



Demonstration Risk Assessment Form

SCIENCE IN SCHOOLS- FEEL THE POWER SHOW

MAY 2021

Demonstrations include:

1. Carbon Arc Lamp
2. Electrocuting a Gherkin
3. Electron Atom Demo
4. Hand Generator with Light
5. Hand generator with Microdet
6. Electromagnet Tug Of War
7. Small electromagnet
8. Static electricity
9. Wire Wool
10. Plasma Ball and Light
11. Electrolysis with Hydrox Bubbles
12. Faraday Motor
13. Van de Graaf Generator

| Likelihood | | Severity of impact | | Current risk |
|------------|---|----------------------------|---|--|
| Certain | 5 | Death or total destruction | 5 | Multiply Likelihood and Severity of impact to get Current Risk rating |
| High | 4 | Major injury or damage | 4 | |
| Medium | 3 | Serious injury or damage | 3 | |
| Low | 2 | Minor injury or damage | 2 | |
| Very low | 1 | Negligible | 1 | |

| Action Rating | |
|---------------------|--|
| 10 and above | The work is too dangerous and should not be undertaken |
| 8 or 9 | The work is high risk. Those undertaking the work must be fully competent and experienced for the type of work, equipment to be used and fully understand all risks present. |
| 5 or 6 | Moderate risk Workers must be fully competent for the type of work and risks present, or under competent supervision. |
| 4 | Low risk. Those undertaking the work must be aware or be made aware of the risks and mitigation measures required. |
| 2 or 3 | Slight risk. Those undertaking the work should be aware or be made aware of the risks and mitigation measures required. |
| 1 | Insignificant risk. Activity suitable for all workers |

ACTIONS NEEDED BY VENUE:

- Isolate Smoke/ Fire Alarms in vicinity of demonstrations
- Ensure 1 x Fire Extinguisher is on Stand-by (only to be used in emergencies- should be either dry powder, carbon dioxide)
- Ensure presenter knows Fire Evacuations procedures
- Ensure presenter knows location of nearest fire extinguishers
- To inform presenter/ Ri (at least 24hr prior to performance time) if any of the attendees suffer allergies to latex or has a heart condition.

Risk assessed by: Fran Scott



The Royal Institution

Science Lives Here

Date of last review: 07/05/2021

Review date: 06/05/2022

General Risks Throughout the Show

| Those at risk (please tick) | Ri Staff | On-Stage Volunteers | Audience | Non-Ri Workers | Others |
|--------------------------------|----------|---------------------|----------|----------------|--------|
| | Y | Y | Y | Y | Y |

| Method Statement | Hazards | Mitigation | Likelihood | Severity of impact | Current Risk |
|------------------|---|--|------------|--------------------|--------------|
| | Electrical hazards The show uses a variety of electric items; some off-the-shelf, some not. | All electrical items will be visually inspected prior to the shows. Where appropriate the items will also be PAT tested | 1 | 4 | 4 |
| | Manual handling | Some of the apparatus used in this show is heavy, and hence correct lifting procedures (bending at the knees) should be used at all times. | 1 | 3 | 3 |
| | Tiredness (particularly driving) As the presenter will be driving to and from the venue there is risk of driving whilst tired. | The Ri will ensure that the presenter's schedule is such that they are not tired whilst on the drive to or from the venue. The presenters are actively encouraged to take a break before the return journey if needed. | 1 | 4 | 4 |

Demonstration: Carbon Arc Lamp

| Those at risk (please tick) | Ri Staff | On-Stage Volunteers | Audience | Non-Ri Workers | Others |
|--------------------------------|----------|---------------------|----------|----------------|--------|
| | Y | Y | Y | Y | Y |

| Method Statement | Hazards | Mitigation | Likelihood | Severity of impact | Current Risk |
|---|--|---|------------|--------------------|--------------|
| <p>The mains electricity supply will be passed across the gap between two carbon electrodes, creating an electrical arc which will emit lots of light.</p> <p>There are two slight variations of this apparatus; one which uses DC, the other AC. They both operate in similar ways (the difference is due to slight difference in the carbon rods used. Older rods = AC, Newer rods= DC).</p> <p>The exact method to use when operating the device is providing in the operating manual.</p> | <p>By necessity for the demonstration, there will be surfaces/contacts electrified to mains voltage, which are either completely exposed or not insulated/enclosed to the standard required by electrical regulations.</p> <p>This creates a significantly enhanced risk of mains electric shock to users of the apparatus and those nearby, which could cause injury or even death.</p> | <p>The apparatus will be unplugged and stored away from access at all times, other than immediately as being demonstrated. Only the presenter and assistants will handle the apparatus, or go near it while any plugged in. The presenter must have experience with the apparatus and know how to handle it. He or she will immediately unplug it and make it safe after presenting it.</p> <p>This demonstration will be performed at a minimum distance of 2m away from the public.</p> <p>When leaving the equipment unattended the footswitch will be taken with the presenter, such that the apparatus cannot be used.</p> | 2 | 4 | 8 |
| | <p>The electric arc will emit a small amount of UV radiation, which may be harmful to eyes with prolonged (yet short) exposure.</p> | <p>The arc will only be displayed briefly, so exposure to UV radiation will be slight. Nevertheless a polycarbonate safety screen will shield the apparatus, which will absorb the majority of the radiation.</p> <p>Audience will also be warned about the brightness, and asked not to stare at the arc. Looking at the ceiling or floor instead (they will still be able to tell that there is light coming from the apparatus)</p> <p>The presenter will wear welding goggles and a long sleeved top and at least 30SPF sunscreen (as they endure repeated exposure).</p> | 5 | 1 | 5 |
| | <p>Accidentally operation and therefore risk of electrocution.</p> | <p>The apparatus is controlled by a foot pedal, with the apparatus only being able to operate when</p> | 5 | 1 | 5 |



