

Molar gas volume

A mole of anything has 6.022×10^{23} particles. This is called Avogadro's number, after Amedeo Avogadro, who first suggested that equal volumes of gas have equal numbers of molecules.

1 mole of any gas takes a volume of 22.4 liters at "normal conditions". 1 mole (approx. 2 grams) of hydrogen gas occupies 22.4 L. 1 mole (32 g) of oxygen gas occupies 22.4 L. 22.4 L is a molar gas volume under the normal conditions. Normal conditions are temperature of 0°C (273 K) and pressure of 1 atm (101 325 Pa)

The number of particles

- We have 1 mol O₂
- It means that we have one mole of O₂ molecules, 6.02×10^{23} O₂ molecules.
- Each O₂ molecule contains two oxygen atoms therefore one mole of O₂ molecules contains $2 \times 6.02 \times 10^{23} = 1.204 \times 10^{24}$ oxygen atoms (2 moles)
- If we have 0.1 mole of H₂O molecules, we have 0.1 mole of oxygen atoms as well
- If we have 0.1 mole of SO₃ molecules, we have 0.1 times 3 = 0.3 moles of O atoms.

Calculations involving moles and masses

a) The coefficients in the chemical reaction tell us the molar ratio of reactants and products.

b) Work out the number of moles of anything you can.

c) Convert moles to the required quantity: mass, volumes, etc.

d) if we have one reactant in excess, we generally do not use its mass to figure out the masses of products in the reaction. Use the limiting reactant to determine the mass of products in the reaction (if you need to find the limiting reactant, divide the number of moles of each reactant by its coefficient. The lowest number will give you the limiting reactant).



If we want the hydrogen and oxygen to react with each other completely and exactly we need to figure out the masses of H₂ and O₂ that correspond to the given ratio (2:1)

	H ₂	O ₂	H ₂ O
moles	2	1	2
Masses,g	$2\text{mol} \times 2\text{g mol}^{-1} = 4\text{g}$	$1\text{mol} \times 32\text{g mol}^{-1} = 32\text{g}$	$2\text{mol} \times 18\text{g mol}^{-1} = 36\text{g}$
moles	20	10	20
Masses,g	40	320	360
moles	0.2	0.1	0.2
Masses,g	0.4	0.32	0.36

Remember, number of moles=mass/molar mass

Questions

1. 4 grams of hydrogen (H_2) were mixed with 64 grams of oxygen (O_2). The mixture exploded, forming water (H_2O). Write down the equation of the chemical reaction. How many grams of water formed? How many grams of oxygen remained unreacted?
2. There are 180 grams of water in a glass. How many molecules are there? How many moles?
3. Write down the total number of hydrogen atoms in 0.05 moles of NH_3 .
4. A 1 liter of a gas has 3.17 grams of this gas under normal conditions. What is its molar mass and molecular weight? Identify this gas. Write down its chemical formula using the periodic table of elements. Hint: it has two identical atoms in a molecule.