

THE SECRET WORLD OF GASES



The Secret World of Gases

Final Report

30th November 2018

UK Association for
**Science and
Discovery Centres**



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Executive Summary

The Secret World of Gases was an exciting national STEM programme created by The UK Association for Science and Discovery Centres (ASDC) in partnership with BOC and the Royal Society of Chemistry.

The vision of this national programme was to engage, inspire and involve school-age children and their families with the amazing stories and science of Gases, investigating the latest innovations, dispelling myths and exploring how gases will be used for a greener future.

In partnership with the Royal Society of Chemistry, BOC, Winchester Science Centre and a range of other experts from across academia and industry, ASDC created, developed and delivered an inspirational suite of hands-on activities, experiments and demonstrations for families to be delivered in Science Centres and Museums. These included a new interactive family show and a series of hands-on, meet-the-expert and busking activities along with programme branding, a website, marketing materials and a bespoke training handbook.

ASDC then selected, trained and equipped nine Science Centres and Museums in England, Scotland, Wales and Northern Ireland to deliver the full Secret World of Gases Programme. This included bringing their staff together for a two-day Training Academy to learn all aspects of the programme including running the shows and activities, the latest science, working with gases and maintaining the equipment. ASDC continued to support these Centres during their delivery period, answering questions and introducing them to experts.

The families programme launched in Science Centres and Museums on the 10th of February 2018 and ran until the October half-term 2018. In total, **106,261 children and adults** took part in The Secret World of Gases, with an additional **12,540** children engaged through schools shows and engagement trails. All resources, training materials and events are available on the project website. www.secretworldofgases.org

The Secret World of Gases aimed to create a step-change in the way Science Centres and Museums deliver the science around chemistry and gases. The programme aimed to go 'beyond the bang' of the more familiar rocketry demonstrations, and to engage families with activities that showcase the multiple uses of gases across our society, from food packaging and production to innovation with hydrogen to create lower carbon transport systems for a greener future.

Feedback from Science Centres and Museums indicate they and their visitors enjoyed and valued this STEM programme sufficiently that they delivered to considerably more families than their collective target of 54,000 (delivering to 106,261 people). In addition, our analysis of the evaluation data shows we have been successful in enhancing and changing the range of chemistry and gases content Science Centres and Museums are confident and skilled to deliver, and will continue to deliver into the future.

The full evaluation of 1,308 people in nearly 500 families who had taken part in The Secret World of Gases shows our activities were equally positive.

The key findings are summarised below:

- **98% of adults and children said that the activities increased their understanding of gases and what they are used for.**
- **96% of adults and children said The Secret World of Gases increased their understanding of the different gases that make up the air around us.**
- **91% of adults and children said that the activities helped to show what chemistry is and what chemists do.**
- **97% of adults and children said that The Secret World of Gases activities were interesting.**
- **96% of adults and children said that The Secret World of Gases activities were fun.**
- **81% of adults and children said The Secret World of Gases activities made them want to find out more about different gases and how they might be used in the future.**
- **76% of adults and children said The Secret World of Gases helped to show them future jobs in chemistry and gases.**



1. Programme Overview

Programme vision and mission

The Vision: To engage, inspire and involve school-age children and their families with the amazing stories and science of Gases, investigating the latest innovations, dispelling myths and exploring how gases will be used for a greener future.

The Mission: To deliver an inspirational and hugely exciting national programme of hands-on activities and experiments for children and families across the UK, through the successful infrastructure of the UK's Science and Discovery Centres and Science Museums.

Gases are used in all areas of science, engineering, medicine and life in general. This project showcases a range of gases and celebrates their huge potential for the future, especially the technological innovations that are vital as we move towards a lower carbon and more energy-efficient society.

For many years, Science Centres and Museums have been using gases in a variety of ways to engage families and school groups. Largely these have focussed on rocketry, physics programmes, and demonstrations of super-cooling with liquid nitrogen and dry ice.

The Secret World of Gases aims to create a step-change in the way Science Centres and Museums use gases and the stories they tell about their role, as well as showing how gases will be used in our future. The programme brings alive the range of gases that BOC work with, celebrating and championing chemistry with young people and their families.

Throughout the development process there was a particular focus on showcasing innovations that are set to create a greener, more sustainable environment and alternative sources of fuel for our future.



The UK Association for Science and Discovery Centres

ASDC brings together the UK's major science engagement organisations to play a strategic role in the nation's engagement with science. Within our membership are over 60 of the nation's largest publicly accessible Science Centres, Discovery Centres, Science Museums and scientific bodies. Together, our vision is for a society where people of all backgrounds and in all parts of the UK are inspired and fully involved with the sciences.

Every year in the UK, 20 million people of all ages and backgrounds choose to engage with science at one of the UK's Science and Discovery Centres or Science Museums. This equates to 385,000 people every week who come to our member Centres to explore and discuss science in an involving and personal way.

Leveraging the ASDC national network

Science and Discovery Centres and Science Museums are already embedded in the heart of their communities in England, Northern Ireland, Scotland and Wales. They all have long-term relationships with communities, schools and families as well as local institutions such as universities, industry and the media. These relationships were mobilised for this national programme offering families unusual and exciting opportunities to discover, discuss, question, test and explore science, chemistry and gases in new ways.

The partnership

In November 2016 ASDC, the Royal Society of Chemistry and BOC, the UK's biggest industrial and medical gases company, began a new partnership bringing together some of the most fascinating and diverse chemistry in the country with the talents and infrastructure of the nation's largest network of science engagement organisations.

The partnership comprises a two-year national STEM programme to engage, inspire and involve school-age children and their families with the amazing stories and science of gases, investigating the latest innovations, dispelling myths and exploring how gases will be used for a greener future.

This programme is directed and project managed by ASDC who have considerable experience managing and delivering national strategic multi-partner science engagement programmes.

The Secret World of Gases has been created in collaboration with the following three expert content partners in collaboration with other experts and academics working in this area:

- BOC / The Linde Group
- the Royal Society of Chemistry
- Winchester Science Centre

2. The Management Board and Project Team

The Management Board

The Management Board for The Secret World of Gases was responsible for the programme governance and strategic direction. This board met twice at the start of the programme for the kick off meetings to shape the programme direction, and several members were present at the Charette. The board then met every six months with email discussions in between where required. The Chair of this Management Board rotated between the Royal Society of Chemistry and BOC/The Linde Group.

Name	Organisation
Dr Alison Eldridge	The Royal Society of Chemistry
Jon Edwards	The Royal Society of Chemistry
Lotte Rietveld	The Royal Society of Chemistry
Stephen Windsor-Lewis	BOC / The Linde Group
Susan Tyzack	BOC
Dr Penny Fidler	ASDC
Andy McLeod	ASDC

The Project Team

The Project Team was responsible for all the content development and deliverables of the programme. It was led by ASDC with expertise and contributions from everyone listed below. Additional expertise came from the academic and engagement experts present at the Charette.

Name	Organisation	Role
Dr Penny Fidler	ASDC	Programme Director
Andy McLeod	ASDC	Project Manager
Dr Ben Littlefield	Winchester Science Centre	Expert Development Partner
Arlan Harris	Arcola Energy	Expert Development Partner
Dr Susan Vickers	Royal Society of Chemistry	Development Partner and representative from Royal Society of Chemistry on Project Team
Susan Tyzack	BOC	Development Partner and representative from BOC on Project Team
Stewart Dow	BOC	Development Expertise
Andy Lane	BOC	Development Expertise
Shaaron Leverment	ASDC	Development Support

3. Development of The Secret World of Gases

The Project Team worked together to create a lively, entertaining, interactive and flexible show for families that Science Centres and Museums could run at weekends, holidays and during other major events.

Throughout the development, the Project Team focussed on the vision of the programme to ensure they were delivering a programme that 'engaged, inspired and involved school-age children and their families with the amazing stories and science of gases, investigating the latest innovations, dispelling myths and exploring how gases will be used for a greener future'.

A key factor in the success of all ASDC programmes is that the equipment and activities we give to Science Centres and Museums are flexible, allowing them to focus on specific content for particular occasions or audiences. This flexibility is critical to the success of our programmes, not least because the Centres we select to take part have their own expertise in specific areas and work locally with universities and other experts who contribute and enhance what is delivered. These local connections are important in bringing the content alive and making it relevant to children and families. Recent academic evidence from Professor Louise Archer's team working on Science Capital, also shows that local relevance is even more important in engaging those who don't usually engage with science.

Therefore, The Secret World of Gases family show was designed to be modular so Science Centres and Museums could pick and choose what to include. We gave them enough content, activities and experiments to run for 45 minutes and Centres were free to run shows of different lengths and choosing modules to suit different audiences and event formats. Generally they ran 20 - 25 minute shows, although some ran everything as a single 45 minute show.

The show content was created and developed by the Project Team led by ASDC in partnership with a host of academic, industrial and other expertise.



The Kick-Off meeting

The partner kick-off meeting was held in December 2016 with the project partners ASDC, the Royal Society of Chemistry and BOC. This one-day meeting led by ASDC had the following goals:

- To overview the project as a whole.
- To overview the programme development process and timelines.
- To discuss and bring to the fore goals, expectations and aspirations of all the partners ensuring there was a single shared vision right from the start.
- To discuss and agree how much each partner wanted to be involved in each stage, any items relating to the decision making processes and agreed point of contact for each partner.
- To discuss and agree the roles that BOC, the Royal Society of Chemistry staff and experts wanted to have in the content development, and assess any time commitments.
- To ensure all partners were happy with the processes across the programme.
- To decide where and when to involve experts from the Royal Society of Chemistry and BOC so we could ensure the highest level of scientific accuracy at all points.
- To begin discussing the overarching key messages and themes for the show, the naming of the programme and show, and wider aspirations for programme branding.
- To agree the date for the Charette and decide the initial list of experts to invite.
- To examine any additional areas of focus and identify where views were different so these could be highlighted and explored at the outset.

The main project planning meeting

This one-day project planning meeting was held in January 2017 involving ASDC and the key project leads from BOC and the Royal Society of Chemistry, as well as the selected expert Science Centre, Winchester Science Centre.

This one-day meeting:

- Outlined the roles and responsibilities of all partners over the two-year programme.
- Discussed and agreed all items of the project management.
- Agreed the framework for the creative content development process.
- Discussed and agreed the overarching key messages and themes for the show.
- Discussed the naming of the show and the programme.
- Discussed the direction for programme branding.
- Finalised the list of experts and programme for the Charette.

4. The Ideas Charette

Across the UK there are a number of people from a variety of academic and industrial backgrounds who have considerable knowledge and experience in the subject area of this programme, as well as those with expertise in engaging families with the great stories and science in this area.

At the start of the programme, ASDC ran an 'Ideas Charette' which efficiently and cost-effectively brought together these people from different backgrounds for a one-day Charette to share inspirational ideas and knowledge that could be incorporated into the project.

ASDC have run a number of Charettes for other programmes and each has proven to be absolutely key to ensuring inspirational, new and highly engaging content for the project. The day was led by the ASDC CEO, Dr Penny Fidler, and was structured to ensure that collective knowledge and ideas were shared with plenty of space for creative and innovative thought.

Participants were arranged in to groups and had the opportunity to share and see lively new demonstrations and experiments, and to use some of the equipment to help inspire and stimulate new creative ideas and experiments to include in the programme.

The following people took part in the Charette. At the end of the day, we asked who would like to be a member of our science and engagement panel for this programme to help us in the development, giving advice on specific questions and content by phone or emails during the programme.

All the experts at the Charette agreed to be on this panel. A list of those present are below and the Charette programme is included in Appendix 1.



The Ideas Charette

Tuesday 14th March 2017

Royal Society of Chemistry, Burlington House, Piccadilly, London W1J 0BA

Name	Position	Organisation
Dr Penny Fidler	CEO	UK Association for Science and Discovery Centres
Andy McLeod	Special Projects Manager	UK Association for Science and Discovery Centres
Dr Ben Littlefield	Head of Education	Winchester Science Centre
Susan Tyzack	Public Engagement Executive	BOC
Stephen Windsor-Lewis	Head of Communication, Europe, Middle East and Africa	BOC/The Linde Group
Stewart Dow	Product and Market Development Manager	BOC
David Henderson	Helium Operations Manager	BOC
Mohammed Kassim	Process Engineer	BOC
Ioulia Habipi	Programme Manager	BOC
Jon Edwards	Communications Manager	Royal Society of Chemistry
Dr Susan Vickers	Public Engagement Executive	Royal Society of Chemistry
Pip Matthews	Inclusion and Diversity Executive	Royal Society of Chemistry
Dr Pete Edwards	Marie Curie Research Fellow	University of York
Dr Jim McQuaid	Deputy Head of School	University of Leeds
Suwanie Wilathgamuwage	Technical Services and Development Manager	HCS Group
Martin Smith	Technical Manager	Thermo Fisher Scientific
Neil Smith	Quotation Manager	Pharmaron
Professor David Read	Professorial Fellow in Chemical Education	University of Southampton
Arlan Harris	Design Engineer	Arcola Energy
Laura Rolinson	Operations Manager and Education Project Co-ordinator	Arcola Energy
Clare Hampson	Education Manager	Catalyst
Dr Sophie Waring	Chemistry Curator	Science Museum
Dr Andrew Steele	Postdoctoral Fellow	Francis Crick Institute
Jim Kirkland	Services Manager – UCL	BOC

Everyone above also signed up to advise us during the project and to be on the science and advisory panel for the programme development. They have been hugely valuable at helping us during the development process.

