



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 .

$250 \div 1000 = 0.25\text{dm}^3$

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

concentration = number of moles \div volume

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

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

1.6 Calculate the percentage by mass of phosphorus in lead phosphate ($\text{Pb}_3(\text{PO}_4)_2$).

Mr of $\text{Pb}_3(\text{PO}_4)_2 = (207 \times 3) + (31 + (16 \times 4)) \times 2 = 811$

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

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 \longrightarrow 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.

$2\text{Li} + 2\text{H}_2\text{O} \longrightarrow 2\text{LiOH} + \text{H}_2$

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.

$400\text{cm}^3 = 0.4\text{dm}^3$

mass = concentration \times volume

mass = $20 \times 0.4 = 8\text{g}$



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

$$3.5 \times 1000 = 3500\text{cm}^3$$

- 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.



- 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.

$$6.02 \times 10^{23}$$

- 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 .

$$0.09\text{kg} = 90\text{g}$$

$$300\text{cm}^3 = 0.3\text{dm}^3$$

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

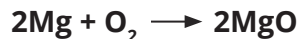
- 3.6 Calculate the relative formula mass of Na_2SeO_3 .

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

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

$$\text{number of moles} = \text{mass} \div M_r$$

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



- 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 $20\text{cm}^3 \pm 0.5$, then the true value could be anywhere within the range $19.5\text{cm}^3 - 20.5\text{cm}^3$.

- 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.

$$\text{balanced equation: } 2\text{Mg} + \text{O}_2 \longrightarrow 2\text{MgO} \text{ (ratio of Mg:MgO} = 1:1)$$

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

$$\text{number of moles of MgO} = 0.2\text{mol}$$

$$M_r \text{ of MgO} = 24 + 16 = 40$$

$$\text{mass of MgO} = 0.2 \times 40 = 8\text{g}$$

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

$$\text{number of moles} = \text{mass} \div M_r$$

$$\text{number of moles} = 2.8 \div 56 = 0.05$$

$$\text{number of atoms} = \text{number of moles} \times \text{Avogadro's number}$$

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



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

$$\text{number of moles} = 25 \div 40 = 0.625 \text{ moles}$$

- 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).

$$M_r \text{ of } \text{MgCl}_2 = 24 + (35.5 \times 2) = 95$$

$$\text{mass} = \text{number of moles} \times M_r$$

$$\text{mass} = 4 \times 95 = 380\text{g}$$

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

$$M_r \text{ of } \text{CO}_3 = 12 + (16 \times 3) = 60$$

$$100 - 60 = 40$$

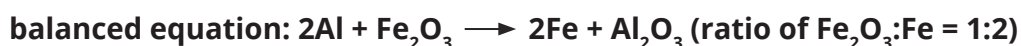
metal X = calcium

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

$$\text{number of molecules} = \text{number of moles} \times \text{Avogadro's number}$$

$$\text{number of molecules} = 2.5 \times (6.20 \times 10^{23}) = 1.505 \times 10^{24}$$

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



$$M_r \text{ Fe}_2\text{O}_3 = (56 \times 2) + (16 \times 3) = 160$$

$$\text{number of moles of Fe}_2\text{O}_3 = 10 \div 160 = 0.0625$$

$$\text{number of moles of Fe} = 0.0625 \times 2 = 0.125$$

$$\text{mass of Fe} = 0.125 \times 56 = 7\text{g}$$

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

$$M_r \text{ of } \text{NaHCO}_3 = 23 + 1 + 12 + (16 \times 3) = 84$$

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

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



$$M_r \text{ of } \text{Cl}_2 = 35.5 \times 2 = 71$$

$$\text{number of moles of Cl}_2 = 28.4 \div 71 = 0.4\text{mol}$$

$$M_r \text{ of NaCl} = 23 + 35.5 = 58.5$$

$$\text{number of moles of NaCl} = 0.4 \times 2 = 0.8\text{mol}$$

$$\text{mass of NaCl} = 0.8 \times 58.5 = 46.8\text{g}$$

- 6.3 Calculate the relative formula mass of $\text{Pb}_3(\text{PO}_4)_2$.

$$(207 \times 3) + (31 + (16 \times 4)) \times 2 = 811$$



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

$$M_r \text{ of MgO} = 24 + 16 = 40$$

$$\text{number of moles} = \text{mass} \div M_r$$

$$\text{number of moles} = 3.2 \div 40 = 0.08$$

$$\text{number of molecules} = \text{number of moles} \times \text{Avogadro's number}$$

$$\text{number of molecules} = 0.08 \times (6.02 \times 10^{23}) = 4.816 \times 10^{22}$$

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



$$M_r \text{ of } H_2O = (1 \times 2) + 16 = 18$$

$$\text{number of moles of } H_2O = 540 \div 18 = 30\text{mol}$$

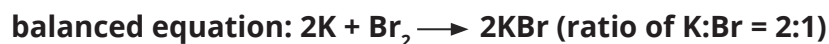
$$\text{number of moles of } C_2H_5OH = 30 \div 3 = 10\text{mol}$$

$$M_r \text{ of } C_2H_5OH = (12 \times 2) + (1 \times 5) + 16 + 1 = 46$$

$$\text{mass of } C_2H_5OH = 10 \times 46 = 460\text{g}$$

- 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.



$$\text{number of moles of } K = 15.6 \div 39 = 0.4\text{mol}$$

$$\text{number of moles of } Br_2 = 9.6 \div 160 = 0.06\text{mol}$$

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

Therefore, bromine is the limiting reactant.