Railway electrification COMING SOON to a line near you

Education plays a vital role in understanding the railway and promoting rail safety
1.0 Introduction
An introduction to this teacher’s pack

2.0 Core lesson plan activity for Key Stages 1 and 2
2.1 Core lesson plan activity for Key Stages 1 and 2
Science (PSHE)
A lesson all about the electrification of the railway, including: the power quiz, Rail Life ‘Safety Top 3’ and class discussion on how to stay safe.

2.2 Including electricity at home and away
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The lesson plan activities have been based on the ‘Key Stage’ structure in England and Wales. For Scotland we have provided the equivalent groupings in this chart.

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1.0 Introduction

Electrifying the railway – faster, greener and more reliable

A third of Britain’s railway is already powered by electricity. More rail routes are being electrified to make journeys faster, greener and more reliable. Electrification will improve travel between major cities and is vital in supporting economic growth.

Note to teachers:
To find out about plans for your region you can download a factsheet from the Primary School Resources section at:
www.networkrail/safetyeducation

Electrification and rail safety

Electrification brings great social and economic benefits but it also has safety implications that pupils need to be aware of.

Electrified overhead lines powering the railway carry electricity 100 times greater than in the home. Underground cables and the third rail also carry electricity that can seriously injure or kill. Staying clear of the track area and being aware of the potential hazards are essential.

These lesson plan activities focus on different aspects of the topic – from the benefits of railway electrification to safety issues. Devised with help from teachers, they cover a wide range of subjects from Science through to PSHE and English. They have been developed to match curriculum areas and meet requirements for PSHE teaching, such as promoting a pupil’s ability to assess and manage risk appropriately and keep themselves safe, whilst also reinforcing an introductory understanding of the science of electricity.

All our lesson plan activities have links to the curriculum and have clear learning objectives

Lesson plan activities have been developed to meet curriculum requirements set down by Education Scotland, Estyn in Wales and Ofsted in England
Lesson plan activities for Key Stages 1 and 2

This set of primary school lesson plan activities covers Key Stages 1 and 2. The social and economic benefits of railway upgrades are explored from a present day and historical perspective. Safety around the railway is also drawn out in a number of ways – from the key facts of staying safe to an analysis of peer group pressure to take risks.

The activities provide a fun and interactive way to introduce discussion about railway electrification and safety into the classroom.

Learning objectives
By the end of these lesson plan activities pupils will understand:

– Historically how trains have been powered over the centuries.
– The benefits of railway electrification.
– The power and danger of electricity used on the railway.
– How to be safe around the railway.
– The relationship between decision making and consequences.
– Peer influence and emotional resilience in relation to safety.

Ofsted
These activities can help your school meet the Ofsted requirement that pupils should be able to ‘assess and manage risk appropriately and keep themselves safe’.

Note to teachers:
For materials covering wider rail safety issues, including use of level crossings, please see:

www.networkrail.co.uk/safetyeducation
2.1 Core railway electrification lesson plan activity

Science (PSHE)

Core lesson plan activity: Railway electrification. The power quiz and class discussion on the railway and using it safely, as well as introductory / background information on electricity.

For this lesson you can download a PowerPoint presentation with accompanying teacher’s notes on railway electrification, together with relevant local information from the Primary School Resources section at: www.networkrail/safetyeducation

The presentation is intended as the ‘core resource’ for any lesson or assembly.

It contains everything the pupils will need to know about the upcoming electrification of the railway including safety messages.

It is intended to be used in conjunction with the additional lesson plan ideas and worksheets that are available. These extra ideas help to bring out different aspects of railway electrification in more depth across a number of different subject areas – from a maths exercise which will help children to calculate the difference between the power of home electricity and that of the railway to a history lesson which explores key dates in railway history and asks pupils to bring these to life.

All our lesson plan activities have links to the curriculum and clear learning objectives.
2.1 Core lesson plan activities for Key stages 1 and 2

There are teacher’s notes to accompany the presentation – but here’s a quick summary of the key points:

Britain’s busy railway is being transformed. Trains that run on diesel fuel are being phased out and replaced by electric ones.

Electric power will mean shorter journey times and larger trains that run more quietly and have less impact on the environment.

There are, however, dangers associated with any power source – electricity on the railway is always on and it’s 100 times greater than the home supply.

In summary, railway electricity is very dangerous so stay safe by remembering the Rail Life ‘Safety Top 3’.

The Rail Life ‘Safety Top 3’:

1. **Stay clear of the tracks. Is it worth putting your life on the line?**
   - electricity can jump up to three metres.
   - don’t play with kites or balloons near overhead lines.

