SCIENCE MUSEUM

WONDERLAB: THE EQUINOR GALLERY

The science and maths behind the exhibits

INFORMATION	Age 7–11 11–14	Topic MATTER	30 MIN
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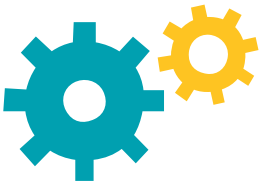
What's the science?



What more will you wonder?
The science and maths behind the exhibits

Wonderlab: The Equinor Gallery is packed with over 50 hands-on experiments and experiences. You need to look closer, ask questions and get creative to discover what they're all about.

If you're still curious you can find out more about the science and maths behind each of the exhibits using these handy resource packs. Check out each of the seven zones that you'll find in the gallery.

Matter

Materials can look and behave differently. You can explore these various properties by making mist flow or catching the moment a droplet falls into water. Discover how materials can also change state and how this can alter their properties.

Find out more about the science behind the Matter zone exhibits in this pack.

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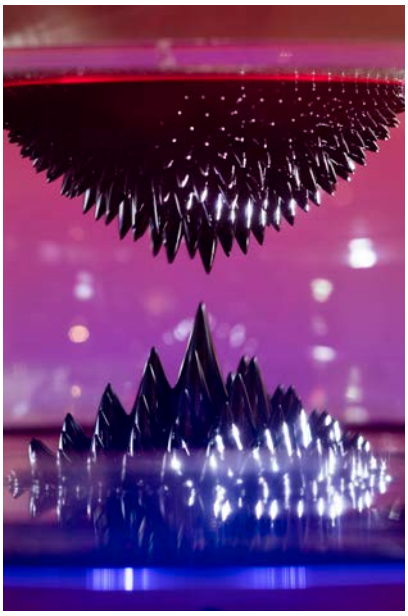
The science behind the exhibit



Magnetic Liquid contains a special material called a ferrofluid, which has some interesting properties. Ferrofluids are made from magnetic material that has been ground into an extremely fine powder and suspended in a liquid. This effectively means that the magnetic particles are evenly distributed throughout the liquid, giving it an overall magnetic property.

Liquid is a state of matter where the particles are quite close together but are still arranged randomly with weak forces of attraction between them. This means liquids have a fixed volume at a given temperature but no fixed shape. This causes liquids to take the shape of the container that holds them. These weak bonds also mean that liquids can move easily and can flow.

Magnetic materials, such as ferrofluids, are attracted to magnets and electromagnets. This attraction acts at a distance. As liquids are defined by their ability to flow and take the shape of their container, the ferrofluid is able to flow towards the magnet, attracting it from a distance. This creates spiky patterns that form along the magnetic field lines of the magnet. When the magnet is strong or close enough to the ferrofluid these spikes can become very long and attach to the magnet itself.

By controlling the distance or strength of the magnet you can create strange and beautiful spiky patterns with the ferrofluid.

The science behind the exhibit

This is no ordinary waterfall. Although the droplets are always falling downwards, it doesn't always look like it.

Behind each stream of water is a set of flashing lights. These lights are flashing so fast our eyes can't detect it. As the lights flash they illuminate the drops of water for a short span of time – enough for our eyes to see them. But in the time it takes for the next flash to happen the drops have fallen a short distance and there is now another droplet in the same place where we saw the last one. Because the droplets look very similar this tricks us into thinking it is the same droplet and that it hasn't moved.

If you slow down the speed of the water drops, the second droplet won't have fallen quite as far before the light flashes again. This makes it appear as though the water drop has moved upwards!

This strange illusion is due to the way we can mistake one water drop for another because of their similar round shapes. Water is a liquid and liquids have no fixed shape but instead take the shape of their containers. So what shape does a liquid take when there is no container?

When water falls it is in no container and the shape it takes is a sphere. All water drops have a similar round shape when they fall. This is due to a property of water called surface tension. Surface tension is the result of the strong forces of attraction between water molecules. When water droplets are in free fall the surface tension makes them take the smallest shape possible, which is a sphere.

