

Name _____ Date _____ Period _____

Need to Know Sheet for Chapter 12 Chemical Quantities and the Mole**Objectives**

Relate Avogadro's number to a mole of a substance, Calculate the mass of a mole of any substance, Convert between mass and mole using molar mass



Mole is an SI unit, used as a measurement of matter to count atoms, molecules or formula units of a substance.

Mole is a SI unit, abbreviated mol

1 Mole = 6.02×10^{23} representative particles = Avogadro's number

Representative particle refers to the species present: usually atoms, molecules or formula units

Substance	Representative Particle	Chemical formula	Representative particles in one mole	Molar mass (in grams)
Aluminum	atom	Al	6.02×10^{23}	
Nitrogen gas	molecule	N ₂	6.02×10^{23}	
Water	molecule	H ₂ O	6.02×10^{23}	
Calcium ion	ion	Ca ²⁺	6.02×10^{23}	
Calcium fluoride	formula unit	CaF ₂	6.02×10^{23}	
Sucrose	molecule	C ₁₂ H ₂₂ O ₁₁	6.02×10^{23}	

The Molar Mass

of any substance is the mass in grams of one mole of the substance.

With Avogadro's number the atomic mass unit u of one particle is converted into grams of one mole

Mass of one particle of a substance = xy u \Rightarrow 1 mole \Rightarrow Mass of one mole = xy grams (g)

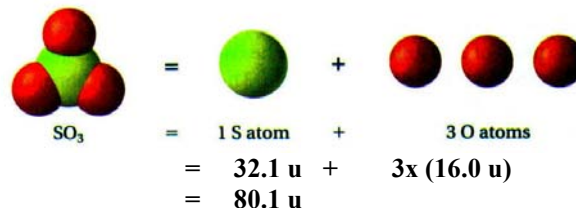
To calculate the molar mass (mass of one mole) of any compound, just add the average atomic mass (see periodic table) of each atom in the formula.

6.02×10^{23} carbon atoms of the isotope carbon-12 (6 protons and 6 neutrons) will have the mass of _____ g.

What is the molar mass of _____ (show one decimal place)

SO₂

NaCl

Na₂O

80.1 u \Rightarrow 1 mole \Rightarrow 80.1 g

Molar volume of a gas is the volume that a mole of a gas occupies at a pressure of 1 atm and a temperature of 0°C.
1 mol (gas) = 22.4 L at STP

Calculating Number of Moles from Molar Mass



Conversion factor: $\frac{1 \text{ mole}}{\text{molar mass}} = \frac{1 \text{ mole}}{\text{xy grams}}$

Start with the known and then use your conversion factor so that the old unit cancels out and you reach the unit of your unknown.

Example problem:

1) How many grams are in 5.5 mol of SO₂?

Known: 5.5 mol of SO₂ Unknown: mass g of SO₂ conversion: $\frac{1 \text{ mole}}{\text{Molar mass}} = \frac{1 \text{ mole}}{64.0\text{g}}$

$$\frac{5.5 \text{ mol of SO}_2}{1 \text{ mol SO}_2} \times 64.0 \text{ g SO}_2 = 352 \text{ g SO}_2$$

Calculating Number of Particles from Mole



Conversion factor: $\frac{1 \text{ mole}}{\text{Avogadro's number}} = \frac{1 \text{ mole}}{6.02 \times 10^{23} \text{ particles}}$

Example problem:

2) How many moles make 7.9 x 10²⁴ oxygen molecules?

Known: 7.9 x 10²⁴ O₂ molecules Unknown: ? mole O₂ conversion: $\frac{1 \text{ mole}}{6.02 \times 10^{23} \text{ O}_2 \text{ molecules}}$

$$\frac{7.9 \times 10^{24} \text{ O}_2 \text{ molecules}}{6.02 \times 10^{23} \text{ O}_2 \text{ molecules}} \times \frac{1 \text{ mole O}_2}{1} = 1.3 \times 10^{24-23} = 13 \text{ mol O}_2$$

Calculating Gas Volume in Liters for Gases at STP from Mole

Conversion factor: $\frac{1 \text{ mole}}{\text{Molar volume}} = \frac{1 \text{ mole}}{22.4 \text{ L}}$



Example problem:

3) How many liters of Helium gas are 1.75 mol He at STP?

Known: 1.75 mol He Unknown: ? L of He conversion: $\frac{1 \text{ mole}}{22.4 \text{ L He}}$

$$\frac{1.75 \text{ mol He}}{1 \text{ mol He}} \times 22.4 \text{ L He} = 39.2 \text{ L He}$$

Under conditions that are different from STP, the number of moles (n) can be calculated for gases using the Ideal Gas Law

$$PV = nRT$$

R is a constant with the value of 8.31, if pressure (**P**) is in kPa,
Volume (**V**) in liter and
Temperature (**T**) in Kelvin

n = number of moles

Example problem:

4) How many moles of hydrogen gas are in a balloon of 575L volume at a pressure of 250 kPa at a temperature of 150K? (**Because the unit for R is rather complicated (L*KPa/mol*K), we don't write it down here, but it basically would cancel out the other units correctly.**)

$$PV = nRT \rightarrow n = \frac{PV}{RT} \rightarrow n = \frac{250 \text{ kPa} \times 575 \text{ L}}{8.31 \times 150 \text{ K}} = 115 \text{ mol}$$