

Introduction

This topic uses the context of rail travel to provide a range of learning activities. The first part starts with the historical setting and asks pupils to imagine what different types of travel were like. It then goes on to look at uses that electric motors are put to, presenting ideas about how technology affects people's lives. Finally it looks at the challenges of running a good service using limited resources; pupils use mathematical understanding and logical thinking to develop and evaluate solutions.

Overall learning objectives	Overall learning outcomes
- To learn how scientific and technological developments have been used to improve the quality of life - To identify the advantages and disadvantages of different technologies - To understand how electrical systems can be used to reduce pollution in areas of high population density - To understand how rail systems are designed and managed to provide a service whilst maximising the use of resources	- To explain how electric traction offered an attractive option in terms of travel - To explain the use of electric motors in a range of contexts - To evaluate alternative solutions to the provision of an effective service

Curriculum learning objectives:

Clean, Green Trains will support the following national curriculum learning objectives at KS2 / P5-7

Maths:

- Teachers should develop pupils' numeracy and mathematical reasoning in all subjects so that they understand and appreciate the importance of mathematics.
- Pupils should be taught to apply arithmetic fluently to problems, understand and use measures, make estimates and sense check their work. They should be taught to apply their mathematics to both routine and non-routine problems, including breaking down more complex problems into a series of simpler steps.

Science:

- Pupils should be taught to identify common appliances that run on electricity

Design & Technology:

- Pupils should be taught to understand how key events and individuals in design and technology have helped shape the world

Geography:

- Pupils should describe and understand key aspects of human geography, including the distribution of natural resources including energy, food, minerals and water

Further resources linked to the curriculum are available at: www.siemens.co.uk/education

Episode 1

The power of steam**Resources required:**

- ☐ Picture of Volks Electric Railway
- ☐ Picture of Brighton Belle

Learning objectives

- To use evidence to understand how people travelled in the late 19th century
- To evaluate the advantages and disadvantages of technology used in transport systems

Learning activities**1. Show pupils a picture of a steam train headed for Brighton in the 1880s.**

Explain that:

- At this time the railways were still fairly new and new lines were still being opened. There were no cars – the nearest anyone had to that was a horse drawn carriage. The only buses were horse drawn as well. Powered flight was yet to be invented.
- Railways were exciting. They offered people the chance to travel the country and opened up areas that only the wealthy could previously have visited. Cheap excursions were offered and people flocked to take them up. Thousands of people would travel from the cities to the coast for days out and holidays. Coastal towns grew if they were on the railway system.
- Yet railway travel wasn't always a happy experience. The engines that pulled the trains were steam engines and though they were exciting to watch they produced large amounts of smoke, soot and ash. If you lived by a railway line, it wasn't a good idea to hang washing out to dry – if you did you found that white sheets or shirts were no longer white. The first underground trains were steam powered – imagine that.
- Steam wasn't the only way of powering trains though. It was powerful and lots of staff knew how to make the engines work well. However some people were starting to experiment with other ways of moving people.

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- In the 1880s railways were still new
- Railways were exciting
- Railway travel wasn't always a happy experience
- Steam wasn't the only way of powering trains through

Travelling to Brighton

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Episode 1, cont'd

The power of steam

Learning activities

2. Show a picture of Volks Electric Railway.

Explain that:

- This is the world's oldest electric railway. It runs along the seafront at Brighton.
- Each coach has an electric motor which powers it along.

Ask pupils to compare this with the steam train; they should suggest similarities and differences.

Their responses might include:



Similarities:

- Run on rails
- Carry people
- Takes them to a destination
- Passengers sit in carriages

Differences:

- Electric train is smaller, lighter and slower
- Electric train can carry fewer people at once
- Electric train gives off no smoke, ash or soot (though the electricity has to be generated somewhere)

3. Ask pupils to produce a poster, divided into two parts. One side is to present the advantages of the steam trains that took people to places like Brighton; the other explains the advantages of having a seafront railway powered by electricity.

4. Afterwards show pupils a picture of the Brighton Belle (an electric train) and explain that forty years later, many of the trains from London to Brighton were electric.



Outcomes

- To be able to explain the role of steam and electric power
- To identify advantages of each
- To present ideas about technological change effectively.

Episode 2

The impact of electric motors

Resources required:

- ☐ Hair drier
- ☐ Battery (or mains powered) fan
- ☐ Food mixer
- ☐ Drill

(Observe reasonable precautions when bringing domestic appliances into school)

Learning objectives

- To understand the range of applications of electric motors
- To identify advantages and limitations they offer as a practical solution

Learning activities

1. Start by showing pupils a couple of devices that have electric motors in them.

Good examples might include:

- Hair drier
- Battery (or mains powered) fan
- Food mixer
- Drill

Ask them to suggest:

- What they all have in them to make them move
- What the device needs to be supplied with to make it move
- What we get from the device

Draw out that they all have motors, that motors need electricity (whether from batteries or from the mains) and that the motor produces movement. Pupils may also, quite rightly, suggest that they tend to produce heat and sound.