2. **Use the level crossing.**
   Shortcuts across the railway can kill.

3. **Know the signs.**
   Be alert to railway signs, they could save your life.

**Why not...**

Have a look at the rest of the lesson plan ideas and worksheets – these could provide a fun and interactive end to the lesson.
2.2 Electricity – home and away

Some background and context for understanding about electricity on the railway, for Key Stages 1 and 2.

Learning about electricity is a core part of the curriculum, but for younger children or those in need of a reminder, here is some fast and fun electricity introductory information looking at the basics of electricity such as a simple circuit, as well as the role of electricity in our homes. Depending on pupils’ existing knowledge of electricity, it may provide a useful foundation for lesson plan activities on railway electrification.

What is electricity used for?

If something moves, lights up, heats things or makes a noise, there is a good chance it is using electricity. Electricity powers everyday appliances in the home such as the TV, kettle, radio and washing machine. Home heating, lighting and computers all rely on it.

Hold a five minute quiz to see how many household items powered by electricity the children can think of and to test what they know about electrical safety in the home.

Below is a link to a fun ‘electricity and our lives’ quiz which you may want to use to explore the context of electricity in a familiar environment: www.engineeringinteract.org/resources/siliconsprites/flash/concepts/electricity.htm

It is important to use electricity safely and to be aware of the dangers.

Don’t be shocked at home! Electricity safety in the home – key facts:

– Never put water or other liquids on, or near, electrical equipment. It’s also important to make sure your hands are dry before using anything electrical.

– Never take electrical equipment such as a radio or hair straighteners into the bathroom.

– Keep electrical items away from candles or fires.

– Don’t try to get toast out of the toaster using a knife.

– Don’t plug too many items into the same socket.

– Make sure any leads, plugs or sockets are not burned or frayed. If an electric cable is damaged get an adult to replace it.

Did you know?

We have known about electricity since ancient times. Electrical effects such as lightning and static electricity were recorded 2,500 years ago. People thought it was magic!
How does electricity work?

Electricity cannot flow without a power supply such as the mains, or a battery and a closed circuit to travel around. We use a power source such as a battery or a generator to make the electricity move along a path or circuit to the object we want to power, such as a light bulb.

The flow of electricity is called current. Electricity flows around a circuit in one direction only. There can only be a current if the circuit is connected with a metal that conducts electricity, such as copper. Circuits can contain other electrical devices such as a motor. The electricity will then flow through and drive the motor enabling a car or train to move forward.

Why not try this fun circuits quiz via the link below:
www.engineeringinteract.org/resources/siliconspies.flash/concepts/simplecircuits.htm

(Reproduced with thanks to engineeringinteract.org c. 2004 University of Cambridge author Peter Stidwell.)

A lot of electricity is needed to move a train, the voltage in overhead power lines is 100 times greater than in your home, so it’s even more dangerous. If you come into contact with it, you will become part of the circuit and be seriously injured or killed.

Prompt questions

Ask the class who has been on a train. Do they know where their local train stations are? What powers the trains in their local area? What should they and their parents do to stay safe?

Why is electricity dangerous?

The human body is made up of 70% water – it’s a very good conductor for electricity. If a person becomes part of an electrical circuit, electric current passes through the body disrupting the working of organs essential for life, such as the heart and lungs.

If you are electrocuted your lungs, heart and blood vessels will tighten or stop working completely, depending on the strength of the current. Electricity burns where it enters and exits the body.

Electricity moves at the speed of light and can jump and arc so you can be electrocuted without touching the source of it. If you are electrocuted your muscles will tighten making it difficult to let go or get away from the object which has electric current passing through it.

Electricity is a force that will always find the easiest path to the ground. It travels fast through water, which makes up 70% of the human body.

Anyone who touches someone being electrocuted, or an object that is ‘live’ with electricity, can become part of the circuit as well. Never touch anyone who has been electrocuted, or anything that has come into contact with an electrical current.

You should always keep liquids and naked flames away from electrical items.
3.0 Additional lesson plan activities for Key Stage 1

3.1 Electrification essentials and staying safe around the railway

Science (PSHE)

Many trains today are powered by electricity carried through overhead power lines or a conductor rail, sometimes called the third rail. The third rail has 750 volts passing through it. Overhead power lines carry 25,000 volts – 100 times greater than the power supply in the home.

Electricity is invisible. But can you guess where it is?

Here is a picture of the railway track:

A worksheet to support this activity can be found under the Primary School Resources section at: www.networkrail.co.uk/safetyeducation

An interactive slide is also available. See slide 19 of the PowerPoint presentation – downloadable via the link above.

