

Writing formulae and balancing equations

Chemistry grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Worksheet answers

Compare each answer with your own and check the method as well as the final equation. Whenever an equation is balanced, count the atoms on both sides again, and for ionic equations check that the total charge is equal on both sides.

Level: Chemistry grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** HS-PS1-7

Problem 1 Formulae from ions

1. Na^+ and Cl^- have equal and opposite charges: NaCl .
2. Mg^{2+} and O^{2-} : MgO .
3. Ca^{2+} needs two Cl^- : CaCl_2 .

NaCl, MgO, CaCl₂.

Problem 2 State symbols

1. (aq) means the substance is dissolved in water.
2. Zinc is solid, hydrochloric acid and zinc chloride are in solution, and hydrogen is a gas.

$\text{Zn(s)} + 2\text{HCl(aq)} \rightarrow \text{ZnCl}_2\text{(aq)} + \text{H}_2\text{(g)}$

Problem 3 Counting atoms

1. $2\text{H}_2\text{SO}_4$: H $2 \times 2 = 4$, S 2, O $2 \times 4 = 8$.
2. $3\text{Mg(NO}_3)_2$: Mg 3, N $3 \times 2 = 6$, O $3 \times 2 \times 3 = 18$.
3. $\text{Al}_2(\text{SO}_4)_3$: Al 2, S 3, O $3 \times 4 = 12$.

H 4, S 2, O 8; Mg 3, N 6, O 18; Al 2, S 3, O 12.

Problem 4 Balance the simple ones

1. Two Cl atoms on the left need 2HCl, and then H is $2 = 2$.
2. Two Cl need 2NaCl, so 2Na.
3. Two O need 2MgO, so 2Mg.

$\text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl}$; $2\text{Na} + \text{Cl}_2 \rightarrow 2\text{NaCl}$; $2\text{Mg} + \text{O}_2 \rightarrow 2\text{MgO}$

Problem 5 Reading particles

1. Left: N_2 has 2 N atoms and 3 H_2 have 6 H atoms. Right: 2 NH_3 have 2 N atoms and 6 H atoms.
2. One N_2 and three H_2 form two NH_3 .

$\text{N}_2 + 3\text{H}_2 \rightarrow 2\text{NH}_3$

Problem 6 Word equation to symbols

1. Calcium carbonate CaCO_3 , calcium oxide CaO and carbon dioxide CO_2 .
2. The equation is already balanced (Ca 1, C 1, O 3 on each side).

**Problem 7 The wrong subscript**

1. H_2O_2 is hydrogen peroxide, a different substance from water. Subscripts must never be changed to balance an equation.
2. Put the coefficient 2 in front of H_2O to give 2 O atoms, then 2 in front of H_2 to give 4 H atoms.

**Problem 8 Formulae with brackets**

1. Ca^{2+} and OH^- : $\text{Ca}(\text{OH})_2$.
2. Al^{3+} and NO_3^- : $\text{Al}(\text{NO}_3)_3$.
3. NH_4^+ and SO_4^{2-} : $(\text{NH}_4)_2\text{SO}_4$.
4. Fe^{3+} and O^{2-} : Fe_2O_3 (6+ and 6-).
5. Cu^{2+} and NO_3^- : $\text{Cu}(\text{NO}_3)_2$.

**Problem 9 Burning fuels**

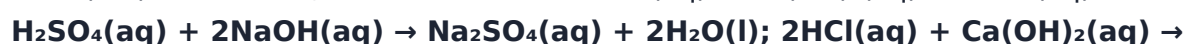
1. The diagram shows one CH_4 , two O_2 , one CO_2 and two H_2O : $\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$.
2. Carbon: 3CO_2 . Hydrogen: $4\text{H}_2\text{O}$. Oxygen: $6 + 4 = 10$, so 5O_2 .
3. Carbon: 2CO_2 . Hydrogen: $3\text{H}_2\text{O}$. Oxygen on the right: $4 + 3 = 7$; ethanol supplies 1, so 3O_2 supply the other 6.

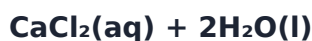
**Problem 10 Balance the metals**

1. Oxygen 6 as the common number: 3O_2 and $2\text{Fe}_2\text{O}_3$, then 4Fe .
2. Chlorine 3 on the right needs 3HCl for one Al ; double all: $2\text{Al} + 6\text{HCl} \rightarrow 2\text{AlCl}_3 + 3\text{H}_2$ (H 6 = 6).
3. Hydrogen on the right is 3 (NaOH 1 and H_2 2); use $2\text{Na} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2$ (H 4 = 4, O 2 = 2).

