

Beads Never Vanish: Build Four Reactions and Catch the Fakes

Investigation question: If every atom in the products has to come from the reactants, can a bead model tell a real chemical equation from a fake one, and why does the pile of beads always have the same mass?

Physical model

Groups of 4

1 session

Setup 5 · Activity 45 · Cleanup 5 min

MS-PS1-5 · assesses

MS-PS1-1 · supports

Scientific purpose

Students use colored pony beads as atoms and short pipe-cleaner pieces as bonds. For four real reactions they build the reactant side exactly as the equation says, pull the bonds, and rebuild the products using only those beads, recording an atom inventory, the regrouping pattern and the mass of the beads before and after. Then they test four claimed equations and reject the ones that need an atom that was never there, or that quietly changed a substance by altering a subscript. The model makes the law of conservation of matter something students enforce with their hands.

Why this helps students with this chapter

On paper, an equation is a row of symbols and students balance it by trial and error without picturing anything. With beads, the reactant side is a fixed pile: there is nowhere to get an extra oxygen from, and nothing to do with a leftover one. Pulling the bonds while the beads stay whole makes the difference between breaking bonds and breaking atoms physical, and massing the same beads before and after turns 'atoms are conserved, so mass is conserved' into a measurement students made themselves.

Standards connections

MS-PS1-5 (assesses, developing and using a physical model that shows the number of each kind of atom unchanged, and therefore the mass unchanged): The atom inventory, the before-and-after bead masses and the drawing are a physical model of conserved atoms; the claimed-reaction verdicts show whether students can use the model to decide what a reaction cannot do. Students count atoms and compare bead masses only; atomic masses are never used, and fixing a fake equation with whole units is an optional extension, not the assessed skill.

MS-PS1-1 (supports, models of simple molecules and extended structures): Students built bead and drawn models of molecules in Lesson 2; this lab reuses that skill so the focus can stay on what changes and what does not when molecules regroup.

Roles (rotate each session)

- **Builder:** Threads beads onto bond pieces to build each molecule or formula unit exactly as the card says, and pulls the bonds when the reaction runs.

- **Atom inspector:** Counts the beads of each color on each side of the arrow, checks that no bead came from the kit and none is left over, and calls a stop when the products cannot be built.
- **Recorder:** Reads each card aloud as a sentence, fills in the inventory, pattern and mass tables, and writes the group's verdict on every claimed card.
- **Mass checker:** Counts out the exact reactant beads before building, masses them in the cup, and masses the same beads again after the products are taken apart.

Materials

Item	Quantity	Per	Note
Pony beads (9 mm) in eight colors, kitted per group: 12 white (H), 12 red (O), 6 gray (Fe), 4 black (C), 2 blue (Pb), 4 purple (K), 4 yellow (I), 4 green (N)	1 kit (48 beads) in a zip bag	group	Any eight distinct colors work; print the key to match the colors you have.
Pipe cleaners cut into 3 cm bond pieces	30 pieces	group	One piece threaded through two beads is one bond. Twist ties cut in half also work.
Reaction mat: a sheet of paper with a large arrow drawn across the middle (reactants left, products right)	1	group	
Reaction cards R1-R4 and claimed cards C1-C4 (text on the recording sheet)	1 set	group	
Small cup for massing beads	1	group	
Digital balance reading to 0.1 g	1	group	Two or three groups can share; the massing step takes under a minute.
Recording sheet and pencil	1	student	

Estimated cost: 12 to 18 per class (an estimate; Estimate for eight groups. One 1-pound bag of assorted pony beads (about \$8, roughly 1,000 beads) plus one small bag each of white and red (about \$3 each) covers the kits with beads to spare; one pack of 100 pipe cleaners (about \$4) cuts into about 1,000 bond pieces. Cups, paper and balances are classroom stock. Kits are reusable for years.)

Safety

- Beads are a choking hazard: nothing goes in mouths, and beads are not flicked or thrown. Count the kit back into its bag at the end.
- Cut pipe-cleaner ends can scratch; fold ends over, and tell students not to press a cut end into skin.
- Dropped beads roll and are a slip hazard on hard floors; pick them up at once.
- No chemicals are used. The reactions on the cards are models only; none of them is performed in this lab, and students are not given any procedure for splitting water, burning iron or burning methane.