5. Selecting the Partner Science and Discovery Centres

ASDC sent out an invitation to participate document in June 2017, along with an application form to all ASDC members. We sought nine partners for delivery.

ASDC also held a bidder's conference call later in June 2017 where all Science Centres and Museums interested in applying had the opportunity to dial in, hear about the programme from the ASDC CEO and Project Manager, have their questions answered and hear the responses given to others who would be bidding. This open framework has been used in all previous ASDC programmes and means there is absolute clarity about what Centres need to deliver, schedules, audiences, grants, budgets and reporting before each Centre applies.

The Selection Panel

ASDC received 13 applications from members interested in delivering The Secret World of Gases. The applications were reviewed by the Selection Panel which met on July 31st 2017 and included staff from the following organisations:

- ASDC
- BOC
- Royal Society of Chemistry

A range of ASDC members were invited to apply, ensuring a geographical spread whilst maximising the numbers of families who could take part.



6. The Secret World of Gases Selected Science Centres and Museums

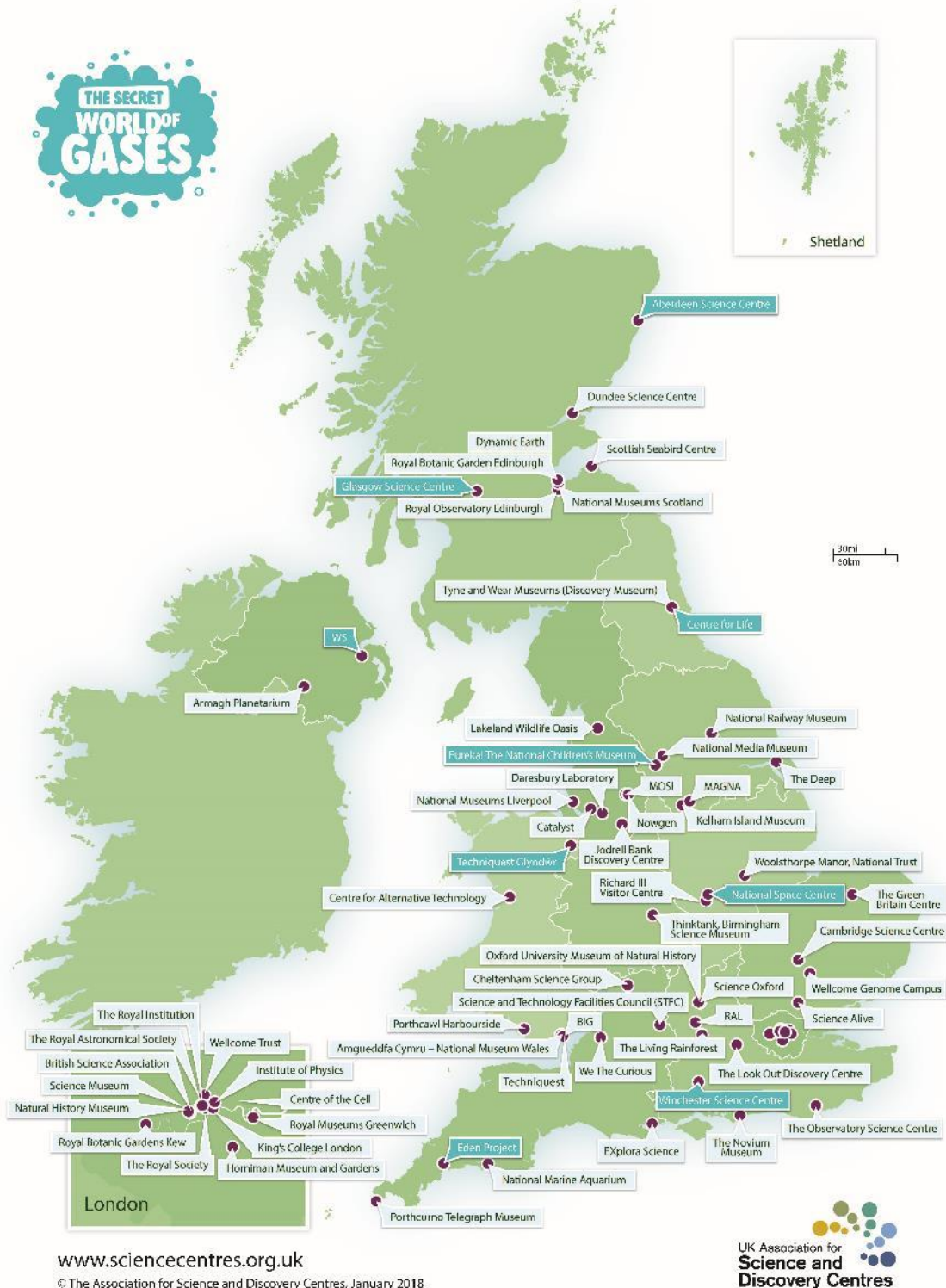
The following Science Centres and Museums were selected to deliver The Secret World of Gases:

1. Aberdeen Science Centre
2. Eden Project, Bodelva Cornwall
3. Eureka! The National Children's Museum, Halifax
4. Glasgow Science Centre
5. Life Science Centre, Newcastle
6. National Space Centre, Leicester
7. Techniquest Glyndŵr, Wrexham
8. W5, Belfast
9. Winchester Science Centre



Map of the nine Science Centres and Museums selected for The Secret World of Gases

The UK Science and Discovery Centre Network



7. The Programme Outputs

This project delivered the following:

1. An exceptional and highly adaptable family show targeted at 5-12 year olds and their families for use by Science Centres and Museums across the UK.
2. A set of hands-on resources and equipment for each Centre.
3. A national Training Academy to train Science Centre staff from nine UK Science Centres and Museums to enable them to run the entire programme and maximise press opportunities across the UK.
4. A meet-the-expert session format for family audiences with introductions to guest scientists and others working with gases.
5. A press and marketing pack with images, sample press releases, approved copy for web and flyers developed in partnership with BOC and the Royal Society of Chemistry.
6. A vibrant and dedicated project website to allow visitors greater access to in-depth information about the show and to provide a central hub for participating Science Centres and Museums to access up-to-date resources and share best practice.



8. The Programme Goals

In addition to the outputs listed in the previous section, the six key goals for this national programme in order of importance are as follows:

1. To inspire children and their families nationally with a new sense of curiosity, questioning and creativity in relation to gases and their potential in future technologies.
2. To inspire children and their families to explore, test, experiment and discuss the amazing range of science and engineering needed to develop new gas technologies.
3. To inspire school aged children within the family learning environment to consider careers in chemistry, science and engineering more widely.
4. To build family science capital given we know 67% of young people feel they get most careers advice from family, and that family science capital is the biggest predictor of whether students will study science (and 80% of a schoolchild's waking time is spent out of school).
5. To increase the public engagement opportunities of BOC scientists (if they wish) and the Royal Society of Chemistry scientists and engineers and enable the public to meet them in informal settings.
6. To train science engagement professionals embedded in ASDC member organisations across the UK, to engage the public with the latest in gas technology, future fuels and sustainability so they can continue to enthuse their 20 million visitors into the future.

9. The Key Audiences

The key audiences for this national programme are:

1. Young people aged 5-12 enjoying learning about gases and their future uses, sustainability, engineering and chemistry in informal contexts.
2. Parents, families and carers of these young people who are equally inspired can continue to encourage their children long into the future.
3. Science Centre and Museum staff who will become experts in using gases and use this knowledge for greater and more wide-ranging science learning programmes around chemistry and the physical sciences.



10. The Training Handbook

The project team wrote and created a vibrant, engaging and informative training handbook. Some pages are shown below.

The handbook is over 100 pages long in a bespoke A4 file and has been hugely well received.

A printed copy was given to all delegates at the Training Academy so they could learn all the different areas of the programme and remind themselves over the year, as well as train their staff to run all of the programme.

The handbook contained the following information:

- Detailed information on all the activities and equipment
- Experiments to try
- Further ideas and information
- The family show and running orders
- Marketing information, branding and PR
- Evaluation guidance
- Health and safety
- A full kit list

This was originally intended as a 40-page manual, but due to the volume of fantastic ideas yielded by the creative development process, and the desire to share as many of these as possible with the wider delivery team, the handbook grew considerably.

9. Capturing carbon dioxide
Make and collect your own balloon of carbon dioxide

Overview

The classic coke-and-mentos experiment is modified to collect the carbon dioxide gas made from the effervescent reaction by capturing it in a balloon.

What's happening?

Carbon dioxide is normally dissolved in the drink when it is bottled. It is responsible for the tingling sensation felt in the mouth when drunk as well as the bubbles observed in a glass. The carbon dioxide is initially forced into the drink at high pressure and low temperature at the bottling plant. When the bottle is sealed the contents become pressurised, forcing the carbon dioxide to stay in solution. When the bottle is opened, the carbon dioxide will be released from the drink until it has reached equilibrium with the air around it.

This process can be sped up by giving the dissolved carbon dioxide growth sites to form bubbles on.

When Mentos are added to a freshly opened diet coke the rough, bumpy

surface of the mint allows bubbles of carbon dioxide to rapidly form and this sends a fountain of diet coke foam several metres into the air.

Why is this important?

Carbonated water is the main (over 90 %) ingredient of most fizzy drinks. Carbon dioxide is ideal to use as it is a colourless gas, inert, cheap and non-toxic. It provides a tingling sensation on the tongue, a mild acidic bite and can act as a preservative.

Beyond this it has a number of very important applications. As an inert gas it can be found in fire extinguishers and in canisters in life jackets for rapid inflation. As a supercritical fluid (a material with the properties of both liquid and gas) it is used to decaffeinate coffee as

More stories to tell

How do the Mentos work?

Imagine the carbon dioxide is stored within a network of water molecules, almost like a cage. The water molecules are connected via polar attractions (known as hydrogen bonds) and these attractions can be disrupted by rough surfaces, breaking open the cage. You can see this happening on a small scale when there is a scratch in the side of a glass and bubbles nucleate and grow from the scratch, sending a stream of bubbles up to the surface of the glass.

Mentos actually have a very rough surface and with a high surface area in a small volume they provide a huge number of growth sites for bubbles to form. They also sink, which means they create bubbles as they fall which in turn help provide more growth sites for even more bubbles!

Mentos also contain gum Arabic (the hardened sap from the acacia tree). It is a surfactant (reduces the surface tension of the liquid it is dissolved in) which also disrupts the hydrogen bonded network of water molecules, further increasing the amount of carbon dioxide that can be released.

Is breathing in carbon dioxide bad for us?

Carbon dioxide is not dangerous on its own in the way that carbon monoxide is. That is why we add it to our drinks to make them fizzy. Humans breathe out carbon dioxide as the end product of respiration. In fact, the concentration of carbon dioxide in our breath is one of the triggers for how regular and deep our breathing is.

However, humans do require oxygen to survive. In some situations, such as in an unventilated small space where the dense carbon dioxide can build up, oxygen in the air can be replaced by carbon dioxide and this can cause humans to pass out within minutes. Continued deprivation of oxygen would then result in permanent damage to the systems of the body or death.

The Activity

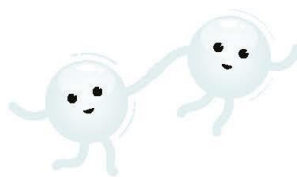
Before the show:

1. Put five Mentos into the neck of the 18 inch balloon.
2. Clip the bottom of the balloon to avoid premature release.

During the demonstration:

1. Open the bottle of fizzy drink and attach the balloon to the neck of the bottle, ensuring the clip (or your fingers) stop the accidental addition of Mentos to the bottle.
2. With a firm grip on the neck of the bottle and balloon, force the Mentos into the bottle.

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11. The Training Academy for Science Centre and Museum Staff

The training programme is fundamental to the success of this programme and considerable resource is put in to achieving excellence. Professional staff who are enthused and fully confident to impart the latest knowledge to their colleagues, children and family visitors back in their part of the UK are the key to success in all ASDC programmes.

The Secret World of Gases two-day residential national Training Academy took place at Winchester Science Centre on the 7th and 8th of November 2017.

Twenty-seven people took part, including two members of staff from the nine selected Science Centres and Museums:

1. Aberdeen Science Centre
2. Eden Project
3. Eureka! The National Children's Museum
4. Glasgow Science Centre
5. Life Science Centre
6. National Space Centre
7. Techniquest Glyndŵr
8. W5
9. Winchester Science Centre

Each Centre were trained in how to use all the equipment and resources as well as discovering the latest knowledge from a host of external speakers including Hydrogen experts and other gases experts. The project paid for Science Centre and Museum staff's travel, accommodation, food and training at the academies.

Topics covered included:

- An introduction to The Secret World of Gases.
- An introduction to the research and work of the Royal Society of Chemistry and BOC.
- How to run all the experiments and hands-on science activities.
- How to use all the equipment and how to maintain it.
- How to run The Secret World of Gases family show and each of the bespoke activities.
- Health and safety surrounding the handling of the various gases and chemicals used.
- Evaluation and reporting.
- A full review of the project branding and logo usage.
- Resources, images, videos and more.
- Ideas to engage children from disadvantaged areas and gender equity.
- Social media strategy and online resources.

The full programme for the Training Academy is included in Appendix 2.