Using the worksheet and/or the PowerPoint slides, ask the class to tell you where electricity can be found in this photo. They may guess the overhead power lines and in the track.

Show them the second version of the photo revealing the ‘hidden places’ where electricity is also present, for example by the side of the track or in an underground cable.

The PowerPoint slide also shows how far electricity can ‘jump’.
Electrification facts

- The third rail and overhead power lines have electricity flowing through them at all times and are never switched off.

- Electricity in overhead power lines can ‘jump’. You don’t have to touch the overhead power lines to get electrocuted. Playing with a kite or balloon, or dangling things from railway bridges near electric power lines are very dangerous things to do.

- The third rail looks like a normal rail, but is electrified. The electricity is so strong that if you touch the rail, you will be seriously injured or killed.

- 9 out of 10 people die from the electric shock received from getting too close to railway overhead power lines.

Prompt questions

Because we can’t see electricity, how do we know when it’s on and to stay away? What does the danger warning sign for electricity look like?

An electricity danger warning sign:

Conclude the lesson with one of the worksheet activities provided, to help pupils to remember what they’ve learned. Choose from the colouring-in and ‘Spot the Hazard’ activity or ‘Signs of Danger’ – downloadable from the Primary School Resources section at:

www.networkrail/safetyeducation

This video clip from BBC Learning Zone is an engaging way to demonstrate the dangers of being close to electricity. It uses a dummy to show how electricity can reach you before you even touch it:

www.bbc.co.uk/learningzone/clips/the-dangers-of-electricity/1646.html
3.2 The power jump

Maths

For this lesson plan activity you will need:

– a tape measure or measuring stick.

The worksheet is available from the Primary School Resources section at: www.networkrail.co.uk/safetyeducation

Arrange the class into groups and ask them to take it in turns to jump as high as they can, while their partner logs the height reached on the worksheet.

The worksheet allows pupils to see comparisons between different heights i.e. their own jump, the World High Jump record, how far electricity can jump etc.
Electrification is coming soon to a railway line near you. What's happening to the line, and why? You can find a fact sheet for your area downloadable from the Primary School Resources section at:
www.networkrail.co.uk/safetyeducation

Further information is available from the core Primary School PowerPoint presentation available under the Primary School Resources section from:
www.networkrail.co.uk/safetyeducation

**Note to teachers:**
You can also find an animation showing the High Output Overhead Line Wiring Train in action, together with photography of other types of equipment and activity in the supporting material section from:
www.networkrail.co.uk/safetyeducation

**Prompt questions**
You can use the following questions to introduce a class discussion:

- Why do you think the line is being electrified?
- What difference will it make?
- Who is going to benefit from the improvements?
**Note to teachers:**
The benefits of electric trains are that they:

- Emit less pollution
- Can carry more people
- Are often faster and more frequent
- Are quieter
- Cause less damage to the track
- Are cheaper to run and better value for money

**Why not...**
You could hold an ‘Electrifying Debate’ for the class to explore the environmental, social and economic benefits of electrification as well as some of the areas of concern – such as safety or disruption to community life.

**Getting to work**
Below is a picture of the engineering team putting up the overhead power line structure on a similar project.
**Electrification project timeline**

Ask the class what needs to be done before engineers put up the overhead power lines. This will help to increase their understanding of the planning and preparation work that goes on behind the scenes before any major transport project.

You could give different groups within the class questions to prompt their thinking:

Which local people and organisations might Network Rail (the organisation that owns and operates the tracks and rail infrastructure in Britain and is delivering the overall project) want to talk to about the engineering and construction plans?

What sorts of objects may need to be cleared to make way for the overhead lines?

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**Note to teachers:**

**Electrification project timeline**

Here is a broad timeline for the preparation and delivery of the engineering and construction work:

1. **Assessment:** of the track area to be electrified i.e. looking at how the lines and cables will be put up, especially in difficult areas such as tunnels.

2. **Preparation:** clearing the areas of any trees and hedges that may be in the way.

3. **The ground is made ready for building activity.**

4. **Steelwork and construction of the electrified line.**

5. **Electrical parts put in place.**

6. **25,000 volts switched on!**
Conclude the lesson with a ‘Signs of Danger’ exercise. Ask the children to create their own signage to show the danger of electricity on the railway. You can use the worksheet downloadable from the Primary School Resources section at: www.networkrail/safetyeducation

Did you know?
An electric eel can produce powerful electric shocks of up to 500 volts.
4.2 Railway line history from the Victorian era to the present day

History (PSHE)

Electrified trains have existed for hundreds of years, but large scale electrification of the railway is the latest development in British railway history. Electricity on the railway is really powerful, so it’s extremely important to stay safe around the railway.

