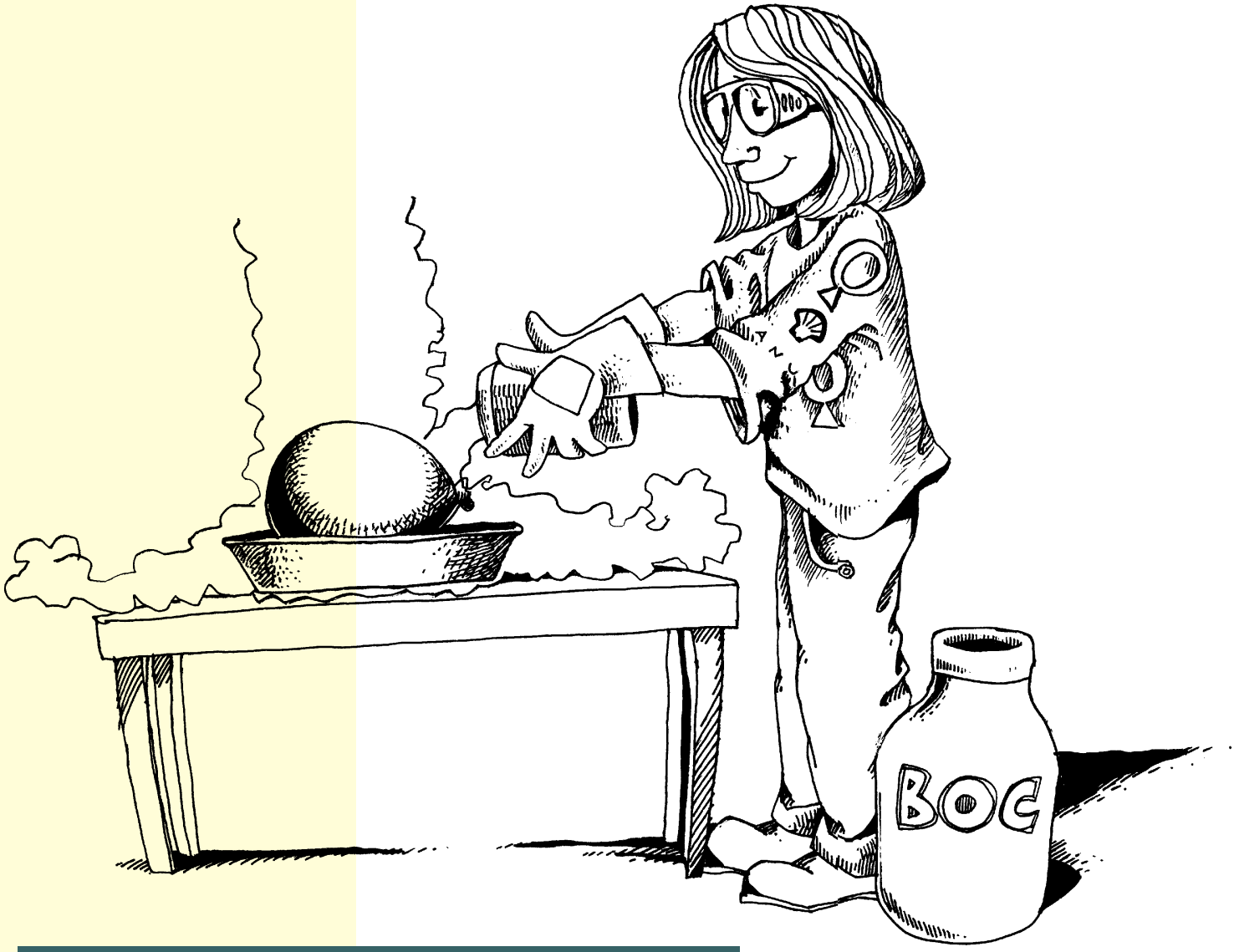
Shell Questacon Science Circus

THE AUSTRALIAN NATIONAL UNIVERSITY

Post-visit resource for teachers

The BOC Liquid Nitrogen Show



Supplementary information for teachers whose classes have experienced the Shell Questacon Science Circus Shows

Thank you for hosting a team from the Shell Questacon Science Circus. We hope you enjoyed our visit.