| | | | | | |
|--|--|---|---|---|---|
| | | <p>this pedal is pressed. An led light will indicate when the apparatus is 'live'.</p> <p>The apparatus will not be left plugged in whilst unattended.</p> <p>If unattended the foot pedal will be taken with the presenter so that passers-by cannot operate the apparatus.</p> | | | |
| | <p>Non-standard electrical device. As this is a specially designed piece of apparatus there is risk (as will all electrical items) that is could provide an electrical hazard.</p> | <p>Apparatus will be inspected for damage before each use, with all damages being reported and the apparatus not used if deemed damaged or there are pieces missing.</p> <p>The apparatus will never be left unattended with the power lead connected. If the apparatus will be unused for any length of time remove the power will be removed completely. The apparatus will not be worked on (including fitting the electrodes) with the power lead connected.</p> <p>A fan heater or kettle is used as a current sink to ensure the correct current is fed to the apparatus.</p> <p>It will be ensured that the apparatus is placed on a stable surface.</p> | 4 | 1 | 4 |
| | <p>The carbon rods and the arc will be very hot to the touch</p> | <p>Under NO circumstances is the operator touch the arc during operation, and in addition the carbon rods will not be touched for at least 10mins after operation has ceased.</p> | 3 | 1 | 3 |
| | <p>Igniting surrounding flammables</p> | <p>As this demonstration is performed as part of a show which contains flammables items, accidental ignition could occur. Therefore the apparatus will be operated a minimum of 1m away from flammable items.</p> | 5 | 1 | 5 |

PPE Requirements

| Item | | Item | | Item | | Item | |
|---------------------|--|---------------------------|---|-----------------|---|---------------------|---|
| Flameproof overalls | | Gloves contact | | High visibility | | Waterproof clothing | |
| Hardhat | | Dust Mask | | Gloves chemical | | Wellington boots | |
| Hearing protection | | Mask chemical vapour/mist | | Safety shoes | | Sun screen | Y |
| | | Laboratory Coat | Y | Eye protection | Y | | |

Demonstration: Electrocuting a Gherkin

| Those at risk (please tick) | Ri Staff | On-Stage Volunteers | Audience | Non-Ri Workers | Others |
|--------------------------------|----------|---------------------|----------|----------------|--------|
| | Y | Y | Y | Y | Y |

| Method Statement | Hazards | Mitigation | Likelihood | Severity of impact | Current Risk |
|--|--|---|------------|--------------------|--------------|
| <p>A gherkin will be subjected to mains voltage, resulting in a strong electrical discharge through the body of the gherkin.</p> <p>Exact operating instructions can be found in the operating manual for the apparatus.</p> | <p>By necessity for the demonstration, there will be surfaces/contacts electrified to mains voltage, which are either completely exposed or not insulated/enclosed to the standard required by electrical regulations.</p> <p>This creates a significantly enhanced risk of mains electric shock to users of the apparatus and those nearby, which could cause injury or even death.</p> | <p>The electric circuit will contain two push-to-make switches which independently break the supply of the live phase – ie both switches need to be held down in order to electrify any exposed contacts.</p> <p>The risk to people other than a single user of the apparatus is partly mitigated by these switches, in that they ensure that the circuit is only made when wanted, and is very unlikely to be accidentally or inadvertently connected. However, someone unaware of the hazard, could in principle try to touch the apparatus while in use. All present should therefore be made aware that they are not to approach the demonstration while it is in use.</p> <p>This demonstration must only be performed by presenters experienced with the apparatus, and who completely understand all the risks.</p> <p>When unattended the power lead will be removed from the apparatus and carried with the presenter.</p> | 2 | 3 | 6 |
| | <p>It is not easy to determine how much current may be drawn by the apparatus while in use. This creates the possibility of blowing fuses or tripping RCDs in the mains supply.</p> | <p>The possibility of an excessively high current being drawn will be eliminated by using a resistor wired in series with the rest of the circuit. This resistor will be in the form of a domestic appliance, such as kettle or fan heater– which is ideal in that it will pass a high enough current for the demonstration to work well, but cannot not pass any more than it would in normal operation, and will also dissipate any excess heat very effectively.</p> <p>In addition an RCD should be used where the apparatus is plugged into the schools’ supply.</p> | 2 | 2 | 4 |
| | <p>The demonstration may give off some smoke.</p> | <p>Smoke detectors in the vicinity of the demonstration should be turned off.</p> <p>This demonstration should not be performed within a small, confined space.</p> | 4 | 1 | 4 |

PPE Requirements

| Item | | Item | | Item | | Item | |
|---------------------|--|---------------------------|--|-----------------|---|---------------------|--|
| Flameproof overalls | | Gloves contact | | High visibility | | Waterproof clothing | |
| Hardhat | | Dust Mask | | Gloves chemical | | Wellington boots | |
| Hearing protection | | Mask chemical vapour/mist | | Safety shoes | | Sun screen | |
| | | Laboratory Coat | | Eye protection | Y | | |