Photos of the Training Academy


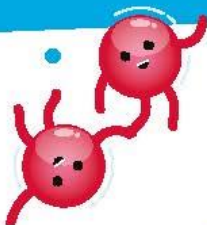



12. Equipment and Activities for each Science Centre and Museum

Every selected Science Centre and Museum was supplied with cutting-edge equipment as part of The Secret World of Gases. The equipment supplied allowed Centres to deliver the activities, experiments, demonstrations and the family show.

The list of the activities is also shown on the contents page of the hand book as shown on page 20. Below is how these activities can be combined to make an excellent show for families.

The Secret World of Gases family show



Overview

The Family Show for The Secret World of Gases is flexible and modular so you can adapt the length to suit your needs. We are giving you 18 Gas activities and if you were to run them all together it would create a show of 45 minutes. We know most science centres have family shows that are around 20 - 30 minutes in length, and below we give you a list of all the activities, and which we would recommend and the running order for two 20-minute family shows, and a 30-minute family show.

We are also providing you with a PowerPoint template including title slides and content slides, which you can use as provided or modify to your needs. We ask that if using PowerPoint, you use the branded Secret World of Gases slide format.

The slides are available on the project website www.secretworldofgases.org

The List of all the Activities

1. Gas bingo
2. Shrinking balloons*
3. Liquid air*
4. Liquid nitrogen fountain**
5. Boiling nitrogen*
6. Keeping food fresh
7. Blazing wotsits**
8. Plane oxygen**
9. Capturing carbon dioxide**
10. Absorbing heat
11. Sublimating carbon dioxide*
12. Ocean acidification
13. Making hydrogen**
14. Hydrostik
15. Hydrogen fuel cell
16. Hydrogen powered car
17. Hydrogen powered bus
18. Hydrogen house

*activities that require some ventilation
**activities that require some ventilation and a high ceiling (suggested at least 3m)

www.secretworldofgases.org The Family Show | 81

13. The Secret World of Gases Equipment

Each of the nine selected Science Centres and Museums were given the following equipment with which to run the programme:

- A large hydrogen-powered dolls house with electric lights, music and fans.
- A hydrogen-powered, remote control bus.
- A hydrogen-powered car, with self-contained water electrolysis unit.
- Hydrogen fuel cells and Hydrostiks (portable, ten litre storage units for holding hydrogen).
- A Hydrofill PRO desktop electrolyser, used to recharge Hydrostiks.
- Equipment for liquid nitrogen experiments including Dewars, tipping trolleys and safety data handling sheets for the safe use of cryogenic substances.
- A range of glassware for chemical reactions including boiling tubes, conical flasks, round-bottom flasks, measuring cylinders and handling equipment.
- A range of other lab equipment including safety screens and chemical apparatus.
- A hand-operated 'gas bingo' machine.
- Health and safety equipment including cryogenic gloves and goggles.
- Branded lab coats and tablecloths.
- A series of short videos and images for use in presenting and explaining the science.
- Banners with the logos of BOC, the Royal Society of Chemistry, ASDC and the project name and brand.
- A full kit list is available in Appendix 3.



Photos of the equipment and activities



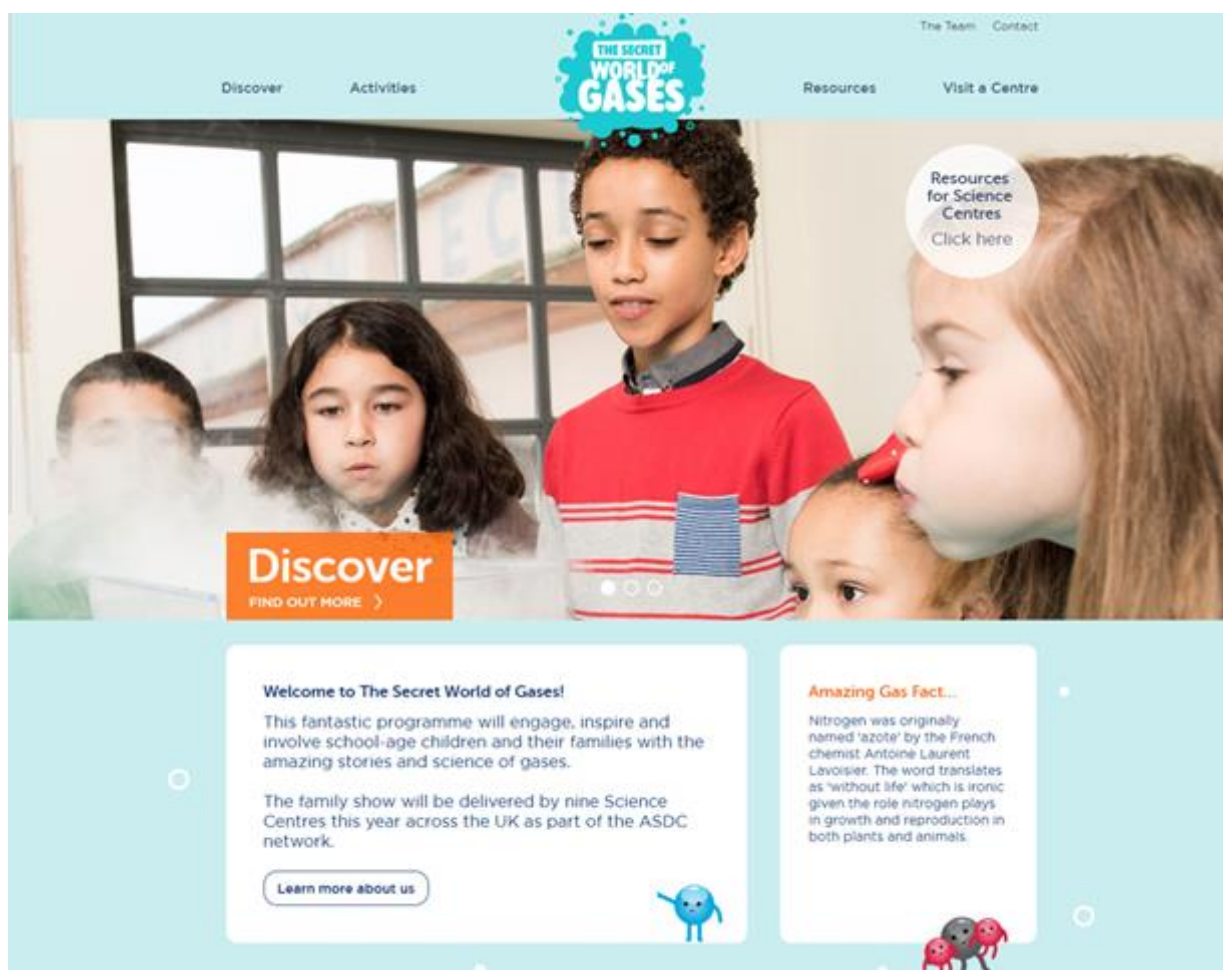
14. The Secret World of Gases Website

The Secret World of Gases website was developed for this programme. The website acts as an easy place where the public can go after an event at a Science Centre or Museum, to find out more about the programme and find links to additional content and research.

The website also includes equipment lists, training handbook, consumables information, show formats and scripts, logo and marketing guidance and brand assets and guidelines, as well as a host of links to other areas of research. It is central to what we do that our resources are open and usable for everyone, to ensure maximum impact in everything we do.

This allows all Science Centre and Museum staff to have access and not just those we trained. It also allows access from all other Science Centres and Museums across the world who want to view the materials, ideas and resources.

www.secretworldofgases.org



15. Digital Engagement

Several Science Centres and Museums ran engaging marketing campaigns, utilising the resources supplied for the programme including the branded assets and marketing text.

Glasgow Science Centre


Glasgow Science Centre
Published by Orlo [?] · September 18 · 🌐

Got September Weekend Plans?

We have a full schedule for the Autumn half term holiday!

Join us for a brand new Live Science Show: The Secret World of Gases where you can discover the amazing stories and science of gases, investigating the latest innovations, dispelling myths and exploring how gases will be used for a greener future through spectacular demonstrations using liquid nitrogen, dry ice and more! Suitable for all ages!!

For full details on what's on this September Weekend visit: <http://socs.i.in/OnZtd>



Glasgow Science Centre
Landmark & Historical Place

[Learn More](#)

Performance for Your Post

21,492 People Reached

40 Reactions, Comments & Shares ⓘ

31 👍 Like	27 On Post	4 On Shares
1 ❤️ Love	1 On Post	0 On Shares
0 Comments	0 On Post	0 On Shares
8 Shares	8 On Post	0 On Shares

311 Post Clicks

52 Photo Views	104 Link Clicks	155 Other Clicks ⓘ
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NEGATIVE FEEDBACK

0 Hide Post	0 Hide All Posts
0 Report as Spam	0 Unlike Page

Insights activity is reported in the Pacific time zone. Ads activity is reported in the time zone of your ad account.

Eureka! The National Children's Museum

As the Secret World of Gases show was part of two Museum-wide events, British Science Week and Steampunk Science (their Easter holiday event theme) it was featured within the marketing for both of these events. In addition, The Secret World of Gases also featured as part of their summer holiday events promotion.


Social Media reach:

Facebook Steampunk science event page featuring The Secret World of Gases: **15,873**.
 Facebook British Science Week event page featuring The Secret World of Gases: **7,362**.
 General tweets for Steampunk Science / British Science Week: **8,791**
 General Facebook Summer event page featuring The Secret World of Gases: **21,100**.


Website reach:

Page views for Steampunk science page featuring The Secret World of Gases: **4,487**.
 Page views for British Science Week featuring The Secret World of Gases: **1,163**.
 The Secret World of Gases blog (<https://www.eureka.org.uk/blog/gases-just-hot-air/>): 321 page views for Summer event
 Total reach for pages featuring The Secret World of Gases: **8,979**.

Gases: More than just hot air!



By: Chris Snowden | Date: 15/03/2018



Gas. Not necessarily the first word that springs to mind when we talk about exciting science, but there are some really amazing ways that we use the gases around us and I'm not even going to mention the version that comes out of certain body parts. Well, probably not.

16. An Overall Identity and Marketing Pack

Once the name had been agreed, ASDC worked with a graphic design company to create a brand for the programme including logos and colour palettes.

We also created illustrated characters to bring the brand alive. The characters represent the molecules of the gases used in the programme, for example hydrogen twins and oxygen twins. Below you can see the water molecule as the red oxygen holding hands with the little white hydrogens all pulling away as water vapour. The carbon dioxide can be seen at the top of the image as the black carbon molecule hugging the oxygen molecules tightly. The idea for these illustrations came from ASDC and we thank the chemists we worked with for helping us to create the perfect characters for the design.



ASDC created a marketing package to assist learning teams and marketing professionals to market the activities easily and effectively to families. This consisted of:

- Logos and all the brand assets.
- Development of new illustrations.
- Sample press releases including standard descriptors of all the partners.
- Sample copy describing the shows and activities for use in flyers and online.
- Guidance on identity and logo usage, and how to credit all partners.
- Images and any credits for Science Centres and Museums to use on flyers and websites.
- Gases characters that Centres can use to enliven their artwork.

17. The Overall Impact of The Secret World of Gases



ASDC and The Secret World of Gases programme committed to reaching 54,000 children and families between February and October 2018. This equates to 6,000 people per delivery Science Centre and Museum.

Centres completed delivery of The Secret World of Gases on October 31st 2018 and together, have reached **106,261** children and families directly with the family show and hands-on activities.

In addition to this, some Centres delivered additional programming using the content from the programme to audiences such as school groups and adults-only 'Lates' events. When including these extra 6,707 audiences, the reach of the programme totalled **112,968**.

The National Space Centre also handed out 6,000 specially-designed 'The Secret World of Gases' themed trail activities to families and children. Including these engagement numbers, the total reach is **118,968**.

ASDC are delighted that the original target reach for The Secret World of Gases has been exceeded and almost doubled by Science Centres and Museums delivering the programme.

The Secret World of Gases has inspired children and families through Science Centres and Museums across the UK. A large part of the programme has been focussed on utilising innovations with gases, particularly hydrogen and in tackling issues such as sustainable transport. With developments in hydrogen trains hitting the news headlines this is highly relevant, especially to Aberdeen Science Centre who were very well positioned to include material around the Aberdeen Hydrogen Bus Project into their programme.

As well as future innovations around gases, Science Centres and Museums have inspired audiences to consider the gases that are in use all around us, utilising the liquid nitrogen equipment and demonstrations that were provided as part of the programme. Demonstrations were also included that looked in more detail at carbon dioxide and oxygen, including how oxygen is generated by a chemical reaction for use in oxygen masks on aeroplanes.

The Secret World of Gases aims to build family science capital by using the family show and family-based activities to engage, involve and inspire family groups learning together. Some of these activities have been delivered in conjunction with experts from BOC and the Royal Society of Chemistry, working closely with Science Centres and Museums within the ASDC network. This has also included Science Centres and Museums working with their local Universities and using the STEM Ambassadors Network.

Working with local chemistry and gases experts on this programme has been extremely valuable for Science Centres and Museums, building and maintaining existing networks to enrich the experience of The Secret World of Gases.