Our science shows are designed to educate and entertain. Did they spark your students' curiosity?

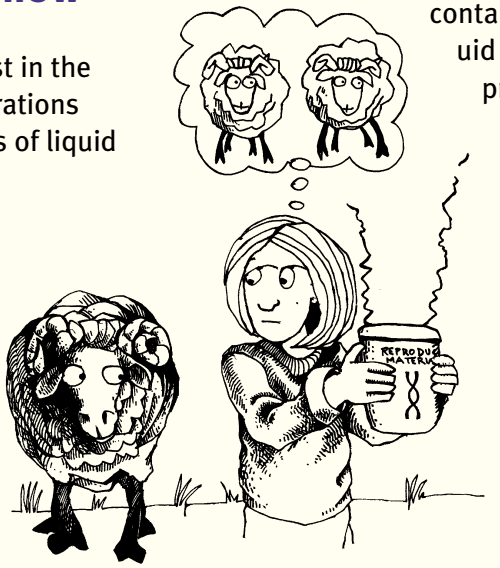
If so, you may be keen to extend the show experience with more activities. Enclosed is information to supplement your own ideas and resources on how to follow-up our visit.

The Liquid Nitrogen Show

This show aims to excite an interest in the properties of matter. The demonstrations illustrate the fascinating properties of liquid nitrogen and show many scientific principles related to everyday life.

Show summary

The Liquid Nitrogen science show varies depending on presenters, time available, age of audience and available materials. The demonstrations are summarised here.



Reproductive cells needed for artificial insemination are stored in liquid nitrogen.

Safety first
The presenter indicates the need for eye and skin protection when using liquid nitrogen. The extremely low temperature liquid is very dangerous.

Fog breath
The presenter gently blows air over the surface of liquid nitrogen. Fog appears because water in the air condenses to form droplets.

Foam eruption
Liquid nitrogen mixed with water and detergent causes a cascade of foam. Water and detergent at room temperature are at least 200°C hotter than the liquid nitrogen. When they are mixed, the nitrogen boils furiously. The turbulence generates a large amount of froth.

Popping tin lids
A small volume of liquid nitrogen is poured into a coffee tin or similar container. When the lid is put on tightly, it pops off with considerable force. Liquid nitrogen expands more than 600 times in volume when it changes from liquid to gas. The build up of pressure resulting from this expansion causes the lid to pop violently.

The Dewar Flask
The presenter explains the structure of the container used to transport and store liquid nitrogen. It has a loose fitting top to prevent pressure build up. It has a double layered walls with a partial vacuum to increase the insulation affect. It is very similar to vacuum flasks used to keep food and drinks hot or cold.

Exploding balloon
A small amount of liquid nitrogen is poured into a side-arm flask. An attached balloon expands rapidly and pops when the flask is stoppered. This is another demonstration of the great volume change with the liquid to gas transformation.

Shrinking balloon
An inflated balloon contracts rapidly when liquid nitrogen is poured over it. It regains its volume when warmed. Cooling the air particles in the balloon lowers their energy levels so they do not move as fast or as forcefully as they do when they are warm. At colder temperatures, there are still as many air particles as it was when warm, but they are packed more closely and not colliding with the balloon as energetically. The properties of the balloon rubber also change. It becomes much less flexible.

Chilled metal
A metal ball and ring are used to demonstrate that metal changes size with temperature. It expands when heating; contracts when cooling.

Shattering balls
Ping-pong and squash balls are super-cooled with liquid nitrogen. They shatter when tapped with a hammer to show the dramatic loss of elasticity at low temperature. Elasticity is regained when the material thaws.

Banana shatter
Bananas, spinach or other plant material are dipped in liquid nitrogen. Living material shatters when tapped with a hammer or crushed with a gloved hand. Unlike rubber or plastic, living material is permanently changed by freezing. This is because the water in cells expands when it freezes. This damages the tissue.