Demonstration: Electron Atom Demo

| Those at risk (please tick) | Ri Staff | On-Stage Volunteers | Audience | Non-Ri Workers | Others |
|--------------------------------|----------|---------------------|----------|----------------|--------|
| | Y | Y | Y | Y | Y |

| Method Statement | Hazards | Mitigation | Likelihood | Severity of impact | Current Risk |
|--|--|---|------------|--------------------|--------------|
| One teacher and four children recreate the movement of the electrons in an atom. | Volunteers may trip as they walk around stage area or bang into demonstrations on stage. | Presenter must ensure all demonstrations and apparatus are safely and securely placed on tables and all floor space leading to and including activity is clear of trip hazards. | 2 | 2 | 4 |
| | May trip on plastic balls used during demonstration. | All balls to be picked up from the floor at the earliest convenience. | 2 | 1 | 2 |

PPE Requirements

| Item | | Item | | Item | | Item | |
|---------------------|--|---------------------------|--|-----------------|---|---------------------|--|
| Flameproof overalls | | Gloves contact | | High visibility | | Waterproof clothing | |
| Hardhat | | Dust Mask | | Gloves chemical | | Wellington boots | |
| Hearing protection | | Mask chemical vapour/mist | | Safety shoes | | Sun screen | |
| | | Laboratory Coat | | Eye protection | Y | | |

Demonstration: Hand Generator with Light

| Those at risk (please tick) | Ri Staff | On-Stage Volunteers | Audience | Non-Ri Workers | Others |
|--------------------------------|----------|---------------------|----------|----------------|--------|
| | Y | Y | Y | | |

| Method Statement | Hazards | Mitigation | Likelihood | Severity of impact | Current Risk |
|---|--|---|------------|--------------------|--------------|
| <p>A hand cranked generator is used to build up a voltage which lights up an led light. This light is either placed in a top hat or in it's own stand on a table. The light is a led in a plastic lightbulb casing.</p> <p>(Note- the key and button extension should be used here and the hand crank held at its base)</p> | <p>Strong Magnets: The magnet used here is extremely powerful. It will attract magnetic objects very strongly, sufficiently to cause injury to body parts caught in the way. This can happen very suddenly and very rapidly. If two such magnets are allowed to come together, they may cause severe crushing injuries, especially to fingers, which may even be severed. Even if they fly together without trapping fingers they may shatter from the impact and project shards of magnet through the air.</p> | <p>The generator has been built by a respected prop builder and supplied to the Ri with a full users' guide.</p> <p>During transport, storage and when not in use, the magnet will be aligned with the end plates which form the structure of the generator. That way they will stay in place and attract minimal extraneous material.</p> <p>It will also be ensured that the operator of the generator (presenter or volunteer) does not have any medical equipment on them that will be affected by strong magnetic fields. Others will be kept at a distance of 2m.</p> | 3 | 3 | 9 |
| | <p>Impact Injury: As the generator is weighty, it could cause damage is it falls</p> | <p>The generator will always be placed on a stable table away from the edge</p> | 1 | 4 | 4 |
| | <p>Lifting Injury: As the generator is weighty, lifting it could cause damage is not undertaken correctly</p> | <p>It will only be lifted by our presenters, all of which are confident in the correct (bending the knees) procedure.</p> | 1 | 2 | 2 |
| | <p>Electrical Injury</p> | <p>As a voltage is generated there is risk of electric shock, to prevent this all wires will be fully insulated and the volunteer will be advised to keep their hands away from the wires. If a shock does occur it will be minimal current and would cause discomfort rather than harm.</p> | 1 | 2 | 2 |

Requirements

| Item | Item | Item | Item |
|---------------------|---------------------------|-----------------|---------------------|
| Flameproof overalls | Gloves contact | High visibility | Waterproof clothing |
| Hardhat | Dust Mask | Gloves chemical | Wellington boots |
| Hearing protection | Mask chemical vapour/mist | Safety shoes | |
| | Laboratory Coat | Eye protection | |



Demonstration: Hand Generator with Microdet

| Those at risk (please tick) | Ri Staff | On-Stage Volunteers | Audience | Non-Ri Workers | Others |
|--------------------------------|----------|---------------------|----------|----------------|--------|
| | Y | Y | Y | | |

| Method Statement | Hazards | Mitigation | Likelihood | Severity of impact | Current Risk |
|---|--|---|------------|--------------------|--------------|
| <p>The hand cranked generator is used to build up a voltage which ignites a squib (microdet). The ignition of this microdet (an off-the-shelf pyrotechnic) causes a loud bang.</p> | <p>Strong Magnets: The magnet used here is extremely powerful. It will attract magnetic objects very strongly, sufficiently to cause injury to body parts caught in the way. This can happen very suddenly and very rapidly. If two such magnets are allowed to come together, they may cause severe crushing injuries, especially to fingers, which may even be severed. Even if they fly together without trapping fingers they may shatter from the impact and project shards of magnet through the air.</p> | <p>The generator has been built by a respected prop builder and supplied to us with a full users' guide.</p> <p>During transport, storage and when not in use, the magnet will be aligned with the end plates which form the structure of the generator. That way they will stay in place and attract minimal extraneous material.</p> <p>It will also be ensured that the operator of the generator (presenter or volunteer) does not have any medical equipment on them that will be affected by strong magnetic fields. Others will be kept at a distance of 2m.</p> | 3 | 3 | 9 |
| | <p>Impact Injury: As the generator is weighty, it could cause damage is it falls</p> | <p>The generator will always be placed on a stable table away from the edge</p> | 1 | 4 | 4 |
| | <p>Lifting Injury: As the generator is weighty, lifting it could cause damage is not undertaken correctly</p> | <p>It will only be lifted by our presenters, all of which are confident in the correct (bending the knees) procedure.</p> | 1 | 2 | 2 |



