Balancing Atoms to Balance Mass

Teacher		**Class**	Year 9
Subject	Science	**Topic**	Balancing chemical equations
Date		**Room**	
Lesson length	60 minutes	**Country**	United Kingdom

Students learn why equations must show equal atoms to keep mass equal. They model atoms with counters and balance symbol equations in pairs.

Curriculum links

- Pupils revisit atoms, elements and compounds and how to balance symbol equations and add state symbols [2]
- Pupils should be able to explain how balancing the number of atoms on the reactant and product sides follows the law of conservation of mass [2]

Learning objectives

- Students will represent reactions using formulae and balanced symbol equations.
- Students will balance equations by counting atoms and adding coefficients only.
- Students will explain that balanced atoms keep total mass equal.

Success criteria

- I can write reactants and products with correct formulae.
- I can balance atoms by changing coefficients only.
- I can explain balanced atoms keeps mass equal.

What students already know

Show H2 + O2 → H2O. Ask: what do the formulae tell us and are O atoms equal on both sides?

Key words

reactant	starting chemical on the left side that takes part in change [7]
product	new chemical made on the right side after change [7]
coefficient	big number placed before a formula to show how many copies [4]
subscript	tiny number after a symbol showing atoms joined in that formula [4]
conservation of mass	rule that total amount stays the same because atoms only rearrange [18]
balanced equation	formula sentence with equal numbers of each atom on both sides [9]

Materials

- two colours of counters or beads (class set)
- printed unbalanced equations and counting grids
- mini whiteboards and pens
- Slides 1-4, 8, 10-12 and Video clip 5 (0:00–2:53)
- Worksheet Task D and Task E copies

Before the lesson

- Print unbalanced equations, counting grids with H and O columns, and Worksheet Tasks D-E
- Test Slides 1-4, 8, 10-12 and Video clip 5 (0:00–2:53) on classroom screen
- Set out two colours of counters or beads and mini whiteboards for pairs

Created with LessonDino.com · AI lesson planner with checkable sources

Lesson outline

0–8 min **Starter** 8 min · Whole class

Recall formulae and create curiosity about unequal atoms.

YOU DO

1. Show Slide 1 and read title: Representing reactions using formulae and equations.
2. Show Slide 2 fact: Atoms are never made or destroyed in reactions. They only rearrange, so each side must have the same atoms.
3. Say the hook and show unbalanced H2 + O2 → H2O on the board.
4. Ask pairs to count H and O on each side on mini whiteboards.

STUDENTS DO

1. Discuss what H2, O2 and H2O mean with partner.
2. Count atoms each side and hold up totals on whiteboards.
3. Listen for why unequal atoms means a problem.

Say: This reaction looks right, but the atoms don't add up — can you catch what's missing and fix it without breaking anything? The formulae tell us which atoms are joined together. In every reaction atoms cannot be made and they cannot be destroyed, they can only be rearranged [4].

Ask: What do the formulae H2 and H2O tell us? (Which atoms are in the substance and how many of each [7].) · Are atoms equal on both sides of H2 + O2 → H2O? (No. H is 2 and 2, but O is 2 on the left and 1 on the right.)

Check understanding: Check whiteboard counts for 2 vs 1 oxygen. If unsure, point to Slide 2 and recount together slowly.

Support: Give symbol key showing H is one counter colour and O is the other colour. **Stretch:** Ask why changing H2O to H2O2 to fix oxygen would be wrong.

Use: Slides 1-2

8–20 min **Teaching** 12 min · Whole class

Model the 4-step method and the difference between coefficients and subscripts.

YOU DO

1. Display Slide 3 steps: Write correct formulae for all substances, Count atoms of each element both sides, Add big numbers in front, one element at a time.
2. Play Video clip 5 (0:00–2:53) on Slide 8 to spot subscripts you must never change and coefficients you can change.
3. Model balancing H2 + O2 → H2O on the board with tallies, adding one coefficient at a time and recounting.
4. Show Slide 4 statement: Balance the atoms, and you balance the mass.

