Properties of materials

Teacher review edition. Ask your teacher if anything is unclear.

Why is a saucepan made from more than one material?

What you will learn

- Describe physical and chemical properties of materials.
- Link a material's properties to its use.
- Plan a fair comparison of two materials.

Choosing a material for a job

A property is a feature of a material. We choose materials whose properties suit the job.

- A saucepan base needs to transfer heat to food.
- A handle must be strong and transfer as little heat as possible to your hand.
- Different parts of one object may need different materials.

Physical properties

Physical property
A feature that can be measured without making a new substance, such as density.

Solubility
The maximum amount that dissolves in a given amount of solvent at a stated temperature.

Property	What it tells us	Example of a use
Strength	How well a material resists breaking under a force.	Steel in a bridge.
Density	How much mass there is in a given volume.	Light materials in aircraft.
Melting point	The temperature at which a solid becomes liquid.	Materials that stay solid in a hot oven.
Thermal conductivity	How easily heat passes through a material.	Metal in a saucepan base.
Electrical conductivity	How easily electric current flows through it.	Copper in electrical wires.
Solubility	How much of it dissolves in a given amount of solvent.	Dissolving a soluble substance to separate a mixture.

Conductors and insulators

> **Conductivity**
> How easily a material carries electric current or transfers heat.

Thermal and electrical conductivity describe different properties.

- Thermal conductor: transfers heat easily.
- Thermal insulator: slows heat transfer, so a suitable insulating handle warms more slowly.
- Electrical conductor: allows current to flow easily.
- Electrical insulator: resists current flow.
- Many metals are good conductors of both heat and electricity.

Chemical properties

> **Chemical property**
> How a substance reacts to form new substances, such as rusting or burning.

- Burning and corrosion are chemical changes.
- Iron reacts with oxygen and water to form rust.
- For outdoor objects, choose corrosion-resistant materials or protect iron with a coating.

Making a fair comparison

For a fair comparison, change the material and keep other important factors the same.

- Insulation test: use equal sleeve thicknesses, identical cups, equal water volumes and the same starting temperature.
- Measure after the same time. A smaller temperature drop suggests less energy escaped.
- Repeat the test to check consistency.
- Solubility test: keep solvent volume and temperature the same; measure the amount that dissolves before saturation.
- Equal stirring times alone do not measure the maximum amount that can dissolve.

More than one property matters

> **Durability**
> How well a material lasts during use.
>
> **Composite**
> A material made by combining different materials to get useful properties.

One useful property does not guarantee that a material suits the job.

- A pan base must conduct heat and stay solid when hot.

- A handle needs low thermal conductivity, strength and resistance to its working temperature.
- Durability means how well a material lasts in use.
- Also consider cost, repair, reuse and environmental effects.
- A composite combines materials for useful properties. Reinforced concrete combines concrete and steel.

Worked examples

Material A melts at 70 °C and is a poor heat conductor. Material B melts at 660 °C and is a good heat conductor. Which better suits a pan base that may reach 180 °C?

Work through it

1. At 180 °C, material A would have melted because its melting point is only 70 °C.
2. Material B would still be solid, and it transfers heat well.
3. B better meets these two requirements. We would also check strength, food safety and cost before choosing it.

Common mistakes

Common mistake: The best heat conductor is also the best saucepan-handle material.

Remember: A handle needs low thermal conductivity to slow heat transfer to your hand.

Common mistake: An insulating material stops all heat transfer.

Remember: Insulation slows heat transfer; it does not prevent it completely.

Answering questions

- Link each material property to the job: for example, copper conducts electricity well, so it suits the conducting part of a wire.
- For a fair comparison, state what you change, what you measure and the important factors you keep the same.

Try an investigation

Compare insulating sleeves around identical cups of warm water. Keep the sleeve thickness, water volume, starting temperature and measuring time the same. Use safe water temperatures selected by your teacher.

Plan, record and review

- Question and prediction: What are you testing, and what do you think will happen? Give a reason.
- Change, measure, keep the same: What will you deliberately change? What will you measure, and in what units? What stays the same to make it a fair test? For an observation, say what you will record consistently instead.
- Record and look for a pattern: Use a table with headings and units. Look for a pattern or a result that does not fit.
- Conclude from evidence: Answer your question using a result or observation. Say if the evidence is unclear.
- Improve the investigation: What would you repeat or change, and how would that make the evidence better?

Do practical work with your teacher and follow the laboratory safety instructions.