chillistick

Fun Experiments

Entertaining science for small kids and big kids!

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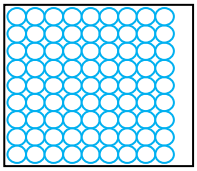
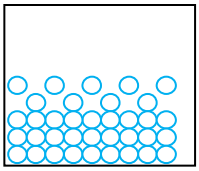
1. States of Matter

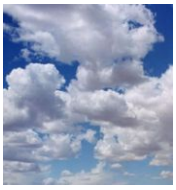


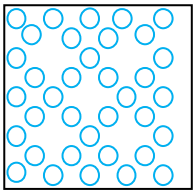
In a solid the particles are tightly packed together and can hardly move. A solid keeps its own shape unless we cut it or shape it ourselves. Anything you can take hold of is a solid.



The particles in a liquid are not so tightly packed. They can move a little. Liquids are runny and flow downwards. They take the shape of the container they are in. The surface of a liquid stays level.

Gas





The particles in gas have lots of room and move around all over the place all the time. Gases are all around us, spreading into any empty spaces they can. Most gases are invisible.

2. Changing States

At normal pressure most chemical compounds and elements possess all three states, each produced at a different temperature. Usually the transition from the solid to the gaseous state requires an intermediate liquid state. When you heat molecules up they take up more space and move around faster. We use heating and cooling to change through the states of matter.

For example; if we **MELT** a solid ice cube it turns into liquid water and if we **EVAPORATE** the water it turns into a gas - water vapor. To reverse these effects, if we **CONDENSE** the water vapour it will turn back to water and if we **FREEZE** the water it will turn back to ice.

3. Carbon Dioxide and Dry Ice

Carbon dioxide (chemical formula CO_2) is one of the primary greenhouse gases in the Earth's atmosphere. We breathe out carbon dioxide as a waste gas, but plants that photosynthesize use carbon dioxide to survive. Dry ice is not ordinary ice - it's not made of water. Dry ice is a solid form of carbon dioxide.
Dry ice is easily manufactured. First, gases with a high concentration of carbon dioxide are produced. Second, the carbon dioxide-rich gas is pressurized and refrigerated until it liquefies. Next, the pressure is reduced. When this occurs some liquid carbon dioxide vaporizes, causing a rapid lowering of temperature of the remaining liquid. As a result, the extreme cold causes the liquid to solidify into a snow-like consistency. Finally, the snow-like solid carbon dioxide is compressed into solid pellets, slices and blocks of dry ice.

Dry ice is -79°c; this is much colder than the temperature of your freezer at home which is around -18°c. It is so cold that it prolonged contact with bare skin would result in frostbite. So when handling dry ice protective gloves MUST be used at all times and safety procedures must always be followed.

4. Dry ice and Sublimation

Normal ice melts to a liquid. Dry ice misses out the liquid state and turns into a gas at atmospheric pressure. This is called SUBLIMATION. When a solid changes to a gas without passing through the liquid phase it SUBLIMATES. When dry ice sublimates it creates CO_2 gas which is heavier than air and is also invisible. There is no liquid phase, and hence it is called 'dry' ice!

Dry ice will sublimate quickly at room temperature as the temperature difference is nearly 100°c (from -79°c to +19°c) If the temperature difference increases the dry ice sublimates at a faster rate. Even just breathing on a piece of dry ice will accelerate the process.

5. What is dry ice used for?

The most common use of dry ice is to package items that need to remain cold or frozen, such as biological samples and perishable goods. It can also be used to flash freeze items including foods, pharmaceuticals and laboratory biological samples.

When shipping important items overseas or long distances, it is vital to consider the insulation of transport container, heat transfer, quantity of ice, duration of the journey, delays in journey, ambient temperature at departure (and destination if overseas).

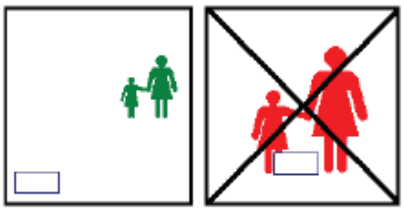
Alternative uses of dry ice include fog machines in theatres, to freeze and remove warts, freeze branding animals and in blast cleaning.