Chilled battery
A small electric circuit (battery, wires, globe) is set-up. When the battery is chilled, the light dims. When it warms, the light glows brightly again. This demonstrates that chemical reactions become slower at lower temperatures.

Safety caution and disclaimer

This show has been developed to be presented by scientists with technical training. It is not implied by the provision of these notes or the show performance that the demonstrations are safe for students or teachers to perform. Liquid nitrogen is a very dangerous substance.

Old tyres can be snap frozen with liquid nitrogen and then shattered. The rubber fragments can then be recycled.

Principles and concepts demonstrated in the Liquid Nitrogen Show

- Scientists are curious about our surroundings. This curiosity leads to questions and ways to seek answers to these questions. Our atmosphere and the gases that it is made from are some of the many things scientists are curious about.
- The atmosphere is a mixture of gases. Most (78%) of the atmosphere is made of a gas called nitrogen. Every breath we take is mostly nitrogen.
- Gas is one of the states that matter can exist in. Matter can also exist as liquid and solid. Changes from one state to another are caused by energy changes which are determined by pressure and temperature. Liquid nitrogen is a spectacular example of this because at very low temperatures (-196°C), nitrogen changes from gas to liquid and vice-versa.
- We normally think of boiling (rapid change from liquid to gas) as being a hot process because we are used to water. Observations of liquid nitrogen makes us re-think the concept of boiling.
- Changes of energy/temperature affect properties of matter. Volume is one of the properties determined by energy/temperature. Flexibility, conductivity, strength and colour are some other properties which change with energy/temperature.
- Nitrogen is colourless, odourless, non-toxic liquid at -196°C. It is solid at -210°C. It is used in the transport of frozen foods, and to provide a cold, inert atmosphere for grinding spices. It is also used extensively by scientists for the preservation of tissues, rapid freezing of samples and researching behaviour of materials at low temperatures. Ice cream manufacturers use it to froth ice cream. Other uses: wart/mole removal; cold-branding of cattle; tenderising meat; storing reproductive tissues and bark removal from logs.

Suggested follow-up activities

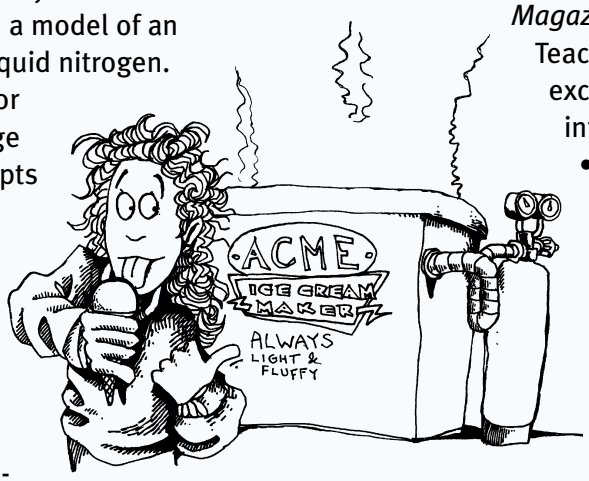
1 Review the show by having students describe their favourite demonstration and explain what it showed. The Show Summary on this sheet may be useful for this exercise.

2 Ask students to explain and discuss other examples from their own experiences where they have seen temperature/energy affect the properties of materials.

3 Discuss or indicate local structures, industries, natural phenomena from your local area which exemplify any of the specific science in the show. For example, bridges or buildings with expansion joints; tyre pressure increasing on hot days; frost damage to taps/pipes; use of liquid nitrogen in any local enterprises e.g. artificial insemination of stock; ice-cream production

4 Storing and transporting liquid nitrogen is a challenge. Set a design project for your students to devise and perhaps build a model of an industrial scale storage tank for liquid nitrogen.