18. Evaluation of The Secret World of Gases

Methodology

The project partners ASDC, Royal Society of Chemistry and BOC, collaboratively designed the evaluation instruments used for The Secret World of Gases programme. ASDC have evaluated every national programme they have delivered and have done a number of the largest studies in informal science learning in terms of overall reach. We have found Interviewer-led surveys to be an effective and reasonable means of gathering honest feedback and insights from families. A mixture of open and closed questions were used in the design in order to yield both quantitative and semi-qualitative data. The full evaluation survey is included in the appendices of this report. The survey aimed to discover whether audiences had fun, found the programme interesting, inspirational, aspirational and educational.

The evaluation of The Secret World of Gases was in two parts. The first was the collation metric data including who the participants were, when the programme was delivered, what form the activities took and which Centres were involved. The second part was an evaluation survey in the form of a questionnaire which gathered data and thoughts from families immediately after engaging with the programme.

Metrics data

Overall, The Secret World of Gases engaged with **106,261** children and adults. The breakdown by each Science Centre and Museum is shown below:

Science Centres and Museums delivering The Secret World of Gases

Science Centre or Museum	Overall Programme Reach
Aberdeen Science Centre	10,202
Eden Project	6,450
Eureka! The National Children's Museum	8,207
Glasgow Science Centre	10,305
Life Science Centre	21,974
National Space Centre	17,286
Techniquet Glyndŵr	5,301
W5	6,948
Winchester Science Centre	19,588
Total	106,261

Techniquet Glyndŵr had a very quiet October half term with their overall visitor numbers down on projections based on previous years. This was due in part to the unusually nice weather, as outlined in the final report submitted to ASDC on 6th November 2018.

The programme was delivered between February 10th and October 31st, with the majority of Science Centres and Museums delivering the family show alongside activities from the wider programme. For example, Eden Project delivered the family show, and at the end of the show, signposted the hydrogen and carbon dioxide activities that were being delivered straight after the show's conclusion. The National Space Centre followed a similar model. W5 began delivery with 'The Big Show', a large-scale version of The Secret World of Gases family show, which delivered to a 200-seater theatre. Aberdeen and Glasgow Science Centre both delivered activities as part of a 'Science On The Spot' programme, in addition to their family show delivery.

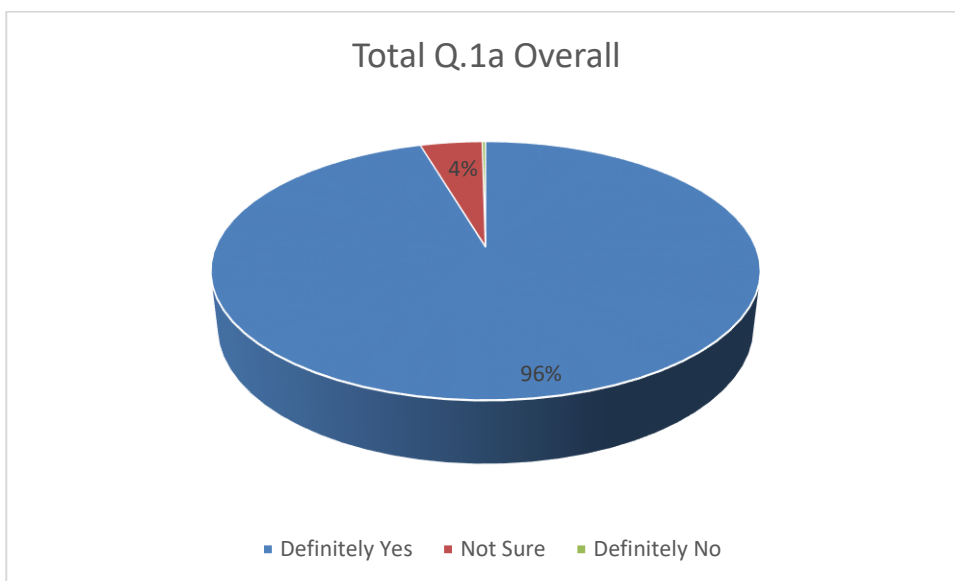
It was always intended that Science Centres and Museums had the freedom to deliver The Secret World of Gases programme in a way that worked for their Centre, and the details of these delivery models were outlined in the individual proposals submitted to ASDC in July 2017.

For more detail on individual Science Centres and Museums, the executive summaries of each submitted report is included in section 25 of this report.

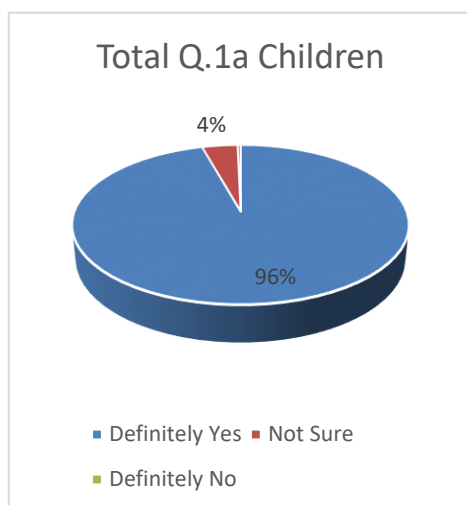
19. Quantitative Survey Data

Were the activities fun?

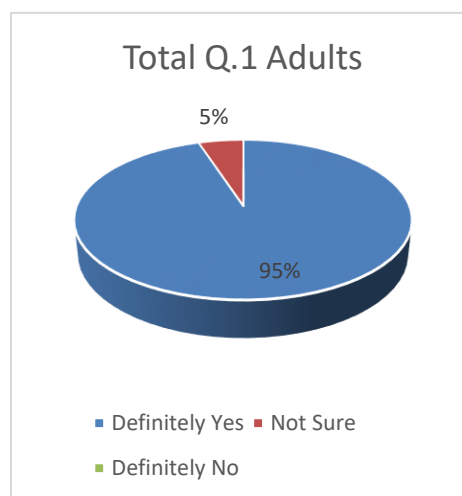
Question 1a): Do you feel that the activities you took part in were fun?



Total overall n = 1,308



Children n = 832

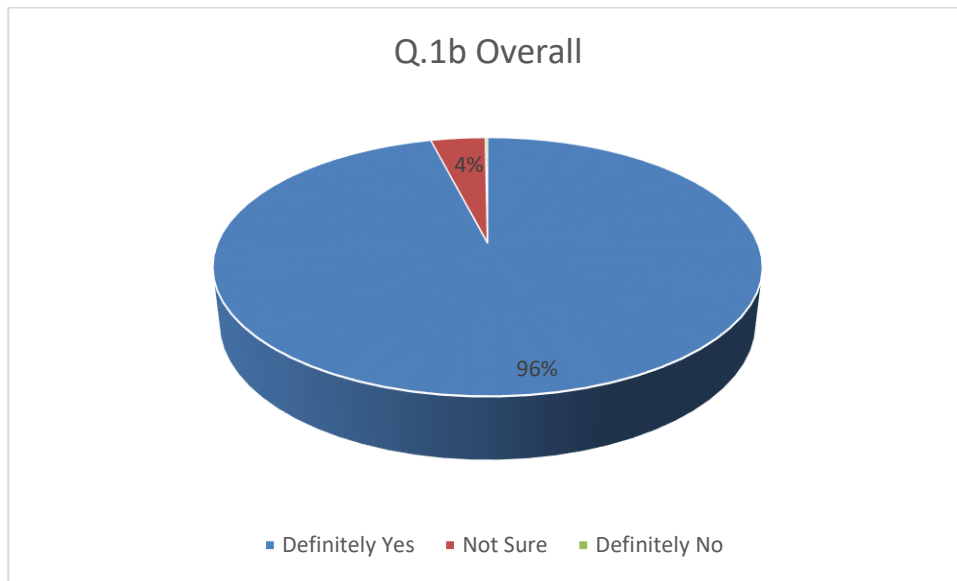


Adults n = 476

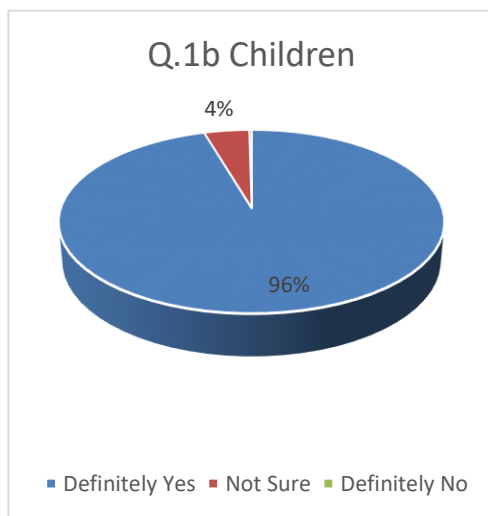
Overall, 96% of people thought the activities were definitely fun, with the remaining 4% answering 'not sure'. The vast majority of the activities were delivered in Centres by trained engagement professionals including Science Centre and Museum staff. The programme was designed to be fun, inclusive and engaging, allowing presenters to engage families with the messages of curiosity and creativity about gases and chemistry. There were no differences between male and female audiences and there was no effect of age on the question.

Were the activities interesting?

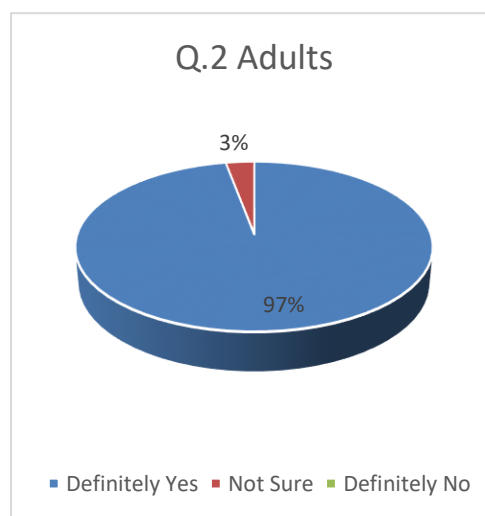
Question 1b): Do you feel the activities you took part in were interesting?



Total overall n = 1,304



Children n = 829

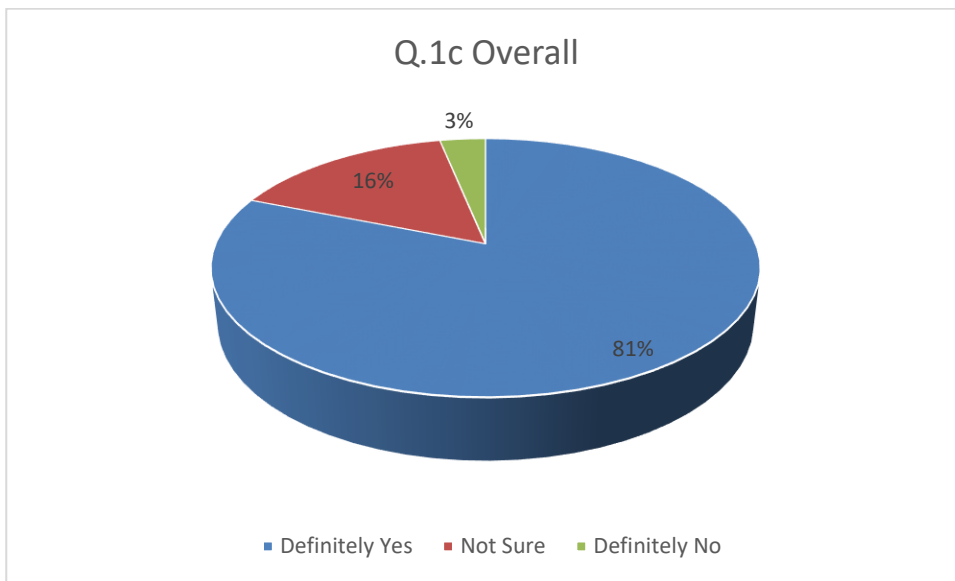


Adults n = 475

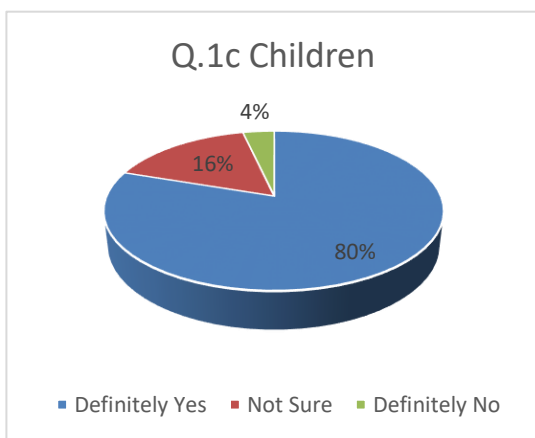
Overall, 96% of audiences found the activities interesting which is a robust result for a national programme exploring gases and chemistry.

Were the activities inspirational?

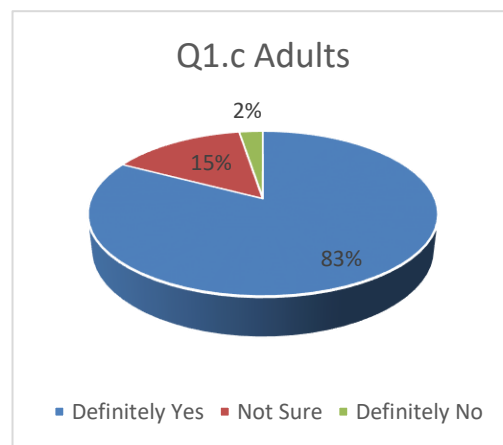
Question 1c): Do you feel the activities you took part in made you want to find out more about different gases and how they might be used in the future?



