Chemistry at Work – a guide for presenters (England & Wales, primary)

Thank you (and your organisation) for agreeing to give a presentation at the forthcoming Chemistry at Work event at XXXXX on DDDDDD, which is for students aged FFFF.

The Chemistry at Work programme is sponsored by the Royal Society of Chemistry and has been running since 1991. There will be about 40 events this year across the UK.

More general information about Chemistry at Work can be found at http://www.rsc.org/lap/educatio/chemwork.htm. For information about this particular event, please contact the Local Organiser, XXXX, on YYYYY.

These notes are aimed to help you give the best possible presentation to your audience of young people.

Aims

The aims of Chemistry at Work are:

- To present a positive image of chemistry and the chemical sciences to young people at school or in college
- To show the variety of what chemists do and how chemistry is part of some jobs where it may not have been expected
- To show that chemistry is an important part of the economy of the country
- To show that chemistry is an interesting and exciting way to earn a living
- To show that chemists are real people (and not nerds).

The events are *not* primarily careers events (although if students leave the event favourably disposed towards a career in chemistry this would be a bonus). Neither are they primarily aimed at teaching students chemistry (although if they leave the event with some extra knowledge, this, too, is a bonus).

What is a Chemistry at Work event like?

Every Chemistry at Work event is different in detail and has its own character. The following points describe a typical event.

- It is aimed at young people at school (different events cater for different age groups from primary to post-16)
- It takes place at a venue such as a school, college, university, conference centre, industrial workplace, *etc*
- It lasts from 1 to 3 days
- It takes the form of a ‘circus’ of several (typically six to eight) short (approximately 25 minute) presentations in which presenters explain how they use chemistry in their everyday work. This may then lead to a related practical activity that is linked (in some way) to their work
- Ideally presentations are interactive and ‘hands on’ as much as possible
- Small groups of students (15 to 20) move around the presentations accompanied by a teacher
- Each student will spend half a day at the event and experience about six presentations
- Some events finish with a talk / demonstration to all, often with a ‘wow’ factor
- It is visited by up to 300 students per day.

Preparing your presentation

Outline

Your presentation will be about 25 minutes long. A presentation for young people needs to be different in many respects from one aimed at adults:

- You will need to grab the audience's attention – the students may not be at your presentation by choice
- You will need to break up your presentation – children have shorter attention spans than adults
- You will need to be aware of the chemistry that your audience does and does not know
- Your presentation will need to be interactive and 'hands on' wherever possible
- You will need to take care with technical terms, jargon and long words.

It will not be possible to cover a lot of detail in the time available, so choose three or four points that you would like to get across. Break up your talk by giving the audience things to look at, pass round or do. Vary your tone of voice. If possible have two (or more) presenters (ideally of different genders and/or ethnicities) to give the audience a different person to look at and a different voice to hear.

Content

Remember that you are not primarily trying to teach chemistry or sell chemistry as a career (at least directly). Your brief is to tell the students about how you use chemistry in your work, how your work fits in with everyday life and why you find your work interesting and stimulating. If at all possible, try to include something active for the students to do. Some simple practical work may be possible even if the event is not held in a laboratory.

Health and safety

The Local Organiser is responsible for general H&S issues such as what to do in the event of an emergency, but do make sure that you are aware of these too. The Local Organiser may not be a chemist and cannot be responsible for any issues to do with any demonstration you might do. You may be asked to fill in a simple risk assessment form. If you have any queries about this, contact the Organiser who can get advice from the National Coordinators.

Know your audience

It is important that you bear in mind the chemistry that your audience will know (and not know) when preparing your presentation. The best way to do this is to use the National Curriculum – the 'Materials and their properties' (*ie* chemistry) section is in the Appendix. The National Curriculum is divided into so-called Key Stages:

KS	School year group	Age
1	1-2	5-7
2	3-6	7-11
3	7-9	11-14
4	10-11	14-16
5	12+ ('6th form')	16+

One can be confident that students in a particular Key Stage will be working on the material in that Key Stage and will have covered the material in earlier Key Stages.

Presentation software

Powerpoint™ and similar presentation software is excellent but beware of basing your whole presentation around it. If all the presenters use it, it can lead to a rather dull experience for the students. *You* are the resource they have come to see and hear!

If using Powerpoint™, structure your presentation so that it asks questions.

Also make sure that equipment is available at the venue if you are not bringing your own.