2. Show a picture of a car, and ask for suggestions as to where there are electric motors.

Point out that the engine isn't electric (unless it's an electric car or a hybrid) but there are many other features that are.

Take feedback – ideas might include:

- Starter motor
- Windscreen wipers
- Screen demister/heater
- Door locks (if remote control)
- Aerial (if retractable)
- Windscreen washer jets

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- What do all the devices have in them to make them move?
- What do the devices need to be supplied with to make them move?
- What do we get from each of the devices?

What makes these work?

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The engine on this car isn't electric but there are many features that are. Can you point them out?

Where are electric motors used for in this?

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Episode 2, cont'd

The impact of electric motors

Learning activities

3. Now ask pupils to come up with examples of domestic devices that have motors in them.

They could work in pairs to come up with ideas that can then be shared. Not all devices do but motors are in a surprising range, including:

- Cooker (if fan assisted)
- Refrigerator (pumping coolant around)
- Shower (if water is pumped by shower unit)
- Computer (cooling fan and CD drive)
- Printer (driving paper through)

There are many other obvious examples that they should come up with.

4. Now show picture of Volks Electric Railway train and explain that each of these had a motor in them to drive the train along.

Show picture of train, compared with horse drawn carriage, steam train and pedestrian. Ask pupils to suggest why the idea of an electric train was a very interesting one when it first came out. Lots of people wanted to ride on the railway – ask for suggestions as to why.

Now show a picture of a modern electric train being used to transport people through a city and explain that these days it's much more common. Compare the modern train with the Volks train and ask for suggestions as to how it's improved.

**5. Show picture of an electric car and explain that although electric trains are common in many parts of the country, electric cars are less familiar, even in urban areas. Ask pupils to discuss and suggest answers to these questions:**

- Why might an electric car be a good idea?
- What might some of the problems be with it?
- Why do you think that there are lots of electric trains in the world but not many electric cars?

**6. Finally ask pupils to suggest what might be powered by motors in a 'house of the future'?**

Take and display ideas; these might include:

- Powered curtains
- Powered window washers
- Powered garage door
- Powered doors

Outcomes

- To identify how and why motors are used in a range of appliances
- To suggest other applications

Episode 3

Operating the railway

Resources required:

Example bus timetable

Calculators, 1 for each pupil

Activity sheets 6 - 9

Learning objectives

- To apply ideas about distance, time and speed to the context of a railway
- To explore how information and estimation can be used to solve problems
- To devise alternative solutions and evaluate them

Learning activities

1. Show pupils a bus departure board. Explain that somebody has had to work out when the buses will be arriving at a particularly stop. A timetable has been written (show an example).

Ask what the timetable shows, and take ideas. Then ask what determines how long it takes the bus to get from one stop to another. Draw out a range of ideas, including:

- The distance
- The amount of traffic
- How fast the bus can go
- How long it needs to spend at a stop, allowing passengers to get off and on.

Ask which of these is fixed and which will vary according to the time of day.

2. Explain that we can work out the speed if we know the distance and the time.

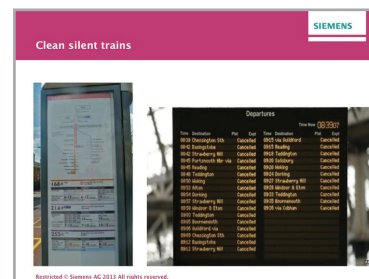
A bus travelling 30 miles every hour is travelling at 30mph.

Slide 24 shows how we can calculate the speed of a train on the Volks Electric Railway. This involves pupils in extracting data, performing calculations (for which they will probably need a calculator) and commenting on the results. This slide is supported by *Activity sheet 1*.

Solution - from slide 24

- The railway is 1620m long
- It takes 12 minutes to get from one end to the other
- The speed is $1620/12 = 135$ metres per minute
- This is $135/60$, or 2.25 metres per second
- Compared with a brisk walking pace of 1.5 metres per second it is clear that this isn't very fast.

3. Now ask pupils to compare organising a bus timetable with organising a railway timetable for a simple system such as the Volks Electric Railway (show picture and draw attention to single track – using Lesson Plan Support PPT). Ask if it would be easier to make a bus timetable or a railway timetable work reliably. Draw out that a railway has a dedicated route which it doesn't need to share – it's like having a private road. However, it's only single track – trains going one way have to share the track with those going the other way.



Episode 3, cont'd

Operating the railway

Learning activities

There are now various solutions that pupils are asked to think through about running a train service. These are designed to develop critical thinking and problem solving skills.

