Metals and alloys: structure and use

Student activity • evidence and modelling

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The question

Why can mixing elements make a useful metal harder?

Compare a regular array of equal discs with an array containing different-sized discs. Use that model to explain resistance to sliding, then select materials for stated uses. This is not a hardness measurement or an alloy-melting practical.

Equipment

- Booklet and two shallow paper work mats
- Per pair: 24 equal paper discs and six larger replacement discs
- Material-property cards supplied in the reference section

Desk activity. Use pre-cut paper discs; keep pieces off the floor and out of mouths. No metal heating or sharp-edged samples.

Course coverage: Chemistry only: 2.25C–2.27C; properties and uses of aluminium, copper, iron and steels; alloy definition and hardness model.

Plan, model or apparatus sketch

Compare equal-disc rows with mixed-size-disc rows.

Method and reasoning

Read the whole sequence before starting

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1. Arrange 24 equal discs in four close-packed rows. Draw the arrangement before moving any discs.

2. Push one row sideways gently and record how the regular rows can move relative to one another. Do not call this a measured metal hardness.

3. Replace six discs with larger discs in the same area. Redraw the arrangement and compare how easily rows can slide in the model.

4. Explain the analogy using different-sized atoms and disruption of regular layers. Identify at least two things that paper discs cannot represent.

5. Use the property cards to choose aluminium for an aircraft panel and copper for a cable conductor; justify with more than one relevant property.

6. Compare low-carbon, high-carbon and stainless steels for a shaped car body, a cutting tool and corrosion-resistant cutlery. State a trade-off for one choice.

7. Correct the claim “an alloy is always a compound of two metals” and explain how carbon can be present in steel.

Cleanup

- Collect and count model pieces for reuse; retain material-choice reasoning.

Record your evidence

Blank spaces are for your own work

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Reference and task data

Property cards: aluminium has low density and a protective oxide film; copper conducts electricity well and is ductile. Low-carbon steel is readily shaped; high-carbon steel is harder but more brittle; stainless steel contains chromium and resists corrosion. Alloys are mixtures of a metal with other elements, not necessarily only metals. Properties depend on composition and treatment.

Case / condition	Evidence or prediction	Explanation / limitation
Equal discs: model		
Mixed-size discs: model		
Material choice / trade-off		

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. Define alloy and use steel to show why “two metals” is incomplete.

2. Sketch and compare the two disc arrangements.

3. Explain increased hardness using disrupted layers, without claiming atoms expand.

4. Give two reasons for selecting copper for a wire conductor.

5. Select steels for a car body, cutting edge and cutlery; explain each.

6. Explain two limits of the disc model and a possible trade-off in material choice.