Tips for talking to primary children

1. Children are not small adults

- Children may not be at your talk by choice – most adult audiences are (at some level!)
- Children will not share your vocabulary – both general language and technical, but they do enjoy 'big words'. Take time to explain what they mean, then model their use by giving examples.
- Many primary children will not understand that words such as 'solution' have more than one meaning – use concrete examples to make the meaning clear, and link technical words to everyday-life situations wherever possible
- Children have shorter attention spans than adults – in minutes this is approximately equal to their chronological age in years plus two. This means that the average Reception child ('year 0') will be able to concentrate for about six minutes, and the average Year 6 child for about 12 minutes. Break up the workshop / talk with opportunities for the children to move about, for example to look at something, and 'chunk' the sessions into small sections.
- Some children may lack the confidence to interact with the speaker – ask questions, interrupt *etc*, especially in large groups. Most children will respond well in small groups. It may help to break up the session by asking the children to discuss something in small groups, and then feed back to the large group. This could be linked to the previous bullet point. For example saying to the children 'I want you to talk about 'x' and decide if you agree or disagree', involves them moving to discuss in small groups and moving back again.
- Young children will be keen to share their personal experiences, for example 'My Daddy has some of that in his car', and may 'go off at a tangent'. They need to be guided gently back on task. Children are generally happy to have a brief acknowledgement of their contribution, and to accept that the discussion will jump back to where it was. Don't feel rude for not responding to 'red herrings' in detail.

2. Say where you are going

Pick a small number of points (one or two) that you want to get across

- Say what your point is going to be.
- Start with the 'big picture'. How does your point fit into the children's understanding of the world?
- Link it to children's experiences.
- Develop it. If possible, provide practical opportunities to illustrate it.
- Share findings and recap what the main message is.

3. Be varied

- Children are used to regular changes of activity rather than concentration on one long argument – look at a children's magazine or TV programme if you don't believe this.
- Give the audience things to do, hear, see, (even feel or smell, if appropriate).
- Have more than one presenter to vary tone of voice and delivery (better still if one is male, one female).
- Involve the audience – get them to help with demonstrations
- Ask questions - but be prepared to wait for answers and don't be thrown if you get no answer at all or an unexpected answer. Children do not have preconceived ideas about what is expected in certain situations. It may be necessary to unpick misconceptions.

4. Things to avoid

- Jargon – this could be:
  - *technical terms (*eg* solution, dissolving – although the oldest primary pupils should have encountered these words)
  - *passive language ('it can be shown that')
- Being derogatory (by implication) about their attainments *eg* 'I knew all about melting and freezing at primary school'
  - *You probably didn't
  - *There will be plenty of things they can do that you couldn't at their age (such as surfing the internet)
- Aping 'yoof' culture – don't talk about the latest pop group, trends, fashions *etc* unless you are sure of your ground 'daddy-oh'.
- Talking down to children. They like to feel grown up!
- Sexism and racism – these are almost always implicit rather than deliberate, but what message does it give if the presenter is always selecting boys to answer questions or help with a demonstration?
- Being threatening – don't imply they are stupid if they can't or won't answer questions. Children respond well to praise and encouragement.

5. Do

- Introduce yourself, your organisation and your place in it. 'I'm Freda Smith and I work for ------ which makes ------. I make sure that all the ------ are ------'.
- Involve as much practical work as possible – this is the best way to develop understanding.
- Take 'goodies' to give away – company pens, posters *etc etc*.
- Visit the venue beforehand. Is there an OHP, projection screen, data projector *etc*?
- Praise answers to questions even if they are not the ones you expected / hoped for
- Use analogies to explain difficult ideas – for example 1 part per million is the same as a £5 note hidden in a pile of paper 50 m high (about the height of a 15 storey building).
- If possible, talk to the teacher or organiser beforehand to find out about the group and their background.
- Time your talk / activity to fit the slot.

6. Watch out for

- Units – most children will not be familiar with non-metric units – inches, pounds *etc.*

- Chemical names – children will know chemicals by everyday names such as ‘white spirit’, vinegar, nail varnish remover.
- Chemical notation – only the most able Year 6 students will have encountered this at all.
- Make sure that you and your AVAs are visible and audible – sit at the back beforehand – can you see your OHTs? It is most frustrating (and only too common) to hear speakers say ‘I know you can’t read this at the back but…’

Appendix

The following pages are taken from the *Materials and their properties* (*ie* Chemistry) section of the National Curriculum for England.
You may find it useful to skim the appropriate section(s) for the age group at which your presentation is aimed to get a feel for the level at which these young people are working.
The whole of the National Curriculum for England can be found at www.nc.uk.net/home.html.

