



Mission Impossible: Science Challenges

Demonstration Sheets

The following pages show images from the teacher's folder. Three of the eleven challenges are available to download.



Science Challenges

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Introduction

Mission ~~Im~~possible: Science Challenges offers a unique way to grab the attention and interest of your students straight away:

- Whether you are looking for something different and exciting to motivate your pupils during your Science Club.
- Wanting to provide a rich and stimulating set of activities for the post exam period.
- Trying to increase the practical problem solving abilities of your students.
- Or even just to increase the amount of interesting practical work that your students do during their normal lessons;

Mission ~~Im~~possible: Science Challenges aims to challenge pupils to compete in teams to solve problems using science. The tasks are all open-ended and may appear at first sight "Impossible" to the pupils, but with some guidance and the time to learn from their mistakes most will find that they can make the impossible possible. The key aspect to their success is having the time to have failures so that they may learn from their mistakes and improve their methods, just as any real scientist does. Many of the simpler challenges have basic methods to follow and are meant as fun introductions to the real challenges that await. The more difficult challenges can be given with very little initial support as long as sufficient time is allocated to the task. If pupils are struggling to come up with ideas there are hint sheets available with each task to help overcome some initial hurdles.

In order to make your job as easy as possible each challenge comes complete with:

- A comprehensive teacher's guide with ideas on how to set up and run the challenge
- A technician's guide to help resource pupil kits
- A health and safety risk assessment (on the CD-ROM)
- Masters for pupil challenge sheets, hint sheets and a mission completed certificate.
- PowerPoint presentation (on the CD-ROM)



Invisible Ink Challenge

Your mission, should you wish to accept it, is.....

To produce a secret message containing between five and ten words, that is invisible to the human eye. During the judging stage you will be asked to reveal your message and only then should it become visible for all to see.

You may use any of the combinations of chemicals given to you and the various types of pen or paper available. You are advised to test in a logical manner and record your results. It is also easier and quicker if you only write one letter or small word whilst you are investigating the different "inks".

This message will self-destruct in five seconds!!!!!!!





Invisible Ink Hint Sheet

When acids become concentrated enough, they will char or burn the paper. You can do this by writing your message, drying it using a hairdryer and then heating the paper using a hotplate or similar to reveal the message. Heating the paper removes (evaporates) moisture and the acids become concentrated enough to char the paper.

Cobalt (II) chloride can exist in two forms, hydrated and anhydrous. When moisture is present (hydrated) it is a pink colour, if it is heated and the water removed (anhydrous) it will turn blue.

Phenolphthalein is an indicator. Normally it is colourless, but when it comes in contact with an alkali it will turn pink.

Ammonium thiocyanate is normally a colourless solution but when it comes in contact with the pale yellow iron (III) chloride solution it turns a blood red colour.

Different "pens" will give different effects and some will be clearer than others.

Different types of paper will give very different effects. Some inks may be more invisible but easier to see when revealed with one particular type or colour of paper. Some types of paper may char more readily than others.



Invisible Inks - **Teacher's Guide**

Chemicals & Equipment:

- Various types and colours of paper e.g. printer, cartridge, filter, blotting, pink paper etc.
- Various types of pens to write with e.g. calligraphy pens, cotton buds, cocktail sticks, fine paint brushes, etc.
- Hair dryers
- Hotplates (if available)
- Lemon juice
- Vinegar
- 1.0 mol⁻¹ sulphuric acid
- 1.0 mol⁻¹ cobalt (II) chloride solution
- 1.0 mol⁻¹ iron (III) chloride solution
- 1.0 mol⁻¹ ammonium thiocyanate solution
- 0.1 mol⁻¹ sodium hydroxide solution
- Phenolphthalein indicator solution

The Challenge:

In two's or three's pupils are to experiment with the different chemicals, papers and pens to find the most clear and reliable method of writing invisible messages and then revealing what is written when they want to. In the challenge competition they must write a secret message of between five and ten words and then reveal their message during the judging stage.

Possible Methods:

This challenge can take up to two sessions with the first session geared towards the pupils experimenting with the different chemicals, papers and pens to identify the most reliable combination. The second session can involve a practice run and then the judging stage. Various criteria can be used to judge the winners such as invisibility of original message, clarity of the revealed message, reliability, innovation and style.



