Activity worksheet: changes of state

Name	Group	Date

What you will learn

With the changes of state simulation you will see, at the same time, what happens in a container and what its particles do when a substance is heated or cooled. You will find out what happens to the temperature during a change of state and why.

How to work. Each activity has three steps:

1. **Predict.** Before looking at the simulation, write down what you think will happen and why.
2. **Observe.** Set up the simulation, watch what happens and note down the data.
3. **Explain.** Compare what happened with your prediction and explain why.

If your prediction turns out to be wrong, don't rub it out: getting it wrong and understanding why is the best way to learn.

Each activity has a link that opens the simulation already set up. If you have the worksheet on paper, go to **simulaciencia.es/en/simulations/cambios-estado** and set it up as described under “Set up the simulation”.

Controls. Above the simulation there are “Restart” (back to the beginning), the hotplate (❄ **Cool**, **Off** or 🔥 **Heat**) and the speed (×1, ×2, ×4). “Off” freezes the temperature so you can look calmly. The “Time” card gives the minutes since the start.

Before you start

What do you think now? Write T (true) or F (false). You will come back to this table at the end.

Statement	T or F
a) If I keep heating water that is boiling, its temperature keeps rising.	
b) With a stronger flame, water boils at a higher temperature.	
c) The bubbles in boiling water are air.	
d) When ice melts, its particles get softer or bigger.	
e) In a solid the particles are still.	
f) Water always boils at 100 °C.	

Activity 1. From ice to steam

Set up the simulation: Heat and cool mode, water, hotplate at +50 % and speed ×2. Open the simulation ready to use

Predict. You start with ice at −20 °C and heat it without stopping. Sketch by hand what you think the graph of temperature against time will look like.

My prediction (graph)

Observe. Press “Restart” and let the simulation run. Write down the time and the temperature at each moment. You can press “Off” to read calmly and “Heat” to carry on.

Moment	Time (min)	Temperature (°C)	State of the substance
It starts to melt			
It finishes melting			
It starts to boil			
It finishes boiling			

Explain.

1. What happens to the temperature while the ice is melting? And while the water is boiling? How can you see that on the graph?
2. Which change of state lasts longer, melting or boiling?

My answers

Activity 2. What we cannot see: the particles

Set up the simulation: the same, with the attractions and speed (trails) boxes ticked. Open the simulation ready to use

Predict. How do you think the particles of ice move? And those of steam? What is there between the particles of steam?

My prediction

Observe. Press “Off” in each state and look at the “WHAT WE CANNOT SEE” panel.

State	How are they arranged?	How do they move?	Are there bonds between them?
Solid			
Liquid			
Gas			

Explain.

1. Do the particles themselves change (their size or shape) when they go from solid to liquid to gas? What changes, then?
2. What are the bubbles that come out of water when it boils?
3. What is there between the particles of a gas?

My answers

Activity 3. With a stronger flame, does it boil at a higher temperature?

Set up the simulation: water, hotplate at **+100 %** and speed ×2. Open the simulation ready to use

Predict. With twice the power of activity 1, at what temperature do you think the water will boil? How long will the boiling last?

My prediction

Observe. Press “Restart” and compare with what you wrote down in activity 1.

Power	Boiling temperature (°C)	How long boiling lasts (min)
+50 % (activity 1)		
+100 %		

Explain. What does the stronger flame achieve? What does it not achieve? Use the bar “Where did the energy supplied go?” to explain what the energy is used for while the water boils.

My explanation

Activity 4. Cooling

Set up the simulation: water, hotplate at +100 % and speed ×4. Wait until all the water has turned into steam and then press ❄ **Cool**. Open the simulation ready to use

Predict. When the steam starts to cool, which changes of state will happen and in what order? At what temperatures?

My prediction

Observe. Write down the changes of state named in the strip at the top.

Change of state	Temperature (°C)	What do you see in the container?

Explain. Is it right to say that when we cool something we “add cold”? Look at the arrows on the hotplate.

My explanation

Activity 5. Each substance has its own temperatures

Set up the simulation: Heat and cool mode, substance **alcohol (ethanol)**, hotplate at +100 % and speed ×4. Open the simulation ready to use

Predict. Do alcohol and nitrogen melt and boil at the same temperatures as water?

My prediction

Observe. Make the curve for each substance and read the temperatures of the plateaus on the graph or on the thermometer.

Substance	Melting point (°C)	Boiling point (°C)	At 20 °C, what state is it in?
Water			
Alcohol			
Nitrogen			
Iron			

Explain. Why do we say that melting and boiling points are **characteristic properties**? What could they be used for in a laboratory?

My explanation

Activity 6. Challenge: dry ice

Set up the simulation: substance **dry ice (CO_2)**, hotplate at +100 % and speed ×2. Open the simulation ready to use

Predict. Dry ice is solid CO_2. When you heat it, will it turn into a liquid like water ice does?

My prediction

Observe. Press “Restart” and look at the container, the graph and the strip at the top.

How many plateaus does the graph have?	At what temperature?	What is the change called?	Does any liquid appear?

Explain. Why is dry ice used to keep things cold without getting them wet?

My explanation

Apply what you have learnt

Answer without the simulation.

1. Name the six changes of state and say whether, in each one, energy has to be given to the substance or taken away from it.

2. Draw the cooling graph of water from 120 °C down to −20 °C and label each section with the state and each plateau with the name of the change.
3. An unknown substance melts at −114 °C and boils at 78 °C. Which one from activity 5 could it be? What state is it in at 0 °C?
4. You put two identical pans of water on the hob, one on a high heat and the other on a low heat. When both are boiling, which one is hotter? Justify your answer.

Question	Answer
1	
2	
3	
4	

Review your ideas

Go back to the “Before you start” table. Would you change any of your answers? Write which one and explain why, using something you saw in the simulation.

What has changed in my ideas

Going further (Year 11): pressure

Set up the simulation: Pressure and temperature mode, water, at 1 atm and 20 °C. Open the simulation ready to use

1. Press the “Top of Everest” example (0.33 atm) and raise the temperature with the slider. At what temperature does water boil there? Why is it hard to cook pasta at the top of a mountain?
2. Press “Pressure cooker” (2 atm). At what temperature does water boil? Why does food cook faster in a pressure cooker?
3. Go back to 1 atm and 20 °C and lower only the pressure. At what pressure does water boil at 20 °C without heating it?

My answers

My answers

Self-assessment

Put an X to show how confident you feel at the end.

I can...	Yes	Nearly	Not yet
Name the six changes of state			
Describe how the particles are arranged and how they move in each state			
Explain why the temperature does not change during a change of state			
Interpret a heating or cooling graph			
Use a prediction and an observation to change an idea I had			

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