Total overall n = 1,279



Children n = 818

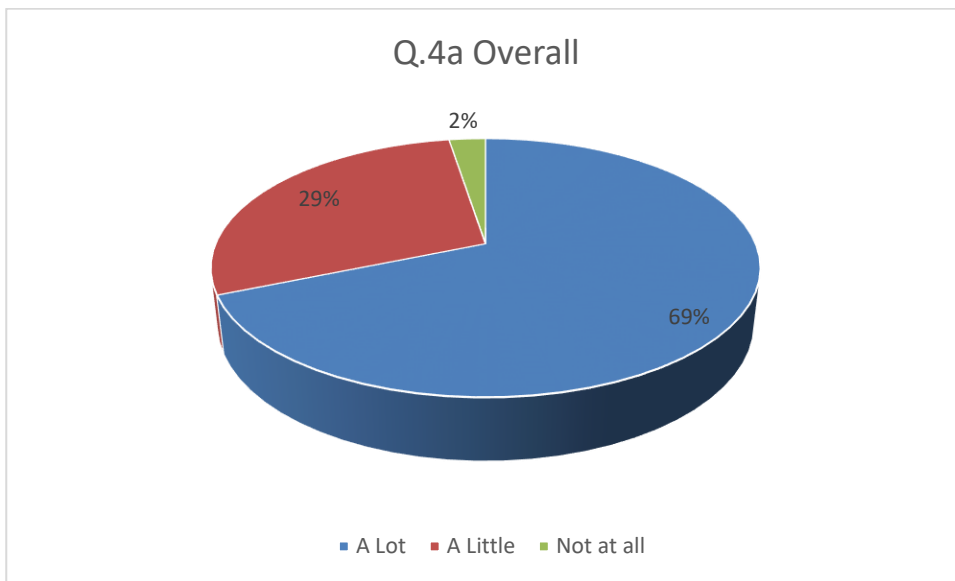


Adults n = 461

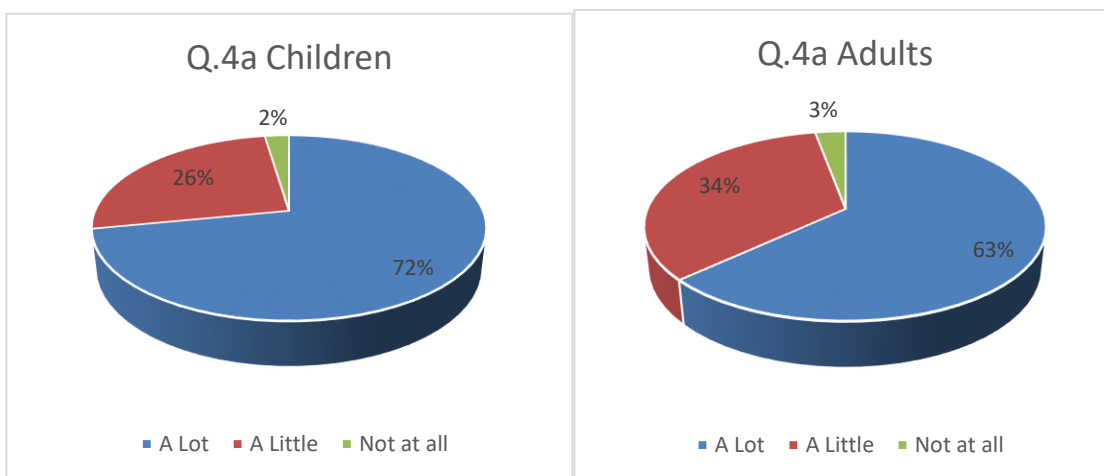
Overall, 81% of audiences reported they wanted to find out more about different gases and how they might be used in the future. This is a very positive result as one of the key programme goals was to inspire children and families to find out more about the range of science and engineering we will require to develop new gas technologies.

Were the activities educational?

Question 4a) Did you feel these activities increased your understanding of gases, and what they are used for?



Total overall n = 1,251

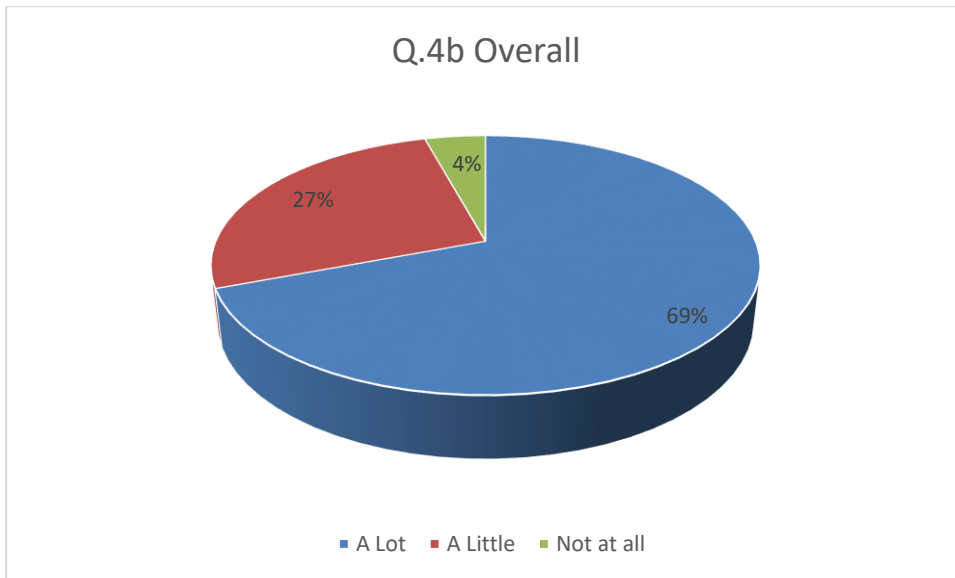


Children n = 804

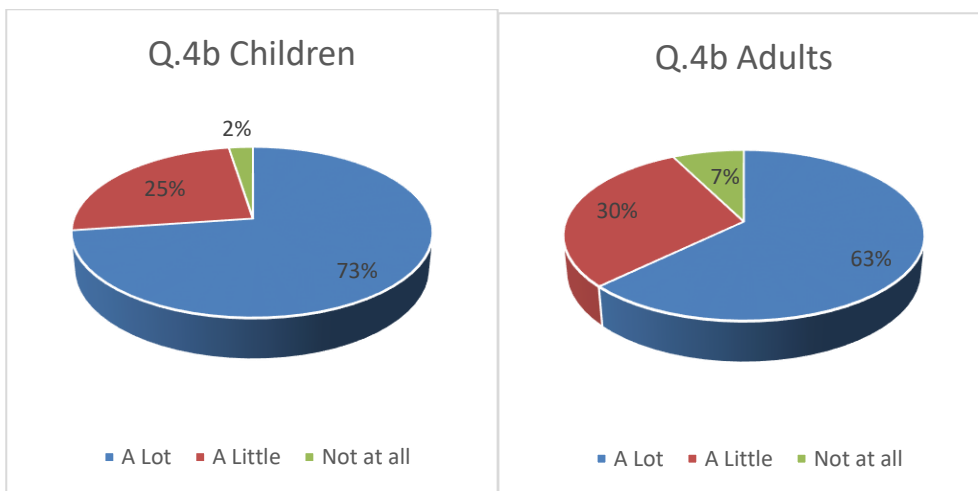
Adults n = 447

Overall, 98% of audiences reported an increase in understanding of gases and their uses as a result of the programme. This is a fantastic result as it suggests that as well as having fun, being interesting, and inspiring audiences, there was a deeper level of understanding about the content of the activities.

Question 4b) Did you feel these activities increased your understanding of the different gases that make up the air around us?



Total overall n = 1,242



Children n = 801

Adults n = 441

One of the goals of the programme was to investigate the gases that makes up the air around us and overall, 96% of audiences reported an increase in understanding of this as a result of the activities.

20. Qualitative Survey Data

As one of the aims of the programme was to ignite curiosity in audiences about the invisible world of gases around us all, one question was included that aimed to uncover anything that audiences found surprising about the content covered in the family show.

Below are some of the answers received from family groups, adults and children:

In answer to the question “Did anything surprise you?”

- “Made chemistry much more interesting and enjoyable. If only school chemistry had been like this. I would have paid more attention and been inspired!” – *adult, Eden Project.*
- “I liked how it related the experiment to real life and the oceans. We felt like chemists didn’t we?” - *adult, Life Science Centre.*
- “I’m learning this at school but it was interesting to see it in action” – *female over 12, National Space Centre.*
- “Seagrass coping with ocean acidification” – *male aged 9, Eden Project.*
- “The hydrogen bus, I didn’t know you could power buses like that” - *female aged 9, National Space Centre.*
- “The plane reaction – I never thought about what happened with the oxygen masks on planes” – *adult female, Life Science Centre.*
- “Nitrogen in food packaging” – *female aged 8, Eden Project.*
- “Some of the information! Difference between hydrogen balloon and air” *female aged 9, Eden Project.*
- “Percentages of gas in the air” – *male aged 10, Eden Project.*
- “Production of oxygen for masks on aeroplanes. Didn’t know that at all!” – *adult male, Techniquest Glyndŵr.*
- “How oxygen is made on planes. I had no idea!” – *adult female, Eureka! The National Children’s Museum.*
- “How much carbon dioxide comes out of a single bottle of coke” – *adult female, Eureka! The National Children’s Museum.*
- “The careers aspect was interesting – lots of food related with nitrogen” – *adult male, Aberdeen Science Centre.*
- “That nitrogen is in crisp packets” – *adult female, W5.*
- “I didn’t expect the show to be so informative. Covered more than expected” – *adult female, Eden Project.*

Adult responses mentioned the oxygen mask as a key surprise finding more than any other single element of the show. Gases in relation to food and drink technologies also feature frequently.

For children, the responses focus on the hydrogen bus, liquid nitrogen experiments and the most visually appealing demonstrations such as the blazing wotsits and demos featuring fire.

21. Quotes from Participants

Selection of quotes from some of the Science Centre and Museum's final reports. Participant information provided where available.

Eden Project:

'I used to hate chemistry at school, I really wish it was like this!' - Mother, 43.

'Gas is ace!' - Father aged 28.

Eureka! The National Children's Museum

'I had no idea how plane oxygen was made, it was really interesting!' – Adult.

What did they enjoy most? 'All of it! It was delivered so clearly and in such an interactive way.' – Adult.

'The colour changing bubbles at the end looked pretty and was like magic!' – Girl, 6.

'It did make me think that doing a job in chemistry might be quite cool, but really I want to be a ninja' – Boy, 7.

Techniquest Glyndŵr

"The show made it seem exciting to be a scientist working with gases."

"The show has changed my view of such jobs in a positive way. I always found science boring in school but clearly it can be exciting."

"Definitely inspires people to go into a profession that involves gases."

"I could see it gave my child something to think about and engage in. Fascinating."

"He enjoyed putting out the flame and making acid from blowing bubbles. Just great having the opportunity to watch the children take an interest."

"I was surprised at how much hydrogen can be stored in such a small canister and that they are used in buses in London."

"Interesting experiments and they loved that it was a bit dangerous. Really kept all of the kids attention, covered a wide variety."

Aberdeen Science Centre

"I really enjoyed the Carbon Dioxide experiments, as a teacher they were useful, simple experiments that could be replicated in the classroom... Using the fire extinguisher was a good example of uses of Carbon Dioxide."

"It was good fun and interesting.... (I was surprised) by the balloons inflating again."

"Interesting for both adults and children, well presented."

“(I enjoyed) the information regarding the composition of the air around us, I never knew about Argon.”

“(I enjoyed) the range of experiments that are different from the shows we’ve seen before at the Centre.”

“The children really enjoyed the experiments which were visual and they could see the change.”

“I liked the different ball for gases, it was a great way of representing the air composition.”

“My son thinks this is the best show he has seen at the Science Centre and he’s seen lots of shows!”

Glasgow Science Centre

“Highly recommend attending one of the shows, we’ve seen one about gases and another on forces - both fab.” [Google review, 14/10/18]

“Live show great entertainment (thank you xx.. You are the boss).” [TripAdvisor 21/10/18]

Ten visitors mentioned the show (in general) as the best aspect of their visit on VisitFlow, our post visit visitor’s survey.

“We went to one of the ‘lectures’ which was on gases and really enjoyed it - well done to the girl who presented it who was very entertaining and informative.” [TripAdvisor, 29/10/18]

“My daughter was so excited about everything. After we visited a show she asked why I wasn’t a scientist as it was great.” [VisitFlow]

Life Science Centre

“My 7-year-old and 4-year-old loved this. Daddy and I found it very interesting too 😊.”
(Facebook comment regarding The Secret World of Gases science show, 6th April)

“Secret World of Gases show was amazing.” (Visitor feedback card, May Half Term 2018)

“The lady who gave the Science Theatre talk about gases was a very good presenter, friendly and very knowledgeable beyond the scope of the talk.” (Trip Advisor, May Half Term 2018)

“Ysmay who put on the science show was brilliant! She really made the show with her acting skills and had a genuine interest for what she was talking about, as did the staff in the Experiment Zone.” (Visitor survey, May Half Term 2018)

“Spent most of the day here, she enjoyed the experiments section making a rainbow out of liquids and inflating a balloon with gases.” (Facebook 6th April)

A family with two children aged 8 and 6 had just arrived at Life from Middlesbrough (and hour’s drive away). The older child was in Experiment Zone with Dad whilst Mum and 6-year-old took part in other activities. They struck up a conversation with an off-duty and incognito member of staff. The mother was saying how they had struggled with the older boy who hadn’t wanted to visit Life as he thought it was ‘for little kids’. Twenty minutes later the son and dad came back from the experiment to join the others. The boy was bubbling with excitement telling the rest of

the family all about the Ocean Acidification experiment. As they left the area, the boy moved close to his Mum and asked “When can we come back here again?”

