Balance and Chemical Calculation – test your starting knowledge

The following tasks cover the high-school knowledge in physics and chemistry that should be a base for your study in the course. The answers are given in square brackets.

Basic SI units and quantities

Liquid nitrogen is used as a refrigerating medium with a low boiling temperature – 77 K. Convert this value to °C.   [–196.15 °C]

The standard pressure is defined as 10^5 Pa. Convert the value to kPa and MPa.
[100 kPa and 0.1 MPa]

How many mL is 2 dm^3 of water?   [2000 mL]

How many rain drops (with an average volume of 30 µL) is needed to fill a swimming pool with a volume of 300 000 L?   [10^{10} drops]

1 m^3 of silver weights approx. 10 500 kg; what is the weight of 1 cm^3?
[10.5 g or 0.0105 kg]

Convert a density of 2.35 g/mL to kg/m^3.   [2350 kg/m^3]

Avogadro's number, moles

How many aluminium atoms are contained in a cube with an edge length of 1 mm? (A_{Al} = 26.98 g/mol; ρ = 2.7 g cm^{-3})   [$6.027 \cdot 10^{19}$ atoms]

Calculate the molar mass of $CuSO_4 \cdot 5H_2O$ using known atomic masses of present elements (A_{Cu}=63.55 g/mol; A_S=32.06 g/mol; A_O=16 g/mol; A_H=1 g/mol)?   [249.61 g/mol]

What is the volume of 1 mol of oxygen that is stored at 500 kPa and 25 °C?
[$4.958 \cdot 10^{-3}$ m^3 or 4.958 L]

Mixture composition

Calculate the mass of a 25% solution which was prepared using 125 g of NaCl.

[500 g]

What is the mass fraction of water in $Na_2SO_4 \cdot 10H_2O$? ($M_{Na2SO4 \cdot 10H2O}$ = 322.19 g/mol; M_{H2O} = 18 g/mol)
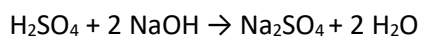
[55.9 %]

How many grams of KOH is dissolved in 200 mL of a 10% solution (ρ = 1.09 g cm^{-3})?

[21.8 g]
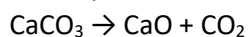
Chemical reaction stoichiometry

How many grams of Na_2SO_4 (M = 142.04 g/mol) are produced when 20.0 g of NaOH (M = 40 g/mol) react in the following neutralization:

H_2SO_4 + 2 NaOH → Na_2SO_4 + 2 H_2O [35.5 g]

What volume of CO_2 (M = 40 g/mol) is produced when 5 kg of $CaCO_3$ (M = 100 g/mol) is fully decomposed at 100 kPa and 800 °C?

$CaCO_3$ → CaO + CO_2 [4.461 m³]