

2.2 THE MOLE AND AVOGADRO'S CONSTANT

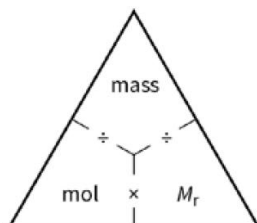
2.2 The mole and the Avogadro constant

Learning outcomes

Candidates should be able to:

1 define and use the term mole in terms of the Avogadro constant

The mole



A mole is defined as the amount of substance which contains 6.02×10^{23} specified particles (atoms, ions, molecules or electrons)

1 mole = 6.022×10^{23} particles (atoms, molecules, formula units, ions, electrons etc.)

Avogadro's constant (L) = 6.022×10^{23}

Number of moles = mass (in gram)/ molar mass (M_r)

Molar masses is a general term used for the mass in grams of 1 mole of a compound, whether ionic, simple molecules of giant covalent structures. 'Relative molecular mass' refers to only to molecules.

1. Use the A_r values below to calculate the relative molecular mass of iron(III) borate, $\text{Fe}(\text{BO}_2)_3$.
(A_r values: Fe = 55.8, B = 10.8, O = 16.0)
2. Use these A_r values (Fe = 55.8, N = 14.0, O = 16.0, S = 32.1) to calculate the amount of substance in moles in each of the following:
 - a. 10.7 g of sulfur atoms
 - b. 64.2 g of sulfur molecules (S_8)
 - c. 60.45g of **anhydrous** iron(III) nitrate, $\text{Fe}(\text{NO}_3)_3$

- ✓ When dealing with moles, it is important to be clear about the type of particle referred to. For example:
✓ 32.0 grams of oxygen O_2 contains 1 mole of oxygen molecules but 2 moles of oxygen atoms
✓ and 1 mole of $MgCl_2$ contains 1 mol of Mg^{2+} ions but 2 moles of Cl^- ions.
3. Use the value of the Avogadro constant ($6.02 \times 10^{23} \text{ mol}^{-1}$) to calculate the total number of atoms in
- a. 7.10 g of chlorine atoms. (A_r value: $Cl = 35.5$)
 - b. 10.7 g of sulfur atoms
 - c. 64.2 g of sulfur molecules (S_8)
 - d. 60.45 g of anhydrous iron(III) nitrate, $Fe(NO_3)_3$
4. Use these A_r values: $C = 12.0$, $Fe = 55.8$, $H = 1.0$, $O = 16.0$, $Na = 23.0$.
Calculate the mass of the following:
- a. 20 moles of carbon dioxide, CO_2
 - b. 0.050 moles of sodium carbonate, Na_2CO_3
 - c. 5.00 moles of iron(II) hydroxide, $Fe(OH)_2$
5. The element copper has a relative atomic mass of 63.5.
Calculate how many atoms are present in 1.05g of copper. [1]

- Which statement about the Avogadro constant is correct?
 A It is the mass of one mole of any element.
 B It is the mass of 6.02×10^{23} atoms of any element.
 C It is the number of atoms in one mole of neon.
 D It is the number of atoms in 12 g of any element.
- Which statement is correct?
 A 1.0 g of hydrogen gas contains 3.0×10^{23} atoms.
 B 4.0 g of helium gas contains 1.2×10^{24} atoms.
 C 16 g of methane gas contains 3.0×10^{24} atoms.
 D 44 g of carbon dioxide gas contains 6.0×10^{23} atoms.
- Which statement about atoms and molecules is correct?
 A The molecular formula of a compound is the simplest whole number ratio of atoms of each element in the compound.
 B One mole of any substance contains 6×10^{23} atoms.
 C The relative atomic mass of an element is the ratio of the average mass of one atom of the element to the mass of an atom of carbon-12.
 D The relative formula mass of a compound is the sum of the individual atomic masses of all the atoms in the formula.
- Which sample contains the same number of the named species as the number of molecules in 35.5 g of chlorine?
 A atoms in 16 g of sulfur
 B atoms in 23 g of sodium
 C ions in 74.5g of potassium chloride
 D molecules in 88 g of carbon dioxide
- Which of these samples of gas contains the same number of atoms as 1 g of hydrogen gas?
 A 22 g of carbon dioxide (M_r : CO_2 , 44)
 B 8 g of methane (M_r : CH_4 , 16)
 C 20 g of neon (M_r : Ne, 20)
 D 8 g of ozone (M_r : O_3 , 48)
- Which would contain 9.03×10^{23} oxygen atoms?
 A 0.25 mol aluminium oxide
 B 0.75 mol sulfur dioxide
 C 1.5 mol sulfur trioxide
 D 3.0 mol water
- How many molecules are present in 62 g of solid white phosphorus, P_4 ?
 A L B $2L$ C $\frac{L}{2}$ D $\frac{L}{4}$
- A medal has a total surface area of 150 cm^2 . It is evenly coated with silver by electrolysis. Its mass increases by 0.216g. How many atoms of silver are deposited per cm^2 on the surface of the medal?

A 8.0×10^{18}

B 1.8×10^{19}

C 8.7×10^{20}

D 1.2×10^{21}

9. Which contains the largest number of hydrogen atoms?

- A 0.10 mol of pentane
- B 0.20 mol of but-2-ene
- C 1.00 mol of hydrogen molecules
- D 6.02×10^{23} hydrogen atoms

10. What contains 9.03×10^{23} oxygen atoms?

- A 0.25 mol aluminium oxide
- B 0.75 mol sulfur dioxide
- C 1.5 mol sulfur trioxide
- D 3.0 mol water

11. What contains the greatest number of the named particles?

- A 6.0 dm^3 of argon atoms at room conditions
- B 6.0 g of carbon dioxide molecules
- C 6.0 g of magnesium atoms
- D 6.0 g of water molecules

6. Calculate how many atoms of carbon are present in 0.18g of ethanedioic acid, $\text{HO}_2\text{CCO}_2\text{H}$.
Show your working.

[3]

7. Diamond is a pure form of carbon. The mass of a diamond can be measured in carats. One carat is 0.200 g of carbon.

Which expression gives the number of carats that contain $6.02 \cdot 10^{23}$ carbon atoms?

- A 0.200×12.0
- B $\frac{0.200}{12.0}$
- C $\frac{12.0}{0.200}$
- D $\frac{0.200}{6.02 \times 10^{23}} \times 12.0$

12. Molten aluminium chloride has a simple molecular structure. Each molecule consists of two aluminium atoms and six chlorine atoms.

Which statement is correct?

A	All the chlorine atoms in 1g of molten aluminium chloride have the same mass.
B	One mole of molten aluminium chloride contains 6.02×10^{23} aluminium atoms.
C	One mole of molten aluminium chloride contains 3.61×10^{24} chlorine atoms.
D	The empirical formula of molten aluminium chloride is Al_2Cl_6 .

13. A sports medal has a total surface area of 150 cm^2 . It was evenly coated with silver by electrolysis. Its mass increased by 0.216 g.

How many atoms of silver were deposited per cm^2 on the surface of the medal?

A 8.0×10^{18}

B 1.8×10^{19}

C 8.7×10^{20}

D 1.2×10^{21}

*****This is not a complete note. It is just to guide you. It is recommended to study the prescribed textbooks along with this material. *****