22. Impact on Centres and their Staff

The Secret World of Gases has been received very positively by Science Centres and Museums. Below are some examples:

From Aberdeen Science Centre:

“In the nine years at the Centre, this has been one of my favourite shows to deliver. Having the training in the safe use of liquid nitrogen has been great and has increased my confidence in using this for future shows” – *Andrew McDonald, STEM Learning Assistant, Aberdeen Science Centre.*

From Winchester Science Centre:

The Secret World of Gases has allowed a step change in skills at Winchester Science Centre, as set out in our original proposal it has enabled the wider delivery team to be trained and gain confidence in techniques where previously there was only one specialist.

Demonstrations and techniques are already being incorporated into our current schools offer and some of the demonstrations underpin future content being created at the moment.

Staff are now empowered with the skills, confidence and facilities to share the stories of gases and their future uses.

On a personal level it is deeply satisfying to bring chemistry into Science Centres and I have been privileged to be part of the wider ASDC team as well as managing the project within Winchester Science Centre.

From Techniquist Glyndŵr interim report:

The overall feeling from the evaluations submitted so far is that visitors have enjoyed the demonstrations in the family show, and were surprised how well the show kept the attention of children. The majority have answered positively in regards to the jobs in chemistry or working with gases.

Some examples of responses include:

- “The show made it seem exciting to be a scientist working with gases.”
- “The show has changed my view of such jobs in a positive way. I always found science boring in school but clearly it can be exciting.”
- “Definitely inspires people to go into a profession that involves gases.”

From Eureka! The National Children’s Museum interim report:

One area of the legacy that we were very pleased to see was the effect on the confidence that our Enablers have gained from performing this show. As most of them do not have a science

background this is quite new for them and we are already looking at how we can reuse some of the demonstrations from The Secret World of Gases in other areas of the Museum and how we can integrate other demonstrations we have not been confident to offer until now.

23. Ideas for Legacy and Future Use of the Programme

Glasgow Science Centre

We are adding some demonstrations from this programme to our existing shows such as Future Fuels. This is an education science show aimed at audiences between P4 and S2, which discusses the ways in which we may have to produce energy in a rapidly changing world.

In addition, we would be very interested in any discussions which take place regarding the use of The Secret World of Gases content as part of a schools programme. We feel that the content lends itself very well to a school audience with strong links to the Curriculum for Excellence.

Aberdeen Science Centre

Aberdeen Science Centre will now use elements including the capturing carbon dioxide, absorbing heat and making hydrogen as part of the daily 20-minute Science on the Spot demonstrations. Families, school pupils, birthday parties and community groups will all engage in these demonstrations. This will show a legacy of The Secret World of Gases show as the banner and table cloths will also be used.

Eden Project

Eden Project intends to embed this programme into its general science communication programme. Any kit we get from delivering this will be used in future events relating to gas. We intend to run several science-themed activities over the next five years and gas will play a part in some of these. Chris Bisson is currently developing a hydrogen powered plant growth cabinet in the Invisible Worlds lab. The intention is to make this resource open access via the ASDC network.

There has been a great deal of interest in this show from nearby schools, we hope to develop an outreach show over the next two years.

Techniquet Glyndŵr

The Secret World of Gases family show will now form part of Techniquet Glyndŵr's core bank of public shows. It will run for a number of weeks in the theatre during school holidays and weekends, roughly every 18 months. The information in the show will be updated overtime, to keep it relevant and accurate, and more staff will be trained as required.

In addition, the activities and demonstrations will be used on a more regular basis when Techniquet Glyndŵr attends special events such as Big Bang fairs and with special events in-centre for example, with youth groups and as part of a new chemistry project with which we have funding from the Royal Society of Chemistry to deliver starting February 2019.

Technique Glyndŵr is looking to use some of The Secret World of Gases equipment in the Key Stage 2 show, 'Introduction to Chemistry'. This will decrease the set up time of this show and provide new and interesting content. This is instead of the Key Stage 2 workshop originally planned, as the equipment is better suited for demonstrations with chosen volunteers rather than a workshop where everyone is hands-on.

W5

There has been some discussion of how the Hydrogen Bus and Hydrogen House could be used in our energy workshop in the future, as well as how the family show could be changed or adapted slightly to fit in with W5 current list of demonstration shows. Aspects of The Secret World of Gases have also been discussed as new ideas to bring into bank of activities the education team uses when doing pop-up science busking, such as the hydrogen bus and gas bingo machine.

Winchester Science Centre

Cryogenic handling has now become a standard technique for the delivery team and dry ice demonstrations from The Secret World of Gases now underpins one of the six key educational workshops offered to school visitors. As part of the organisations standard repertoire demonstrations now utilise these techniques at events such as the HMS Sultan and Farnborough International Airshow as well as other community festivals such as the Graze Festival, and as a core part of the Centre's public offer in the form of live science shows.

As well as allowing practitioners to develop their skills and become confident with the demonstrations, it has also increased the general chemistry awareness across the Centre, with the project partly responsible for an audit in COSHH procedures as well as more chemical solutions to school's workshops and public material.

The demonstrations and concepts introduced by The Secret World of Gases are now a staple at Winchester Science Centre and are now independent of any one advocate or driving force.

24. Reports from Science Centres and Museums

Aberdeen Science Centre

Aberdeen Science Centre (ASC) has engaged with 10,202 family members with The Secret World of Gases show. This has been primarily during February half-term, weekends and as part of the Centre theme during the school Summer holidays. The family show consisted of experiments predominantly with liquid nitrogen and carbon dioxide and has exceeded the contracted deliverables of 7,039.

The Secret World of Gases show was delivered at four special events during the delivery phase; British Science Week's Discovery Day, IET Engineering Open House Day, Marvellous Microbes Day and as a Stuff Worth Knowing Talk.

As part of British Science Week on the 3rd of March 2018, ASC delivered an annual Discovery Day. This is a day where stall holders and activity providers attend ASC to engage and enthuse

the audience in a variety of STEM related topics. The Secret World of Gases show was delivered along with the *'Flashes and Bangs'* show which was presented by Dr Alan McCue who is a lecturer at Aberdeen University and member of the Royal Society of Chemistry. Alan was also a brilliant source of expertise to answer staff questions and broaden their Chemistry knowledge, helping members of the STEM Learning Team to deliver the show with confidence and have the ability to answer children's questions with certainty. Alan then hosted a 'Stuff Worth Knowing' talk for an adult audience of 16+ around ice cream and the uses of liquid nitrogen in industry.

ASC aims to link careers into all the shows and workshops that are delivered within the Centre, the Engineering Open House Day and Marvellous Microbes were events which gave The Secret World of Gases a platform and a new audience to the discussion of careers in chemical engineering.

The Secret World of Gases show allowed the Marketing team to create new content for a range of media outlets making excellent use of the 'What's On' guide in the local paper, advertisements in the Raring2Go! magazine and social media which all played an important role in the success of The Secret World of Gases programme. Social media proved a brilliant platform to display photographs and videos of the show with the video of the Genie in a Bottle receiving 598 views.

Feedback from the show has been extremely positive from both visitors and staff members. Comments include, *"Interesting for both adults and children, well presented"* and *"brilliant day out, the whole family loved the gases show"* and *"this is my favourite show to deliver."*

ASC has achieved the contracted deliverables of 7,039 having engaged with a total of 10,202 participants. The legacy of this show is guaranteed as ASC will incorporate elements of the family show, in particular the carbon dioxide experiments into the Science on the Spot demonstrations which are delivered to all schools, community groups and birthday parties.

Eden Project

At Eden Project, we dedicated an entire weekend's programme to The Secret World of Gases on the 28th and 29th of April 2018. The staff that have led on the delivery of this were Rob Copeland and Emma Smart who worked with Science Project Manager, Chris Bisson, to create a 45 minute show using some of the demonstrations covered in The Secret World of Gases Training Academy at Winchester Science Centre. To enhance the delivery at Eden Project we created several Secret World of Gases demonstration areas across our entire site.

Every member of the delivery team loved the content and the opportunity to communicate gas science to our visitors.

To ensure that the entire Eden Project was programmed with The Secret World of Gases over the dedicated weekend of the 28th and 29th April, we developed our own in-house trail (see attached) aimed at our slightly younger visitors who had to 'find the gases in our air' and colour them in the correct CPK colour. This proved to be extremely successful and really helped with communicating the intended messages and interpretation to a whole new audience. We are happy to share this with other Centres.

Eureka! The National Children's Museum

Since the start of the project, Eureka! The National Children's Museum has delivered The Secret World of Gases to a total of **8,207** people. This has been through a family show offered during British Science Week, the Easter Holidays and a Home Educator Day; as well as through busking activities in the Summer Holidays and other events.

The majority of visitors who interacted with the project have done so through the 30 minute family show taking place within the Museum Theatre. The family show was delivered to 500 people in British Science Week, 5,605 people in the Easter Holidays and 223 people during one of our regular Home Educator days. The show was based around 'states of matter' and incorporated demonstrations and themes from the project. From making hydrogen and a hydrogen bus, to shrinking balloons with liquid nitrogen and using solid carbon dioxide to fill bubbles full of water vapour, the show has been incredibly popular. The evaluations completed for the family show are overwhelmingly positive and there have been some great comments from visitors both with the demonstrations and for the staff performing the show.

The show also contributed to an incredibly busy Easter Holidays, with nearly 40,000 visitors through our doors. It has also attracted a slightly older audience than our usual visitors, with nearly 25% of the children viewing the show aged 9 or over, compared with around 10% of children visiting the museum aged 9 and over.

In addition to the family show, we also showcased the project through trolley-based science busking during the Summer Holidays as part of our Summer Festival events to 379 people. This incorporated some of the same demonstrations as the family show along with additional demonstrations that enabled visitors to get more hands on with the project.

Eureka! was also invited to send a member of staff down to the Royal Society of Chemistry's Open House London event on 22nd September, where a modified version of the family show was performed to 1,500 people through the day. It was a great opportunity to showcase the project to an audience unfamiliar with the Museum and furthermore, as an example of what funding and help from the RSC can help make possible.

Our Enablers have really enjoyed performing the show, learning many new skills and using equipment and chemicals they have not had the opportunity to use before. We have already utilised this new knowledge and confidence to incorporate The Secret World of Gases demonstrations and themes into other engagement activities within the Museum and as a springboard to research and use other new and interesting science demonstrations.

In addition to the contracted deliverables, we have also delivered a slightly extended version of the family show to school visitors during British Science Week. Although not part of the total participants for the project, we delivered the show to 716 primary age children and their teachers during this time. Some of the demonstrations were also shown at one of our adult's only Lates events in March, with 217 people attending.

Glasgow Science Centre

Glasgow Science Centre (GSC) launched "The Secret World of Gases" at the end of March 2018. We have delivered this program in two distinct formats, a Science on the Spot drop-in style

within our Science Mall over the Easter Holidays, and a science show for families and education groups within our Science Show Theatre, and at the Bluedot Festival. Together these two formats have engaged with a total of **10,472** individuals across the period of the project. This has been a fantastic example of how delivering this style of programme alongside ASDC and other partner organisations are extremely valuable to Science Centres across the country.

Glasgow Science Centre began delivery of The Secret World of Gases on Friday 30th March, at the beginning of the Easter holidays in Scotland. As outlined in our application we have delivered the first block of our engagement in an adapted style of Science on the Spot (SOTS). We provided the audiences with a small seating area within the science mall which gave the feeling of a miniature science show. This meant that we achieved higher quality engagement and longer dwell times than we usually would with short term interactions. The Science on the Spot style provides us with a way to reach more of our visitors with inspiring live demonstrations, exciting information and a five-star experience.

Activities were delivered daily between 30th March and 15th April within an area of the building adjacent to our Planetarium exit and entrance to our Science Show Theatre. This is a high footfall area where we were confident that we would engage with a large number of people. This is positively reflected in the metrics document.

We delivered the family show in our Science Show Theatre throughout September and October 2018 for family audiences, as well as offering the show to education audiences in October. This was a change from our original plans - to deliver the show in July during our summer holidays - due to the European shortage of dry ice.

Life Science Centre

Life developed a 20-minute science theatre show from The Secret World of Gases resource material. The show highlighted the main gases making up the atmosphere around us, from hydrogen (most common in the universe) to nitrogen (most abundant on Earth's atmosphere), including oxygen and carbon dioxide. The presenters combined the highly specialised content with engaging demonstrations dealing with the different properties of gases and their applications in everyday life.

The Secret World of Gases show ran from 20th March to 17th June 2018. In that time over 10,000 members of public saw it on weekends and school holidays. The show was also performed on weekdays reaching a further 5,000+ people. These were mainly non-target schoolchildren, but some additional families and adult groups would have been amongst them.

The audience enjoyed the show, as demonstrated by the evaluation questionnaires. They appreciated the opportunity to talk about something so close to home and yet so far from common conversations, and many expressed an interest in travelling in hydrogen-fuelled vehicles one day.

