

The Mole

CA Standards

Students know the quantity *one mole* is set by defining one mole of carbon 12 atoms to have a mass of exactly 12 grams.

Students know one mole equals 6.02×10^{23} particles (atoms or molecules).

Students know how to determine the molar mass of a molecule from its chemical formula and a table of atomic masses and how to convert the mass of a molecular substance to moles, number of particles, or volume of gas at standard temperature and pressure.

The Mole

1 dozen = 12

1 gross = 144

1 ream = 500

1 mole = 6.02×10^{23}



There are exactly 12 grams of carbon-12 in one mole of carbon-12.

Avogadro's Number

6.02×10^{23} is called "Avogadro's Number" in honor of the Italian chemist Amadeo Avogadro (1776-1855).



Amadeo Avogadro

I didn't discover it. Its just named after me!

Calculating Formula Mass

Calculate the formula mass of carbon dioxide, CO_2 .



$$12.01 \text{ g} + 2(16.00 \text{ g}) = 44.01 \text{ g}$$

\therefore One mole of CO_2 (6.02×10^{23} molecules) has a mass of 44.01 grams

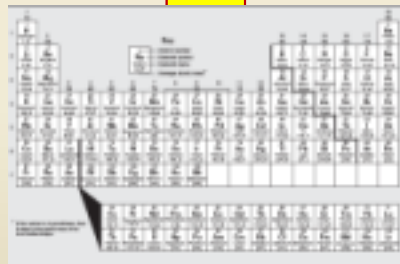
Atoms
or molecules

Liters

6.02×10^{23}

Mole

22.4
L



A standard periodic table of elements, showing various chemical symbols and their corresponding atomic numbers, arranged in rows and columns.

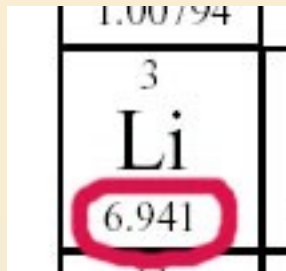
Grams

Mole
Relationships

Calculations with Moles:

Converting moles to grams

How many grams of lithium are in 3.50 moles of lithium?



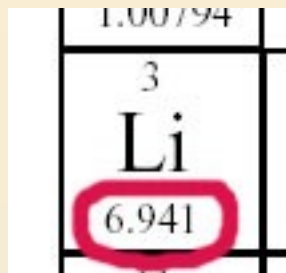
| |
|---------|
| 1.00794 |
| 3 |
| Li |
| 6.941 |

$$3.50 \text{ mol } \cancel{\text{Li}} \left| \frac{6.94 \text{ g Li}}{1 \cancel{\text{ mol Li}}} \right. = 24.3 \text{ g Li}$$

Calculations with Moles:

Converting grams to moles

How many moles of lithium are in 18.2 grams of lithium?



| |
|---------|
| 1.00794 |
| 3 |
| Li |
| 6.941 |

$$\frac{18.2 \text{ g } \cancel{\text{Li}}}{6.94 \cancel{\text{ g Li}}} \times \frac{1 \text{ mol Li}}{1} = 2.62 \text{ mol Li}$$

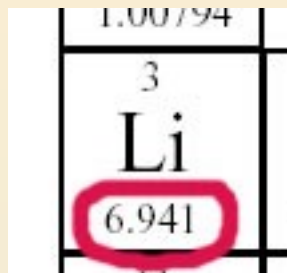
Calculations with Moles: Using Avogadro's Number

How many atoms of lithium are in 3.50 moles of lithium?

$$\frac{3.50 \text{ mol}}{1 \text{ mol}} \times \frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mol}} = 2.07 \times 10^{24} \text{ atoms}$$

Calculations with Moles: Using Avogadro's Number

How many atoms of lithium are in 18.2 g of lithium?



| |
|---------|
| 1.00794 |
| 3 |
| Li |
| 6.941 |

| | | |
|---------------------|--------------------|---|
| 18.2 g Li | 1 mol Li | $6.022 \times 10^{23} \text{ atoms Li}$ |
| 6.94 g Li | 1 mol Li | |

$$(18.2)(6.022 \times 10^{23})/6.94 = 1.58 \times 10^{24} \text{ atoms Li}$$

Standard Molar Volume

Equal volumes of all gases at the same temperature and pressure contain the same number of molecules.

- Amedeo Avogadro

At STP (Standard Temperature and Pressure):

1 mole of a gas occupies 22.4 liters of volume

Calculations with Moles: Using Standard Molar Volume

How many moles of hydrogen are in 100 L of hydrogen at STP?

$$\frac{100 \text{ L}}{22.4 \text{ L}} \times \frac{1 \text{ mol}}{1} = 4.64 \text{ mol}$$

Calculations with Moles: Using Standard Molar Volume

How many liters are occupied by 3 moles of oxygen gas at STP?

$$\frac{3 \text{ mol}}{1 \text{ mol}} \times \frac{22.4 \text{ L}}{1} = 67.2 \text{ L}$$