| | | | | | |
|--|--|--|---|---|---|
| | <p>Squib (microdet) creates loud explosive noise on ignition</p> | <p>All audience to be advised to cover their ears ahead of explosion. Those with sensitive hearing to be advised to leave the room. Presenter to wear ear defenders.</p> | 2 | 4 | 8 |
| | <p>Squib (microdet) creates an amount of shrapnel on ignition</p> | <p>Protective shield to go in front of squib to protect audience and presenter from cardboard pieces released from the shell.</p> <p>Audience to be at a minimum of 3 meters distance from squib (this is less than the standard as the protective shield is being used)</p> | 2 | 4 | 8 |
| | <p>Working with Microdets (pyrotechnics):</p> <p>Microdets (also known as squibs) are small pyrotechnics. Classification 1.4G (UN0431)</p> <p>http://www.lemaitreltd.com/p/Microdets/Ozzic%5B%5DyA98g</p> <p>http://www.lemaitreltd.com/includes/images/uploads/ecommerce/documents/SDS%20Flash%20Reports,%20Maroons%20and%20Microdets%20(2017)%20-%20u5n52btf.ksd.pdf</p> <p>They are small cardboard tubes filled with aluminium powder, magnesium powder and an oxidizer with a remote igniter.</p> | <p>Microdets to be sourced from a reputable supplier. When handling Microdets, goggles are to be worn at all times and there will be no naked flames, smoking or eating within the immediate area.</p> <p>Hands are to be washed after using, before eating.</p> | 2 | 4 | 8 |
| | <p>Storage and Transporting Microdets:</p> <p>As microdets are classified as a pyrotechnics there are rules and regulations</p> | <p>Microdets are classified as category 1.4G (the second lowest – safest- there is).</p> <p>The law states that if NEC (net explosive content) is lower than 5kg then no licence is needed. We will always ensure that the NEC is well below this limit.</p> | 2 | 4 | 8 |



| | | | | | |
|--|--|--|---|---|---|
| | <p>governing their storage and transport.</p> <p>http://www.legislation.gov.uk/ukxi/2014/1638/contents/made</p> | <p>Each microdet has a NEC of 0.15g, therefore we could need to carry over 30,000 of them to exceed this limit (we normally carry 24 as a maximum)</p> <p>Microdets will always be stored and transported within a corrected labelled (1.4G) UN box. They will be kept in a cool, dry location, away high temperatures, shock, static discharge, vibrations or other physical stresses that might result in a hazardous situation.</p> <p>They, along with the other 'dangerous goods', are to ideally be placed in a locked room if left unattended whilst at a venue. If this is not possible then they are to be carried with the presenter and not left unattended.</p> | | | |
| | <p>Non-Standard Ignition System:</p> <p>As we are using a non-standard ignition system we need to take care to avoid premature ignition.</p> | <p>Premature ignition will be negated with the use of a 'circuit connecting system' or an 'arm key extension' box. This is a plastic box which is inserted into the hand crank generator, which contains an arm key and switch. Only when the key is in the 'on' position and the button pressed, *and* the magnet on the generator spinning will an electric current be able to pass through to the pyrotechnics. So, basically with the key on and magnet turning, until the button is pressed on this 'circuit connecting system', no connection will be made between the generator and the microdets and so no ignition will occur.</p> <p>The procedure for working with the microdet will be as follows:</p> <p>BEFORE SHOW:</p> <ol style="list-style-type: none">1. With goggles on, position the microdet in laboratory retort clamp (the microdet will not be connected to anything else at this point)2. The wires from the end of the microdet will be plugged into the 'speaker cable box'.3. The spade connectors on the other end of this 'speaker cable box' will NOT be attached to the generator, instead they will be taped to the table near the generator.4. Ensure the 'arm key extension' box is not plugged into the generator. <p>DURING SHOW:</p> | 2 | 4 | 8 |



1. Put goggles on and place the microdet into its firing position on stage. Ensuring the safety screen is between 'the microdet and the audience' and 'the microdet and you'
2. Select volunteer and get them onto stage
3. Ensuring the microdet and the 'arm key extension' box is NOT attached, show the volunteer how to use the generator. Ensure it is set up for them being either right or left handed.
4. Once mastered. Ask the volunteer to step back and give them goggles and ear defenders
5. Now, attach the spade connectors and the 'arm key extension' box to the generator
6. Ensuring the magnet is HORIZONTAL, and blocking the volunteer from being able to spin the magnet, show that even when the key is 'on' and the fire button is pressed, the microdet does not fire. (i.e. turn key to on and push button = no effect)
7. Now invite the volunteer to step forward to generator. Position yourself between the microdet and the volunteer
8. Warn the audience of the loud noise and get them to cover their ears.
9. Turn the key to 'arm', volunteer to spin magnet, and when ready push the button to fire the microdet.

Notes:

-If the volunteer is too small/ young to operator the generator, then the presenter will be in charge of operating the generator, and the volunteer the fire button.

-If (for some reason) two volunteers are used, then one volunteer will operator the generator, and the other will push the button with the presenter very much in control of the button-pusher.