Acids such as vinegar, lemon juice and sulphuric acid will all char paper if they become concentrated enough. Pupils can write their message and then use the hairdryer to dry the ink. It should be invisible. Heating the paper using the hotplate or a very hot hairdryer or radiator will cause the paper to char where they have written and the message appears. Pupils will get different results with different types of paper and pens.

Cobalt (II) chloride solution is a pale pink colour and will therefore dry as invisible ink on pink paper. When heated, using a hotplate, hot hairdryer or radiator, the cobalt (II) chloride takes on its anhydrous form and appears blue. What is good about this method is that the cobalt (II) chloride can be rehydrated (by breathing on it) after reading the message and made to disappear again.

Both phenolphthalein indicator solution and sodium hydroxide solution are colourless and either can be used to write the message. However when they come in contact with one another the phenolphthalein turns pink and the message appears. Care needs to be taken to ensure the message doesn't blur if too much revealing agent is used. Pupils will need to experiment with various ways of applying the revealing agent.

Ammonium thiocyanate solution is colourless and so can be used as the invisible ink. When it comes in contact with the pale yellow iron (III) chloride solution it forms a blood red complex and the message is revealed. Care needs to be taken to ensure the message doesn't blur if too much revealing agent is used. Pupils will need to experiment with various ways of applying the revealing agent.



Invisible Inks - Technician's Guide

The Challenge:

In two's or three's pupils are to experiment with the different chemicals, papers and pens to find the most clear and reliable method of writing invisible messages and then revealing what is written when they want to. In the challenge competition they must write a secret message of between five and ten words and then reveal their message during the judging stage.

Chemicals & Equipment:

- Various types and colours of paper e.g. printer, cartridge, filter, blotting, pink paper etc. These should be cut into A5 or postcard size sheets and kept in labelled bags.
- Various types of pens to write with e.g. calligraphy pens, cotton buds, cocktail sticks, fine paint brushes, etc. Art departments are a good source for old pens and brushes or purchase from Yorkshire Purchasing Organisation or other stationary supplier.
- Hair dryers. Biology departments usually have these; ensure they are PAT tested.
- Hotplates (if available). Chemistry departments often have these; ensure they are PAT tested and have a "Hot" warning sign on them.
- Lemon juice. Available in supermarkets. Store in labelled 30ml screw top plastic bottles.
- Vinegar. Use white or pickling vinegar, available in supermarkets. Store in labelled 30ml screw top plastic bottles.
- 1.0 mol⁻¹ sulphuric acid. Store in labelled 30ml screw top plastic bottles.
- 1.0 mol⁻¹ cobalt (II) chloride solution. Store in labelled 30ml screw top plastic bottles.
- 1.0 mol⁻¹ iron (III) chloride solution. Store in labelled 30ml screw top plastic bottles.
- 1.0 mol⁻¹ ammonium thiocyanate solution. Store in labelled 30ml screw top plastic bottles.
- 0.1 mol⁻¹ sodium hydroxide solution. Store in labelled 30ml screw top plastic bottles.
- Phenolphthalein indicator solution. Store in labelled 30ml screw top plastic bottles.



Nerves of Steel Challenge

Your mission, should you wish to accept it, is.....

To produce an electronic device that can be used to test how nervous somebody is by detecting any trembles in their hand movements. During the judging stage you will be asked to demonstrate your device and test volunteers.

You may use any of the equipment given to you and the various types of buzzers, bells or alarms available. You are advised to test in a logical manner and record your results. It is advisable to get your teacher to show you how to set up some simple electronic circuits.

This message will self-destruct in five seconds!!!!!!





Nerves of Steel Hint Sheet

The simplest way to complete the challenge is to create a series circuit using a battery, a buzzer; a coat hanger bent into an intricate shape and a loop of wire used to navigate along the coat hanger. These components must be attached in a circuit. Get your teacher to show you what a series circuit is if you don't know.

The coat hanger can be bent into an intricate shape that the person being assessed for nerves will have to navigate from one end to the other without touching the wire with the loop. The series circuit will be completed when contact is made and the buzzer will sound. The two ends of the coat hanger will need to be held in something so as to keep it upright and stable.

You might be able to think of even better ways to test how much hand movement somebody makes when they are nervous.



Nerves of Steel - **Teacher's Guide**

Chemicals & Equipment:

Metal coat hangers

6v battery

Electronic Buzzers, bells or alarms

Wires

Crocodile Clips

Heavy duty wire cutters/pliers

Emery paper or fine sandpaper

Wooden or plastic blocks

Insulation tape

The Challenge:

In two's or three's pupils are to produce an electronic device that can be used to test how nervous somebody is by detecting any trembles in their hand movements. During the judging stage they will be asked to demonstrate your device and test volunteers. They may use any of the equipment given to them and the various types of buzzers, bells or alarms available.

