## Essential Question

How can we count atoms by weighing them?

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# What Is a Mole?

- A counting unit, like a dozen
- 1 mole = $6.02 \times 10^{23}$ particles
- This number is Avogadro's number

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# Kinds of Particles

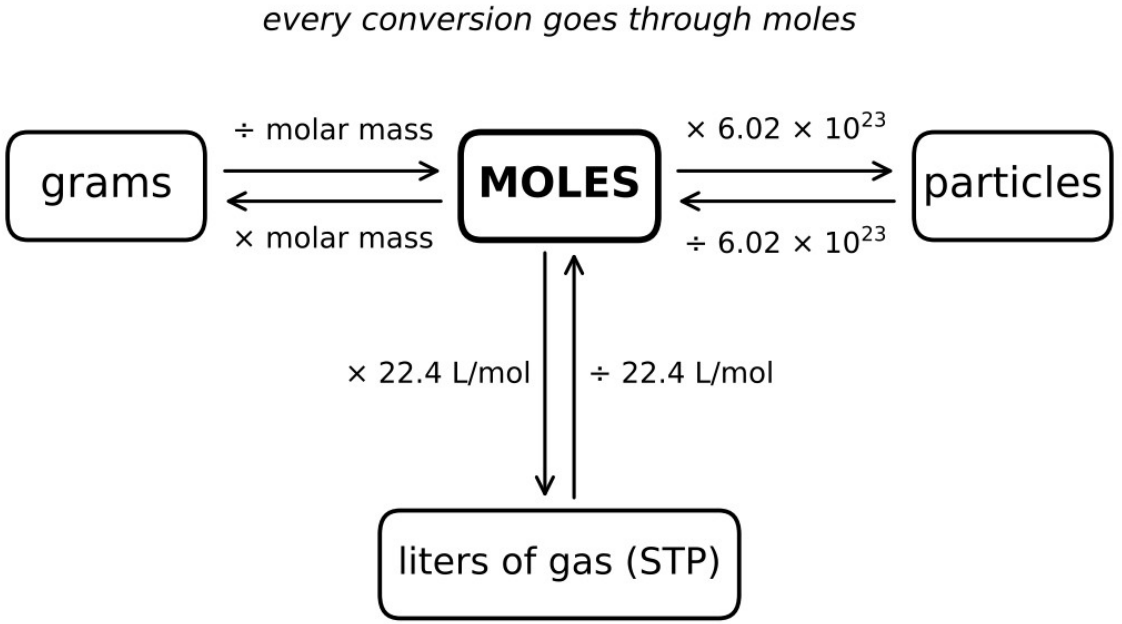
- 1 mole of any of them = $6.02 \times 10^{23}$ particles

| Substance | Particle |
|---|---|
| element (Fe) | atoms |
| covalent compound ($H_2O$) | molecules |
| ionic compound (NaCl) | formula units |

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# The Mole Map

- Moles are in the middle
- Every conversion goes through moles
- Grams, particles and liters of gas connect only to moles




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# Dimensional Analysis

- Multiply by a conversion factor
- Put the unit you have on the bottom
- 24 eggs × (1 dozen / 12 eggs) = 2 dozen

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# Mole Conversion Factors

- Each equality gives two factors
- 1 mol $H_2O$ = 18.02 g $H_2O$
- 18.02 g / 1 mol or 1 mol / 18.02 g
- Pick the one that cancels your unit

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# Grams ↔ Moles

- Use the molar mass
- Grams → moles: × 1 mol / molar mass
- Moles → grams: × molar mass / 1 mol

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# Moles ↔ Particles

- Use Avogadro's number
- Moles → particles: × $6.02 \times 10^{23}$
- Particles → moles: ÷ $6.02 \times 10^{23}$
- Particle counts are always huge

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# Moles ↔ Liters of Gas

- STP: 0 °C and 1 atm
- 1 mol of any gas = 22.4 L (the molar volume)
- Gases only, not solids or liquids

| Moles of gas | Liters at STP |
|---|---|
| 0.500 mol | 11.2 L |
| 1.00 mol | 22.4 L |
| 2.00 mol | 44.8 L |

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# Example: Grams to Moles

How many moles are in 25.0 g of sodium chloride, NaCl?

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# Example: Moles to Grams

What is the mass of 0.750 mol of carbon dioxide, $CO_2$?

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# Example: Moles to Molecules

How many molecules are in 2.40 mol of water, $H_2O$?

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# Example: Atoms to Moles

How many moles of iron are in $3.01 \times 10^{23}$ atoms of Fe?

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# Example: Liters of Gas to Moles

A balloon holds 5.60 L of helium gas at STP. How many moles of helium are in the balloon?

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# 1-Step Conversions

## Big Ideas

- 1 mole = $6.02 \times 10^{23}$ particles
- Grams ↔ moles: use molar mass
- Moles ↔ particles: use Avogadro's number
- Moles ↔ liters of gas at STP: use 22.4 L/mol
- Unit you have goes on the bottom

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