Moles and reacting masses

Worked solutions

GCSE science calculations

This topic online

1 **Higher tier**

A gas cartridge for a paintball marker holds 88 g of carbon dioxide, CO_2.

Relative atomic masses (A_r): C = 12, O = 16

Calculate the number of moles of carbon dioxide. (2 marks)

$M_r = 12 + (2 \times 16) = 44$

Moles = mass ÷ M_r

$n = 88 \div 44$

2 mol

2 **Higher tier**

Daniel measures out 9.0 g of pure water, H_2O.

Relative atomic masses (A_r): H = 1, O = 16

Calculate the number of moles of water. (2 marks)

$M_r = (2 \times 1) + 16 = 18$

Moles = mass ÷ M_r

$n = 9.0 \div 18$

0.5 mol

3 **Higher tier**

A gas jar contains 0.40 mol of methane, CH_4.

The Avogadro constant is 6.02×10^{23} per mole.

Calculate the number of methane molecules in the gas jar.

Give your answer in standard form to 3 significant figures. (2 marks)

Number of particles = moles × 6.02×10^{23}

$N = 0.40 \times 6.02 \times 10^{23}$

$N = 2.408 \times 10^{23}$

2.41×10^{23}

Free for classroom and home use: print, photocopy and share. Not for resale or re-hosting.

4 **Higher tier**

A builders' merchant sells a 2.5 kg bag of powdered calcium carbonate, $CaCO_3$.

Relative atomic masses (A_r): Ca = 40, C = 12, O = 16

Calculate the number of moles of calcium carbonate in the bag. (3 marks)

Mass must be in g: 1 kg = 1000 g

2.5 kg = 2.5 × 1000 = 2500 g

M_r = 40 + 12 + (3 × 16) = 100

Moles = mass ÷ M_r

n = 2500 ÷ 100

25 mol

5 **Higher tier**

A painkiller tablet contains 450 mg of aspirin. The relative formula mass (M_r) of aspirin is 180.

Calculate the number of moles of aspirin in one tablet.

Give your answer in standard form. (3 marks)

Mass must be in g: 1000 mg = 1 g

450 mg = 450 ÷ 1000 = 0.45 g

Moles = mass ÷ M_r

n = 0.45 ÷ 180

n = 0.0025 mol

2.5×10^{-3} mol

Free for classroom and home use: print, photocopy and share. Not for resale or re-hosting.

6 **Higher tier**

Mei cuts a small square of aluminium foil with a mass of 54 mg.

Relative atomic mass (A_r): Al = 27

The Avogadro constant is 6.02×10^{23} per mole.

Calculate the number of aluminium atoms in the square.

Give your answer in standard form to 3 significant figures. Show your working.

(3 marks)

Mass must be in g: 1000 mg = 1 g

54 mg = 54 ÷ 1000 = 0.054 g

Moles = mass ÷ Ar

n = 0.054 ÷ 27 = 0.002 mol

Number of particles = moles × 6.02×10^{23}

N = $0.002 \times 6.02 \times 10^{23}$

N = 1.204×10^{21}

1.20×10^{21}

7 **Higher tier**

A technician needs 0.15 mol of sodium hydroxide, NaOH, to make up a solution.

Relative atomic masses (A_r): Na = 23, O = 16, H = 1

Calculate the mass of sodium hydroxide she should weigh out.

(2 marks)

Mr = 23 + 16 + 1 = 40

Moles = mass ÷ Mr

0.15 = m ÷ 40

Multiply both sides by 40

m = 0.15 × 40

6.0 g

8 **Higher tier**

Rhys collects 0.050 mol of an unknown gas. The gas has a mass of 3.2 g.

Calculate the relative formula mass (M_r) of the gas.

(2 marks)

Moles = mass ÷ Mr

0.050 = 3.2 ÷ Mr

Rearrange: Mr = mass ÷ moles

Mr = 3.2 ÷ 0.050

64

Free for classroom and home use: print, photocopy and share. Not for resale or re-hosting.

9 **Higher tier**

An iron nail contains 3.01×10^{22} atoms of iron.

