Insulation: comparing cooling over time

Student activity • investigation and reasoning

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The question

Does a felt sleeve reduce the cooling of a cup of warm water?

Compare two matching covered cups, one insulated and one bare. Use measured cooling curves and explain the limits of the comparison.

Equipment

- Two matching heat-resistant cups and lids, two temperature probes, tray
- Felt sleeve, 100 mL measuring cylinder and timer

Staff dispense warm water at 50 °C or below. Keep cups stable in trays and probe leads clear. Do not use glass-fibre insulation or cut lid holes during the lesson. Wipe spills and leave wet sleeves to dry.

Course coverage: Shared Physics / Double Award: 4.6, 4.7, 4.10. Reducing unwanted thermal transfers.

Plan, model or apparatus sketch

Draw a labelled setup or force diagram; include the measured quantities.

Method and reasoning

Read the whole sequence before starting

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1. Work in five groups of six. Place two matching heat-resistant cups on a tray. Fit a dry felt sleeve around one cup; leave the other bare. Use matching lids with pre-made thermometer holes.

2. Staff add 100 mL of water at no more than 50 °C to each cup. Position both probes at the same depth, away from the walls and base, and record the initial temperatures.

3. Record both temperatures at 0, 2, 4, 6, 8 and 10 minutes. Keep the cups in the same location and do not lift the lids or handle them while cooling.

4. Plot temperature against time for each cup. Calculate each temperature fall over ten minutes; note any unequal starting temperatures.

5. Compare class repeats with similar starting temperatures. Explain how trapped air and reduced air movement can reduce energy transfer.

6. Propose a separate experiment changing only the lid. Explain why changing insulation and lid together would not isolate either factor.

Cleanup

- Allow water to cool, empty cups at the sink and dry equipment and sleeves.

Record your evidence

Blank spaces are for your own work

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Reference and task data

Use actual readings, not an ideal cooling curve. Cooling rate depends on the difference from room temperature. A single pair with unequal initial temperatures cannot give a secure material ranking.

Time / min	Bare / °C	Insulated / °C
0		
2		
4		
6		
8		
10		

Show your calculations, labelled model or correction here.

Explain and evaluate

Use evidence and show calculation steps where relevant

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1. What is the independent variable?

2. What should remain the same?

3. How is temperature fall calculated?

4. Why does trapped air help?

5. Why keep both lids the same?

6. Why is a vacuum different from trapped air?