STUDENTS DO

1. Watch video and call out subscripts that must stay fixed.
2. Copy the tallies and repeat counts aloud.
3. Practise saying: formulas are fixed, only coefficients change [4].

Say: Check that all the formulae in the equation are correct and deal with only one element at a time [3]. Balancing is adding BIG numbers. You cannot change any of the small numbers in a chemical formula [3]. Only coefficients, the big numbers in front, can change [4].

Worked example: H2 + O2 → H2O is unbalanced: H 2 and 2, O 2 and 1. Put 2 in front of H2O: H2 + O2 → 2H2O gives H 2 and 4, O 2 and 2. Put 2 in front of H2: 2H2 + O2 → 2H2O gives H 4 and 4, O 2 and 2. Now equal, so balanced [4].

Ask: Can we balance oxygen by changing O2 to O3? (No, formulas are fixed and subscripts can never change [4].) · What do we do after adding one big number? (Recount each element again and repeat if needed [3].) · Check why H2O is not H2O2? (Changing subscript makes a different substance, not water.)

Check understanding: Hinge on whiteboards: which can change, 2 in 2H2O or 2 in H2O? Reteach with counters if many choose subscript.

Support: Give counting grid with columns for H and O on reactants and products sides to fill before choosing coefficients. **Stretch:** Ask students to predict why we balance O after H in this example.

Use: Slides 3-4; Slide 8; Video clip 5 (0:00–2:53)

Created with LessonDino.com · AI lesson planner with checkable sources

20–40 min **Main activity** 20 min · Pairs

Practise balancing simple equations by modelling atoms with counters.

YOU DO

1. Hand out two colours of counters, printed unbalanced equations and mini whiteboards.
2. Demonstrate modelling H2 + O2 → H2O where each counter is one atom and atoms only rearrange [4].
3. Set pairs to find coefficients for H2 + O2 → H2O and Mg + O2 → MgO by adding one coefficient, then recounting.
4. Remind class to write tallies underneath to prove equal numbers on both sides [4].

STUDENTS DO

1. Place counters for reactants, then rearrange to make products.
2. Try coefficients, recount H, Mg and O each time.
3. Write balanced equation with tallies on whiteboard to show.

Say: Model with counters and rearrange them to show atoms are not lost or made. Never change the small subscript numbers [3]. Add a big number in front of one formula, recount both sides, then repeat until every element matches.

Worked example: Pair talk-through for 2H2 + O2 → 2H2O: left has 4 H counters and 2 O counters, right has 4 H and 2 O, so H 4 and 4, O 2 and 2, balanced [4].

Ask: How many Mg and O atoms on each side of 2Mg + O2 → 2MgO? (Mg 2 and 2, O 2 and 2, so balanced.) · Why must total number of each atom be equal both sides? (Because atoms cannot be made or destroyed, only rearranged [4].)

Check understanding: Pairs hold up whiteboards with equation and tallies. If unequal, send back to recount one element at a time [3].

Support: Give counting grid with columns for each element on reactants and products sides to fill in before choosing coefficients. **Stretch:** Move to N2 + H2 → NH3 and balance it in three checks to reach N2 + 3H2 → 2NH3 [18].

Use: Slide 4

40–52 min **Practice** 12 min · On their own

Apply inspection independently and secure key vocabulary.

YOU DO

1. Hand out Worksheet Task D and Task E.
2. Direct students to Task D instruction: Complete the table by adding the missing coefficients. Start with: Count atoms on the left...
3. Direct students to Task E instruction: Match each term to its meaning by writing the number in the circle.
4. Circulate, prompting use of smallest possible whole-number coefficients [7].

STUDENTS DO

1. Complete Task D table by counting atoms and adding coefficients.
2. Complete Task E matching for reactant, product, coefficient and subscript.
3. Swap with partner to verify atom by atom and lowest whole-number ratio [6].

Say: Work on your own using inspection: write correct formulae first, count atoms, adjust one coefficient, recount and repeat until equal [14]. Reactants are written on the left and products on the right with plus signs between formulas [7].