Teacher preparation and setup

1. Count out one kit per group into a zip bag using the quantities above, and tape a copy of the atom key to each bag. Kits are the slow part of prep; students can help count at the end of the previous class.
2. Cut pipe cleaners into 3 cm pieces (one 30 cm pipe cleaner gives ten) and fold any sharp wire ends over with pliers.
3. Build card R3 yourself once: $\text{Pb}(\text{NO}_3)_2$ needs one blue, two green and six red beads. If you can build it, every other card is easier.
4. Print the recording sheet (the cards are on it) and draw the arrow mats, or have groups draw their own in the first minute.
5. Decide whether every group masses beads or whether, with few balances, the Mass checker from each group takes a turn at one shared balance while the group builds the next card.

Investigation design

Independent variable	The reaction card being modeled: which substances, how many units of each, and whether the card is a real equation or a claimed one
Dependent variable	The count of each kind of atom on each side of the arrow, whether the products can be built at all, and the mass of the beads before and after regrouping
Controlled	The same atom key for every group, one color per element; Only beads counted out for the reactant side may be used to build products; Beads are massed without bond pieces, in the same cup, on the same balance; Every molecule is built exactly as its formula says, with the coefficient applied to the whole formula
Trials	Each group models four real reactions and four claimed ones; the class pools its verdicts on the claimed cards on the board.
Comparison	Reactant inventory against product inventory for every card; real cards against claimed cards.

Student procedure

1. Set up the mat with the arrow pointing right. Left of the arrow is the reactant side, right is the product side. Sort the kit by color and have the Atom inspector check the counts against the key.
2. Card R1. The Recorder reads the equation as a sentence ('two water molecules become two hydrogen molecules and one oxygen molecule'). The Mass checker counts out exactly the beads the reactant side needs (coefficient times each subscript), masses them in the cup, and records the mass. These beads, and only these, may be used for the whole card.
3. The Builder builds the reactant molecules on the mat's left side: one bond piece through two beads is one bond. Build each water molecule as an oxygen bead with a hydrogen bead bonded on each side. The Atom inspector counts the beads of each color on the left and the Recorder fills in the 'reactants' column of the inventory table.
4. Run the reaction: the Builder pulls out every bond piece. The beads do not break, split or change color; only the bonds are gone. Slide the loose beads to the right side of the arrow.

5. Build the products exactly as the card says, using only the beads on the mat. No bead may come from the kit and none may be left over. Count each color on the right and record it under 'products'. Then take the products apart, return the beads to the cup, mass them again and record.
6. Decide the regrouping pattern by counting substances: one reactant into two or more products is break apart; two or more reactants into one product is join; two into two with partners traded is swap; anything else is a mix. Record it with the number of substances on each side.
7. Repeat steps 2 to 6 for cards R2, R3 and R4. For R3 the subscript 2 outside the parentheses multiplies everything inside: build two nitrate groups (one green bead with three red beads bonded to it) and bond both to the blue bead.
8. Claimed cards C1 to C4. For each card, count out and build the reactant side exactly as written, pull the bonds, and try to build the products exactly as written from those beads alone. If you cannot, the Atom inspector names the atom that is missing or left over and the Recorder writes 'fake'. If you can, check the card's claim: count the beads in each molecule you built and ask whether the formula on the card describes the substance the card names. Record the verdict.
9. Make the drawing on the recording sheet for card R4: circles for atoms, labeled, before and after, with the same atoms in both pictures.
10. Return every bead to the kit bag (the Atom inspector counts them back in), then answer the analysis questions on your own before comparing within the group.

Expected observations

- Every real card builds with no bead left over: R1 uses 6 beads (4 H, 2 O), R2 uses 10 (4 Fe, 6 O), R3 uses 13 (1 Pb, 2 N, 6 O, 2 K, 2 I), R4 uses 9 (1 C, 4 H, 4 O), and the before and after bead masses match.
- C1 builds (4 H and 4 O on each side). C2 stops one oxygen bead short of an O_2 molecule. C4 stops one oxygen bead short of Fe_2O_3 . C3 builds, but the reactant molecule is H-O-O-H and the Atom inspector should notice it is not a water molecule.
- Most groups sort R1 as break apart, R2 as join, R3 as swap and R4 as a mix; a few groups call R4 a swap because it has two substances on each side, which the debrief corrects by asking whether partners were simply traded.

