Fizzics Education

Phase change science

Changes of state
Video: supersaturated solutions
Experiment 1: Increasing ice
Experiment 2: Make super toffee
Experiment 3: Microwave soap
More phase change activities

Changes of state

Bored with your outer solidity? Want to be more fluid? Why not change your state? Many things around you – from freezing water to cooking eggs – undergo change of state or phase changes, that is their physical properties change from liquid to solid (freezing), liquid to gas (boiling) or solid to gas (sublimation), to name a few. Without freezing, melting, evaporation and condensation there would be no weather, oceans, or rock formation - the Earth would never have crystallised out of the liquid that formed from the swirling cloud of gas and dust around the Sun.

You may think your body is an exception, but changing states is also an important physical process within the body – like blood coagulating into blood clots and forming scabs, for example.

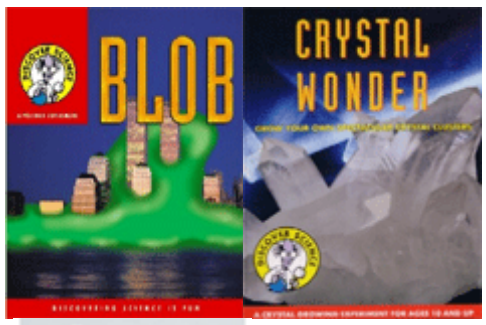
It's generally accepted that there are five states of matter: solid, liquid and gas, Bose-Einstein condensates (BEC, very low temperature matter), and plasma (highly energised matter).

Phase change lends itself to some great experiments (who can resist putting some soap in the microwave). You can also grow your own crystals, freeze yourself some toffee, or investigate the volume change in water and ice.

Video: supersaturated solutions

Insert video image
By adding heat you can force more of a solute (the stuff that's being dissolved) to dissolve into the solvent, creating a supersaturated solution. When the solution experiences a change in pressure or temperature, it causes the solute to rapidly precipitate. You can download a pdf of instructions for the sodium acetate experiment from Sci tech.
Click to play video

Experiment kits showing phase changes:




Just a few found on our website!

Experiment 1: Increasing ice

You will need
Water
A measuring cup
A freezer

Instructions: Carefully pour water into a small measuring container - those used for medicines are ideal. Check the level, and then freeze for about an hour. Check the height of the ice cube that forms – is it higher or lower than before? Can you notice any other effects of expansion, such as bulges and

'Matter of' facts:

Jelly is an example of a colloid, an assmeblage of colloidal particles (particles that are larger than molecules but too small to be seen without a microscope). Smoke in air is a colloid, as is egg white.

The change from glassy to amorphous states in chalcogenide glass is utilised in phase change memory (PRAM), touted as the next generation of random access memory (RAM).

Bose-Einstein condensates form at less than one-millionth of a degree above -273 degrees C - absolute zero (the coldest anything can get).

The 'Z machine', a particle accelerator at the Sandia Natioanl Laboratories in New Mexico created a plasma that reached a temperature of 2 billion degrees Kelvin.

Carbon nanotubes have a tensile strength 50 times stronger than steel.

See a 2 metre flour fireball Fizzics Education conducted at the...

... a massive change of state...
(courtesy ABC News)

cracks? Try this with a baloon and use Vernier Callipers to measure the change in diameter (you'll need to hang the balloon to keep it round).
Results: Ice is one of the few materials that expand when frozen. Crystalline solids are characterised by tightly packed molecules. Heating into a liquid causes the molecules to become excited and move about more quickly. Water is different because of the effects of hydrogen bonding. The crystalline structure of ice has gaps in the molecular structure that make it take up more volume than water, which fits together very nicely because of the way hydrogen and oxygen moelcules are arranged (more on this here). The crystal structure of ice also makes it less dense than water, which is why ice floats.

Anyone who has left a can of soft drink in the freezer has seen this happen, i.e. the can bulges and can break... just don't do it deliberately at home!

Experiment 2: Make super toffee

You will need
A saucepan
Sugar
Water
Food colouring
String or a seed crystal

Instructions: There's a myriad of toffee recipes, here's just one. The experiment is similar to growing salt crystals, except the supersaturated sugar solution is hot, so have an adult handy.

What's happening? Toffee is made from a supersaturated solution of sugar and water. Sugar is dissolved in heated water. When it cools, the sugar crystallises. Seed crystals or a rough string help the crystals nucleate and start to grow – crystals growing from molten rock in a magma chamber work on the same principle.

Experiment 3: Microwave soap

You will need:
A microwave-safe bowl
Houeshold soap (wet soap works best, so use an old bar of soap from the shower)

Instructions: Place the bar of soap in a microwave-safe dish and zap it on high for between 30-60 seconds. You may need longer for low power microwaves. Watch as a foamy mass grows from the soap!

What's happening? The water inside the soap is undergoing a phase change from liquid to water vapour, and expanding. The foamy effect also comes about from the expansion air bubbles trapped inside the soap. Basically by heating the soap and expanding water and air inside you end up with this lovely warm soapy foam (careful; do not touch until the soap is cool). I used a small bar of soap and zapped it for about a minute.

More phase change activities

Fizzics: Supercooled water can make instant ice crystals

Fizzics: Does hot water freeze faster than cold water?

BBC science clips: changes of state

looks after our own hedging, tree pruning and lawns so we know they do the job right!

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or send an email from their website to find out more.

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