

Moles

Lecture 7



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INTRODUCTION

- Mole
- Balancing equations
- Calculations using the equations (STOICHIOMETRY)



THE MOLE

the fundamental unit of measurement in chemistry

Dozen = 12 used to count eggs easily

Mole = 6.02×10^{23} used to count subatomic particles easily

7 dozen eggs = $7 \times 12 = 84$ eggs

7 moles of carbon atoms = $7 \times 6.02 \times 10^{23} = 4.21 \times 10^{24}$ neon atoms

7 moles of CO_2 molecules = $7 \times 6.02 \times 10^{23} = 4.21 \times 10^{24}$ CO_2 molecules

$$N = n \times 6.02 \times 10^{23}$$

N – number of particles (molecules, atoms)

n – number of moles

30 eggs = $30 \div 12 = 2.5$ dozen

8.14×10^{23} NH_3 molecules = $8.14 \times 10^{23} \div 6.02 \times 10^{23} = 1.35$ moles of NH_3



The MOLE: unit used to deal with large numbers of atom/molecules



THE MOLE - DEFINITIONS

mole - the amount of substance that contains the same number of particles (atoms/ ions/ molecules/ formula units etc.) as there are atoms in exactly 12 g of carbon-12.

molar mass – (molecular weight) mass of 1 mole of a substance in g/mol (sum of atomic masses of constituent atoms)

Avogadro's number - number of particles in one mole of any substance, equal to $6.02214076 \times 10^{23}$

stoichiometry - the relationship between the relative quantities of substances taking part in a reaction or forming a compound, typically a ratio of whole integers.



WHY IS MOLE IMPORTANT?

Compare reactions (e.g. fuels)

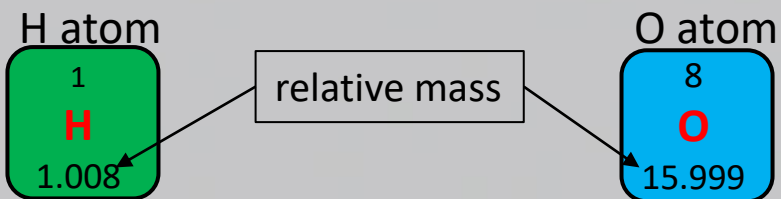
Work out concentrations (e.g. acids)

Work out how much material is needed (e.g. mass balance)



MOLAR MASS (MM)

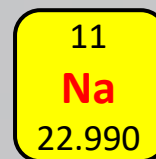
1 mole of a pure substance weighs the relative mass in grams



1 mole of H atoms weighs 1.0 g
Molar mass = 1.0 g/mol
 6.02×10^{23} H atoms weigh 1.0 g

1 mole of O atoms weighs 16.0 g
Molar mass = 16.0 g/mol
 6.02×10^{23} O atoms weigh 16.0 g

NaCl 'formula unit'



$$23.0 + 35.5 = 58.5$$



molar mass of H_2O = 18.0 g/mol
1 mole of H_2O weighs 18.0 g
 6.02×10^{23} H_2O molecules weigh 18.0 g

Molar mass of NaCl = 58.5 g/mol
1 mole of NaCl weighs 58.5 g
 6.02×10^{23} NaCl molecules weigh 58.5 g



MASS TO MOLES

1 bag of sugar weighs 3.0 kg

4 bags of sugar weigh $4 \times 3.0 = 12.0$ kg of sugar

7.0 kg of sugar ???

$7.0 \text{ kg} / 3.0 \text{ kg/bag} = 2.33$ bags of sugar

1 mole of water weighs 18.0 g

4 moles of water weigh $4 \times 18.0 = 72.0$ g of water

45.0 g of water ???

$45.0 \text{ g} / 18.0 \text{ g/mol} = 2.5$ moles of water

grams = moles x Molar Mass

$$g = n \times MM$$



COUNTING BY WEIGHT

How many water molecules are in 36.0 g of water?

$$g = n \times MM \longrightarrow n = \frac{g}{MM}$$

$$N = n \times 6.02 \times 10^{23}$$

$$g = 36.0 \text{ g}$$

$$MM = 18.0 \text{ g/mol}$$

$$n = \frac{36.0 \text{ g}}{18.0 \text{ g/mol}}$$

$$n = 2.00 \text{ mol H}_2\text{O}$$

$$N = 2.00 \text{ mol} \times 6.02 \times 10^{23} \text{ molecules/mol}$$

$$N = 1.20 \times 10^{24} \text{ molecules H}_2\text{O}$$



Practice problem 1: How many moles of AlCl_3 is equivalent to 3.45×10^{22} AlCl_3 "molecules" (formula units)? Answer using 3 decimal places.

Practice problem 2: To the nearest whole number, what is the molar mass of K_2Se ?

Practice problem 3: How many moles of H_3PO_4 are contained in 0.352 grams of H_3PO_4 . Enter your answer to 5 decimal places.

Practice problem 4: How many grams (to the nearest whole number) of $\text{C}_7\text{H}_{11}\text{O}_2$ are contained in 4.45 moles of $\text{C}_7\text{H}_{11}\text{O}_2$.