The Avogadro constant is 6.02×10^{23} per mole.

Calculate the number of moles of iron atoms in the nail. (2 marks)

Number of particles = moles × 6.02×10^{23}

$3.01 \times 10^{22} = n \times 6.02 \times 10^{23}$

Divide both sides by 6.02×10^{23}

$n = 3.01 \times 10^{22} \div 6.02 \times 10^{23}$

0.05 mol

10 **Higher tier**

Ayesha heats 5.04 g of sodium hydrogencarbonate, $NaHCO_3$, in a boiling tube that has a mass of 22.15 g.

$2NaHCO_3 \rightarrow Na_2CO_3 + H_2O + CO_2$

Relative atomic masses (A_r): Na = 23, H = 1, C = 12, O = 16

Calculate the maximum mass of sodium carbonate, Na_2CO_3, she can make. Show your working. (4 marks)

The boiling tube (22.15 g) does not react, so its mass is not used

M_r of $NaHCO_3 = 23 + 1 + 12 + (3 \times 16) = 84$

Moles = mass ÷ M_r

$n(NaHCO_3) = 5.04 \div 84 = 0.06$ mol

Ratio from the equation: 2 $NaHCO_3$: 1 Na_2CO_3

$n(Na_2CO_3) = 0.06 \div 2 = 0.03$ mol

M_r of $Na_2CO_3 = (2 \times 23) + 12 + (3 \times 16) = 106$

Mass = moles × M_r

$m = 0.03 \times 106$

3.18 g

Free for classroom and home use: print, photocopy and share. Not for resale or re-hosting.

11 **Higher tier**

In a fume cupboard, a teacher heats aluminium foil in chlorine gas. 5.4 g of aluminium reacts with 21.3 g of chlorine, Cl_2, to make 26.7 g of aluminium chloride, $AlCl_3$.

Relative atomic masses (A_r): Al = 27, Cl = 35.5

a. Calculate the number of moles of aluminium.

b. Calculate the number of moles of Cl_2.

c. Calculate the number of moles of $AlCl_3$.

d. Use your answers to write the balanced symbol equation for the reaction.

Show your working. (5 marks)

Moles = mass ÷ Mr for each substance

a)

n(Al) = 5.4 ÷ 27 = 0.2 mol

b)

Mr of Cl2 = 2 x 35.5 = 71

n(Cl2) = 21.3 ÷ 71 = 0.3 mol

c)

Mr of AlCl3 = 27 + (3 x 35.5) = 133.5

n(AlCl3) = 26.7 ÷ 133.5 = 0.2 mol

d) Divide every number of moles by the smallest, 0.2

Al : Cl2 : AlCl3 = 1 : 1.5 : 1

Double to get whole numbers

Al : Cl2 : AlCl3 = 2 : 3 : 2

$$2Al + 3Cl_2 \rightarrow 2AlCl_3$$

Free for classroom and home use: print, photocopy and share. Not for resale or re-hosting.

12 **Higher tier**

Jamal heats a mixture of 7.0 g of iron powder and 3.2 g of sulfur powder until they react.

Fe + S → FeS

Relative atomic masses (A_r): Fe = 56, S = 32

a. Identify the limiting reactant.

b. Calculate the maximum mass of iron sulfide, FeS, that can be made.

c. Calculate the mass of the reactant that is left over.

Show your working. (5 marks)

a) Moles = mass ÷ Ar for each reactant

n(Fe) = 7.0 ÷ 56 = 0.125 mol

n(S) = 3.2 ÷ 32 = 0.1 mol

Ratio Fe : S = 1 : 1, and 0.1 < 0.125, so sulfur runs out first

sulfur

b) Use the moles of the limiting reactant, not the iron

n(FeS) = n(S) = 0.1 mol

Mr of FeS = 56 + 32 = 88

m = 0.1 × 88

8.8 g

c) Iron used = 0.1 mol

n(Fe left) = 0.125 − 0.1 = 0.025 mol

m = 0.025 × 56

1.4 g

Free for classroom and home use: print, photocopy and share. Not for resale or re-hosting.