6 Dry Ice Safety

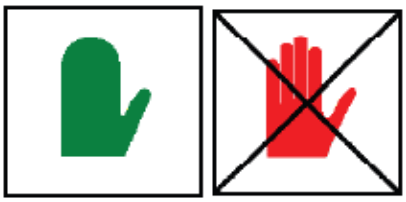
Dry ice is vital for many activities, and is also great fun when used safely. Always follow safety guidelines, prepare hazard assessment and ensure that all experiments are age appropriate.
Here are some basic important safety tips, but for more information please download Material Safety Data Sheet available on our website:

http://www.chillistick.co.uk/safety-c-322.html

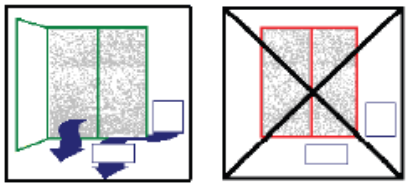
Always ensure a responsible adult is in charge of the ice, keeping it away from unsupervised children. **Do not** put dry ice in drinks, unless using a Chillistick, which has been specifically designed for this purpose.



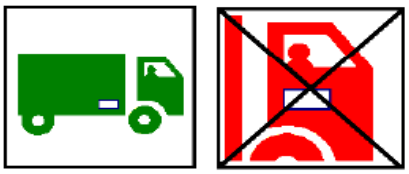
Always handle dry ice with protective gloves; dry ice is extremely cold (-78°c) and direct contact with bare hands or skin can cause frostbite.



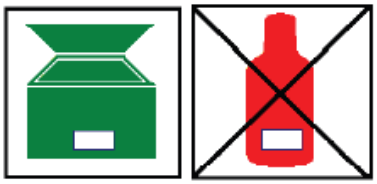
Always use dry ice in a well-ventilated environment; it sublimates into large quantities of carbon dioxide gas, which could displace oxygen-containing air and pose a danger of asphyxiation.



When transporting dry ice **always** ensure that there is good ventilation within the vehicle and that windows are at least partly opened. Where possible, secure the package during transit and isolate dry ice from the driver in a suitable container. Use well-insulated storage containers that will prolong the life of the ice and reduce the build-up of CO_2 gas



Do not place dry ice in any air tight container. Dry ice sublimates quickly and will rapidly build up pressure. If you are using glassware in any of the experiments ensure that the glass is Pyrex - this will not crack when subject to rapid cooling and heating as envisaged here.



7.1 Hot Water and Dry Ice

Add a small quantity of dry ice (around 30g) to a small Pyrex glass beaker or conical flask and pour around 200ml of hot tap water (no more than 50) over the top. You will observe the dry ice rapidly sublimating, producing a large volume of carbon dioxide. The white fog is not CO_2 gas, but an aerosol of tiny water droplets which refract light and look like mist, which is what it is! (CO_2 gas is invisible.)

7.2 Pouring Carbon Dioxide

Add a small quantity of dry ice to your selected Pyrex glassware and pour hot tap water over it, approximately in the ratio of 30g of dry ice to 200ml of water. You will immediately see white 'smoke' being produced. Hold the glass and tilt it a little being careful not to pour any liquid out. The white vapour is an aerosol of tiny water droplets being carried in a stream of CO_2 gas. Observe as the gas flows down the edge of the glass and sinks to the floor, please remember:CO_2 gas is invisible! CO_2 gas is 50% heavier than air and so the white smoke tends to fall to the floor. (molecular weight of air is 27; molecular weight of CO_2 is 44.

7.3 Spooky Scene

Ask the students to sit in a circle. Put around 200g of dry ice in a plastic bucket and pour around 3 litres of hot tap water in. This will produce a spectacular fog effect which will pour out of the bucket and creep along the floor. Some scary films use this for special effects for scary fog effects!

7.4 Gas Fire Extinguisher

Repeat experiment 7.2. Light a candle and place it on the table in front of you. Pour the CO_2 gas over the flame and watch it go out. The flame will be extinguished as the area is starved of oxygen. There are several types of fire extinguishers; each with different agents designed for specific fire hazards. Some extinguishers (black) contain carbon dioxide and are used on flammable chemical or electrical fires. Other extinguishers contain water (red), cream (foam) or dry powder (blue).

7.5 Instant Bubbles

Repeat experiment 7.1 and this time add some washing up liquid into the container, or better still some bubble solution. Bubble solution makes better bubbles than washing up liquid, here is a tested recipe:

250ml washing up liquid
250ml glycerol (or glycerine)
4l Water

Add some dry ice and pour hot water over it. Watch as the glass overflows with sparkling bubbles. Pop a bubble and see the CO_2 gas released the before your eyes. As the dry ice sublimates in the bubbly liquid, the gas becomes trapped in the bubbles and is released when it's popped.