The science behind the exhibit

Water Drop Photography explores the shape of water. Water is a liquid, which means it has a fixed volume but no fixed shape. This means water, like other liquids, takes the shape of the container that holds it.

However, when water is no longer in a container it takes the shape of a sphere. This is due to a property of water called surface tension. Surface tension is the result of the strong forces of attraction between water molecules. When water droplets are in free fall the surface tension makes them take the smallest shape possible, which is a sphere.

As the droplet falls it will keep this sphere shape until it hits the pool of water beneath it. When the droplet hits the water it causes the liquid in the container to change shape. The force of the droplet hitting the liquid can make the pool of water jump up into a splash and then ripple outwards until the liquid settles down again into the shape of the container. The droplet is now incorporated into the main body of the liquid.

We can make it easier to see the shape of water by taking a high-speed photograph at the moment the water drop falls. High-speed photography works in a similar way to regular photography. To take a good photo at high speed the camera needs a flash with a very short duration. The shorter the burst of light from the flash, the shorter the amount of time the film is exposed to light, and the easier it is to capture the droplet falling and the splash it forms in the water.

In this exhibit you can vary the time of the flash and try to capture an image of a water droplet as it falls or as it splashes into the water cup.

The science behind the exhibit

The Icy Bodies exhibit looks at two materials, dry ice and water, and their changes of state. Solids, liquids and gases are called states of matter. Materials can be changed from one state of matter to another by a change in temperature or pressure. Normally when a solid material is heated it will melt into a liquid. However, some materials such as dry ice (carbon dioxide) turn straight into a gas when their solid form is heated.

Carbon dioxide is unusual because it has a very high pressure point. When solid carbon dioxide is heated at normal air pressure there isn't enough pressure to keep the molecules in liquid form. Instead the molecules have enough energy to escape completely as a gas. This means that carbon dioxide, also known as dry ice, turns from a solid straight into gas in a process called sublimation.

When a pellet of dry ice (solid carbon dioxide) is released onto water it warms up and sublimates into carbon dioxide gas. The gas creates a cushion of air beneath each pellet. This cushion reduces the friction between the pellet and the surface of the water that it is floating on, allowing the force of the gas being released to propel the dry ice across the surface of the water. The irregular shape of the pellet causes more gas to be released where the surface area is greater, making the pellet move in one direction or even in circles.

Carbon dioxide will sublimate at temperatures above −78.5˚C. This means that at room temperature the dry ice pellet is still very cold. This causes the water vapour gas in the air around the pellet to cool down. When water vapour cools it condenses into a liquid. This causes tiny water droplets to form, which we see as mist. As the pellet moves across the water it creates these misty trails of condensing water vapour behind it, wherever it has last been.

The science behind the exhibit

Watch Water Freeze shows the changes of state of both freezing and melting. The three states of matter are called solid, liquid and gas. When there is a change in temperature or pressure for a material this can lead to a change in its state. Every material has a different set of temperatures and pressures at which it changes state. Water freezes from a liquid to a solid at 0˚C at atmospheric pressure. When ice is heated above 0˚C it will melt back into a liquid.

Solids have strong bonds between their molecules. When water freezes the molecules line up to form these strong bonds and create feather-like spiky structures, called ice crystals. These ice crystals can be revealed with a polarising filter. As the crystals form they don't grow equally because some areas of the structure have more strains and stresses than others.

When light hits the stresses and strains in the crystals this causes light to be reflected back in different directions. When you look through the polarising filter the wavelengths of light that lined up with each other in the same direction will get through the filter and we can see this as colours. This means the polarising lenses allow us to see the shapes of the ice crystals.

When water is added onto the ice it heats up the crystals, causing them to melt and the colours to disappear. This can also happen if you place your finger on the ice. However, the cold surface will make the ice crystals regrow quickly so they can be seen once again through the polarising filter. The ice crystals will grow differently each time, so you will see different patterns or shapes.