Science Key Stage 1

Sc3 Materials and their properties

Grouping materials

1 Pupils should be taught to:
a use their senses to explore and recognise the similarities and differences between materials
b sort objects into groups on the basis of simple material properties [for example, roughness, hardness, shininess, ability to float, transparency and whether they are magnetic or non-magnetic]
c recognise and name common types of material [for example, metal, plastic, wood, paper, rock] and recognise that some of them are found naturally
d find out about the uses of a variety of materials [for example, glass, wood, wool] and how these are chosen for specific uses on the basis of their simple properties.

Changing materials

2 Pupils should be taught to:
a find out how the shapes of objects made from some materials can be changed by some processes, including squashing, bending, twisting and stretching
b explore and describe the way some everyday materials [for example, water, chocolate, bread, clay] change when they are heated or cooled.

Science Key Stage 2

Sc3 Materials and their properties

Grouping and classifying materials

1 Pupils should be taught:
a to compare everyday materials and objects on the basis of their material properties, including hardness, strength, flexibility and magnetic behaviour, and to relate these properties to everyday uses of the materials
b that some materials are better thermal insulators than others
c that some materials are better electrical conductors than others
d to describe and group rocks and soils on the basis of their characteristics, including appearance, texture and permeability
e to recognise differences between solids, liquids and gases, in terms of ease of flow and maintenance of shape and volume.

Changing materials

2 Pupils should be taught:
a to describe changes that occur when materials are mixed [for example, adding salt to water]
b to describe changes that occur when materials [for example, water, clay, dough] are heated or cooled
c that temperature is a measure of how hot or cold things are
d about reversible changes, including dissolving, melting, boiling, condensing, freezing and evaporating
e the part played by evaporation and condensation in the water cycle
f that non-reversible changes [for example, vinegar reacting with bicarbonate of soda, plaster of Paris with water] result in the formation of new materials that may be useful
g that burning materials [for example, wood, wax, natural gas] results in the formation of new materials and that this change is not usually reversible.

Separating mixtures of materials

3 Pupils should be taught:
a how to separate solid particles of different sizes by sieving [for example, those in soil]

b that some solids [for example, salt, sugar] dissolve in water to give solutions but some [for example, sand, chalk] do not
c how to separate insoluble solids from liquids by filtering
d how to recover dissolved solids by evaporating the liquid from the solution
e to use knowledge of solids, liquids and gases to decide how mixtures might be separated.

Science Key Stage 3

Sc3 Materials and their properties

Classifying materials

1 Pupils should be taught:

Solids, liquids and gases

a how materials can be characterised by melting point, boiling point and density
b how the particle theory of matter can be used to explain the properties of solids, liquids and gases, including changes of state, gas pressure and diffusion

Elements, compounds and mixtures

c that the elements are shown in the periodic table and consist of atoms, which can be represented by symbols
d how elements vary widely in their physical properties, including appearance, state at room temperature, magnetic properties and thermal and electrical conductivity, and how these properties can be used to classify elements as metals or nonmetals
e how elements combine through chemical reactions to form compounds [for example, water, carbon dioxide, magnesium oxide, sodium chloride, most minerals] with a definite composition
f to represent compounds by formulae and to summarise reactions by word equations
g that mixtures [for example, air, sea water and most rocks] are composed of constituents that are not combined
h how to separate mixtures into their constituents using distillation, chromatography and other appropriate methods.

Changing materials

2 Pupils should be taught:

Physical changes

a that when physical changes [for example, changes of state, formation of solutions] take place, mass is conserved
b about the variation of solubility with temperature, the formation of saturated solutions, and the differences in solubility of solutes in different solvents
c to relate changes of state to energy transfers

Geological changes

d how forces generated by expansion, contraction and the freezing of water can lead to the physical weathering of rocks
e about the formation of rocks by processes that take place over different timescales, and that the mode of formation determines their texture and the minerals they contain
f how igneous rocks are formed by the cooling of magma, sedimentary rocks by processes including the deposition of rock fragments or organic material, or as a result of evaporation, and metamorphic rocks by the action of heat and pressure on existing rocks

Chemical reactions

g how mass is conserved when chemical reactions take place because the same atoms are present, although combined in different ways
h that virtually all materials, including those in living systems, are made through chemical reactions, and to recognise the importance of chemical change in everyday situations [for example, ripening fruit, setting superglue, cooking food]

i about possible effects of burning fossil fuels on the environment [for example, production of acid rain, carbon dioxide and solid particles] and how these effects can be minimised.