Ask: In Task D, which element should you balance first? (The element in only one reactant and one product, then recount [3].) · What is a coefficient? (Big number in front you can change (Slide 10 wording).)

Check understanding: Collect two answers for Task D and check tallies as class. Re-model any miscount on board.

Support: Supply correct formulae so focus is only on finding coefficients [3], plus pre-filled atom counts to compare. **Stretch:** Rewrite one answer with smallest whole numbers and state the reactant to product ratio, e.g. 1:2:1:2 [7].

Use: Worksheet Tasks D-E

Created with LessonDino.com · AI lesson planner with checkable sources

52–60 min **Plenary** 8 min · Whole class

Check objectives and link atom balance to mass conservation.

YOU DO

1. Revisit Slide 10 words: reactant - starting substance on the left side, product - new substance made on the right side, coefficient - big number in front you can change.
2. Ask Slide 11 question: If mass stays the same, why must atom numbers match on both sides?
3. Run Slide 12 quiz on N2 + 3H2 → 2NH3 and H2O to H2O2 true or false.
4. Link back to Slide 4: Balance the atoms, and you balance the mass.

STUDENTS DO

1. Think, pair, share answer to why atom numbers must match.
2. Answer quiz on whiteboards: 6 and 6 - balanced, False - never change a formula.
3. Self-assess against success criteria with thumbs.

Say: The total mass of reactants equals total mass of products because no atoms can be created or destroyed [18]. Year 9 pupils use this to explain balancing [2]. If atoms match, mass must match.

Worked example: N2 + 3H2 → 2NH3 has two nitrogen atoms and six hydrogen atoms on each side [18]. That gives 6 and 6 - balanced for hydrogen.

Ask: If mass stays the same, why must atom numbers match on both sides? (Atoms only rearrange, so equal atoms means equal mass [18].) · True or false: change H2O to H2O2 to balance? (False - never change a formula.)

Check understanding: Whiteboard quiz answers. If quiz fails, replay coefficient vs subscript point tomorrow.

Support: Provide sentence starter: If there are more oxygen atoms on the left than the right, then mass would... [4]. **Stretch:** Ask what is wrong with changing a subscript like H2O to H3O and why that makes a different substance.

Use: Slides 10-12

Common mistakes

Mistake	How to spot it	How to fix it
Changing subscripts instead of coefficients to balance, e.g. H2O to H2O2	Formula has new small number but coefficient still 1	Remind formulas are fixed, only coefficients change; changing subscript makes a different substance [4]
Adding several big numbers at once without recounting	One element balances but another is now unequal	Deal with only one element at a time, recount and repeat until all match [3]
Thinking mass can disappear, so unbalanced equation is fine	Says ash weighs less so atoms were lost	Stress total mass of reactants equals total mass of products because no atoms are lost or made [18]

Support

- Counting grid with H, O, N columns for left and right totals
- Sentence starters linking counts to conservation

Stretch

- Balance N2 + H2 → NH3 to N2 + 3H2 → 2NH3 with full recount [18]

Created with LessonDino.com · AI lesson planner with checkable sources

- Correct formulae supplied so focus is on coefficients only
- Simplify to smallest whole-number coefficients and state ratio e.g. 1:2:1:2 [7]
- Add state symbols like (g) and (l) without changing atom balance [18]

For the LSE or teaching assistant

Sit with pairs using counters; prompt counting grid use, ask for left-right totals aloud, check tallies before they write final coefficients.

Check for understanding

Question	Answer
In N2 + 3H2 → 2NH3, how many H atoms on each side?	6 and 6 - balanced
True or false: you can change H2O to H2O2 to balance an equation?	False - never change a formula
Balance 2H2 + O2 → 2H2O: how many H and O on each side and why does this keep mass equal?	H 4 and 4, O 2 and 2; equal atoms means equal mass as atoms only rearrange [4][18]

Homework

Balance Mg + O2 → MgO and CH4 + O2 → CO2 + H2O with atom tallies underneath.