Likely difficulties

- Applying the coefficient only to the first element (reading $2H_2O$ as 4 H and 1 O). Have the Recorder say 'two whole molecules' and the Builder build two complete molecules before anyone counts.
- The parentheses in $Pb(NO_3)_2$: students build one nitrate group or put the 2 on the lead. The card and procedure both spell it out; check this group first.
- Groups 'borrow' a bead from the kit to finish a claimed card and declare it real. The Atom inspector role and the count-out-first step exist to prevent this; ask any group that says C2 or C4 works to show their count.
- Students treat C3 as real because the beads balance. Ask them to count the beads in the reactant molecule and name the substance; two O beads in a chain is hydrogen peroxide.

- Bond pieces get lost in the pile and students think a bead is missing. Count beads, not bonds; bonds are not conserved in the model and need not be.

Structured debrief

1. Pool the verdicts on C1 to C4 on the board. C1 is real; C2 and C4 are fake because an atom is missing (one oxygen in each); C3 is the trap: the beads balance, but H-O-O-H is hydrogen peroxide, not water, so the card is mislabeled. Ask which rule each fake broke and make students say 'bonds break, beads do not' and 'a subscript belongs to the substance.'
2. Put the bead masses on the board for a few groups. Every before and after pair matches to the balance's last digit because they are the same beads. Then ask the bridge question: real atoms also keep their mass, so what must be true of a real reaction in a sealed bag? Connect to Lab 1 station B.
3. Return to R1 and R2 with the counts: in R1 the number of molecules changed (two became three) while the atoms did not; in R2 four iron atoms and six oxygen atoms became two heavier units. Ask where the six oxygen atoms were before: in the air, where the balance in the phenomenon could not count them. That is the whole explanation of the steel wool gaining mass.
4. If students ask how to fix C2 or C4, show that the only allowed move is adding whole molecules or formula units with more beads ($2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2$; $4\text{Fe} + 3\text{O}_2 \rightarrow 2\text{Fe}_2\text{O}_3$), never changing a subscript. Keep this as a demonstration or extension; the assessed skill is counting, not balancing.

Recording sheet: what students fill in

Lab 2 recording sheet: Beads never vanish

Two rules of the model — Rule 1: a bond piece can be pulled out at any time. A bead can never be split, swapped for another color or taken from the kit. Rule 2: the products of a card may be built only from the beads that were on the reactant side, with none left over. If you break a rule to make a card work, the card is fake.

Atom key

Symbol	Element	Bead color
H	hydrogen	white
O	oxygen	red
C	carbon	black
Fe	iron	gray
Pb	lead	blue
K	potassium	purple
I	iodine	yellow
N	nitrogen	green

Reaction cards

1 R1: Water split by electricity

$2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2$. Two water molecules become two hydrogen molecules and one oxygen molecule. Build a water molecule as O in the middle with an H on each side.

2 R2: Steel wool burning in air

$4\text{Fe} + 3\text{O}_2 \rightarrow 2\text{Fe}_2\text{O}_3$. Four iron atoms and three oxygen molecules become two formula units of iron oxide. Iron atoms start alone, with no bonds. Build each Fe_2O_3 unit as two gray beads and three red beads bonded together in any arrangement.

3 R3: Lead nitrate meets potassium iodide

$\text{Pb}(\text{NO}_3)_2 + 2\text{KI} \rightarrow \text{PbI}_2 + 2\text{KNO}_3$. The $(\text{NO}_3)_2$ means two nitrate groups, each one N with three O. Build KI as one purple and one yellow bead bonded. Products: PbI_2 is one blue with two yellow; each KNO_3 is one purple bonded to a nitrate group.

4 R4: Methane (natural gas) burning

$\text{CH}_4 + 2\text{O}_2 \rightarrow \text{CO}_2 + 2\text{H}_2\text{O}$. One methane molecule (a black bead with four white beads bonded to it) and two oxygen molecules become one carbon dioxide molecule (O bonded on each side of C) and two water molecules.

5 C1: Claimed. Hydrogen peroxide breaking down

$2\text{H}_2\text{O}_2 \rightarrow 2\text{H}_2\text{O} + \text{O}_2$. Build each hydrogen peroxide as a chain H-O-O-H. The card claims two hydrogen peroxide molecules become two water molecules and one oxygen molecule.