Possible Methods:

This challenge can be completed quite easily in a couple of sessions, but you may want to allow more time for teams to perfect their device and make it look more attractive. The simplest way to complete the challenge is to create a series circuit using the battery; the buzzer; the coat hanger bent into an intricate shape and a loop of wire used to navigate along the coat hanger.

The pliers can be used to unwind the coat hanger and then cut off a piece to make a loop. The coat hanger can then be bent into an intricate shape that the person being assessed for nerves will have to navigate from one end to the other without touching the wire with the loop. The series circuit will be completed when contact is made and the buzzer will sound. The two ends of the coat hanger will need to be held in the block of wood to keep it upright and stable.



It might take a fair bit of trial and error to find the best way of connecting the coat hanger and metal loop into the circuit, but crocodile clips are quite effective. Another problem that can occur is that the coat hanger wire is often coated in a non-conducting coating that prevents the circuit being completed. In order to overcome this, teams will need to rub off the coating using the emery paper.

It is possible that teams devise other methods in order to complete the challenge and credit can be given for originality in the final judging stage. Points can also be awarded for effectiveness, style and reliability.



Nerves of Steel - Technician's Guide

The Challenge:

To produce an electronic device that can be used to test how nervous somebody is by detecting any trembles in their hand movements. During the judging stage they will be asked to demonstrate their device and test volunteers.

Chemicals & Equipment:

- Metal coat hangers (Heavy gauge wire will also work but is more expensive)
- 6v battery (Rapid Electronics order code 18-0270 @ £1.90 each)
- Electronic Buzzers or bells (Rapid Electronics order code 35-0100 @ £0.58 each)
- Wires (Normal class room electronics leads are fine)
- Crocodile Clips
- Heavy duty wire cutters/pliers (These are needed to cut the coat hanger and bend it into different shapes)
- Emery paper/cloth or fine sandpaper (The coat hangers have a thin coating that prevents them from conducting very well, the pupils will need to sand off this coating before their device will work properly)
- Wooden or plastic blocks (These can be off cuts from a Design & Technology Department or other source. They will need two small holes to be drilled into them that can fit the two ends of the coat hanger or wire.)
- Insulation tape



DNA Dilemmas Challenge

Your mission, should you wish to accept it, is.....

To isolate DNA (deoxyribonucleic acid) from different plant sources and show that it is indeed an acid. You will need to follow the instructions given to you in order for you to successfully complete your mission.

You will have to perform two important tasks carefully. The first will be to prepare the plant tissue for extraction; the second to separate the DNA from the plant extract. After this you will need to prove that you have got an acid.

This message will self-destruct in five seconds!!!!!!





DNA Dilemmas Hint Sheet

Preparing the plant extract

1. Add 3g of sodium chloride to 10cm³ washing up liquid. Make up to 100cm³ with distilled water.
2. Cut the plant material into small pieces roughly 5mm square. Place the pieces in a 250cm³ beaker and add the salt/detergent solution.
3. Stir the mixture and maintain it at 60°C in the water bath for exactly 15 minutes.
4. Cool the mixture in an ice bath for 5 minutes, stirring frequently.
5. Pour the mixture into a liquidiser and blend for only 5 seconds on high speed.
6. Filter the mixture into the second 250cm³ beaker. Ensure that the foam on the surface of the liquid does not contaminate the filtrate.
7. Store the filtrate until the next session in a fridge.

Separating the DNA from the plant extract

1. Add the enzyme to the plant extract in a boiling tube and mix well.
2. Form a layer of ice-cold ethanol on top of the plant extract/enzyme mixture by pouring it slowly down the side of the boiling tube. Leave the tube for 2-3 minutes without disturbing it.
3. Gently rotate the glass rod in the liquid, at the interface of the alcohol and detergent mixture. Take care not to mix the layers too much or to break the fragile DNA. The white web of mucus like DNA can be drawn from the boiling tube using a Pasteur pipette and re-suspended in a 4% sodium chloride solution.
4. The DNA is now ready to test for acidity.



