Elements, compounds and mixtures

Particle models • classification • melting-point evidence

YEAR 10 / LESSON 4 / CHEMISTRY + SCIENCE (DOUBLE AWARD)

The question

What can particle models and melting-point evidence tell us about a sample?

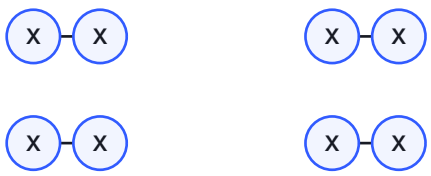
A pure substance contains one chemical substance: it may be an element or a compound. A mixture contains more than one substance. In this desk activity you classify six particle models, build your own representations, and interpret a small invented melting-range dataset. The models and data are teaching tools; they are not observations from a chemical reaction or a heating experiment.

Model key: X and Y are different fictional elements. Each circle is an atom; a connecting line represents a bond. Colour is not required: read the letters. Cards show selected molecular/atomic models, not every possible structure.

CARD A



CARD B



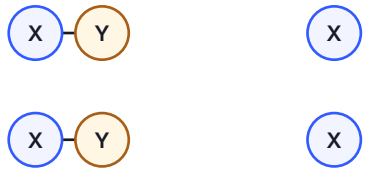
CARD C



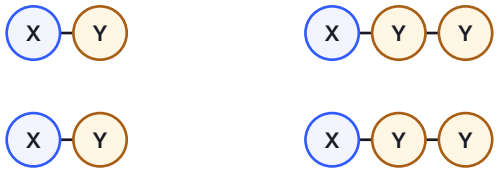
CARD D



CARD E



CARD F



Course links: 1.8 and 1.9. Chemistry and Science (Double Award). A pure element can contain molecules; a pure compound is still one substance.

Build, sort and explain

Class desk activity • no chemical heating experiment

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Equipment

- One printed set of particle-model cards A–F per pair
- Twelve reusable counters marked X and twelve marked Y, or paper circles bearing those labels
- Six short removable connectors or pencil lines to represent bonds in the model
- Plain paper, pencil, ruler and two labelled sorting areas
- Student booklet with the invented melting-range dataset

Desk activity only: no chemicals, heating or flames are required. Keep counters and connectors out of mouths and count them back into their storage box. Use pre-cut paper pieces. Keep the working area clear.

Activity sequence

1. Read the model key: X and Y mean two different fictional elements. Each circle stands for an atom. A line between circles represents a bond in the model; proximity alone does not. Colour is only an aid: read the letters.

2. Examine cards A–F before sorting. For each, count the different atom types and the different chemical substances represented. Count repeated identical molecules as one substance, not several.

3. Classify each card as an element, compound or mixture. For a mixture, say whether it contains elements, compounds, or both. Record the evidence in your own words before checking with another pair.

4. Build a model containing four separate X atoms and four separate Y atoms: a mixture of two elements. Rearrange the same counters to make four identical X–Y pairs. Draw the before and after models and check the atom counts. This change of the model represents a chemical change; joining counters does not perform a real chemical reaction.

5. Now model two X–Y pairs mixed with two separate X atoms. Sort the separate X atoms away from the X–Y pairs without breaking any model bonds. Explain why sorting a mixture is different from breaking a compound into elements. Model handling is an analogy; it is not a laboratory separation method for atoms.

6. Classify the named examples in your booklet using their stated identities, not their appearance. A substance with molecules can still be an element. A clear, uniform solution can still be a mixture.

7. Study the supplied invented melting ranges. Calculate each range width. Decide which results are consistent with a narrow melting range and which suggest a mixture. All three samples were imagined at the same pressure and with the same measurement method; none is a measured classroom sample.

8. Explain why melting evidence alone cannot tell whether a pure sample is an element or a compound. Compare the model and melting evidence, and identify at least one limitation of each.

Record your model evidence

Write your classification before comparing with another pair

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Card	Atom types	Substances	Element / compound / mixture	Evidence
A				
B				
C				
D				
E				
F				

Before: four separate X atoms and four separate Y atoms

After: four identical X–Y pairs. Label the atom totals.

What changes in the model? What stays the same? Why is this not an actual chemical reaction?

Use names and physical evidence

Classify the stated substance, not its colour or appearance

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Named example	Classification	Reason
Nitrogen, N_2		
Carbon dioxide, CO_2		
Pure water, H_2O		
Air (several gases)		
Sodium chloride dissolved in water		
Brass (copper and zinc alloy)		

Invented melting-range dataset

These numbers were created for reasoning practice. They are not reference values for named substances or measurements made by your class. Assume the same pressure and measurement method for every sample.

Sample	Starts melting / °C	Fully melted / °C	Range width / °C
1	79.5	80.5	
2	72.0	78.0	
3	114.0	115.0	

At a fixed pressure, an ideal pure substance has a fixed melting point. Real measurements can show a small apparent range because of resolution and technique. Mixtures may melt over a broader range; a narrow range alone does not prove purity.

Which samples show similar narrow ranges? Which shows a broader range?

Explain and evaluate

Use both the particle models and the invented data

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1. What is the difference between an atom type and a chemical substance? Use cards B and D to explain.

2. Explain why card B can represent a pure element even though its particles are joined in pairs. Why is card C a compound?

3. How many substances are represented in cards E and F? Explain why repeated identical molecules do not increase that number.

4. In the counter task, show that atoms are conserved when separate X and Y atoms are rearranged into X–Y pairs. Why does manipulating counters not demonstrate a real chemical reaction?

5. What does the invented melting dataset suggest about samples 1, 2 and 3? State what it cannot prove.

6. Why can clear salt water be a mixture? Why does a pure compound count as a pure substance even though it contains more than one element?

Model limitations

Atoms are not coloured counters. Bonds are not plastic connectors. Real particles move, and many substances—including ionic compounds—are not made of separate small molecules. Use the model for classification and atom counting; do not infer real reaction conditions from it.

Cleanup: Count and return the counters, connectors and cards. Keep your classifications, drawings and written explanations.