6 C2: Claimed. Water split, short version

$\text{H}_2\text{O} \rightarrow \text{H}_2 + \text{O}_2$. A student says one water molecule becomes one hydrogen molecule and one oxygen molecule.

7 C3: Claimed. Water split, 'fixed' version

$\text{H}_2\text{O}_2 \rightarrow \text{H}_2 + \text{O}_2$. The same student noticed that C2 did not work and fixed it by changing the small 1 after O to a 2. The card still says the reactant is water.

8 C4: Claimed. Iron burning, short version

$2\text{Fe} + \text{O}_2 \rightarrow \text{Fe}_2\text{O}_3$. A student says two iron atoms and one oxygen molecule become one formula unit of iron oxide.

Atom inventory for the real reactions

Card	Element	Atoms on the reactant side	Atoms on the product side	Same? (yes/no)
R1	H			
R1	O			
R2	Fe			
R2	O			
R3	Pb			
R3	N			
R3	O			
R3	K			
R3	I			
R4	C			

Card	Element	Atoms on the reactant side	Atoms on the product side	Same? (yes/no)
R4	H			
R4	O			

Pattern and bead mass

Card	Substances on the left	Substances on the right	Pattern (break apart / join / swap / mix)	Bead mass before (g)	Bead mass after (g)
R1					
R2					
R3					
R4					

Claimed cards: the verdicts

Card	Can the products be built from the reactant beads alone? (yes/no)	Which atom is missing or left over?	Does each formula describe the substance the card names? (yes/no, and why)	Verdict: real, fake, or mislabeled
C1				
C2				
C3				
C4				

-  Draw card R4 twice: the reactant side (one methane molecule and two oxygen molecules) and the product side (one carbon dioxide molecule and two water molecules). Use labeled circles for atoms and short lines for bonds. Under the drawings, write the count of C, H and O in each picture and one sentence saying why the two piles of beads had the same mass.

Answer: Before: one C circle with four H circles bonded to it, plus two pairs of bonded O circles. After: one C with two O bonded to it, plus two groups of one O with two H. Counts under both pictures: C 1, H 4, O 4. Sentence: the beads in both piles are the same beads, nothing was added or removed, so their mass had to be the same.

Why: This is the model MS-PS1-5 asks for. Shapes need not be accurate; the atom inventory must be identical and the sentence must connect the same atoms to the same mass.

Also acceptable: Accept bonds drawn as touching circles instead of lines.

- Both pictures contain exactly 1 C, 4 H and 4 O, labeled
- Atoms are regrouped into the product molecules named on the card
- Counts written under each picture match
- Sentence links unchanged atoms to unchanged mass

1. Which claimed card fooled your group the longest, and what finally gave it away?

Answer: Group-specific. Most often C3: the beads balance, so it looks real, and what gives it away is counting the beads in the reactant molecule (H-O-O-H has two oxygens, so it is hydrogen peroxide, not water). Some groups name C4 because they tried to build Fe_2O_3 and only found two red beads.

Why: The purpose is to make students articulate the rule the fake broke. Any card with a correct reason earns credit.

- Names a claimed card
- States the specific check that exposed it (missing atom, or formula not matching the named substance)

2. For card R3, how many red (oxygen) beads did the reactant side need? Which numbers in $\text{Pb}(\text{NO}_3)_2$ told you, and what did you do with them?

Answer: Six red beads. The subscript 3 inside the parentheses means three O in each nitrate group, and the subscript 2 outside the parentheses means two nitrate groups: $3 \times 2 = 6$. The coefficient of $\text{Pb}(\text{NO}_3)_2$ is 1, so there is one unit.

Why: Checks that students can read a subscript after parentheses as multiplying everything inside. This is the hardest counting move in the lab.

Also acceptable: Accept 'two groups of three oxygens' without the multiplication written.

Analysis questions: answer key

3. In R1, two molecules of water became three molecules (two H_2 and one O_2). Did the number of molecules change? Did the number of atoms change? Explain why counting atoms, not molecules, is the test of whether an equation can be real.

Answer: The number of molecules changed: two water molecules became three molecules (two H_2 and one O_2). The number of atoms did not change: 4 H and 2 O before and after. Molecules can be made or unmade because they are just groups of atoms with bonds between them, but atoms cannot be made or unmade, so the only test that always works is whether every kind of atom has the same count on both sides.