Patterns of behaviour

3 Pupils should be taught:

Metals

a how metals react with oxygen, water, acids and oxides of other metals, and what the products of these reactions are
b about the displacement reactions that take place between metals and solutions of salts of other metals
c how a reactivity series of metals can be determined by considering these reactions, and used to make predictions about other reactions

Acids and bases

d to use indicators to classify solutions as acidic, neutral or alkaline, and to use the pH scale as a measure of the acidity of a solution
e how metals and bases, including carbonates, react with acids, and what the products of these reactions are
f about some everyday applications of neutralisation [for example, the treatment of indigestion, the treatment of acid soil, the manufacture of fertilizer]
g how acids in the environment can lead to corrosion of some metals and chemical weathering of rock [for example, limestone]
h to identify patterns in chemical reactions.

Double Science Key Stage 4

Sc3 Materials and their properties

Classifying materials

1 Pupils should be taught:

Atomic structure

a that atoms consist of nuclei and electrons
b the charges and relative masses of protons, neutrons and electrons
c about mass number, atomic number and isotopes
d about a model of the way electrons are arranged in atoms
e how the reactions of elements depend on the arrangement of electrons in their atoms

Bonding

f that new substances are formed when atoms combine
g that chemical bonding can be explained in terms of the transfer or sharing of electrons
h how ions are formed when atoms gain or lose electrons and how giant ionic lattices are held together by the attraction between oppositely charged ions
i how covalent bonds are formed when atoms share electrons
j that substances with covalent bonds may form simple molecular structures or giant structures
k ways in which the physical properties of some substances with giant structures differ from those with simple molecular structures.

Changing materials

2 Pupils should be taught:

Useful products from organic sources

a how the mixture of substances in crude oil, most of which are hydrocarbons, can be separated by fractional distillation
b the use of some of the products from crude oil distillation as fuels
c the products of burning hydrocarbons
d that alkanes are saturated hydrocarbons, and alkenes are unsaturated hydrocarbons

e how addition polymers can be formed from the products of crude oil by cracking and polymerisation
f some uses of addition polymers

Useful products from metal ores and rocks

g about the variety of useful substances [for example, chlorine, sodium hydroxide, glass, cement] that can be made from rocks and minerals
h how the reactivity of a metal affects how it is extracted from its naturally occurring ores
i an example of how a less reactive metal can be extracted by reduction with carbon or carbon monoxide
j an example of how a metal can be purified or recycled by electrolysis
k an example of how a reactive metal can be extracted by electrolysis

Useful products from air

l the importance for agriculture of converting nitrogen to ammonia
m how nitrogenous fertilisers are manufactured, their effect on plant growth, and the environmental consequences of over-use

Quantitative chemistry

n to represent chemical reactions by balanced symbol equations and to use these to predict reacting quantities
o to determine the formulae of simple compounds from reacting masses

Changes to the Earth and atmosphere

p how the Earth's atmosphere and oceans have changed over time
q how the carbon cycle helps to maintain atmospheric composition
r how the sequence of, and evidence for, rock formation and deformation is obtained from the rock record.

Patterns of behaviour

3 Pupils should be taught:

The periodic table

a that there are approximately 100 elements and that all materials are composed of one or more of these
b that the periodic table shows all the elements, arranged in order of ascending atomic number
c the connection between the arrangement of outer electrons and the position of an element in the periodic table
d that elements in the same group of the periodic table have similar properties
e how the properties of elements change gradually from the top to the bottom of a group
f the properties and uses of the noble gases
g the properties and reactions of the alkali metals
h the properties, reactions and uses of the halogens
i about similarities between transition metals and about the characteristic properties of their compounds
j some uses of transition metals

Chemical reactions

k about different types of chemical reaction, including neutralisation, oxidation, reduction and thermal decomposition, and examples of how these are used to make new materials
l to recognise patterns in chemical reactions and use these to make predictions
m about ways in which knowledge about chemical reactions is applied when new substances are made

Rates of reaction

n about the great variation in the rates at which different reactions take place
o how the rates of reactions can be altered by varying temperature or concentration, or by changing the surface area of a solid reactant, or by adding a catalyst

p how the rates of many reactions depend on the frequency and energy of collisions between particles

Reactions involving enzymes

q about the effect of temperature on the rates of enzyme-catalysed reactions and their dependence on pH

r how enzymes may be used in biotechnology

Reversible reactions

s about manufacturing processes based on reversible reactions, and how the yield of these depends on the conditions

Energy transfer in reactions

t that changes of temperature often accompany reactions

u that reactions can be exothermic or endothermic

v how making and breaking chemical bonds in chemical reactions involves energy transfers.