A detailed timeline showing the history of the railway in Britain is available for download under the Primary School Resources section at: www.networkrail/safetyeducation

Give all the children the worksheet at the start of the lesson.
Prompt questions

- What are the benefits of travelling on the railway now, compared with 150 years ago?  
  (For example: faster travel, greater comfort.)

- In your view, what have been the most exciting advances made on the railway?  
  (For example, the Channel Tunnel, Eurostar.)

- What safety measures have been invented?  
  (For example, signalling, level crossings.)

- What do you think the best invention has been?  
  (For example, points, Brunel’s bridges.)

- Why do you think we are using electricity to power our trains today?  
  (For example, more cost-effective, environmentally friendly.)

- Which do you think is more important: train speed, safety or comfort?

Get each pupil to choose a different date in railway history and ask them to explain their choice. Then ask them to take on the role of a newspaper journalist and write a headline and a four paragraph newspaper article reporting on the news story.

Note to teachers:

A more detailed history of Britain’s railway can be found at:  
www.teachingzone.org/railway/pdf/history.pdf

An animation of Stephenson’s Rocket in action can be found at:  
www.bbc.co.uk/history/interactive/animations/rocket/index_embed.shtml
4.3 Power up!

**Maths**

This activity is designed to explore pupils' knowledge and understanding of multiplication and the difference between numbers in a real world scenario.

The learning is brought to life through the use of fun and practical examples.

Use the ‘Power up’ worksheet downloadable from the Primary School Resources section at: [www.networkrail.co.uk/safetyeducation](http://www.networkrail.co.uk/safetyeducation)

You might want to start with a ‘railway numbers game’ to get the calculations going!

**Note to teachers:**

Put simply, volts are units of electric force.

- How many volts are there at a railway substation?  
  (Answer: 132,000 volts.)

- Note to teachers: a railway substation is part of a system to generate and/or transmit electricity across the railway.

- How many volts are there in the electrified overhead lines?  
  (Answer: 25,000 volts.)

- How many volts are there in the electrified third rail?  
  (Answer: 750 volts.)
Whose choice is it?

Accidents on the railway can happen whether you’re on your own, or with other people. Whether the accident is caused by an innocent mistake or the result of a deliberate act – it can lead to people being injured or killed.

This lesson plan activity looks at the factors involved in decision-making.

There is a mini self-assessment exercise on decision making and advice in the worksheet available from the Primary School Resources section at: www.networkrail/safetyeducation

After the class has completed the worksheet activities, you may wish to try a ‘silent debate’. Ask the pupils to think about a time when they made:

a) A good decision
   
b) A bad decision
   
   – In each case, what lead to them making that decision?
   
   – What were the consequences?

Ask the pupils to write their responses to the questions on Post-it notes, gather them in after each question and stick them onto a large sheet of paper. Or ask pupils to write down their thoughts and ‘post’ them in a ballot box. These can then be pulled out at random and used as part of the discussion.

Below are a couple of stories based on real life incidents which may help to set the scene for the discussion.
Mandy’s story
Mandy* was playing on a bridge over the railway track when she found a metal pole and pushed it through a hole in the bridge fencing. The pole made contact with 25,000 volts of electricity in the overhead line. Mandy was badly burnt and is scarred for life.

Ed’s story
Ed* was with a couple of friends at a train station. He and a friend stepped off the platform to pick up something they had dropped from the track, but Ed touched the electrified line and died instantly.

Prompt questions
– Have you ever been in a potentially dangerous situation without knowing it, like Mandy?
– What did you do or say when you thought the situation might be getting dangerous?
– Has a friend ever persuaded you to do something you didn’t want to do, and it felt dangerous?
– How did they persuade you?
– Thinking back, how might you have done things differently to stay safe?
– Write a story about a person who was influenced to do something they didn’t want to do. How did they feel? What did they learn?

*Names have been changed.
These lesson plan ideas have been carefully developed with teachers to match curriculum areas and meet requirements for PSHE teaching set down by Education Scotland, Estyn in Wales and Ofsted in England. They have also been approved by teaching improvement advisers in other subject areas.

**Key Stages 1 and 2**

**Core lesson plan activity**
Local rail electrification. Electricity at home and away; the Power Quiz and the Rail Life ‘Safety Top 3’. Class discussion on the electrified railway and how to stay safe. Electricity at home and away – background information and exercise. An introductory/reminder exercise on electricity and staying safe, and a simple electrical circuit.