Why: Students must separate 'molecules' from 'atoms' as the thing that is conserved. This is the distinction the compare slide in the presentation sets up.

- States that the molecule count changed (2 to 3)
- States that the atom count did not (4 H, 2 O)
- Explains that atoms, not molecules, are the conserved units

4. Your bead mass before and after each real reaction should have matched. Explain why, using the word atom. Then say what this shows about the mass of the real substances if the reaction ran inside a sealed container.

Answer: The beads after the reaction were the same beads as before; none was added, taken away or changed, so the pile had the same mass. Every bead stands for an atom, and real atoms also keep their own mass through a reaction, so if a real reaction ran in a sealed container where no atoms could enter or leave, the mass of the products would equal the mass of the reactants.

Why: This is the full chain of MS-PS1-5: same atoms, therefore same mass, with the sealed-container condition made explicit.

- Explains the equal bead masses by the beads being the same objects
- Transfers the idea to atoms keeping their mass
- Includes the condition that nothing enters or leaves

5. Card C2 claims $\text{H}_2\text{O} \rightarrow \text{H}_2 + \text{O}_2$. Use the beads to explain why it cannot happen as written. Then explain why the student who 'fixed' it on card C3 by writing H_2O_2 has not described water splitting at all.

Answer: C2 cannot work because one water molecule has only one oxygen bead and the card asks for an O_2 molecule, which needs two; there is no second oxygen bead on the reactant side and taking one from the kit would be creating an atom. C3 'fixes' the count by changing the subscript on O from 1 to 2, but H_2O_2 is a different substance, hydrogen peroxide; the beads balance only because the student started with a different molecule. Changing a subscript changes what you have, so C3 describes something, but not water splitting.

Why: The central misconception repair of the lab: subscripts are identity, coefficients are quantity. Full credit needs both halves.

- Explains the missing oxygen atom in C2
- Recognizes that H_2O_2 is a different substance (hydrogen peroxide)
- States that changing a subscript changes the substance, so C3 is not about water

6. In R2, the product pile had more beads than the iron beads alone. Use this to explain why burned steel wool has more mass than the shiny pad it came from, and say where those extra atoms were before the reaction.

Answer: The iron oxide units contain the four iron beads plus six oxygen beads that came from the oxygen molecules. Burned steel wool has more mass than the shiny pad because oxygen atoms from the air bonded to its iron atoms and brought their mass with them. Before the reaction those oxygen atoms were in the air around the pad, where a balance holding only the pad could not count them.

Why: Connects the bead count to the lesson's phenomenon. Students need to name the air as where the oxygen was.

- Attributes the extra mass to oxygen atoms joining the iron
- Locates those atoms in the air before the reaction
- Does not claim matter was created or that heat added mass

7. Sort R1 to R4 by regrouping pattern using only the number of substances on each side of the arrow. Which card was hardest to sort, and what made it hard?

Answer: R1: one substance to two, break apart. R2: two substances to one, join. R3: two to two with lead and potassium trading partners, swap. R4: two to two, but a mix, because methane and oxygen both come completely apart and the atoms rejoin in two new ways rather than trading partners. R4 is usually the hardest because the two-and-two count looks like a swap.

Why: Students apply the substance-counting rule and recognize its limit: two-and-two is a swap only when groups trade partners whole.

Also acceptable: Accept R3 named as hardest because of the parentheses, with the swap still identified.

- Correct pattern for all four cards
- Names a hard card with a reason tied to the counting rule

8. A card you did not build reads $2\text{Fe}_2\text{O}_3 \rightarrow 4\text{Fe} + 3\text{O}_2$ (iron oxide taken back apart into iron and oxygen gas). Without beads, use coefficient $\times$ subscript to count the iron atoms and the oxygen atoms on each side. Would it pass the bead test?

Answer: Left: $2\text{Fe}_2\text{O}_3$ gives Fe $2 \times 2 = 4$ and O $2 \times 3 = 6$. Right: 4Fe gives Fe 4; 3O_2 gives O $3 \times 2 = 6$. Both sides have 4 Fe and 6 O, so it passes the bead test. It is card R2 written backwards.

Why: Checks coefficient $\times$ subscript without beads and shows that the atom test does not care which direction the arrow points.