**Problem 11 Neutralisation equations**

1. H_2SO_4 has 2 H^+ , so it needs 2 NaOH : $\text{H}_2\text{SO}_4(\text{aq}) + 2\text{NaOH}(\text{aq}) \rightarrow \text{Na}_2\text{SO}_4(\text{aq}) + 2\text{H}_2\text{O}(\text{l})$.
2. $\text{Ca}(\text{OH})_2$ has 2 OH^- , so it needs 2 HCl : $2\text{HCl}(\text{aq}) + \text{Ca}(\text{OH})_2(\text{aq}) \rightarrow \text{CaCl}_2(\text{aq}) + 2\text{H}_2\text{O}(\text{l})$.





Problem 12 A precipitate forms

1. $\text{AgNO}_3(\text{aq}) + \text{KCl}(\text{aq}) \rightarrow \text{AgCl}(\text{s}) + \text{KNO}_3(\text{aq})$.
2. K^+ and NO_3^- are in solution before and after, so they are the spectators.
3. Silver and chloride ions form the solid.



Problem 13 Which formulae are wrong?

1. NaO, MgCl and CaNO_3 are wrong. Al_2O_3 and K_2SO_4 are correct.
2. Na_2O , MgCl_2 and $\text{Ca}(\text{NO}_3)_2$.
3. Na^+ has one positive charge, but O^{2-} has two negative charges, so two sodium ions are needed.



Problem 14 Conservation of mass

1. $4.8 + 3.2 = 8.0 \text{ g}$.
2. The law of conservation of mass: the total mass of reactants equals the total mass of products.
3. Oxygen from the air joined the magnesium, so the solid gains the mass of the oxygen.

8.0 g of magnesium oxide.

Problem 15 Zinc in copper sulfate

1. $\text{Zn}(\text{s}) + \text{Cu}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{Zn}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) + \text{Cu}(\text{s})$.
2. Sulfate, SO_4^{2-} .
3. $\text{Zn}(\text{s}) + \text{Cu}^{2+}(\text{aq}) \rightarrow \text{Zn}^{2+}(\text{aq}) + \text{Cu}(\text{s})$. Charge on the left is 2+ and on the right is 2+.



Problem 16 Harder balancing

1. For $2\text{C}_4\text{H}_{10}$: 8CO_2 and $10\text{H}_2\text{O}$, so oxygen on the right is $16 + 10 = 26$ and 13O_2 are needed.
2. Take 3CO so that 3 carbons give 3CO_2 , and oxygen $3 + 3 = 6$ on the left and 6 on the right; Fe needs 2.
3. Calcium needs $3\text{Ca}(\text{OH})_2$ and phosphorus needs $2\text{H}_3\text{PO}_4$. Hydrogen is $6 + 6 = 12$, so $6\text{H}_2\text{O}$ (oxygen $6 + 8 = 14$ and $8 + 6 = 14$).



Problem 17 Three precipitations

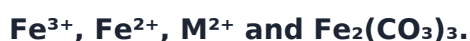
1. $\text{Ba}^{2+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq}) \rightarrow \text{BaSO}_4(\text{s})$; spectators Na^+ and Cl^- ; charge $0 = 0$.

2. $\text{Mg}^{2+}(\text{aq}) + 2\text{OH}^{-}(\text{aq}) \rightarrow \text{Mg}(\text{OH})_2(\text{s})$; spectators Na^{+} and NO_3^{-} ; charge $2+ + 2(1-) = 0 = 0$.
3. Reaction 1 has spectators Na^{+} and Cl^{-} , and reaction 2 has spectators Na^{+} and NO_3^{-} . Both ionic equations have zero charge on each side.



Problem 18 Deduce the ion charge

1. Total negative charge is $3 \times 2- = 6-$, so 2 Fe ions carry $6+$: each is $3+$.
2. One O^{2-} means Fe is $2+$.
3. $2 \times 3- = 6-$, so 3 M ions carry $6+$: each is $2+$.
4. $2 \times 3+ = 6+$ and $3 \times 2- = 6-$: $\text{Fe}_2(\text{CO}_3)_3$.



Problem 19 A displacement reaction

1. Al, CuCl_2 , AlCl_3 , Cu. Chlorine needs 6 on each side: $2\text{Al}(\text{s}) + 3\text{CuCl}_2(\text{aq}) \rightarrow 2\text{AlCl}_3(\text{aq}) + 3\text{Cu}(\text{s})$.
2. Chloride is the spectator: $2\text{Al}(\text{s}) + 3\text{Cu}^{2+}(\text{aq}) \rightarrow 2\text{Al}^{3+}(\text{aq}) + 3\text{Cu}(\text{s})$.
3. Left: $3 \times 2+ = 6+$. Right: $2 \times 3+ = 6+$.



Problem 20 Heating limestone

1. $\text{CaCO}_3(\text{s}) \rightarrow \text{CaO}(\text{s}) + \text{CO}_2(\text{g})$.
2. $10.0 - 5.6 = 4.4 \text{ g}$.
3. $4.4 \div 10.0 \times 100 = 44 \%$.
4. The carbon dioxide gas escapes from the open crucible, so it is no longer weighed, but the total mass of the products is still 10.0 g .

4.4 g of CO_2 , which is 44 % of the original mass.