The show was recommended for ages 7 and above, at parental discretion. Life's usual recommendation is 5+, although it is not uncommon to find children of all ages amongst the audience. For this show it was noticeable that fewer younger visitors joined the audience. The

promotional material and show description clearly skewed the audience to an older family demographic, the target for this project.

National Space Centre

During the summer holiday period July to September, the National Space Centre, Education and Space Communications team ran The Secret World of Gases talks and activities. During this period we reached 17,038 participants who took part in shows, busking activities or expert talks.

The shows were run three times daily throughout this period and concentrated on nitrogen and oxygen gases demonstrations. Each show lasted approximately 20 minutes and on average we had attendees of approximately 60. Over the entire period we ran 153 shows with a total audience of 9,362.

The busking activities we ran were the ocean acidification activity looking at the changes to the pH level of the oceans due to the increased carbon dioxide in our environment, how this affects the life in the ocean and what we can do to reduce this effect. We also ran the hydrogen fuel cell bus demonstration. This worked well together as we could talk about alternative uses for gases and the positive strides forward in using alternative fuels.

We also had three days of expert speakers come and visit the National Space Centre to do talks about different gases in our atmosphere.

We also ran family trails in around the galleries. These were hugely popular and were harder to quantify in terms of participants however, we estimate that approximately 6,000 trails were used over the summer period. The trails used specially designed information boards with information about specific gases and related them to exhibitions in our galleries. Using The Secret World of Gases molecule pictures participants then matched the pictures on trails to those in the galleries. The Royal Society of Chemistry supplied us with pencils which we gave to all those that completed the trail.

Techniquet Glyndŵr

Techniquet Glyndŵr reached 5,301 people during 2018 with The Secret World of Gases. 3,601 participated in the family show, 350 with activities alongside Meet the Expert sessions and 1,340 through the hands-on activities at other special events.

The Secret World of Gases was well received by visitors and staff alike. Feedback confirmed both children and adults enjoyed the opportunity to find out the amazing things gases can do.

The number and variety of activities allowed each Science Communicator trained in the project to create their own version of the family show; picking their favourite demonstrations to showcase and sharing their favourite nuggets of information relating to latest innovations and dispelling myths.

The equipment was great for both large audiences in the family show and one-to-one discussions at special events. Techniquet Glyndŵr will run the show again as part of its rolling public programme and make use of the demonstrations at various community events on a regular bases.

Techniquiest Glyndŵr is slightly restricted by its current theatre space and doesn't have the ceiling height needed for some of the demonstrations. However, Claire and Kevin who attended the Training Academy put together a great version of the show, showcasing different gases found in the atmosphere and their uses. Audiences particularly enjoyed seeing liquid air, discovering wonderful experiments with liquid nitrogen, learning about carbon dioxide and its effects, and making carbon dioxide fire extinguishers using household chemicals. The gas bingo was a great way to explain the composition of air and the hydrogen powered house and bus showed the usefulness of gases for our future sustainability.

Techniquiest Glyndŵr is thankful to the UK Association of Science and Discovery Centres, the Royal Society of Chemistry and BOC for the opportunity to be involved in this project. It has provided Techniquiest Glyndŵr staff with personal development opportunities, increased the chemistry knowledge of Science Communicators and highlighted to visitors the importance of the gases all around us.

The Secret World of Gases family show will now form part of Techniquiest Glyndŵr's core bank of public shows. It will run for a number of weeks in the theatre during school holidays and weekends, roughly every 18 months. The information in the show will be updated overtime, to keep it relevant and accurate and more staff will be trained as required.

In addition, the activities and demonstrations will be used on a more regular basis when Techniquiest Glyndŵr attends special events such as Big Bang fairs and with special events in-centre, for example with youth groups and as part of a new chemistry project we have funding from RSC to deliver starting February 2019.

W5

W5 has delivered the Secret World of Gases family show more than 100 times to over 6,500 people. Delivery was split into two phases, Phase 1 which was presented in the W5 Lecture Theatre, 'The Big Show' took aspects of the family show provided by ASDC as well as adapting other portions of the family show and added in some extra demonstrations.

The show was delivered every weekend between 10th February to 18th March as well as daily shows from 12th to 16th February to coincide with both the Northern Ireland half-term school holidays and the Northern Ireland Science Festival. 'The Big Show' was delivered a total of 40 times to 3,415 people.

Phase 2 was a scaled down version of the family show delivered on the W5 exhibition floors. 'The Floor Show' ran daily during the Northern Ireland school summer holidays in July and August, and delivered 64 times to 2,945 people.

W5 had intended on delivering The Secret World of Gases firstly in our 200 seat Lecture Theatre between half-term and Easter, before changing the show slightly to be delivered as a floor show in the W5 exhibition areas. When writing the show it was decided that the activities provided through the project handbook and training course, while engaging and effective, would not be suitable for a show in the Lecture Theatre due to the size and scale of them compared to that of the room, so the activities we adapted in some ways and other demonstrations added to them. The main message of the show, exploring the gases we use in our lives and how they will be

used for a greener future, was kept the same but the content was changed to fit the needs of the show.

'The Floor Show' was more directly taken from the demonstrations provided by ASDC and from the training sessions held in Winchester Science Centre, with some minor tweaks.

W5 also delivered two 'Meet the Expert' sessions on Saturday afternoons providing members of the public with the opportunity to meet experts from BOC, MOF Technologies and Queen's University Belfast, and hear more about the work they do with gases as well as take part in hands on activities. These sessions were free for any W5 visitors to attend resulting in 588 people engaging with the experts.

Winchester Science Centre

The Secret World of Gases has been a major success for Winchester Science Centre, both in terms of providing an exciting scaffold to base the entirety of the February half term offer on (the busiest period of the year for the Centre) and in upskilling and providing confidence to all delivery staff in cryogenic material handling, and a variety of classic chemistry demonstrations. The project team comprised of Liz Mitchell (Project Officer) and Dr Ben Littlefield (Project Manager).

Over the project period Winchester Science Centre has delivered The Secret World of Gases content to 10,908 members of family audiences as part of its contracted deliverables (6,858 more attendees than promised) and a further approximately 8,938 members of the public and school students at public and schools events. Winchester Science Centre has also promoted and demonstrated The Secret World of Gases content on BBC Radio Solent and Heart South Coast as part of their British Science Week special programs on the 12th and 15th of March respectively. It has also toured content to community events such as HMS Sultan in Gosport and major events such as Farnborough International Air Show.

The majority of the delivery was via live family shows presented by staff at the Centre. This was a shortened version of the full family show focusing on the composition of the atmosphere and then encouraging audiences to discover more about solutions to challenges faced and what chemists are doing towards a greener future. The show was modified slightly to engage a younger audience than originally intended and was very successful in engaging audiences with the stories and properties of gases, but less effective at communicating the role of and potential career paths in chemistry.

One of the main impacts of The Secret World of Gases has been staff empowerment. The demonstrations and skills developed over the project have enabled staff to incorporate learning into the wider offer provided by Winchester Science Centre. The techniques will continue to be used on a weekly basis and the demonstrations and shows created for The Secret World of Gases will be used as a major part of the Centre's repertoire in the future.

Over the course of February Half term 2018, over 8,028 family members attended The Secret World of Gases live show (61 % of total Centre footfall for the period). This number was logged by ticketing the show and requiring visitors to pre-book attendance (for no extra charge) so

numbers could be managed. There were a number of extra 'walk-ins' so the actual number was likely higher than the number reported here.

A modified family show was presented five or six times a day for the whole of February half term. The show was focused on the composition of the atmosphere around us and some of the unusual stories about the gases present. The show started with an eliciting questions exercise and introducing the scientific method by comparing the properties of helium and hydrogen balloons. This was added as the younger audiences encountered needed immediate interaction and a dramatic hook. It also allowed the presenter to refer back to the original experiment throughout the show when discussing the properties of gases. The show then followed the handbook suggested format of nitrogen demonstrations, oxygen demonstrations, carbon dioxide demonstrations and ended on a discussion about the future potential of hydrogen as an energy vector (demonstrated using a hydrogen/oxygen balloon and signposting to the hydrogen bus).

It was decided not to use smaller scale or more adult demonstrations such as 'liquid air' or 'hydrogen generation' as the audience ages were younger than expected and required much more visual/dramatic demonstrations. Humour was added in delivery regarding the oxygen mask section with presenters and ushers taking the part of air stewards/stewardesses. Presenters experimented with the 'shrinking balloons' activity, getting audience members to predict how many balloons would fit into a Dewar with a hidden balloon animal at the bottom. Anecdotal feedback was very positive for the show which is reflected in the formal evaluation carried out for the ASDC. Presenters enjoyed delivering the show but some found it a challenge delivering it as a solo presenter, most shows were therefore joint presented.

The shows were less effective in highlighting the role Chemists play, as they focused on the gases themselves rather than the careers/people involved in understanding them. This was heavily down to the language used and could be easily addressed. When the Centre delivers the show again the team will ensure the human side is highlighted.

The project has delivered a comprehensive resource and toolkit that Winchester Science Centre will use as a reference and a key part of its repertoire for years to come. Staff who delivered the show and subsequent related content at events from West Quay to Farnborough International Air Show have all enjoyed the demonstrations and content they are discussing and it is easy for them to transfer their enthusiasm for such a compelling concept. Moving forward, The Secret World of Gases will be a key part of the training plan for future staff at Winchester Science Centre and is remembered fondly by staff and public alike:

"... Personally my favourite science show I have ever presented" – Officer at Winchester Science Centre.

25. Appendices

Appendix 1: The Ideas Charette

Gases for our Future The Ideas Charette



Tuesday 14th March 2017

10:30 am – 5:00 pm

Royal Society of Chemistry, Burlington House, Piccadilly, London W1J 0BA

10:30 – 11:00	Registration with coffee and pastries Introducing participants to one another	
11:00 – 11:30	Welcome Introduction to the project, and the project team	Dr Penny Fidler (Chair) ASDC CEO
	A Welcome from BOC	Stephen Windsor-Lewis BOC/The Linde Group
	A Welcome from Royal Society of Chemistry With findings from Public Attitudes to Chemistry Research	Jon Edwards Royal Society of Chemistry
11:30 – 11:45	Introduction by all the Charette participants Goals of the day	All Dr Penny Fidler
11:45 – 12:30	Cool kit: Creating an excellent set of hands-on equipment and demos Dr Ben Littlefield will introduce this session presenting a selection of great hands-on demos for families related to gases, including: <ul style="list-style-type: none"> • The Shrinking Gas Balloon • Super-cooled magnets and the Maglev Train • Bouncing bubbles & Floating Bubbles • Ideas with a thermal imaging camera <p>The idea is to spark your ideas to create a great set of kit and activities to engage the public with how gases will and might be used for a better future.</p>	Dr Ben Littlefield , Winchester Science Centre Dr Andrew Steele , Francis Crick Institute Dr Susan Vickers Royal Society of Chemistry Clare Hampson , Catalyst Professor Jim McQuaid Leeds University
12:30 – 1:00	Round table discussion: Your ideas for cool kit and great activities that deliver the project vision <ul style="list-style-type: none"> • What equipment should we include in the kit? • How could we use it with different ages? • What stories can we tell about the future use of gases? • For this session, you will be working in small groups and asked to feedback ideas to everyone at the end. 	Dr Penny Fidler and the project team

1:00 – 1:45	Lunch	
1:45 – 2:30	<p>Cool kit and great activities: New ideas and Big Ticket items.</p> <p>A Hydrogen HYMERA fuel cell generator: Showcased by Stewart Dow of BOC and a discussion of the future uses of Hydrogen.</p>	<p>Stewart Dow BOC</p>
	<p>Hydrogen fuel cell cars: Arlan Harris and Laura Rolinson of Arcola Energy showcasing a Hydrogen fuel cell-powered car, the hydrogen fuel cells, an electrolyser and a robot.</p>	<p>Laura Rolinson Arlan Harris Arcola Energy</p>
	<p>Helium: An overview</p> <p>Where it is from, what it can do now and its potential for the future.</p>	<p>David Henderson BOC</p>
2:30 – 3:30	<p>Thinking creatively: Wouldn't it be great if...</p> <p>We want this project to create some fabulous new activities for families and children to help them explore gases and how these will be used in the future.</p> <p>We want new ideas and activities to get families thinking and questioning what these gases are, where they come from and their potential to solve some of today's challenges.</p> <p>In this session, we are asking you to come up with brilliant ideas to bring alive the stories and science of gases. In groups with participants from different backgrounds, we will ask you to play with ideas, think creatively and freely and to find new ways to help people understand 'the invisible world of gases' and how gases will be used to power and shape our future.</p> <p>Fabulous ideas don't always appear on demand, and pop up at a time they choose, so we would be delighted if you would contact us after the Charette to add your latest strokes of genius!</p> <p>The output of this session will be your ideas written on the cards supplied. The last 15 minutes will be a chance to hear everyone's ideas.</p>	<p>Chaired by Dr Penny Fidler, this will be a combination of individual and group work</p>
3:30 – 3:45	Coffee and cakes	
3:45 - 4: 30	<p>You really shouldn't miss</p> <p>In this session, we will ask you to tell us about remaining excellent ideas, demos, websites, apps, experiments, social media, people, projects and equipment you would love to see play a part in the wider project. From hydrogen fuel cells to levitating magnets, what shouldn't we miss as we create our kit?</p>	<p>Chaired by Dr Penny Fidler, this will be a combination of individual and group work</p>
4: 30 - 5:00	Group discussion to share all the ideas and explore the next steps	<p>Dr Penny Fidler and Andy McLeod</p>

5:00	Close	
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The format of the Charette

A Charette brings together people from a variety of backgrounds to come up with new ideas and to address specific questions. The purpose of this Charette is to bring together some of the very best people in the UK at the start of this exciting national project, to work collectively for one day to share ideas with the project team and contribute to the development of resources for the project.