The science behind the exhibit

Cloud Rings is all about how gases move and flow. Gas is a state of matter where the particles are widely spaced apart with almost no forces of attraction between them. This means that a gas has no fixed shape or volume and always spreads out to fill a container. It also means that gases can flow, like liquids do. Therefore both liquids and gases are known as fluids.

In the Cloud Rings exhibit a pool of smoke is created in a central chamber. When you push down on the top part of the chamber this causes the gas to flow out of the narrow opening. If the smoke is pushed out of the opening quickly enough this causes smoke rings to form, which travel up to the ceiling.

Cloud rings, also known as vortex rings, are formed when fluid is forced quickly out of a narrow opening. The ring is generated because the fluid exiting the opening is not all moving at the same speed. Towards the centre of the hole the fluid travels faster than the fluid at the edge of the hole. This is because the outer parts of the fluid are slowed down by the edges of the opening around it. This makes the central part move faster relative to the edges and causes the gases to flow in a doughnut shape.

The mist is what makes the ring visible, but it doesn't interfere with the ring's movement. Cloud rings can happen in any gas or liquid, but they aren't always visible as the fluid creating the ring can look similar to the medium around it. Here the mist scatters the light hitting it, making the smoke rings visible.

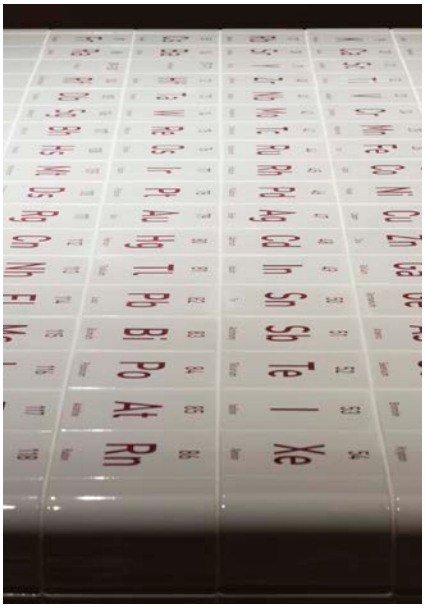
The science behind the exhibit

Clouds and mist are made from tiny water droplets. Clouds form when water vapour in the air rises and cools. When water vapour cools it changes state from a gas into water in a process called condensation. These tiny water droplets are light enough that they float in the air. When many of these tiny droplets are formed near each other they become visible as clouds or mist.

Both liquids and gases can flow easily because they have no fixed shape. This means that clouds and mist can move and flow easily through the air. When you touch or blow the mist in this exhibit it will move and swirl in interesting shapes.

The clouds we see in the sky behave in the same way. Winds can blow clouds across the sky and you can see them moving and changing shape. When enough water droplets form inside these clouds the droplets become too heavy to stay afloat and fall as rain. Sometimes they might become so cold that the droplets freeze and change state from liquid into solid. Then the droplets become ice crystals and eventually fall as hail or snow.

The science behind the exhibit



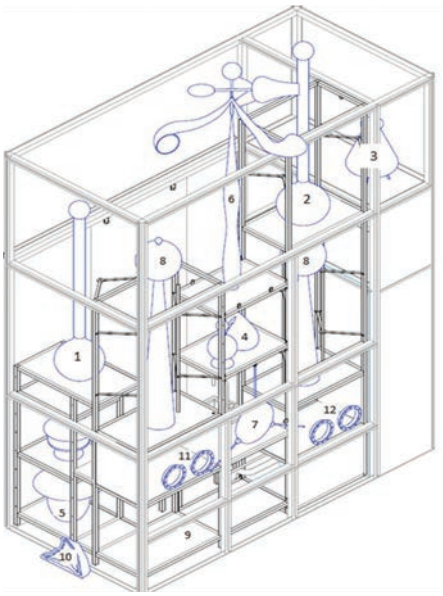
The Chemistry Bar focuses on the properties of different materials, and how their properties will affect how they look and behave. Over time materials can change state and undergo chemical reactions.