**Science:**
- Recognise that there are hazards in living things, materials and physical processes, and assess risks and take action to reduce risks to themselves and others.
- Understand everyday appliances that use electricity.

**PSHEE:**
- Recognise what is right and wrong.
- Take part in discussions with the whole class.
- Understand rules for, and ways of, keeping safe.

**UNDERSTAND:**
- About everyday appliances that use electricity.
- About simple series circuits involving batteries, wires, bulbs and other components.
- How a switch can be used to break a circuit.

**1. Key Stage 1**

**Electrification essentials and the Rail**
Electrification essentials and the Rail Life ‘Safety Top 3’. Colouring-in exercise and spot the danger.

**Science:**
- Recognise that there are hazards in living things, materials and physical processes, and assess risks and take action to reduce risks to themselves and others.

**PSHEE:**
- Recognise what is right and wrong.
- Take part in discussions with the whole class.
- Understand rules for, and ways of, keeping safe.

**2. Key Stage 1**

**The Power Jump**

**Maths:**
- Use appropriate mathematical equipment when solving problems involving measures or measurement.
- Recognise simple spatial patterns and relationships and make predictions about them.
- Use mathematical communication and explanation skills.
1. **Key Stage 2**

**What’s happening on the line?**

**Science:**
- Recognise that there are hazards in living things, materials and physical processes, and assess risks and take action to reduce risks to themselves and others.
- Understand everyday appliances that use electricity.

**PSHEE:**
- Recognise what is right and wrong.
- Take part in discussions with the whole class.
- Understand rules for, and ways of, keeping safe.

2. **Key Stage 2**

**Train timeline: from Victorians to electrification**

**History:**
- Recognise that the past is represented and interpreted in different ways, and give reasons for this.
- Study the impact of significant individuals, events and changes in work and transport on the lives of men, women and children from different sections of society.

**PSHEE:**
- Recognise what is right and wrong.
- Take part in discussions with the whole class.
- Understand rules for, and ways of, keeping safe.

3. **Key Stage 2**

**Power Up! Maths Quiz**

**Maths**
- Make connections in mathematics and appreciate the need to use numerical skills and knowledge when solving problems in other parts of the mathematics curriculum.
- Use appropriate calculation skills to solve problems involving data.

4. **Key Stage 2**

**Whose choice is it?**

**PSHEE:**
- Take part in discussions with the whole class.
- Understand rules for, and ways of, keeping safe.
- Face new challenges positively by collecting information, looking for help, making responsible choices, and taking action.
- Recognise that pressure to behave in an unacceptable or risky way can come from a variety of sources, including people they know, and how to ask for help and use basic techniques for resisting pressure to do wrong.
- Consider social and moral dilemmas that they come across in life.
Further Resources

There are a number of key resources you can use to support all of these activities.

www.rail-life.co.uk

Rail Life is a new Network Rail initiative created by young people for young people that raises awareness of rail safety issues. The high impact youth website contains facts, videos, advice and lots of content on rail safety for 11–17 year olds.

The vision for the campaign is that it will become the main place that young people will go to for insights and information on many aspects of the railway – from safety and careers, to general information about Britain’s transforming rail network.

www.networkrail.co.uk/safetyeducation

You will find a wide range of Rail Life teaching resources on rail safety on the Network Rail website, ranging from assembly kits to lesson plans, for use in schools, youth clubs and other community settings.

www.trackoff.org/Teacher Packs.aspx

You will find a range of teaching resources on rail safety here. We have also listed specific resources you can use within each lesson plan activity. They can be used for different age groups as you see fit. Network Rail’s regional community safety managers work with local communities and a variety of organisations including local police, sports clubs, schools and local councils to raise awareness of the dangers of taking risks on the railway and to get young people involved in positive activities.

For further information, email: communitysafety@networkrail.co.uk
Nominate a pupil to become a ‘Rail Life Rep’!

Rail Life Reps are pupils nominated by you to plan, develop and deliver a railway safety programme for the rest of the school through assemblies, competitions and class initiatives. ‘Rail Life Reps’ is a multi-agency initiative driven by Network Rail and the British Transport Police and supported by Train Operating Companies. Participating schools are supported by a designated mentor from Network Rail or the British Transport Police.

Those joining up receive a CD-Rom explaining all about the scheme, as well as pin badges for your nominated Rail Life Reps to wear with pride! Rail Life Reps receive a pack with a DVD outlining the role. It includes resources, ideas and suggestions they can use throughout the year.

For further details please get in touch with your Network Rail Community Safety Manager by emailing us at: communitysafety@networkrail.co.uk