For this Ideas Charette we are delighted to be joined by BOC scientists, Royal Society of Chemistry members, university researchers as well as public engagement professionals from ASDC, Winchester Science Centre and others. The format of the day will allow you to work in small groups, individually and to share ideas with the wider Charette. We will also have 'Ideas Cards' and other mechanisms to capture all the information.

The Project Vision

The Vision: To engage, inspire and involve school-age children and their families with the amazing stories and science of Gases, investigating the latest innovations, dispelling myths and exploring how gases will be used for a greener future.

The Project Mission

The Mission: To deliver an inspirational and hugely exciting national programme of hands-on activities and experiments for children and families across the UK, through the successful infrastructure of the UK's Science and Discovery Centres and Science Museums.

Appendix 2: The National Training Academy



The Training Academy

November 7th - 8th 2017

Day 1: Tuesday 7th November

Time	Session	
9:15 - 10:00	Registration with coffee and pastries	
10:00 - 11:20	Welcome Introductions to the project team and funders	Dr Penny Fidler, CEO of ASDC
	A welcome to Winchester Science Centre and Planetarium	Ben Ward, CEO of Winchester Science Centre and Planetarium
	Introductions by all the participants	All Delegates
	An Overview of The Secret World of Gases (including the project vision, mission, a broad overview of the equipment and resources, grants and your delivery timeframes).	Dr Penny Fidler, CEO of ASDC
	A welcome from the Royal Society of Chemistry, with findings from the public attitudes to chemistry survey.	Dr Susan Vickers, Public Engagement Executive, Royal Society of Chemistry
	An introduction to BOC	Susan Tyzack, Public Affairs Manager, BOC UK & Ireland
11:20 - 11:40	Coffee	
11:40 - 1:00	Familiarising yourself with the training handbook	Andy McLeod, Special Projects Manager, ASDC
	Health and safety across the project and your responsibilities	Dr Penny Fidler
	Safe Gas Handling for Liquid nitrogen	Andy Lane, BOC
	The Hands-on Equipment Training Part 1: Liquid nitrogen 1. The liquid nitrogen fountain 2. Shrinking balloons	Andy McLeod and Dr Ben Littlefield, Head of Education, Winchester Science Centre and Planetarium
1:00 - 1:45	Lunch	

1:45 - 3:30	The Hands-on Equipment Training Part 2: Andy McLeod and Dr Ben Littlefield 1. Gas bingo 2. Making liquid air 3. Boiling nitrogen 4. Keeping food fresh 5. Plane oxygen 6. Health and safety questions and discussion
3:30 - 3:45	Coffee break and Blazing Wotsits (Dr Ben Littlefield)
3:45 - 5:00	The Hands-on Equipment Training Part 3: Hydrogen activities with Andy McLeod, Dr Ben Littlefield and Arlan Harris (Arcola Energy)
	<ul style="list-style-type: none"> • Making hydrogen using magnesium • Splitting water to make hydrogen, to use as a fuel • Hydrostik and hydrogen storage • How a hydrogen fuel cell works • The hydrogen house • The hydrogen bus • The hydrogen car • Commercial hydrogen fuel cells
5:00 - 5:45	Special Guest: Dr Ben Todd, Managing Director of Arcola Energy Ltd How can we create a zero emissions transport system for the future and could hydrogen help?
5:45pm	Close
6pm	Taxis back to the hotel
7:45 for 8pm	Dinner in the hotel dining room

Information for Training Academy Delegates (read in advance)

- 1. Please ensure you bring with you a copy of your proposal so that you are clear on what your centre needs to deliver. We can clarify any points you are unsure of.**
2. Please look at what your Centre has in the way of liquid nitrogen equipment and bring a list with you.
3. Please remember that after the training academy that you, on behalf of your centre, will be responsible for all health and safety and risk assessments. You will also be responsible for running the programme and meeting the deliverables you outlined in your proposal. Please therefore ask all the questions you need during the academy - we are here to help. Likewise, if there is something you don't understand, please ask us.
4. We want you to meet and speak to all other delegates, therefore at each break or meal, please introduce yourself to at least two people you don't already know.
5. Please sit on different tables each day to mix people around.

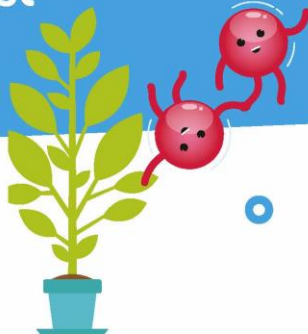


Day 2: Wednesday 8th November

Time	Session
8:30 - 8:45	Taxis leave hotel
8:45 - 9:15	Coffee and arrivals at Winchester Science Centre and Planetarium
9:15 - 11:00	Welcome back and overview of both days
	The Hands-on Equipment Training Part 4: Carbon Dioxide and other gases with Andy McLeod and Dr Ben Littlefield <ul style="list-style-type: none"> • Capturing CO₂ • Future of CO₂ • Absorbing heat • Sublimating CO₂ • Ocean acidification • Argon • Gases in medicine • Health and Safety - any questions
11:00 - 11:20	Coffee, biscuits and a team photo
11:20 - 12:45	A full run through of the family show: Andy McLeod and Dr Ben Littlefield
	Questions on the experiments, activities and the show
	Gas handling: specialist expertise
	Where to get your gas
12:45 - 1:30	Lunch
1:30 - 3:15	The website: Dr Penny Fidler
	Your evaluation and contractual commitments: Dr Penny Fidler
	'Meet the Expert' sessions and where to find the experts: Project team
	The marketing resources and your responsibilities: Dr Penny Fidler
	Reaching wider audiences, and gender equity: Shaaron Leverment
	Cleapss and health and safety: Project team
	Training your staff and ensuring quality and accuracy of the content: Project team
3.15-3.30	Coffee
3.30-4.00	Final questions, your next steps: Project team
4:00	Close
4:15	Taxis to the train station (for those who want to leave immediately)
4.00 -5:00	Opportunity to ask the project team any questions, including about the chemistry. Opportunity to talk with other participants and to look around Winchester Science Centre.
5:15	Taxis to the train station

Appendix 3: The Secret World of Gases Kit List

Kit List



Overview

At the core of this project is the set of project equipment. This equipment is intended to be flexible. It can be used by your staff, and the scientists and engineers you work with, for a host of activities and demonstrations.

Standard equipment list:

Item	Activity(ies)	Supplier or notes
One bingo machine and set of balls	1	Supplier: Bingo Bingo Supplies Ltd and The Precision Plastic Ball Company Ltd.
Standard balloons (white, red, blue and black)	2, 5, 8, 9	Balloons supplied from Amazon, or BOC 18 inch latex balloons.
Metal tongs with rubber handles	2	Insulated handles for handling balloons in liquid nitrogen: from general scientific equipment supplier.
Sausage balloons	2, 3	Balloons supplied from Amazon or BOC, 18 inch latex balloons.
B34 quick-fit borosilicate tube	3, 5	B34 refers to the size of the neck, quick-fit is a special type of neck on the tube. From general scientific equipment supplier.
B19 to B34 borosilicate adapters x 2	3, 5	Two adapters required to connect 18 inch balloon to B34 quick-fit borosilicate tube. From general scientific equipment supplier.
B34, B24 quick-fit clips x 2	3, 5	Clips to maintain quick-fit joints.
Elastic bands	3, 5	To attach balloons to glassware.
Rubber tubing (4 x 1 m)	4	From general scientific equipment supplier.

Funnel	5	For use in pouring liquid nitrogen into borosilicate tube.
Plastic Jars (x 2)	6	Jars supplied from Amazon.
Wide neck quick-fit 500 mL round bottom flask (RBF)	7	Should be wide-neck to lower speed of exhaust, from general scientific equipment supplier.
Retort stand	7	Heavy based metal stand.
Boss	7	A double ended clamp for attaching clamps to retort stand, from general scientific equipment supplier.
Clamp	7	A long armed clamp with screw to close jaws, should be bare metal, from general scientific equipment supplier.
Heat proof mat (x 4)	7	From general scientific equipment supplier.
Portable Bunsen burner	7	From general scientific equipment supplier.
Safety screen	7	From general scientific equipment supplier.
Long-handled spoon	7	From general scientific equipment supplier.
250 mL conical flask with B19 quick-fit neck (x 2)	8, 13	From general scientific equipment supplier.
Balloon clip (x 2)	8, 9	Units supplied from Amazon.
USB cup warmer	10	Units supplied from Amazon.
Balloon pump	10	Units supplied from Amazon.
Glass jug	11	Must have a good spout for pouring and be at least 2 L.
Tea lights	11	General supplies.
Cling film	11	General supplies.
Plastic tub (35 L)	11	Clear sides are a must.
Polystyrene cups	11	Used for safely handling solid carbon dioxide.
2 L glass measuring cylinder	12	From general scientific equipment supplier.
Metal spoon-end spatula	12	From general scientific equipment supplier.
Hydrostik	14	Supplied by Arcola Energy.

Hydrogen experiments:

Item	Activity(ies)	Supplier or notes
Remote control bus	16	Supplied by Arcola Energy.
Hydrogen fuel cell (x 4)	16, 18	For both bus and house, supplied by Arcola Energy.
Arduino controller (x 2)	16, 18	For both bus and house, supplied by Arcola Energy.
Arcola fuel cell controller (x 2)	16, 18	For both bus and house, supplied by Arcola Energy.
Balloon valve (x 2)	16, 18	For both bus and house, supplied by Arcola Energy.
Hydrostik valve (x 2)	16, 18	For both bus and house, supplied by Arcola Energy.
Car chassis	17	Supplied by Horizon Education.
Solar panel charging kit	17	Supplied by Horizon Education.
Battery pack	17	Supplied by Horizon Education.
Reversible hydrogen fuel cell	17	Supplied by Horizon Education.
Electrolysis tanks and tubes	17	Supplied by Horizon Education.
Fan(s)	18	Supplied by Arcola Energy.
RGB LED strips	18	Supplied by Arcola Energy.
Micro-servos	18	Supplied by Arcola Energy.
On/off switch	18	Supplied by Arcola Energy.
Indicator LEDs	18	Supplied by Arcola Energy.
Dolls House	18	Supplied by Arcola Energy.



Consumables and PPE

Item	Activity(ies)	Supplier or notes
Liquid nitrogen	16	Supplied by BOC.
Apples	16, 18	General supplies.
Potassium chlorate	16, 18	General chemical supplies.
Wotsits®	7	General supplies.
Hydrogen peroxide (30 %)	16, 18	General chemical supplies.
Manganese dioxide	16, 18	General chemical supplies.
Diet coke (2 L)	17	General supplies.
Mentos	17	Should be original only, general supplies.
Solid carbon dioxide	17	General chemical supplies.
Bubble mixture	17	General supplies.
Sodium hydroxide	12	General chemical supplies.
Universal Indicator	12	General chemical supplies.
Hydrochloric acid (2 M)	13	General chemical supplies.
Magnesium ribbon	13	General chemical supplies.
Cryogenic gloves	1, 2, 3, 4, 5, 11, 12	From general scientific equipment supplier.
Face shield	General use	From general scientific equipment supplier.
Goggles	General use	From general scientific equipment supplier.
Lab coat	General use	Supplied by ASDC
Nitrile gloves	General use	From general scientific equipment supplier.

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Appendix 4: The Secret World of Gases Evaluation Survey



Ask one of the adults Hello! My name is ... and I work for [name of your Centre]. Thanks for watching/taking part in The Secret World of Gases; we'd love to know what you all thought. Would you and your family be willing to help us – it will only take about three minutes?

1. Do you feel the activities you took part in *Read out each question & the range of answer options*

		Definitely No	Not Sure	Definitely Yes
a) Were fun?	Adult			
	Child 1			
	2 etc			
b) Were interesting?	Adult			
	Child 1			
	2 etc			
c) Made you want to find out more about different gases and how they might be used in the future?	Adult			
	Child 1			
	2 etc			

2. What did you most enjoy about these activities, and why?

Children's responses

Adult's responses

3. Did anything surprise you?

4. Did you feel these activities increased your understanding of...

		Not at all	A little	A lot
Gases, and what they are used for?	Adult			
	Child 1			
	2 etc			
The different gases that make up the air around us?	Adult			
	Child 1			
	2 etc			

5. Did you feel these activities helped to show you...

		Not at all	A little	A lot
What chemistry is, and what chemists do?	Adult			
	Child 1			
	2 etc			
Future jobs in chemistry and gases?	Adult			
	Child 1			
	2 etc			

6. Has The Secret World of Gases made you think that a job in chemistry or working with gases might be interesting?

[Children's responses](#)

[Adult's responses](#)

7. What are the ages of your children?

	Gender (interviewer please answer)		Age
Child 1	F	M	
Child 2	F	M	
Child 3	F	M	

THANK YOU FOR YOUR TIME TODAY

Additional Information for the interviewer

TODAYS DAY and DATE.....

CENTRE VISITED.....