5 Provide time and materials for students to extend their knowledge of some of the phenomena, concepts and inventions mentioned in the show. Examples include atmospheric composition; general properties of nitrogen; other roles of elemental nitrogen e.g. as a source of nitrates; effects of frost and extreme cold on people and other living organisms; expansion and contraction of matter due to temperature change.



Ice cream is made light and puffy by pumping liquid nitrogen into the liquid mix.

6 Ask your students to devise and carry out their own experiments on temperature and fluids. Divide your class into groups (research teams) of 3 for experiment planning. You may like to allocate specific roles eg recorder, equipment manager, communicator within each group. Emphasise the cooperative nature of laboratory work—teamwork is essential in science! Include a good reader in each group. Safety is paramount in any science project. Textbooks and the Internet are useful starting points. Encourage students to gather as much information as they can before they begin to do anything.

Did you know?

An Australian pioneered the technique of freezing embryos. Neil Moore from the University of Sydney developed the method of freezing sheep embryos for export in 1976.

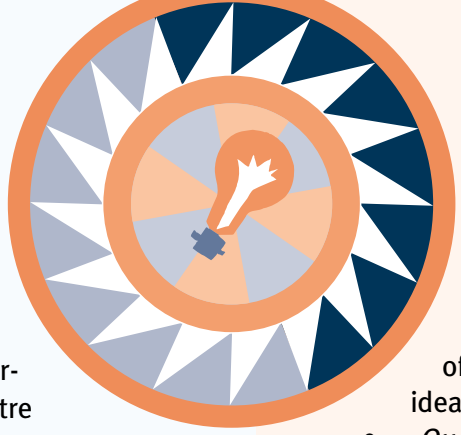
Before any practical work begins, provide a few basic project management guidelines for your students.

7 Look for science activities and demonstrations on the Questacon web site. Go to: http://www.questacon.edu.au/

8 *(For senior secondary students)* Extend studies of phase changes, kinetic theory and energy.

9 Initiate discussion on the general contribution of science and scientists to our culture, economy and environment. For example:

- discuss or find examples of how science and technology have improved our standard of living. There are numerous examples including more productive crop plants; more effective medicines; new and better materials and processes; faster and more reliable communication and information technology; more effective ways of identifying and treating environmental problems; better food production, processing and storage; cleaner and more efficient mineral extraction methods. *Australian Innovation Magazine* (refer to Student and Teacher Resources below) is an excellent source of the latest information.
- discuss past and present examples of people being curious about nature and how scientific study is one way of satisfying our curiosity. For example, compare ancient and modern ways of explaining and studying the weather or the night sky.
- discuss the skills we need to develop for doing experiments. For example, observing, imagining, recording, discussing, interpreting, and designing are a few of the things we need to practice in science. Designing experiments on matter is one of these skills.
- research on the lives and achievements of some of Australia's past and present outstanding scientists. There are numerous people who could be included. eg Macfarlane Burnet; Carolyn Mountford; Gustav Nossal; Peter Doherty; John Eccles; Mark Oliphant; Don Metcalfe; Frank Fenner; William Farrer; Peter Medawar; Kate Helms; Helen Newton Turner; Howard Florey; Nancy Millis;



Ernest Titterton; Bede Morris; Nancy Burbidge; Paul Wild; Susan Serjeantson; Peter Bishop; Elizabeth Truswell; and Kerin O'Dea.

10 Arrange an excursion to Questacon: Australia's leading interactive Science and Technology Centre is Questacon in Canberra. Exhibitions are constantly changing. There are a number of remarkable exhibits which are exciting examples of the science of matter and energy. For example, there is an enormous Tesla coil which regularly discharges 'lightning bolts' which crackle through the air for many metres. There are numerous other fascinating exhibits which model scientific concepts, natural phenomena and inventions. Tel. (02) 6270 2893 for group bookings.

Try this!

Float an ice-cube in water and lay a piece of string over the top. Sprinkle some salt over the string on the ice-cube. Wait a few seconds, then lift the string.

