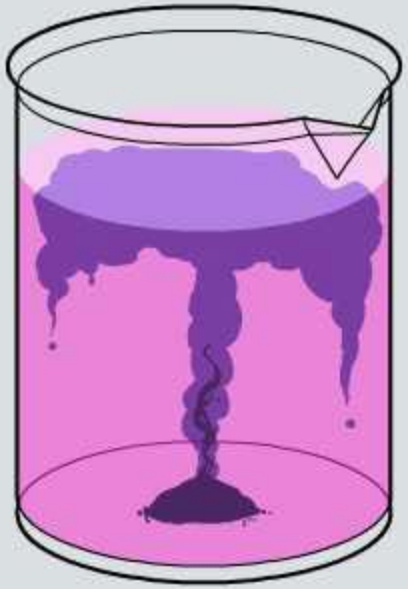
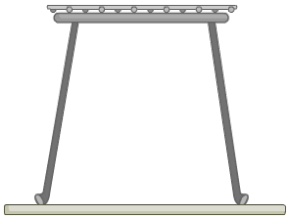
# Conduction and Convection



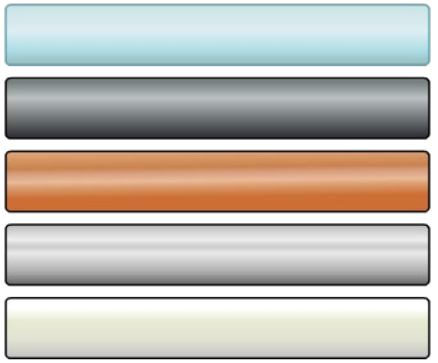
# Designing a conduction experiment

Can you design an experiment to investigate how well different materials conduct heat? Remember to make your experiment a fair test to ensure you get reliable results. The available apparatus includes:

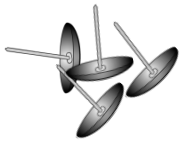
wax blobs



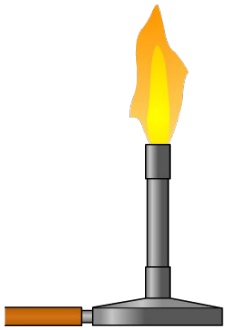
tripod



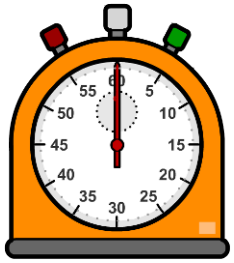
metal, glass and ceramic rods



thumb tacks



Bunsen burner




stopwatch

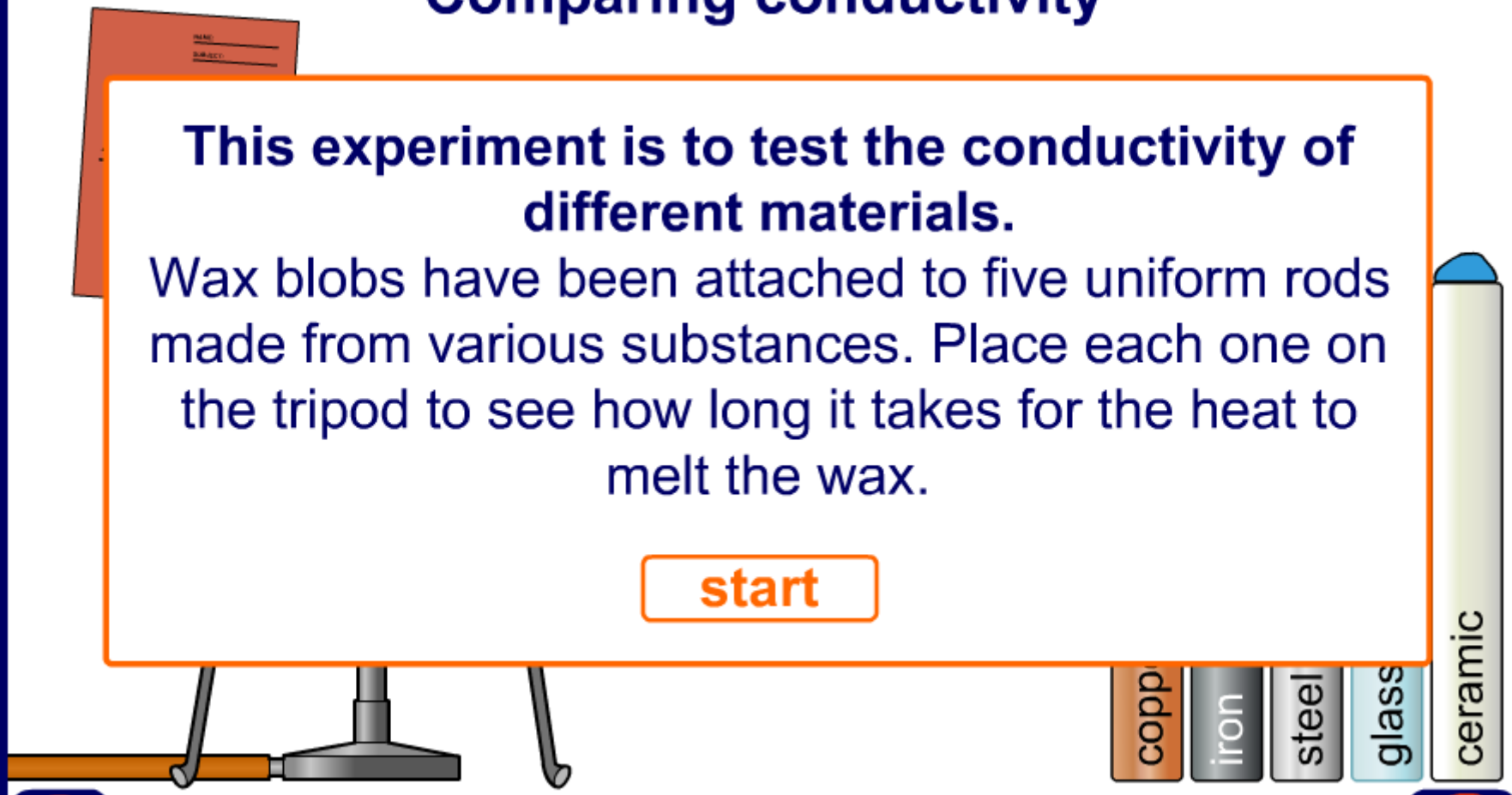
# Investigating conduction

## Comparing conductivity

**This experiment is to test the conductivity of different materials.**

Wax blobs have been attached to five uniform rods made from various substances. Place each one on the tripod to see how long it takes for the heat to melt the wax.

start



# Conduction in metals and nonmetals

If you touch a piece of wood and a piece of copper metal that are both at room temperature (about 21 °C), which material feels warmer?

The wood feels warmer because it is a poor **conductor**.

The wood cannot conduct heat away from your hand as quickly as the copper, which is a good conductor.

# Conduction in nonmetals

## How does conduction take place in a nonmetal?

Ceramic is a nonmetal that can be used to make ornamental vases.

If a ceramic rod is heated at one end, heat energy travels to the other end.

Click **"play"** to find out how conduction of heat takes place in ceramic.

# Conduction in metals

Metals are good conductors of heat because:

- metals contain many free electrons
- the free electrons can move between atoms at high speed
- the free electrons carry energy from high-energy atoms to low-energy atoms further away from the heat source.