7.6 Tasty Gas and the Blackcurrant Cloud

Repeat 7.2: let your volunteer taste/smell the gas. What do they think the gas tastes like? – like burps??! Carbon dioxide is in carbonated fizzy drinks and dry ice is CO_2 in its solid form so if we drink a lot of soda we burp!! For a spectacular effect fill a large plastic bucket half full with hot tap water. Add to this about 1/3rd of a bottle of Ribena or other squash. Using a scoop add dry ice in the ratio of 30g of dry ice to 200ml water. Can your volunteers smell the flavour? It should be very apparent. The CO_2 gas is bubbling through the juice, on breaking the surface the bubble collapses. This atomises a small quantity of the juice into the atmosphere, and to your nose!

7.7 Screaming Metal

Place a piece of dry ice on a towel or similar soft surface and press a metal object such as a spoon onto the ice. Can you hear the high pitched screeching sound? When the room temperature metal touches the very cold dry ice it causes a thin layer of dry ice to sublimate. The CO_2 gas pushes against the metal triggering vibrations that result in the noise. What happens when the spoon is placed in boiling water first and then put against the ice?

7.8 Self-Inflating Balloon

Place around 10grams of dry ice inside a balloon. Add about 100ml of hot tap water, then tie the balloon and leave it in a place for a few minutes to observe what happens. As the dry ice is sublimating, the gas will make the balloon expand. To fully inflate you may need to place the balloon in a hot water bath or under a hot tap. The energy from the water is making the dry ice sublime, and the volume difference between solid dry ice and CO_2 gas is about x 800 fold, so the balloon gets bigger!

7.9 Let It Blow!

Place one piece of dry ice (about 4grams) in a 35mm film canister and put the cap on. Turn the canister upside down on its lid, pointing it away from people. As the dry ice sublimates, the pressure from the gas builds up and the plastic cap pops off. You've made a canister cannon!! *WARNING*: Never do this with screw cap bottles. You may feel more comfortable putting a bucket or a thick plastic bag over the canister so that it cannot fly off and alarm anyone, be warned the noise as the cap blows off is quite loud!

7.10 Gas Catherine Wheel

Use a drawing pin to create two holes in opposite sides at the bottom of a 35mm film canister. Push the holes in at an angle so they are pointing out like a pinwheel (Catherine Wheel) firework. Trap a thread under the lid, add on piece of dry ice and warm water to the canister, replace the lid and hold it in the air by the thread. As the dry ice sublimates and builds up pressure, gas escapes through the holes, spinning the canister around.

7.11 Smoking Drinks

Dry ice should NEVER be put directly into a drink in case of accidental ingestion. If you want a fun way to add atmosphere to a party at School consider the Dragon Mist Juice Jug provides great mist effects that children and adults will simply adore. Perfect for any celebration, party and table top decoration.

How does it work? The jug has 2 compartments one for the drink and the other for the dry ice. Simply fill the jug with the drink you require. Add dry ice to the centre piece and just add water.... immediately the drink will start to bubble, creating a thick water fog which looks very cool. The white fog is composed of tiny droplets of water - just like mists formed in nature. The mist spreads the odour of the drink so that you smell the drink before you taste it!

Please remember: adult supervision at all time.

7.12 Gigantic bubble

For this experiment you will need: a large round bowl, a strip of cloth longer than the diameter of the bowl and a bowl of detergent.

Run the cloth saturated in detergent around the edge of bowl - be careful not to drop any bubble solution into the bowl. Soak the strip of cloth in the bowl of detergent. Fill the large round bowl with hot water and bubbling dry ice. Then make the cloth taught and drag it tightly over the top of the bowl making a film of detergent. As the dry ice continues to sublimate, the bubble fills with dry ice until it's so big it explodes and releases CO_2 everywhere!

http://www.youtube.com/watch?v=76CNkxizQuc&feature=related

7.13 Floating Bubble

For this experiment you will need: a large container and some bubble solution.

Put some dry ice in a large container and add cold tap water in the ratio of 40g of dry ice to 200ml of water. The dry ice will sublime to a gas which being heavier than air will stay in the container to form a cushion of CO_2. Here we are not trying to make smoke, but rather create an atmosphere in the container of CO_2 gas. Using bubble solution blow bubbles into the container and watch them hover as the air in the bubble is supported on a cushion of CO_2. Because carbon dioxide is denser than air, it can support the weight of the bubble.

7.14 Dry ice shower and bouncing bubbles!

For this experiment you will need: to watch the video in the following link to construct a shower tube: http://www.youtube.com/watch?v=pP_lZaOchE0

Add warm tap water to the container and when ready add some dry ice in the ratio of 40 grams to 200ml of water. Replace the top and fog will come out of the shower spout. Go around the room and give children a dry ice shower! Dip the end of the tubing into some detergent or bubble solution and watch as CO_2 filled bubbles are produced! Try catching them in your gloved hands.

