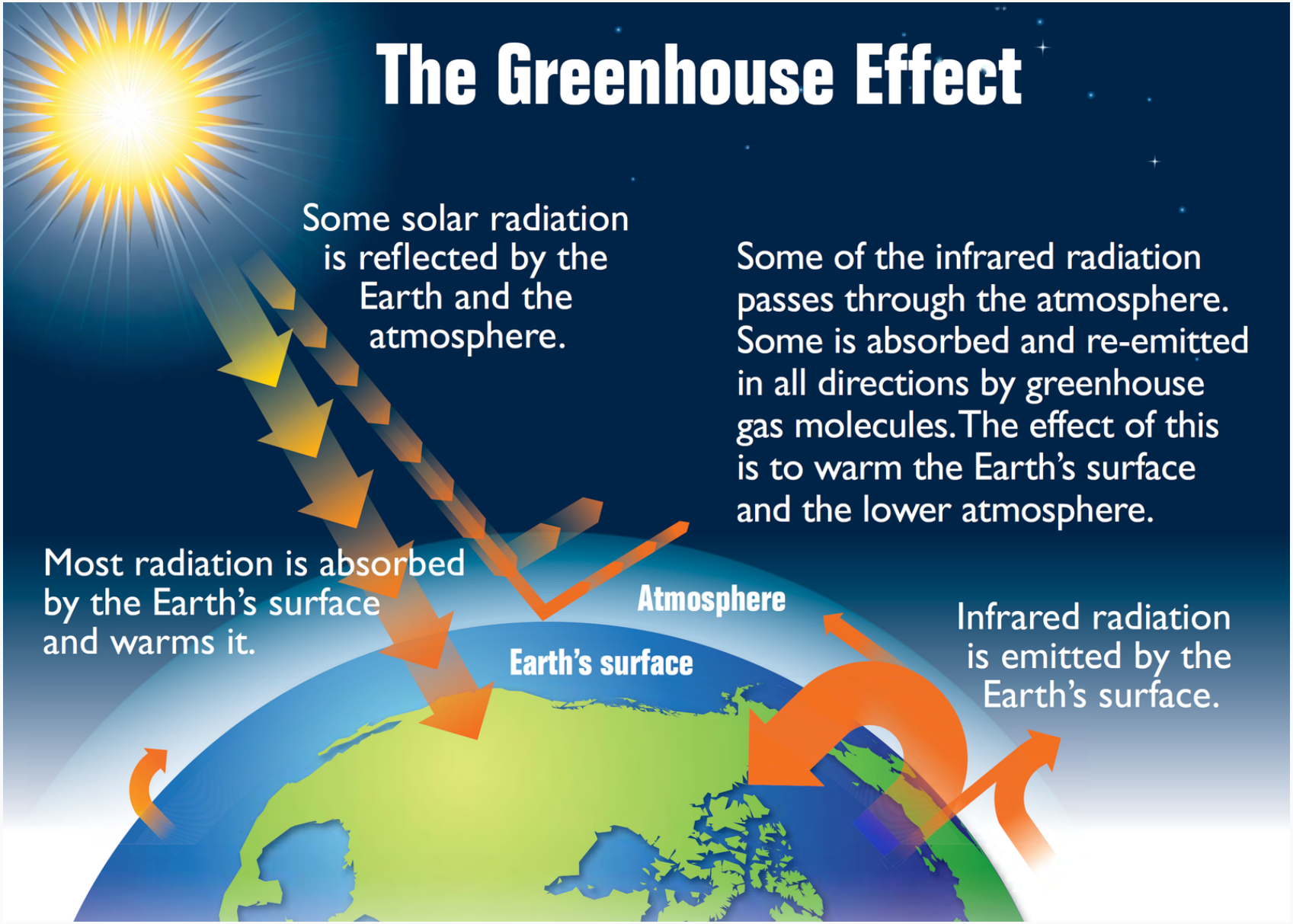
- Lab Practicuum Week; Mon - Lab Review
- Submit **All** Lab Assignments...