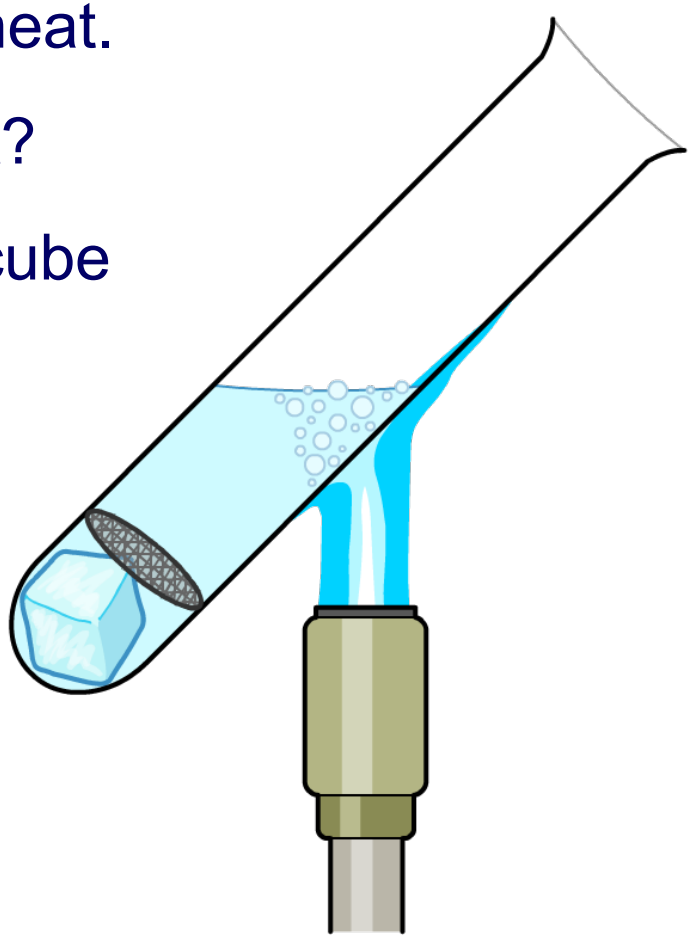
# Conduction in metals

# Conduction in liquids

Metals are good conductors of heat and almost all nonmetals are poor conductors of heat.

Are liquids good at conducting heat?

- Use some gauze to hold an ice cube at the bottom of a tube of water.
- Carefully heat the water at the top of the tube only until this water is boiling.
- If the liquid is good at conducting, the ice should quickly melt – it doesn't.

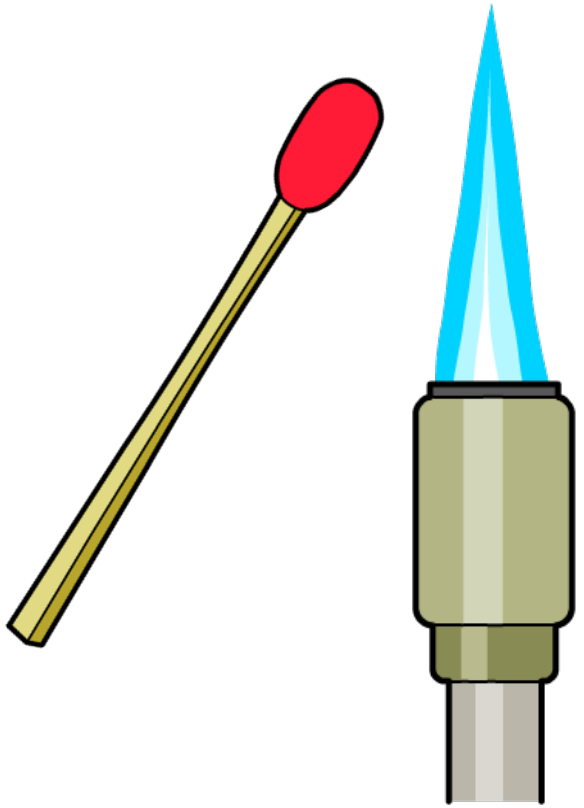


Liquids are poor conductors of heat (i.e. good insulators).

# Conduction in gases

Are gases good at conducting heat?

- Carefully hold a safety match 1 cm away from a Bunsen burner flame. (Do not put the match in the flame!)



- If a gas is a good conductor, the air between the flame and the match should conduct heat and light the match – it doesn't.

Gases are poor conductors of heat (i.e. good insulators).

