AQA Quantitative Chemistry Dice Challenge **Answers**

In the answers below, the first number indicates the row and the second number indicates the column in which the question is found e.g. 3.2 is the question in row 3, column 2.

1.1 Name the type of salt produced when hydrochloric acid reacts with an alkali.

chloride

1.2 How do you convert from cm^3 to dm^3?

divide by 1000

1.3 Convert $250cm^3$ to dm^3.

$250 \div 1000 = 0.25dm^3$

1.4 Write down the formula used to calculate concentration of a solution using the number of moles and volume.

concentration = number of moles ÷ volume

1.5 Calculate the concentration of a solution containing 0.9 moles of hydrochloric acid dissolved in $6dm^3$ of water.

concentration = $0.9 \div 6 = 0.15mol/dm^3$

1.6 Calculate the percentage by mass of phosphorus in lead phosphate ($Pb_3(PO_4)_2$).

Mr of $Pb_3(PO_4)_2 = (207 \times 3) + (31 + (16 \times 4)) \times 2 = 811$

$$\frac{(31 \times 2)}{811} \times 100 = 7.6\%$$

2.1 How do you convert from dm^3 to cm^3?

multiply by 1000

2.2 Write the word equation for the reaction between magnesium and hydrochloric acid.

magnesium + hydrochloric acid ⟶ magnesium chloride + hydrogen

2.3 Nitric acid contains one atom of hydrogen, one atom of nitrogen and three atoms of oxygen. Write down the chemical formula of nitric acid.

HNO_3

2.4 Balance the symbol equation.

$2Li + 2H_2O \longrightarrow 2LiOH + H_2$

2.5 What is a random error? Give an example to support your answer.

A random error may be caused by human error such as a poor technique when taking measurements or by faulty equipment. For example, stopping a stopwatch too early or too late.

2.6 Calculate the mass of potassium chloride that is dissolved in $400cm^3$ of water to make a $20g/dm^3$ salt solution.

$400cm^3 = 0.4dm^3$

mass = concentration × volume

mass = $20 \times 0.4 = 8g$

3.1 Convert $3.5dm^3$ to cm^3.

$3.5 \times 1000 = 3500cm^3$

3.2 Sulfuric acid contains two atoms of hydrogen, one atom of sulfur and four atoms of oxygen. Write down the chemical formula of sulfuric acid.

H_2SO_4

3.3 Complete the sentence: The law of conservation of mass states that...

no atoms are lost or made during a chemical reaction so the mass of the products is equal to the mass of the reactants.

3.4 State Avogadro's number.

6.02×10^{23}

3.5 Calculate the concentration of a solution containing 0.09kg of solute dissolved in $300cm^3$ of solvent. Give your answer in g/dm^3.

0.09kg = 90g

$300cm^3 = 0.3dm^3$

concentration = $90 \div 0.3 = 300g/dm^3$

3.6 Calculate the relative formula mass of Na_2SeO_3.

$(23 \times 2) + 79 + (16 \times 3) = 173$

4.1 Write down the formula used to calculate the number of moles of a substance using its mass and relative formula mass.

number of moles = mass $\div$ M_r

4.2 Write the balanced symbol equation for the reaction between magnesium and oxygen.

$2Mg + O_2 \longrightarrow 2MgO$

4.3 Define uncertainty.

Uncertainty is the interval within which the true value of a measurement can be expected to lie. For example, if a value is given as $20cm^3 \pm 0.5$, then the true value could be anywhere within the range $19.5cm^3 - 20.5cm^3$.

4.4 Carbon-12 and carbon-14 are both examples of isotopes. What are isotopes?

Isotopes are atoms of the same element that have the same number of protons but a different number of neutrons.