Lecture

- Finish up Ch 9; Begin Ch 10 and 11
- Final Exam Dec 10th in Lecture
- Quiz and Homework posted this Fri, Dec 2nd

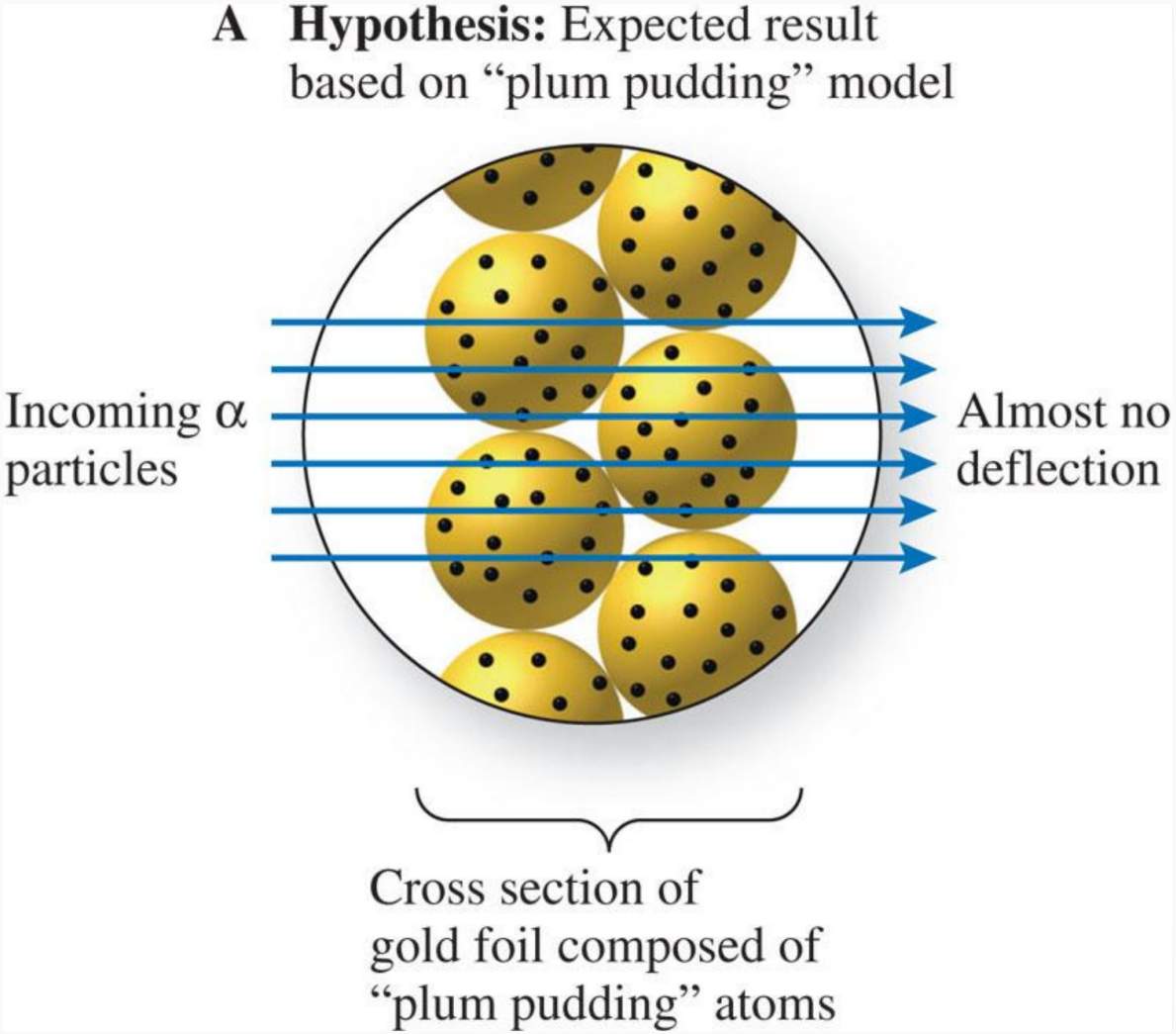
Outline

Greenhouse Effect



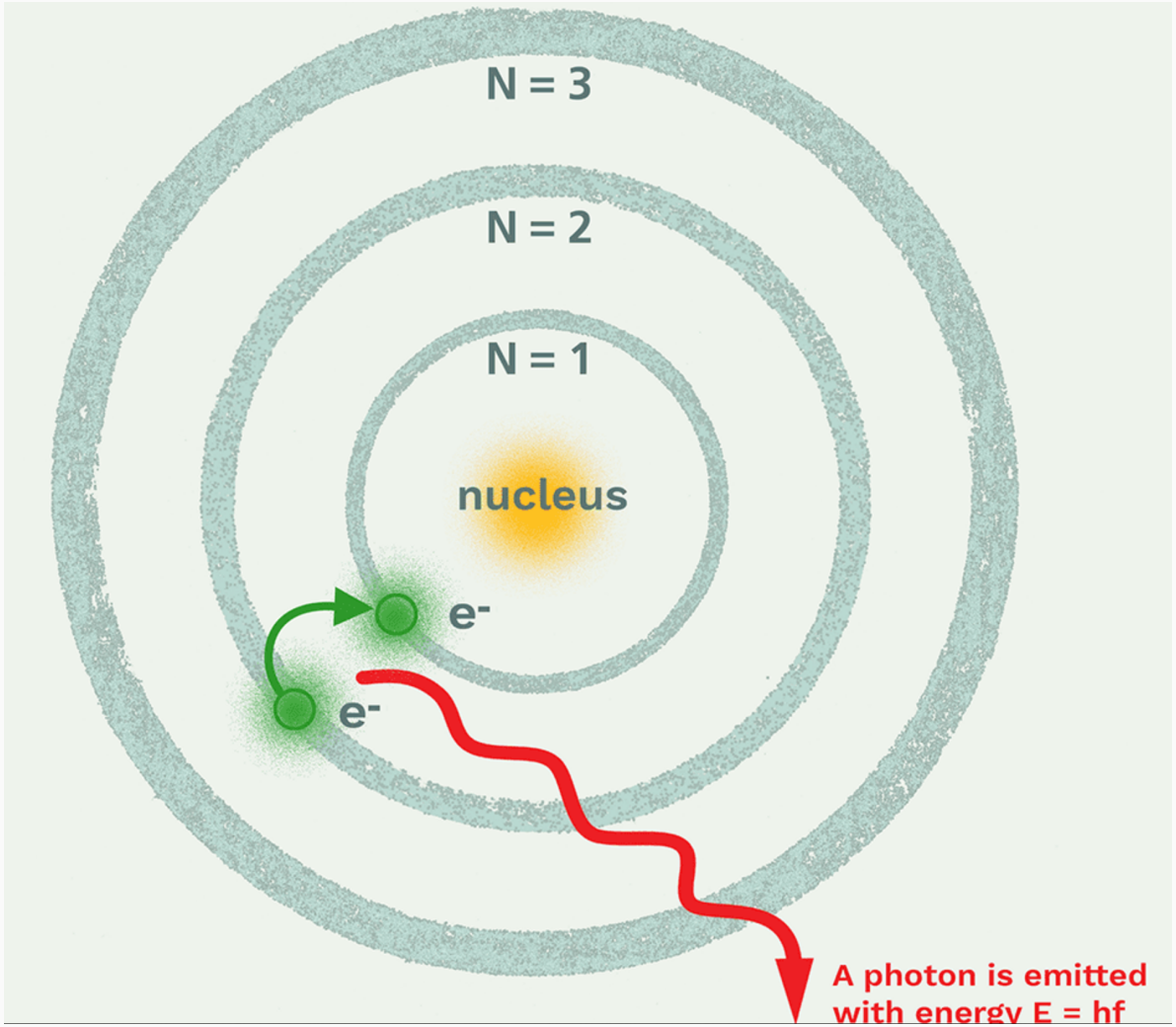
Recall the Models

Plum Pudding Model



Recall the Models

Bohr Model



Ideal Gas Model

Assumptions

- There is a large number of molecules that are in random motion
- Volume of the molecule is small relative to the volume occupied by the gas
- All molecules of a given gas are identical
- There no interactions between molecules (intermolecular forces)
- Collisions between gas molecules are perfectly elastic

Ideal Gas Formula

$$PV = nRT \tag{1}$$

where P is pressure (atm), V is volume (L), n moles of gas (mols), R is gas constant, and T is temperature (K)

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Gas Constants - Use the appropriate once based on the units in the problem

$$\begin{aligned} R =& 8,314.46 \frac{\text{L Pa}}{\text{K mol}} = 0.082057 \frac{\text{L atm}}{\text{K mol}} \\ =& 62.3636 \frac{\text{L Torr}}{\text{K mol}} \end{aligned}$$

Using Ideal Gas to Obtain Gas Laws

Boyle's Law - hold n and T constant

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Charles' Law - hold n and P constant

$$\begin{aligned} PV &= nRT \\ \frac{V}{T} &= \frac{nR}{P} = \text{constant} \\ \frac{V_1}{T_1} &= \frac{V_2}{T_2} \end{aligned} \tag{3}$$

Finding Density from Ideal Gas Law

Q: What are the units for density?

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$$PV = nRT$$

$$\frac{n}{V} = \frac{P}{RT}$$

Given this ratio, the last step is to multiply by the molar mass of the given substance

$$D = \frac{n\,MM}{RT}$$

where MM is the molar mass

Finding Molar Mass from Ideal Gas Law

Q: What are the units for molar mass?