# Conductor or insulator?

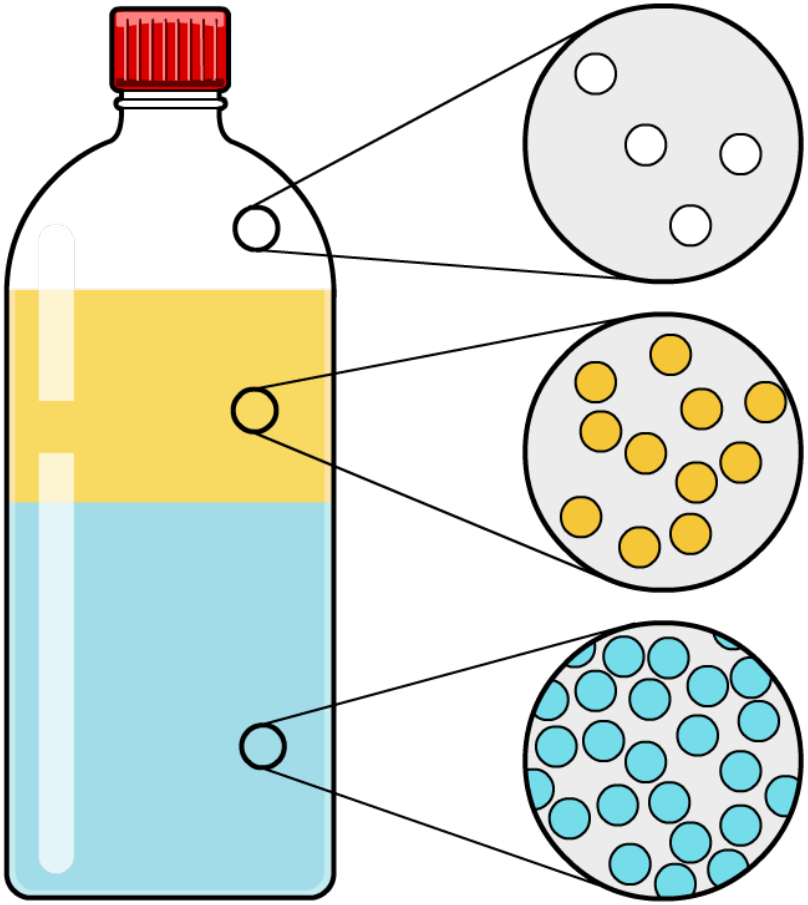
# Convection and density

The **density** of a substance depends on how far apart its particles are.

If water, oil and air are mixed together, they will settle out in order of density. Which one will rise to the top?

The air is least dense and rises to the top. The water is the most dense and sinks to the bottom.

This is important in explaining how heat is transferred by **convection**.

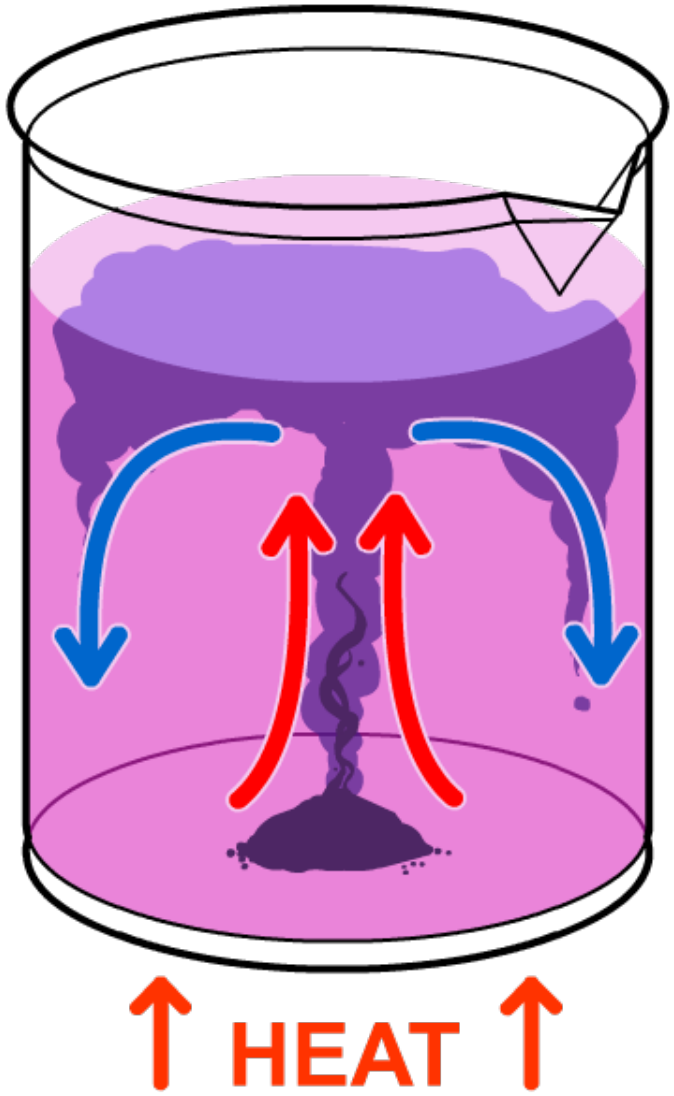


# Convection currents in a liquid

The movement of hotter areas in a liquid can be seen using potassium permanganate as a dye.