Also acceptable: Accept 'it is R2 reversed, so it must balance' only if the counts are also shown.

9. What does the bead model get right about a chemical reaction? Name two things it gets wrong or leaves out, and say why that does not matter for counting atoms.

Answer: It gets right that atoms are kept whole, that only bonds break and form, that products are built from exactly the reactant atoms, and that the same atoms have the same mass. It gets wrong or leaves out: all beads have about the same mass while real atoms of different elements do not; bonds are sticks instead of shared electrons and no energy is tracked; iron oxide and lead iodide are drawn as little units when they are large networks, and potassium nitrate stays dissolved as separate ions; molecule shapes are not real; and nothing actually reacts. None of this changes the count of each kind of atom, which is what the model is for.

Why: Students should name the model's purpose and its boundaries. Any two accurate limitations earn credit; the last sentence is what separates proficient from basic.

- Names at least two things the model gets right about conservation
- Names two accurate limitations
- Explains why the limitations do not affect atom counting

Individual evidence of learning

Each student submits their own inventory, pattern and mass tables, the verdict table, the R4 drawing with its counts and sentence, and written answers to q1 through q9. The drawing with q4 is the primary evidence for MS-PS1-5; the verdict table with q5 shows whether the student can use the model to reject an impossible equation.

Assessment criteria

Criterion	Proficient looks like
Atom inventory	All twelve inventory rows are correct, with coefficients applied to every atom in the formula and the parentheses in R3 handled correctly.
Conserved atoms, conserved mass	The R4 drawing shows the same labeled atoms before and after, and q4 states that the beads (atoms) are the same objects, so their mass is the same, and applies this to a sealed real reaction.
Using the model to judge a claim	C1 is accepted, C2 and C4 are rejected with the missing oxygen atom named, and C3 is identified as a different substance because a subscript was changed.
Regrouping patterns	R1 to R4 are sorted by counting substances, with R4 recognized as a mix rather than a swap, and the reasoning is stated.

Accessibility adaptations

- Provide a half-completed inventory for R1 and R2 (reactant column filled) and limit the claimed cards to C1, C2 and C4 for students who need more support; C3 can be done with the teacher.
- Use large beads with big holes and full-length pipe cleaners for students with limited fine-motor control, or magnetic tiles labeled with symbols; let a partner build while the student counts and records.
- Offer a large-print atom key with the element names in the student's home language, and accept spoken answers to q3, q5 and q9 recorded on a device.
- For students ready for more, give a bag of reactant beads for R2 with extra iron (for example 10 gray and 6 red) and ask how many Fe_2O_3 units can be built and what is left over, which previews limiting reactants without naming them.

Low-cost alternative

Use paper circles in eight colors (or white circles labeled with symbols) and tape as bonds; or use eight kinds of dry pasta or cereal, not to be eaten. If no balance is available, skip the mass columns and rely on the counts; a kitchen scale reading to 1 g works if each group masses all four reactant sets together.

Model limitations

Beads are all about the same mass, while real atoms of different elements have different masses; the model shows that the same atoms give the same mass, which is all the standard asks, and never that an oxygen atom is heavier than a hydrogen atom. Bond pieces are sticks that break cleanly; real bonds are shared electrons that take energy to break and give energy back when formed, which is Lesson 14. Fe_2O_3 , PbI_2 and KNO_3 are built as separate little units here, but in reality iron oxide and lead iodide are extended networks and potassium nitrate stays dissolved in water as separate ions; the units are a counting model for where atoms end up. Molecule shapes are not accurate. No reaction actually happens in this lab, and this activity has not been physically tested by the authors; bead counts and kit sizes were worked out on paper.

Teacher notes

Watch the first count on R1 at every table; a group that reads $2\text{H}_2\text{O}$ as 4 H and 1 O will carry the error through the lab. The claimed cards are the assessment of understanding: a group that accepts C2 or C4 has broken rule 1 or rule 2, and a group that accepts C3 as 'water splitting' has not yet separated subscripts from coefficients, which W7 repairs. Do not teach balancing as a skill here; if a group fixes C2 by adding a second water molecule, praise it as adding whole units and leave it there. Keep one built set of R2 (four gray beads, three red pairs, then two Fe_2O_3 units) on the demonstration table for the burning-steel-wool slide.