Reacting masses and moles

Pearson Edexcel 1CH0 Separate Chemistry · Foundation and Higher

Questions 3 to 8 require Higher content. Show your working and give units.

Name _____ Date _____

1. Conserve the total mass

In a sealed flask, two solutions react to form a solid precipitate. The flask and its contents had a total mass of 172.4 g before mixing. What should the mass be after the reaction? Explain.

2. Reacting masses

$S + O_2 \rightarrow SO_2$

Sulfur burns completely in excess oxygen. Find the mass of sulfur dioxide made from 12.8 g of sulfur. Use relative masses S = 32 and SO_2 = 64.

3. From grams to moles (Higher)

A sample contains 5.85 g of sodium chloride, NaCl. Calculate the amount in moles. Use A_r values Na = 23 and Cl = 35.5.

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4. From moles to grams (Higher)

Find the mass of 0.125 mol of calcium hydroxide, $Ca(OH)_2$. Use A_r values Ca = 40, O = 16 and H = 1.

5. Making iron (Higher)

$Fe_2O_3 + 3CO \rightarrow 2Fe + 3CO_2$

Calculate the mass of iron made from 32.0 g of iron(III) oxide with excess carbon monoxide. Show your working in moles. Use $M_r(Fe_2O_3) = 160$ and $A_r(Fe) = 56$.

6. Which reactant runs out? (Higher)

$4Al + 3O_2 \rightarrow 2Al_2O_3$. In a model reaction 5.40 g of aluminium reacts with 3.20 g of oxygen. Identify the limiting reactant and find the maximum mass of Al_2O_3. Use A_r Al = 27 and O = 16.

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7. Use reacting masses (Higher)

11.2 g of iron reacts with 4.80 g of oxygen gas to make 16.0 g of Fe_2O_3. Use the masses to deduce the coefficients in $Fe + O_2 \rightarrow Fe_2O_3$. Use A_r values Fe = 56 and O = 16.

8. How much remains? (Higher)

$2Mg + O_2 \rightarrow 2MgO$

At the start, a sealed vessel contains 3.60 g Mg and 1.60 g O_2. When the reaction is complete, calculate the mass of the reactant left over. Use A_r values Mg = 24 and O = 16.

9. Extra challenge · Compare two carbonate masses

Calcium carbonate decomposes completely: $CaCO_3 \rightarrow CaO + CO_2$. A sealed container starts with 30.0 g of pure $CaCO_3$. A different, open container starts with 22.0 g. Use the relative formula masses $CaCO_3$ = 100 and CaO = 56 to calculate the mass of solid left in each container. Explain what happens to the total mass inside each container.

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Worked answers

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1. Conserve the total mass

172.4 g. The atoms are rearranged during the reaction. No substances can enter or leave the sealed flask.

2. Reacting masses

The equation gives a mass ratio of 32 parts sulfur to 64 parts sulfur dioxide. Mass of sulfur dioxide = 12.8 × (64 ÷ 32) = 25.6 g.

3. From grams to moles (Higher)

M_r(NaCl) = 23 + 35.5 = 58.5. Amount = mass ÷ molar mass = 5.85 g ÷ 58.5 g mol^{-1} = 0.100 mol.

4. From moles to grams (Higher)

M_r = 40 + 2 × (16 + 1) = 74. Mass = 0.125 mol × 74 g mol^{-1} = 9.25 g.

5. Making iron (Higher)

Amount of Fe_2O_3 = 32.0 ÷ 160 = 0.200 mol. The equation gives 2 mol of Fe for each mole of Fe_2O_3, so 0.400 mol of Fe forms. Mass of iron = 0.400 × 56 = 22.4 g.

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Worked answers

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6. Which reactant runs out? (Higher)

Al = 5.40 ÷ 27 = 0.200 mol. O_2 = 3.20 ÷ 32 = 0.100 mol. To use all the Al would need 0.200 × 3 ÷ 4 = 0.150 mol of O_2. Oxygen limits the reaction.

Al_2O_3 = 0.100 × 2 ÷ 3 = 0.0667 mol to 3 significant figures. Using the unrounded amount, its mass is 0.100 × 2 ÷ 3 × 102 = 6.80 g.

7. Use reacting masses (Higher)

Fe = 11.2 ÷ 56 = 0.200 mol. O_2 = 4.80 ÷ 32 = 0.150 mol. Fe_2O_3 = 16.0 ÷ 160 = 0.100 mol.

Divide all three amounts by 0.050 mol to get the smallest whole-number ratio, 4 to 3 to 2. The balanced equation is $4Fe + 3O_2 \rightarrow 2Fe_2O_3$.

8. How much remains? (Higher)

Mg = 3.60 ÷ 24 = 0.150 mol. O_2 = 1.60 ÷ 32 = 0.0500 mol. The available oxygen can react with 0.100 mol of Mg, leaving Mg in excess.

Mg left = 0.150 − 0.100 = 0.0500 mol. Mass left = 0.0500 × 24 = 1.20 g.

9. Extra challenge · Compare two carbonate masses

Calcium oxide mass = starting mass × 56 ÷ 100. The sealed container has 16.8 g of solid and the open one has 12.32 g, or 12.3 g to 3 significant figures.

The sealed container still has 30.0 g of contents because the CO_2 stays inside. The open container loses CO_2 to the surroundings, so the remaining mass is just the calcium oxide.

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