4.5 Calculate the maximum mass of magnesium oxide that can be formed from 4.8g of magnesium.

balanced equation: $2Mg + O_2 \longrightarrow 2MgO$ (ratio of Mg:MgO = 1:1)

number of moles of Mg = $4.8 \div 24 = 0.2mol$

number of moles of MgO = 0.2mol

M_r of MgO = 24 + 16 = 40

mass of MgO = $0.2 \times 40 = 8g$

4.6 Calculate the number of atoms in 2.8g of iron. Give your answer in standard form.

number of moles = mass $\div$ M_r

number of moles = $2.8 \div 56 = 0.05$

number of atoms = number of moles $\times$ Avogadro's number

number of atoms = $0.05 \times (6.02 \times 10^{23}) = 3.01 \times 10^{22}$

5.1 Calculate the number of moles in 25g of NaOH (M_r = 40).

number of moles = 25 ÷ 40 = 0.625 moles

5.2 What is a systematic error? Give an example to support your answer.

A systematic error causes readings to differ from the true value by the same amount each time a measurement is made. For example, if a balance is not reset to zero at the start of the investigation, all the measurements will vary by the same amount.

5.3 Calculate the mass of 4 moles of magnesium chloride ($MgCl_2$).

M_r of $MgCl_2$ = 24 + (35.5 × 2) = 95

mass = number of moles × M_r

mass = 4 × 95 = 380g

5.4 The relative formula mass of an unknown metal carbonate (XCO_3) is 100. Identify metal X.

M_r of CO_3 = 12 + (16 × 3) = 60

100 – 60 = 40

metal X = calcium

5.5 Calculate the number of molecules in 2.5 moles of ammonia (NH_3). Give your answer in standard form.

number of molecules = number of moles × Avogadro's number

number of molecules = 2.5 × (6.20×10^{23}) = 1.505×10^{24}

5.6 Calculate the mass of iron produced from 10g of iron (III) oxide in the reaction below.

balanced equation: $2Al + Fe_2O_3 \longrightarrow 2Fe + Al_2O_3$ (ratio of Fe_2O_3:Fe = 1:2)

M_r Fe_2O_3 = (56 × 2) + (16 × 3) = 160

number of moles of Fe_2O_3 = 10 ÷ 160 = 0.0625

number of moles of Fe = 0.0625 × 2 = 0.125

mass of Fe = 0.125 × 56 = 7g

6.1 Calculate the percentage by mass of sodium in sodium bicarbonate ($NaHCO_3$).

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

$$\frac{23}{84} \times 100 = 27.4\%$$

6.2 Calculate the maximum mass of sodium chloride produced when 28.4g of chlorine reacts with sodium.

balanced equation: $2Na + Cl_2 \longrightarrow 2NaCl$ (ratio of Cl_2:NaCl = 1:2)

M_r of Cl_2 = 35.5 × 2 = 71

number of moles of Cl_2 = 28.4 ÷ 71 = 0.4mol

M_r of NaCl = 23 + 35.5 = 58.5

number of moles of NaCl = 0.4 × 2 = 0.8mol

mass of NaCl = 0.8 × 58.5 = 46.8g

6.3 Calculate the relative formula mass of $Pb_3(PO_4)_2$.

(207 × 3) + (31 + (16 × 4)) × 2 = 811

6.4 Calculate the number of molecules of magnesium oxide in 3.2g of magnesium oxide (MgO). Give your answer in standard form.

M_r of MgO = 24 + 16 = 40

number of moles = mass ÷ M_r

number of moles = 3.2 ÷ 40 = 0.08

number of molecules = number of moles × Avogadro's number

number of molecules = 0.08 × (6.02×10^{23}) = 4.816×10^{22}

6.5 Calculate the mass of ethanol needed to produce 540g of water in the reaction below.

balanced equation: $C_2H_5OH + 3O_2 \longrightarrow 2CO_2 + 3H_2O$ (ratio of C_2H_5OH:H_2O = 1:3)

Mr of H_2O = (1 × 2) + 16 = 18

number of moles of H_2O = 540 ÷ 18 = 30mol

number of moles of C_2H_5OH = 30 ÷ 3 = 10mol

Mr of C_2H_5OH = (12 × 2) + (1 × 5) + 16 + 1 = 46

mass of C_2H_5OH = 10 × 46 = 460g

6.6 15.6g of potassium and 9.6g of bromine are reacted together to produce potassium bromide.

Explain which reactant is the limiting reactant.

balanced equation: $2K + Br_2 \longrightarrow 2KBr$ (ratio of K:Br = 2:1)

number of moles of K = 15.6 ÷ 39 = 0.4mol

number of moles of Br_2 = 9.6 ÷ 160 = 0.06mol

0.2 moles of bromine would be required to react with 0.4 moles of potassium.

Therefore, bromine is the limiting reactant.