This cycle is called a **convection current**.

Can you use the concept of density to explain how the convection current moves?



# How does convection in a liquid occur?

## How does convection heat water in an electric kettle?

The heat source in an electric kettle is a heating element at the bottom of the kettle.

Click "**play**", or the "**on**" button, to find out how convection makes it possible for this heating element to heat all the water in the kettle.

# Explaining convection

## How does a heater warm a room by convection?

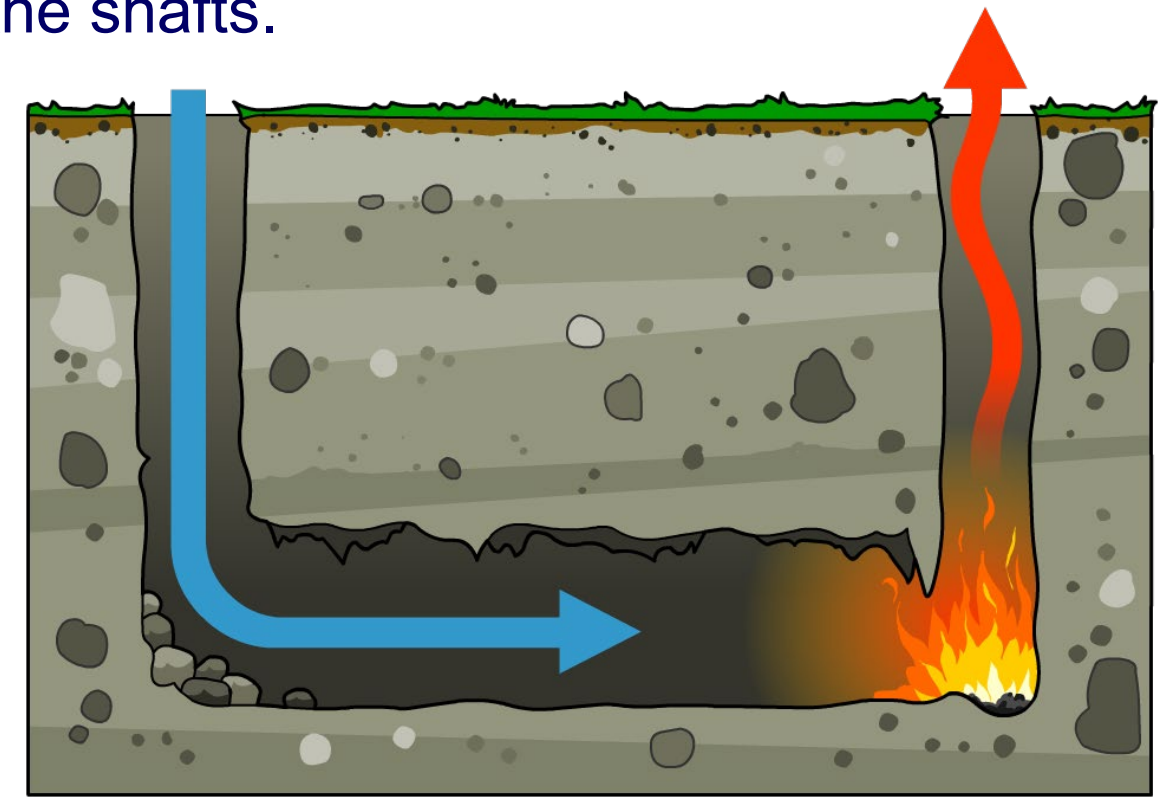
1. The less dense air rises.
2. The heater eventually heats all the air in the room.
3. A convection current is set up.
4. The wall heater heats up the nearby air.
5. Cooler, denser air moves into its place.
6. As the air warms up, its density decreases.

?

C solve

# Convection currents in a coal mine

When shaft mining was first used to mine coal, convection currents caused by an underground fire were used to ventilate the shafts.



Why do you think miners don't use this method anymore?