DNA Dilemmas - **Teacher's Guide**

Chemicals & Equipment:

For preparing the plant extract

- Liquidiser.
- Sharp knives and chopping boards
- Water bath. **Set at 60°C**
- Ice in jugs or large beakers
- Thermometers.
- 250cm³ beakers.
- Coffee filter papers. **Not chemical filter paper**
- Various plant materials. **Onions and kiwi fruit both work well.**
- Washing up liquid.
- Sodium chloride.
- Distilled water.

For separating the DNA from the plant extract

- Slender glass rods
- 10cm³ syringes. **One per group for measuring out the liquids**
- Boiling tubes. **One per group**
- Boiling tube rack. **Or small beaker to hold the boiling tube upright**
- Plant extract. **Prepared in a previous session and stored in a fridge.**
- Protease enzyme, Novo Neutrase.
- Ice cold 95% ethanol. **Store in a freezer before using to ensure it is ice cold.**

The Challenge:

In two's or three's pupils are to isolate DNA (deoxyribonucleic acid) from different plant sources and show that it is indeed an acid. They will need to follow the instructions given to them in order for them to successfully complete their mission.

Possible Methods:

Preparing the plant extract

1. Add 3g of sodium chloride to 10cm³ washing up liquid. Make up to 100cm³ with distilled water.
2. Cut the plant material into small pieces roughly 5mm square. Place the pieces in a 250cm³ beaker and add the salt/detergent solution.



3. Stir the mixture and maintain it at 60°C in the water bath for exactly 15 minutes. This treatment causes the plant cell membranes to break down. The detergent forms complexes surrounding the membrane phospholipids and proteins, causing them to precipitate out of solution. In addition the sodium ions from the salt shield the negatively charged phosphate groups of the DNA molecules causing them to coalesce. At 60°C DNase enzymes, which would otherwise start to cut the DNA into fragments, are partially denatured.
4. Cool the mixture in an ice bath for 5 minutes, stirring frequently. This slows the breakdown of DNA, which would occur if a high temperature were maintained.
5. Pour the mixture into a liquidiser and blend for only 5 seconds on high speed. This degrades the cell walls and membranes further, permitting the release of DNA. Do not blend too long or this will break up the DNA fibres.
6. Filter the mixture into the second 250cm³ beaker. Ensure that the foam on the surface of the liquid does not contaminate the filtrate. The filtrate contains soluble proteins and DNA.
7. Store the filtrate until the next session in a fridge.

Separating the DNA from the plant extract

1. Add the enzyme to the plant extract in a boiling tube and mix well. The enzyme will degrade the proteins associated with the DNA.
2. Form a layer of ice-cold ethanol on top of the plant extract/enzyme mixture by pouring it slowly down the side of the boiling tube. Leave the tube for 2-3 minutes without disturbing it. DNA is insoluble in ice-cold ethanol. Bubbles will form and whilst other compounds in the mixture will dissolve, the DNA will precipitate.
3. Gently rotate the glass rod in the liquid, at the interface of the alcohol and detergent mixture. Take care not to mix the layers too much or to break the fragile DNA. The white web of mucus like DNA can be drawn from the boiling tube using a Pasteur pipette and re-suspended in a 4% sodium chloride solution.
4. The DNA is now ready to test for acidity using Universal Indicator.



DNA Dilemmas - Technician's Guide

The Challenge:

For pupils to isolate DNA (deoxyribonucleic acid) from different plant sources and show that it is indeed an acid. They will need to follow the instructions given to them in order for them to successfully complete their mission.

Chemicals & Equipment:

For preparing the plant extract

- Liquidiser. **Make sure its PAT tested.**
- Sharp knives and chopping boards
- Water bath. **Set at 60°C**
- Ice in jugs or large beakers
- Thermometers. **One per group**
- 250cm³ beakers. **Two per group**
- Coffee filter papers. **One per group, not chemical filter paper.**
- Various plant materials. **Onions and kiwi fruit both work well.**
- Washing up liquid. **Not the thicker concentrated type.**
- Sodium chloride. **Table salt is fine.**
- Distilled water. **Usually available from the chemistry department.**

For separating the DNA from the plant extract

- Slender glass rods
- 10cm³ syringes. **One per group for measuring out the liquids**
- Boiling tubes. **One per group**
- Boiling tube rack. **Or small beaker to hold the boiling tube upright**
- Plant extract. **Prepared in a previous session and stored in a fridge.**
- Protease enzyme, Novo Neutrase. **Available from NCBE**
- Ice cold 95% ethanol. **Store in a freezer before using to ensure it is ice cold.**