On display in the cabinet are lots of slow experiments. Some of these experiments include crystallisation, where water will evaporate from a container slowly over time. This evaporation leaves behind the sugar or salt that was in the solution. The sugar or salt appears as solid deposits on the object in the container. It will be deposited in layers, gradually forming crystals on the object, which will appear to grow slowly over time.

The cabinet also contains feely boxes where you can explore unusual objects. Inside the boxes are different materials with various properties – for example mercury, the only liquid metal element. You can use your skills to investigate these objects further to find out more about their properties.

You also might notice our giant periodic table, which shows the complete table of the elements with their chemical symbols and numbers. Examples of these elements and their properties may be found in other parts of the Chemistry Bar, such as liquid nitrogen used in live demos or mercury in the feely boxes.

1 **Water Thermometer**
2 **Water Barometer**
3 **Gold Pot**
4 **Chemistry Garden**
5 **Salt Maker**
6 **Windmill**
7 **Glass Lens**
8 **Underwater Fountain**
9 **Laboratorium**
10 **Amethyst**
11 **Glove Box**
12 **Glove Box**



The science behind the exhibit

1 Water Thermometer
This piece is a huge glass thermometer. The main chamber contains 70 litres of red-coloured water. The water expands and contracts with temperature changes. In the neck of the glass is a narrow capillary tube that the water travels up and down as it expands and contracts.

2 Water Barometer
This is a simple barometer. The container is closed and gives an indication of the air pressure of our atmosphere. A tall tube is standing upside down in a pool of water so that the water rises partly up the tube. Air pressure pushes down on the pool of water and makes it rise up inside the tube. As the air pressure changes so does the height of the liquid in the tube.

The Water Barometer's shape is inspired by the old nautical storm glass.

3 Gold Pot
The Gold Pot contains gold-coloured powder dissolved in water. The flask also contains oil and a small pump. As the pump pushes the gold-coloured liquid and oil around the flask you can clearly see the currents forming.

This pot of 'liquid gold' is inspired by the beginnings of chemistry. For centuries there was a search for the 'philosopher's stone', which was said to turn other metals into gold.

4 Chemistry Garden
Iron chloride and water glass (sodium silicate) are mixed together in this experiment. The iron chloride starts to dissolve in the water but then forms insoluble iron silicate by a double decomposition reaction. The crystals formed look like plants and grow upwards.

5 Salt Maker
In the Salt Maker salt is dissolved in hot water. Crystals will form on the string suspended in the solution. As the solution cools and the water evaporates, crystallisation begins on the rough surface of the string.

The science behind the exhibit

6 Windmill
Windmills use the energy of the wind to rotate. This glass windmill is partly powered by air currents in the gallery, but is also given some help from a few small motors.

7 Glass Lens
This lens is made from glass filled with water and then sealed for ever. As the lens has curved surfaces light is bent through refraction, meaning the light rays change direction as they pass through the glass.

8 Underwater Fountain
The two Underwater Fountains are mixtures of coloured water and oil. These materials have different densities and don't mix. The oil forms a layer on top of the water. As we pump air through the mixture the coloured water is bubbled up through the oil and then falls back to the layer of water again.

9 Laboratorium
Laboratorium connects together a series of flasks of coloured water. Every few minutes air is pumped through the flasks. Both air and water are fluids and can flow. As the air moves through the water they both move and change shape.

10 Amethyst
Amethyst is a form of quartz crystal that is violet in colour. Amethyst geodes form when large crystals grow inside the open spaces inside rock.

11 and 12 Glove Boxes
The Glove Boxes contain a range of different materials that have different properties. Properties are how a material looks and behaves. Some of the materials are shiny, others are spiky or squishy or heavy or hard. You can compare the different properties of the materials by handling them using the gloves.