

Balancing Chemical Equations

How to balance an equation

1. Count the atoms of each element on both sides.
2. Change **coefficients only**, never subscripts.
3. Balance metals first, then non-metals, and leave H and O for last.
4. If a polyatomic ion (like SO_4) appears unchanged on both sides, balance it as one unit.
5. Check every element again and reduce to the lowest whole-number ratio.

A Count the atoms

3 marks

1. $3\text{H}_2\text{O}$

Element	H	O
Atoms		

2. $2\text{Ca}(\text{NO}_3)_2$

Element	Ca	N	O
Atoms			

3. $4\text{Al}_2(\text{SO}_4)_3$

Element	Al	S	O
Atoms			

B Balance: the basics

8 marks

4. ____ H_2 + ____ O_2 → ____ H_2O 5. ____ N_2 + ____ H_2 → ____ NH_3 6. ____ Na + ____ Cl_2 → ____ NaCl 7. ____ Mg + ____ O_2 → ____ MgO 8. ____ Al + ____ O_2 → ____ Al_2O_3 9. ____ KClO_3 → ____ KCl + ____ O_2 10. ____ Fe + ____ Cl_2 → ____ FeCl_3 11. ____ CH_4 + ____ O_2 → ____ CO_2 + ____ H_2O

C Balance: polyatomic ions and more

6 marks

12. $\text{Pb}(\text{NO}_3)_2 + \text{KI} \rightarrow \text{PbI}_2 + \text{KNO}_3$
13. $\text{Ca}(\text{OH})_2 + \text{HCl} \rightarrow \text{CaCl}_2 + \text{H}_2\text{O}$
14. $\text{Al} + \text{CuSO}_4 \rightarrow \text{Al}_2(\text{SO}_4)_3 + \text{Cu}$
15. $\text{Na}_3\text{PO}_4 + \text{MgCl}_2 \rightarrow \text{Mg}_3(\text{PO}_4)_2 + \text{NaCl}$
16. $\text{H}_2\text{SO}_4 + \text{NaOH} \rightarrow \text{Na}_2\text{SO}_4 + \text{H}_2\text{O}$
17. $\text{Fe}_2\text{O}_3 + \text{CO} \rightarrow \text{Fe} + \text{CO}_2$

D Combustion reactions

3 marks

18. $\text{C}_3\text{H}_8 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$
19. $\text{C}_2\text{H}_6 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$
20. $\text{C}_6\text{H}_{12}\text{O}_6 + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$

E Word equations: write and balance

3 marks

21. Hydrogen gas reacts with chlorine gas to form hydrogen chloride.

22. Zinc reacts with hydrochloric acid to form zinc chloride and hydrogen gas.

23. Sodium reacts with water to form sodium hydroxide and hydrogen gas.

F Spot the mistake

2 marks

24. A student balances $\text{H}_2\text{O} \rightarrow \text{H}_2 + \text{O}_2$ by writing $\text{H}_2\text{O}_2 \rightarrow \text{H}_2 + \text{O}_2$. What is wrong? Fix it.

25. A student writes $4\text{H}_2 + 2\text{O}_2 \rightarrow 4\text{H}_2\text{O}$. What is wrong? Fix it.

G Challenge

2 marks

26. $\text{C}_4\text{H}_{10} + \text{O}_2 \rightarrow \text{CO}_2 + \text{H}_2\text{O}$

27. Explain how a balanced equation shows the law of conservation of mass.

Balancing Chemical Equations

ANSWER KEY**How to balance an equation**

1. Count the atoms of each element on both sides.
2. Change **coefficients only**, never subscripts.
3. Balance metals first, then non-metals, and leave H and O for last.
4. If a polyatomic ion (like SO_4) appears unchanged on both sides, balance it as one unit.
5. Check every element again and reduce to the lowest whole-number ratio.

A coefficient of 1 is shown here for clarity; students may leave it blank.

A Count the atoms

3 marks

1. $3\text{H}_2\text{O}$

Element	H	O
Atoms	6	3

2. $2\text{Ca}(\text{NO}_3)_2$

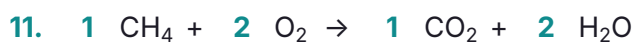
Element	Ca	N	O
Atoms	2	4	12

3. $4\text{Al}_2(\text{SO}_4)_3$

Element	Al	S	O
Atoms	8	12	48

B Balance: the basics

8 marks



C Balance: polyatomic ions and more

6 marks

12. 1 $\text{Pb}(\text{NO}_3)_2$ + 2 KI $\rightarrow$ 1 PbI_2 + 2 KNO_3
13. 1 $\text{Ca}(\text{OH})_2$ + 2 HCl $\rightarrow$ 1 CaCl_2 + 2 H_2O
14. 2 Al + 3 CuSO_4 $\rightarrow$ 1 $\text{Al}_2(\text{SO}_4)_3$ + 3 Cu
15. 2 Na_3PO_4 + 3 MgCl_2 $\rightarrow$ 1 $\text{Mg}_3(\text{PO}_4)_2$ + 6 NaCl
16. 1 H_2SO_4 + 2 NaOH $\rightarrow$ 1 Na_2SO_4 + 2 H_2O
17. 1 Fe_2O_3 + 3 CO $\rightarrow$ 2 Fe + 3 CO_2

D Combustion reactions

3 marks

18. 1 C_3H_8 + 5 O_2 $\rightarrow$ 3 CO_2 + 4 H_2O
19. 2 C_2H_6 + 7 O_2 $\rightarrow$ 4 CO_2 + 6 H_2O
20. 1 $\text{C}_6\text{H}_{12}\text{O}_6$ + 6 O_2 $\rightarrow$ 6 CO_2 + 6 H_2O

E Word equations: write and balance

3 marks

21. Hydrogen gas reacts with chlorine gas to form hydrogen chloride.
 $\text{H}_2 + \text{Cl}_2 \rightarrow 2\text{HCl}$
22. Zinc reacts with hydrochloric acid to form zinc chloride and hydrogen gas.
 $\text{Zn} + 2\text{HCl} \rightarrow \text{ZnCl}_2 + \text{H}_2$
23. Sodium reacts with water to form sodium hydroxide and hydrogen gas.
 $2\text{Na} + 2\text{H}_2\text{O} \rightarrow 2\text{NaOH} + \text{H}_2$

F Spot the mistake

2 marks

24. A student balances $\text{H}_2\text{O} \rightarrow \text{H}_2 + \text{O}_2$ by writing $\text{H}_2\text{O}_2 \rightarrow \text{H}_2 + \text{O}_2$. What is wrong? Fix it.
Changing a subscript changes the substance (H_2O_2 is hydrogen peroxide). Only change coefficients:
 $2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2$
25. A student writes $4\text{H}_2 + 2\text{O}_2 \rightarrow 4\text{H}_2\text{O}$. What is wrong? Fix it.
It balances, but coefficients must be in the lowest whole-number ratio: $2\text{H}_2 + \text{O}_2 \rightarrow 2\text{H}_2\text{O}$

G Challenge

2 marks

26. 2 C_4H_{10} + 13 O_2 $\rightarrow$ 8 CO_2 + 10 H_2O
27. Explain how a balanced equation shows the law of conservation of mass.
Atoms are only rearranged in a reaction, not created or destroyed, so the same number of each atom (and the same total mass) appears on both sides.