Salt lowers the freezing point of water and causes the ice to melt. The melting ice and dissolving salt absorb heat from the mixture, making the temperature fall to as low as -20°C. The water re-freezes over the string so you can lift the ice-cube!

Student and teacher resources

There are many resources available for inspiration and information. Some of our favourites which contain up to date ideas are:

- *Questacon Exsciter Science kits.* These contain numerous tried and tested ideas and materials for hands-on activities. Tel (02) 6270 2807 for details.
- *Questacon's award winning web site:* http://www.questacon.edu.au/
- *Ingenious CD* Tel. (02) 6270 2807 for details
- *Questacon Mag* Tel. (02) 6270 2855 for subscription details
- *Australian Science (incorporating Search)* Tel. (03) 9824 1699 for subscription details
- *Science Australia* by the Curriculum Corporation (national secondary science texts) Tel 1800 337 405
- *Primary Investigations* by the Australian Academy of Science (national primary science texts) Tel (02) 6247 5777 for a free information package.
- *New Scientist* Tel 1300 360127 for subscription details
- *Scientriffic magazine* Tel. (02) 6276 6643 for subscription details
- *The Helix magazine* Tel. (02) 6276 6643 for subscription details
- *Australian Innovation Magazine* Department of Industry, Science and Resources GPO Box 9389 Canberra ACT Australia 2601 Tel. (02) 6213 6304 or fax (02) 6213 6818
- *Australian Academy of Science web site:* http://www.science.org.au/nova/
- Contact ASTA, PO Box 334 Deakin West ACT 2600 Tel (02) 6282 9377 email: asta@asta.edu.au for information about professional associations.
- An extensive range of kits, books and fascinating science teaching resources are available from the Questacon shop in Canberra or by mail order from Questacon, King Edward Terrace, Canberra ACT 2600 Request a catalogue by Fax (02) 6273 5100 or Tel (02) 6270 2807.

National curriculum links

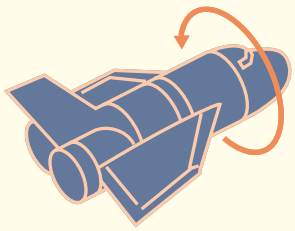
The Liquid Nitrogen Show:
Show presentations are varied by presenters according to the age and level of audience. Accordingly, curriculum links will also vary. The following table indicates which outcomes are linked with the Liquid Nitrogen Show depending on the level and content which is emphasised.

Key scientific words and concepts

nitrogen, matter, liquid, gas, solid, heat, energy, temperature, expansion, contraction, vapour, condensation, fog, volume, pressure, elasticity, reaction rate, boiling, freezing, phase change, kinetic energy, observations, evidence

STRAND	Earth and Beyond	Energy and Change	Life and Living	Natural and Processed Materials	Working Scientifically
OUTCOMES* linked to the Liquid Nitrogen Show	1.5 5.1	1.5 2.5 2.6 3.5 4.5 6.6.	5.8	1.10 1.11 1.12 2.10 2.11 2.12 3.10 3.11 3.12 4.10 4.11 4.12 6.10 7.10	1.13 1.15 1.16 1.17 2.13 2.14 2.17 3.15 3.18 4.15 4.17 4.18 5.18 8.14

*Source: Science – a curriculum profile for Australian schools (1994) Curriculum Corporation



The Shell Questacon Science Circus

The Shell Questacon Science Circus is one of several national Outreach Programs of Questacon–The National Science and Technology Centre. It is staffed by science graduates who are completing a Graduate Diploma in Scientific Communication at the Australian National University. The Science Circus takes the fascination and enjoyment of science throughout Australia by exhibiting in public venues and presenting shows in schools and other community places. Our other Outreach Education Programs include the Questacon Science Squad, Questacon Maths Centre, Starlab and NRMA RoadZone. Information about our Outreach Programs can be obtained by phoning (02) 6270 2820 or by visiting our Internet site http://questacon.edu.edu.au

Liquid nitrogen is used by researchers for preserving living material for many years. It is also used in electron microscopy.

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