IN THE EVENT OF A MISFIRE the following procedure will be followed:

1. Turn key to unarm position
2. The system is now 'safe' and the audience can stand at ease/ remove hands from ears.
3. Taking the key with you, check all connections working your way from the microdet back to the generator.



| | | | | | |
|--|------------------------|---|---|---|---|
| | | <p>Remember that more than one connection may be loose.</p> <p>4. Repeat the firing routine above.</p> | | | |
| | Disposing of Microdets | <p>Once fired the microdets can be disposed of in the normal rubbish.</p> <p>If a misfire occurs and the microdet doesn't fire, it will be disposed of according to advice from the supplier. Therefore it will be immersed in water for 24 hours (ensuring that they are sunk under the surface of the water) and that any paper tops so should be pieced so that the water can easily permeate the device. After which they can be disposed of in the normal rubbish.</p> | 1 | 2 | 2 |

PPE Requirements

| Item | | Item | | Item | | Item | |
|---------------------|---|---------------------------|--|-----------------|---|---------------------|--|
| Flameproof overalls | | Gloves contact | | High visibility | | Waterproof clothing | |
| Hardhat | | Dust Mask | | Gloves chemical | | Wellington boots | |
| Hearing protection | Y | Mask chemical vapour/mist | | Safety shoes | | | |
| | | Laboratory Coat | | Eye protection | Y | | |

Demonstration: Electromagnet Tug of War

| | | | | | |
|---------------------------------------|---------------|--------------------------|---------------|----------------|--------|
| Those at risk (please tick) | Ri Staff Y | On-Stage Volunteers Y | Audience Y | Non-Ri Workers | Others |
|---------------------------------------|---------------|--------------------------|---------------|----------------|--------|

| Method Statement | Hazards | Mitigation | Likelihood | Severity of impact | Current Risk |
|---|---|--|------------|--------------------|--------------|
| <p>An off-the-shelf electromagnet (some with extended wires) is attached to 2 ropes. 2 volunteers are selected to pull on the ropes and attempt to pull the electromagnet apart.</p> <p>When switched on the electromagnet will stay strong, only when it is switched off will the electromagnet separate.</p> <p>Most electromagnets are powered by a 9 volt battery.</p> <p>One electromagnet in use is powered by a benchtop power supply.</p> | <p>Volunteers may sustain injury through falling during the tug-of-war, for instance, if a member of the other team suddenly lets go, or if a volunteer loses grip on the rope.</p> | <p>The presenter will be on hand to act as a 'catcher' in the event that any of the volunteers suddenly fall backwards.</p> <p>In addition the volunteers will be instructed to not pull each other and to concentrate on working together rather than as if they are separate teams (it's both teams against the electromagnet). They will also be instructed to take a wide stance to minimise the probability they will fall.</p> <p>Ideally, also a safety rope will be attached between the two elements that come apart, such that if they do come apart they only separate a small distance (the distance of the safety rope)</p> | 2 | 4 | 4 |
| | Friction burns from rope. | The presenter should instruct the volunteers not to wrap the rope around their arms. | 2 | 2 | 4 |
| | Apparatus falling | <p>For the apparatus where a table top power pack is used, the presenter is to hold the middle of the electromagnet as the two teams attempt to pull it apart, this will prevent the teams from pulling the power pack off the table.</p> <p>In addition, the electromagnet will be attached via long leads.</p> | 1 | 2 | 2 |
| | Shock Hazard | <p>As electricity is being used, there is risk of electric shock. However, using a bench top power supply will ensure that the currents (and voltages) used will not be more of a discomfort rather than a danger if a shock does occur.</p> <p>That said, it will be ensured that those holding the electromagnet do not suffer from any heart conditions or have medical equipment that may be affected by electric currents</p> | 1 | 3 | 3 |

PPE Requirements

| Item | Item | Item | Item |
|---------------------|---------------------------|-----------------|---------------------|
| Flameproof overalls | Gloves contact | High visibility | Waterproof clothing |
| Hardhat | Dust Mask | Gloves chemical | Wellington boots |
| Hearing protection | Mask chemical vapour/mist | Safety shoes | |
| | Laboratory Coat | Eye protection | |

Demonstration: Small Electro Magnet

| Those at risk (please tick) | Ri Staff | On-Stage Volunteers | Audience | Non-Ri Workers | Others |
|--------------------------------|----------|---------------------|----------|----------------|--------|
| | Y | Y | Y | | |

| Method Statement | Hazards | Mitigation | Likelihood | Severity of impact | Current Risk |
|--|-------------------|---|------------|--------------------|--------------|
| Electricity will be run through a wire via either a power pack or from a battery (9V PP3). This wire is wrapped around a nail. This induces a magnetic field in the nail which can be used to pick up smaller nails/ paperclips. | Sharp edges | The nail(s) used will be blunted using sandpaper if necessary. | 1 | 1 | 1 |
| | Electrical Injury | The bench top power supply will be ensured that it is in full working order prior to being used. Ideally either PAT tested or less than 6 months old | 2 | 2 | 4 |
| | Shock Hazard | As electricity is being used, there is risk of electric shock. However, using a bench top power supply will ensure that the currents (and voltages) used will not be more of a discomfort rather than a danger if a shock does occur. That said, it will be ensured that those holding the electromagnet do not suffer from any heart conditions or have medical equipment that may be affected by electric currents | 1 | 3 | 3 |
| | Battery disposal | If a battery is used, when it is used up it is to be disposed of in a battery disposal drop-off rather than in domestic rubbish | 1 | 1 | 1 |

PPE Requirements

| Item | Item | Item | Item |
|---------------------|---------------------------|-----------------|---------------------|
| Flameproof overalls | Gloves contact | High visibility | Waterproof clothing |
| Hardhat | Dust Mask | Gloves chemical | Wellington boots |
| Hearing protection | Mask chemical vapour/mist | Safety shoes | |
| | Laboratory Coat | Eye protection | |