Sources

1. Year 9 Curriculum Knowledge At A Glance · kls.herts.sch.uk · https://www.kls.herts.sch.uk/assets/Year-9-Curriculum-Knowledge-At-A-Glance.pdf
2. science yr 9 curriculum · trinity.bexley.sch.uk · https://trinity.bexley.sch.uk/wp-content/uploads/2025/05/science-yr-9-curriculum.pdf
3. Balancing equations - Revise: Balanced equations - National 5 Chemistry ... · bbc.co.uk · https://www.bbc.co.uk/bitesize/guides/zs3297h/revision/2
4. Balancing chemical equations · bam.files.bbci.co.uk · https://bam.files.bbci.co.uk/bam/live/content/z29wcxs/transcript
5. Chemical Equation Balancer - AllCalculators.co.uk · allcalculators.co.uk · https://allcalculators.co.uk/chemical-equation-balancer/
6. Worked examples: Balancing more complex chemical equations · khanacademy.org · https://www.khanacademy.org/science/ms-chemistry/xc370bc422b7f75fc:chemical-changes/xc370bc422b7f75fc:chemical-reactions/v/worked-examples-balancing-more-complex-chemical-equations
7. 5.8 Writing and Balancing Chemical Equations – Chemistry Fundamentals · pressbooks.online.ucf.edu · https://pressbooks.online.ucf.edu/chemistryfundamentals/chapter/writing-and-balancing-chemical-equations/
8. Balancing Chemical Equations - Inquiry based Introduction - Cont… · phet.colorado.edu · http://phet.colorado.edu/gl/contributions/view/3422
9. Balancing Chemical Equations · flexbooks.ck12.org · https://flexbooks.ck12.org/cbook/ck-12-chemistry-flexbook-2.0/section/11.3/primary/lesson/balancing-equations-chem/
10. Balancing chemical equations: form the perspective of Hilbert ba… · arxiv.org · https://arxiv.org/html/2410.06023v1
11. Flexi answers - How to balance chemical equations? | CK-12 Foundation · ck12.org · https://www.ck12.org/flexi/physical-science/balancing-equations/how-to-balance-chemical-equations/
12. Worked example: Balancing a redox equation in acidic solution · khanacademy.org · https://www.khanacademy.org/science/ap-chemistry-beta/x2eef969c74e0d802:chemical-reactions/x2eef969c74e0d802:oxidation-reduction-redox-reactions/v/balance-and-redox-reactions1
13. Research backed method for teaching Balancing Chemical Equations to ... · mindmatterspedagogy.com · https://www.mindmatterspedagogy.com/post/methods-for-teaching-balancing-equations
14. How to Balance Chemical Equations Step by Step | Element Lookup · elementlookup.com · https://elementlookup.com/learn/balancing-chemical-equations/
15. BALANCING CHEMICAL EQUATIONS LESSON PLAN - Kesler Science · keslerscience.com · https://keslerscience.com/balancing-chemical-equations-lesson-plan-a-complete-science-lesson-using-the-5e-method-of-instruction
16. Balancing Chemical Equations Worksheets - Mashup Math · mashupmath.com · https://www.mashupmath.com/balancing-chemical-equations-worksheet

Created with LessonDino.com · AI lesson planner with checkable sources

17. School chemistry elementary: Balancing chemical equations (Levelled Books) - Iqbal, Mazhar: 9781530207954 - AbeBooks · abebooks.com · https://www.abebooks.com/9781530207954/School-Chemistry-Elementary-Balancing-Chemical-9781530200/plp
18. Balanced chemical equations - Atoms, elements and compounds ... · bbc.co.uk · https://www.bbc.co.uk/bitesize/guides/zg2h4qt/revision/6
19. Balancing Chemical Reactions | Brilliant Math & Science Wiki · brilliant.org · https://brilliant.org/wiki/balancing-reactions/
20. Balancing Chemical Equations Chemistry Tutorial · ausetute.com.au · https://www.ausetute.com.au/balcheme.html