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Q: What are the units for molar mass?

$$PV = nRT$$
$$n = \frac{PV}{RT}$$

Determine the moles and given the mass, divide by the moles

Outline

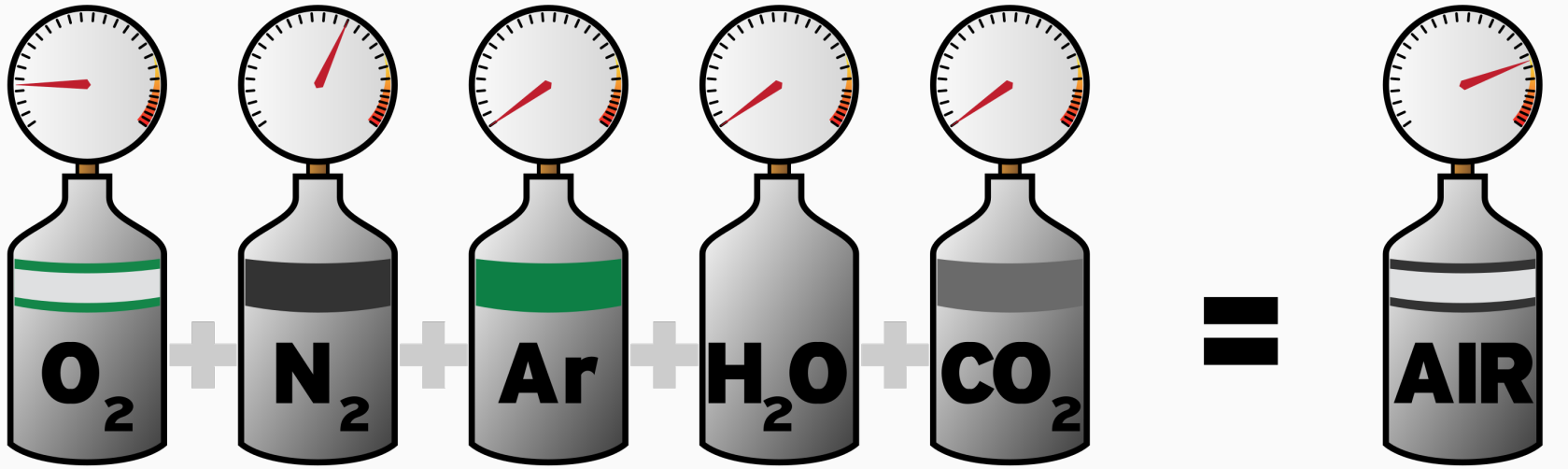
Dalton's Law of Partial Pressures

Gases in a mixture behave independently and exert the same pressure they would exert if they were in a container alone

$$P_{\text{Total}} = P_A + P_B + P_C + \cdots \tag{4}$$

where P_{Total} is the total pressure and $P_A, P_B, \cdots$ are the pressures of the components

Dalton's Law of Partial Pressures



$$P_{\text{Total}} = P_{\text{O2}} + P_{\text{N2}} + P_{\text{Ar}} + P_{\text{H2O}} + P_{\text{CO2}}$$

Practice: Dalton's Law of Partial Pressure

Suppose gaseous oxygen (O_2) is produced by:

$2KClO_3(s) \rightarrow 2KCl(s) + 3O_2(g)$

If 1.50L of O_2 is collected over water at 300.K and 0.970atm, how many moles of O_2 is produced? The vapor pressure of water is 0.0351atm.

Mole Fraction

Expressing the relative amounts of substances in a mixture

$$\chi_A = \frac{n_A}{n_{\text{Total}}} \tag{5}$$

where χ_A is the mole fraction of component A, n_A is the amount of moles for A, and n_{Total} is the total amount of moles in the mixture

Dalton's Law of Partial Pressure

Since each gas component exert its own pressure, the partial pressure of each component can be expressed by

$$P_A = \chi_A P_{\text{Total}} = \frac{n_A}{n_{\text{Total}}} P_{\text{Total}} \tag{6}$$

Practice: Dalton's Law of Partial Pressures

A flask contains a mixture of 1.25 mols of hydrogen gas and 2.90 moles of oxygen gas. If the total pressure is 104.kPa, what is the partial pressure of each gas?

Outline

Practice: Moles-Volume

Assuming ideal gas conditions, the sample of $H_2(g)$ occupies a 8.00L container at 5.00 atm and 298.15K. What volume of $H_2O(g)$ is produced by the reaction at 423.15K and 0.947atm, if all $H_2(g)$ reacts with copper(II) oxide?

Practice: Mass-Volume

Assuming ideal gas conditions, how many moles $CaCO_3(s)$ form if 3.45L of $CO_2(g)$, measured at 318.15K and 1.37atm, react with excess CaO(s)? How many grams?