Demonstration: Static electricity

| Those at risk (please tick) | Ri Staff | On-Stage Volunteers | Audience | Non-Ri Workers | Others |
|--------------------------------|----------|---------------------|----------|----------------|--------|
| | Y | Y | Y | | |

| Method Statement | Hazards | Mitigation | Likelihood | Severity of impact | Current Risk |
|---|---|--|------------|--------------------|--------------|
| Two volunteers and/ or presenter use plastic rods, combs or balloons to build up a static charge to attract/ repel balloons/ pieces of paper/ feathers. | Volunteers could poke themselves using the rod or comb. | Show volunteers how to correctly rub the rod/comb. Supervise the volunteers as they conduct the demonstration. | 2 | 1 | 2 |
| | Volunteers could receive a small shock from the static charge | The spark felt will be uncomfortable rather than at all dangerous. | 2 | 1 | 2 |
| | Latex allergy | The school is to inform the Ri and/or presenter of any severe latex allergies of those who will be attending the show. And if any are present, the presenter should substitute the latex balloons for either latex free version or another object that can be charged up with static electricity | 1 | 4 | 4 |

PPE Requirements

| Item | Item | Item | Item |
|---------------------|---------------------------|-----------------|---------------------|
| Flameproof overalls | Gloves contact | High visibility | Waterproof clothing |
| Hardhat | Dust Mask | Gloves chemical | Wellington boots |
| Hearing protection | Mask chemical vapour/mist | Safety shoes | |
| | Laboratory Coat | Eye protection | |

Demonstration: Wire Wool

| Those at risk (please tick) | Ri Staff | On-Stage Volunteers | Audience | Non-Ri Workers | Others |
|--------------------------------|----------|---------------------|----------|----------------|--------|
| | Y | Y | Y | | |

| Method Statement | Hazards | Mitigation | Likelihood | Severity of impact | Current Risk |
|--|--|--|------------|--------------------|--------------|
| Wire wool is held across the terminals of a battery to intentional short circuit the battery. As the electricity flow through the wire wool, the resistance is enough to cause the wire wool to catch light. | By necessity for the demonstration, there will be contacts electrified to a battery voltage. There is a risk of electric shock to presenter. | This demonstration will only be performed by the presenter. In addition, it will be a 9V battery used, therefore any shock will uncomfortable rather than dangerous. | 3 | 1 | 3 |
| | Fire spreading | This demonstration will be conducted either with a small piece of wire wool, or on a larger piece contained within a pyrex bowl. Either way the area in the immediate vicinity of the performance of his demonstration (1m) will be clear of other flammables. The fire/ smoke alarms should be isolated. | 2 | 2 | 4 |
| | Accidental ignition | During transport and storage, the battery will be stored in a non-conductive box away from the wire and only positioned next to it during this demonstration. | 1 | 2 | 2 |
| | Shorting a battery In this demonstration, the battery is deliberate shorted. This could cause the battery to get hot. | The battery only needs to be shorted for a very short period of time (1-2seconds). This short time is not enough to cause serious heating of the battery. However, before conducting the demonstration the battery used will be visually inspected to ensure that it is not damaged in any way. | 2 | 2 | 4 |



| | | | | | |
|--|------------|---|---|---|---|
| | Eye Injury | Sometimes the wire wool can be blown to increase the spread of the wire within the bowl, this means there is a risk that some wire embers may enter the presenter's eye. So if the presenter does blow on the bowl they should do so either with their eyes closed or whilst wearing goggles. | 1 | 2 | 2 |
|--|------------|---|---|---|---|

PPE Requirements

| Item | | Item | | Item | | Item | |
|---------------------|--|---------------------------|--|-----------------|---|---------------------|--|
| Flameproof overalls | | Gloves contact | | High visibility | | Waterproof clothing | |
| Hardhat | | Dust Mask | | Gloves chemical | | Wellington boots | |
| Hearing protection | | Mask chemical vapour/mist | | Safety shoes | | | |
| | | Laboratory Coat | | Eye protection | Y | | |

Demonstration: Plasma Ball and Light

| Those at risk (please tick) | Ri Staff | On-Stage Volunteers | Audience | Non-Ri Workers | Others |
|--------------------------------|----------|---------------------|----------|----------------|--------|
| | Y | Y | Y | | |

| Method Statement | Hazards | Mitigation | Likelihood | Severity of impact | Current Risk |
|---|-----------------------|---|------------|--------------------|--------------|
| <p>A table top plasma ball is turned on and demonstrated that the electric arcs move to the outside of the ball. Then a small fluorescent tube lightbulb is brought near to the plasma ball and the light bulb lights up even through it is not plugged in.</p> <p>An audience volunteer may be used.</p> | Glass smashing injury | <p>There is risk that either the plasma ball or the light bulb may smash.</p> <p>The plasma ball will be placed on a stable position and always wrapped in protective material when transported. It will not be handled by a volunteer.</p> <p>The light can be wrapped in clingfilm, such that if it does break the pieces will be contained within the clingfilm.</p> | 1 | 2 | 2 |
| | Cut injury | If any glass breakages occur they will be cleared up at the earliest convenience using gloved hands and disposed of either wrapped in the rubbish or in a glass disposable bin | 1 | 1 | 1 |
| | Electrical hazard | The plasma ball will be checked that it is in full working order with no bare wires etc. Ideally it will be PAT Tested or less than 6 months old. | 1 | 3 | 3 |
| | Electric shock | There is only risk of this if the glass/ protective dome of the plasma balls breaks. If it does, the gasses inside the dome will escape. The plasma ball needs to be disposed of but in a place where it cannot be retrieved and used by curious bystanders. Therefore dispose of either at home in a private dustbin or bring to the Ri for disposal. | 1 | 1 | 1 |