7.15 Climb the PH scale

For this experiment you will need: universal indicator (or boiled red cabbage juice) and sodium hydroxide (or a household cleaner or detergent).

Take a beaker of hot water and add a few drops of universal indicator. Universal indicator changes colour on contact with acids or alkalis and is a gauge of a liquids pH. The water will be green and indicates that it is neutral (if using red cabbage juice will be red/purple). Add some sodium hydroxide to the liquid and observe a colour change from green to blue/purple. This indicates that sodium hydroxide is a strong alkali. Add a few pieces of dry ice and watch it bubbling away and changing the colour again. You should observe it going back up the pH scale past green to red indicating that it is acidic. Dry ice or carbon dioxide is an acidic oxide and reacts with water to give carbonic acid.

7.16 Shattering flowers

For this experiment you will need: methylated spirits (denatured alcohol) and a fresh flower or green leaf. **Prepare COSHH assessment and follow all safety rules including using skin and eye protection.**

Add Dry Ice to a beaker of methylated spirits. The alcohol does not freeze like water, but becomes a super cooling liquid. Flowers and green leaves can carefully be dipped into the liquid and will freeze in just a few seconds. Astonishingly the flowers or leaves can be shattered, broken and snapped apart. Why don't you try freezing a banana skin?

7.17 Smoke rings

Probably our favourite experiment! For this you will need: to watch the video in the following link to construct a vortex generator: http://www.youtube.com/watch?v=nQHjExZvuy4

When dry ice is placed inside the generator with some water the fog makes the vortex rings visible. You should be able to observe a doughnut ring shape. You could even have a child blow out a candle using a vortex generator!

7.18 Cloud Chamber

Dry ice is also an essential element of the functioning of a cloud chamber.

A Cloud Chamber is a device used to detect ionizing particles and to determine their trajectories. It does not show the particles themselves, but where they have been. A cloud chamber is in effect a sealed chamber that is cooled so that supersaturation of alcohol or water vapour will occur within it. This means that when an ionizing particle travels condensation will occur about the nucleus of the ions it produces- these are called condensation nuclei, as the vapour in the chamber is on the verge of condensing, much in the same way that water vapour condenses around dust particles in the atmosphere to form clouds. This condensation trail leaves a fine mist that we can see which tells us where the particle was/originated from and the path it has taken from then.

A difference in temperature between the top (heater) and the bottom (dry ice) of a sealed container full of alcohol produces a supersaturated environment necessary for the mist (or cloud) to be formed.

A few Kg of dry ice will provide a few days of operation.

For more information about the cloud chamber loan scheme and demonstrations organised by Dr. Cristina Lazzeroni from the University of Birmingham, see

http://epweb2.ph.bham.ac.uk/user/lazzeroni/outreach/cloud-chamber/

8. Ice-Cream

Using dry ice to make ice-cream and smoothies can be fun for school events. Mrs Zoe Edwards of Wycombe Abbey School made ice-cream for a school event using pre-mixed Smoothies and dry ice. Zoe says, 'it went brilliantly! We had run out of 40 litres of smoothie an hour into our 2 hour time slot! It was so successful that we had a queue forming 10 minutes before we opened the first carton! The dry ice was perfect. I am hoping to do the same activity next year as it is such a winner.' Zoe advises using Innocent smoothies - 'we tried other brands but Innocent was the best. We added one carton at a time to the bowl and then added 2 heaped desert spoons of icing sugar - whisk and then add dry ice whilst whisking - probably no more than 2 or 3 desert spoons at a time.'

The icecream was made using our rice grade pellets. When using dry ice in food preparation, you need to take exactly the same precautions as you would with naked flames, hot pans and baking trays straight out of the oven. Don't let it come into direct contact with your skin or you will get a nasty burn. Make sure all the dry ice used to freeze an ice cream has sublimed before serving.

9. Further information

We hope you enjoy your experience with dry ice and look forward to hearing the feedback from your event. We would love to add new experiments to these notes - please share your ideas!

If you would like some more information on dry ice, ordering, delivery or for a quote please contact Chillistick Ltd at http://www.chillistick.co.uk and on 08433 192919.

If you have any ideas you would like to share and see added to this educational pack please contact us with your thoughts. For more information on dry ice workshops in your school or on amazing high energy, interactive, sub-zero parties please contact us.