PPE Requirements

| Item | | Item | | Item | | Item | |
|---------------------|--|---------------------------|---|-----------------|--|---------------------|--|
| Flameproof overalls | | Gloves contact | Y | High visibility | | Waterproof clothing | |
| Hardhat | | Dust Mask | | Gloves chemical | | Wellington boots | |
| Hearing protection | | Mask chemical vapour/mist | | Safety shoes | | | |
| | | Laboratory Coat | | Eye protection | | | |

Demonstration: Electrolysis and Hydrox Bubbles

| Those at risk (please tick) | Ri Staff | On-Stage Volunteers | Audience | Non-Ri Workers | Others |
|--------------------------------|----------|---------------------|----------|----------------|--------|
| | Y | Y | Y | | |

| Method Statement | Hazards | Mitigation | Likelihood | Severity of impact | Current Risk |
|---|--|--|------------|--------------------|--------------|
| <p>Before the show the electrolysis kit is set up as follows:</p> <ul style="list-style-type: none"> - A solution of sodium bicarbonate is placed in a gas jar, leaving 2-3 cm of air at the top, with a bung that has 2 carbon electrodes and a rubber hose attached. This assembly is held in a clamp stand. - Also in a clamp stand is a conical flask filled with water. The open end of the rubber hose is submerged in this water. - A bench top power supply is attached to the electrodes using crocodile clips (polarity does not matter, in fact variation between shows will reduce corrosion long term). - The power supply is set so that current will go to the maximum possible in the circuit (16v overall max) and the voltage turned to 32v for one minute. A timer should be set so this is not forgotten about. This will rapidly produce bubbles in the solution which will travel through the hose and bubble through the water in the conical flask. The purpose of this is to remove dissolved oxygen from the water, plus flush out normal air from the gas jar and hose. After 1 minute the voltage should be reduced to somewhere between 4-6v so the bubbles in the conical flask are slow | <p>The mixture of gases is explosive in any quantity, and does not need ambient oxygen to react, just a source of ignition, no matter how slight.</p> <p>This gas, if confined, could cause the apparatus to explode.</p> <p>There is particular risk of flashback – the gases in the rubber tube igniting and flashing back to the jar.</p> <p>If the water in the conical flask becomes soapy (eg after repeated performances of the demo), the gas mixture may collect in bubbles which could ignite unexpectedly</p> | <p>No more than a few millilitres of the gas mixture should be allowed to accumulate anywhere. The jar must be kept nearly full so as to minimise the headspace inside, and <u>must be</u> sealed with a fail-safe closure (eg a bung) that will give way if necessary.</p> <p>The tube must be placed into the conical flask beneath the water line so that it acts as a valve and will aid to prevent flashback. In addition, the tube must be kept away from sources of ignition, which will be present. This is especially important to consider when igniting the bubbles – this must not be done until the tube has consciously been placed back into the conical flask of water.</p> <p>The gas mixture that is evolved before the demonstration is performed will be produced slowly, but must be allowed to disperse rather than accumulate anywhere. It is lighter than air, so will escape to the atmosphere from an open flask, and this must be allowed to happen. The water in the conical flask should not be allowed to become soapy, as this will cause the gas to accumulate in bubbles. If this does happen, be aware of the hazard and try to disperse the bubbles frequently.</p> | 1 | 4 | 4 |
| | <p>The apparatus includes several wires, including some attached to the electrolysis jar. These may pull on it if snagged.</p> | <p>All wires and cables must be carefully managed and taped wherever possible, and must not be allowed to pull on the apparatus.</p> | 2 | 2 | 4 |

| | | | | | |
|---|--|---|---|---|---|
| <p>but steady. approximately 1 bubble per second. The setup runs like this until needed in the finale.</p> <p>During the Show:</p> <ul style="list-style-type: none"> - The apparatus is left to run throughout the show - A volunteer is selected from the audience - A small amount of water with washing up liquid in it is add to the palm of their hand. - When it is needed the voltage is increased to max (32 Volts) to cause more bubbles to be produced (this should be for the shortest time possible) - Wearing goggles and ear defenders, the pipe from the electrolysis apparatus is fed into the water, causing hydrox bubbles to be formed in the volunteer's hand - Using a long handled gas lighter, these bubbles can be ignited to produce a loud 'pop'. | <p>Spillages present a slipping hazard</p> | <p>Any spills to be cleaned up immediately</p> | 1 | 1 | 1 |
| | <p>Water and electricity present a shock risk</p> | <p>Water is contained within a sealed unit, should the unit begin to leak, presenter is to disconnect electricity at supply and cease demonstration.</p> | 1 | 2 | 2 |
| | <p>The exploding hydrox bubbles will produce a loud noise.</p> | <p>Goggles and ear defenders to be worn by presenter and volunteer. Audience instructed to cover their ears.</p> <p>The presenters are trained in the correct amount of bubbles to produce an appropriate sound for the venue. If needed, a test explosion will be conducted in the venue prior to the shows to ensure the correct amount of bubbles and so associated 'size of explosion' is produced.</p> | 2 | 2 | 4 |
| | <p>Burning the volunteer</p> | <p>The fire of the bubbles in so transient that the heat from the fire will not have time to cause damage to the volunteer. In addition, the specific heat of capacity is such that the water in the volunteer's hand will 'absorb' the heat and prevent it from causing any damage.</p> <p>Also, a long handled gas lighter will be used to light the fire and not a burning splint (or spill) to prevent any hot embers from falling onto the volunteer's hand.</p> | 2 | 2 | 4 |

PPE Requirements

| Item | | Item | | Item | | Item | |
|---------------------|---|---------------------------|--|-----------------|---|---------------------|--|
| Flameproof overalls | | Gloves contact | | High visibility | | Waterproof clothing | |
| Hardhat | | Dust Mask | | Gloves chemical | | Wellington boots | |
| Hearing protection | Y | Mask chemical vapour/mist | | Safety shoes | | | |
| | | Laboratory Coat | | Eye protection | Y | | |

Demonstration: Faraday Motor

| Those at risk (please tick) | Ri Staff | On-Stage Volunteers | Audience | Non-Ri Workers | Others |
|--------------------------------|----------|---------------------|----------|----------------|--------|
| | Y | Y | Y | | |

| Method Statement | Hazards | Mitigation | Likelihood | Severity of impact | Current Risk |
|---|-----------------------------------|--|------------|--------------------|--------------|
| <p>A bespoke made piece of apparatus including a wooden base, stand and a glass bowl is used in the following way...</p> <p>The glass bowl is placed on the wooden base, over 2 small neodymium magnets (one of which is attached to the base and the other placed on top of the fixed one). The bowl is filled with sodium bicarbonate solution. A copper wire is suspended from the top of the stand so that it dangles into the solution, but does not touch the bottom.</p> <p>Using a benchtop power supply, current is run through the dangling wire and the solution via inputs built into the apparatus. The dangling wire should start to rotate around the magnets.</p> | Glass smashing injury/ Cut Injury | There is risk that bespoke bowl may smash. If any glass breakages occur they will be cleared up at the earliest convenience using gloved hands and disposed of either wrapped in the rubbish or in a glass disposable bin. | 1 | 2 | 2 |
| | Electrical Hazard | The bench top power supply will be ensured that it is in full working order prior to being used. Ideally either PAT tested or less than 6 months old | 2 | 2 | 4 |
| | Shock Hazard | As electricity is being used, there is risk of electric shock. However, using a bench top power supply will ensure that the currents (and voltages) used will not be more of a discomfort rather than a danger if a shock does occur. That said, it will be ensured that those touching the dangling (and so live wire) do not suffer from any heart conditions or have medical equipment that may be affected by electric currents | 1 | 3 | 3 |
| | Working with Neodymium Magnets | Neodymium (rare earth) magnets are very strong therefore care must be taken when using them. This includes keeping all magnetic material away from them, and ensuring that fingers are clear of the contacts points when the magnets are brought together. | 1 | 2 | 2 |
| | Toxic reactions | Ensure that the wire used for the motor is <u>not</u> made of stainless steel, as this reacts with sodium bicarbonate during electrolysis to produce toxic chromium, therefore preferably the wire should be made of copper. | 1 | 1 | 1 |

PPE Requirements

| Item | Item | Item | Item |
|---------------------|---------------------------|-----------------|---------------------|
| Flameproof overalls | Gloves contact | High visibility | Waterproof clothing |
| Hardhat | Dust Mask | Gloves chemical | Wellington boots |
| Hearing protection | Mask chemical vapour/mist | Safety shoes | |
| | Laboratory Coat | Eye protection | |

Demonstration: Van De Graaff Generator

| | | | | | |
|---------------------------------------|----------|---------------------|----------|----------------|--------|
| Those at risk (please tick) | Ri Staff | On-Stage Volunteers | Audience | Non-Ri Workers | Others |
| | Y | Y | Y | | |

| Method Statement | Hazards | Mitigation | Likelihood | Severity of impact | Current Risk |
|--|-------------------------------------|--|------------|--------------------|--------------|
| <p>A van de graaf generator is used by the presenter to create some sparks. Then a Barbie doll and some (approx. an 8cm high pile) small metal pie dishes are placed on the large dome of the van de graaf generator. When the van de graaf is switched on the Barbie doll's hair will become separated and the pie dishes will all gracefully fly off.</p> | Electrical fault | Ensure van de Graaff is in fully working order. Ideally the Van de Graaff will either be brand new (less than 6months old) or will be PAT tested. | 1 | 1 | 1 |
| | Trip hazard | If the wires are trailing over the stage they will be secured with gaffer tape. | 1 | 1 | 1 |
| | Static Shock | Only the presenter will be on stage when the Van de Graaf is switched on. All the presenters are fully trained in how to use a Van de Graaff generator and will ensure that the earthing globe/ earthing wires are used when necessary. They have no heart conditions or health equipment that prevent them from using such equipment. | 3 | 1 | 3 |
| | Working with High Voltage Apparatus | As this machine uses high voltage it should not be used near those with pace makers or other electrical based health equipment therefore the audience will be warned that if they do have a pacemaker or other electrical based health equipment to stand back at least 3metres | 1 | 5 | 5 |

PPE Requirements

| Item | Item | Item | Item |
|---------------------|---------------------------|-----------------|---------------------|
| Flameproof overalls | Gloves contact | High visibility | Waterproof clothing |
| Hardhat | Dust Mask | Gloves chemical | Wellington boots |
| Hearing protection | Mask chemical vapour/mist | Safety shoes | |
| | Laboratory Coat | Eye protection | |