Part 1: Single Track

(Slide 26 and Activity sheet 2, Answer A)

Pupils are presented with a simple system and asked to work out a timetable for one train going up and down. It takes 12 minutes to travel the length of the line and 3 minutes to unload and reload with passengers.

Solution - from Slide 26 notes:

- It will make four single journeys in an hour
- It can carry 120 passengers in the hour.



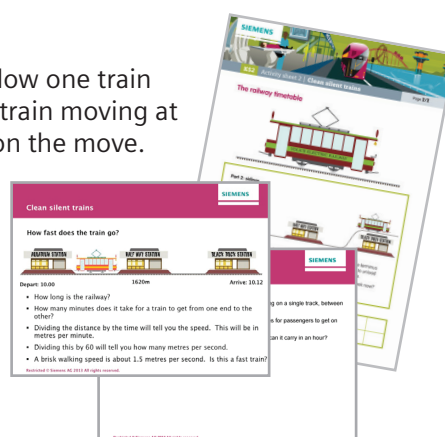
Part 2: Sidings

(Slides 27 & 28 and Activity sheet 2, Answer B)

In this solution there are three trains. Sidings at the stations allow one train to depart as soon as another has arrived. There's still only one train moving at once, but trains can unload and reload whilst another train is on the move.

Solution - from Slide 28:

- There will now be five journeys each hour (60/12)
- 150 passengers can be carried per hour
- More passengers are being carried, but the service uses three trains instead of one. There's always a train waiting in a (terminus) station which is good for attracting passengers but each train is running for 12 minutes and standing for the next 24 minutes.



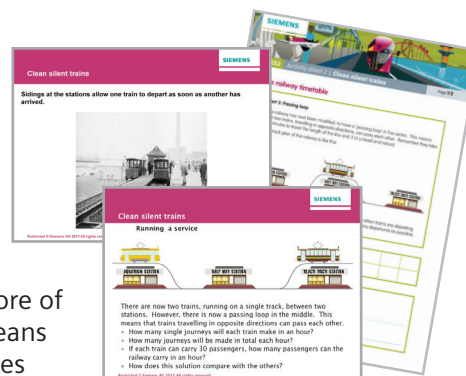
Part 3: Passing Loop

(Slides 29 & 30 and Activity sheet 2, Answer C)

This is an alternative solution, using a passing loop in the centre instead of sidings at the stations. Two trains now leave from either end simultaneously and pass in the middle.

Solution - from Slide 30:

- Each train will now make four single journeys an hour (12 minutes to travel and 3 to reload)
- With two trains there will now be eight journeys an hour
- This means that 240 passengers can be carried
- This is better than the previous solution in that more passengers per hour can be carried and with fewer trains. It means that two trains are moving at once, so safety is more of an issue (though not that much at these speeds). It also means that there is a departure from each terminus every 5 minutes instead of every 24 minutes.



Episode 3, cont'd

Operating the railway

Learning activities

Part 4: Single Track and two coaches

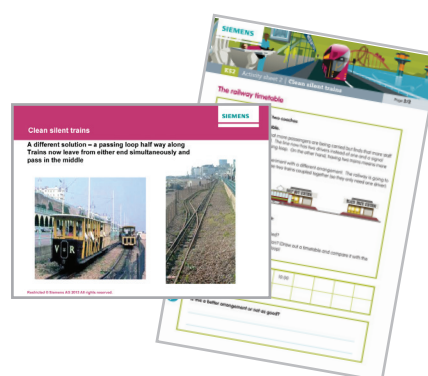
(Slide 31 and Activity sheet 2, Answer D)

This solution simply involves running one train with two coaches. No additional trackwork is needed.

Solution - from Slide 31:

- It will make four single journeys in an hour
- The train can carry 60 passengers
- As each train now carries 60 passengers it can carry 240 per hour

This is clearly an effective solution as it carries up to 240 passengers per hour with only one driver and no complicated trackwork or risk of collision. However there is now only one departure every half hour from each terminus so some business may be lost as passengers can walk the distance in less than 30 minutes.



Slide 32 is an extension activity. It challenges pupils to think of solutions not simply in terms of how many passengers can be carried but also frequency of service. If departures are too far apart, business will be lost. Pupils can go back over their solutions and identify how frequently trains are departing from a terminus station.

The answers are:

Solution 1	One single carriage	Every 30 minutes
Solution 2	Three single carriages and sidings	Every 24 minutes
Solution 3	Two single carriages and a passing loop	Every 15 minutes
Solution 4	One double carriage	Every 30 minutes

Outcomes

- To be able to calculate and comment upon the speed of the train
- To be able to evaluate solutions to the challenge of organising an effective service

Episode 3, cont'd

Operating the railway

Learning activities

Answers from Activity sheet 2

A - Single track, one coach

Train departs Aquarium Station at:	10.00	10.30	11.00	11.30	12.00
Train departs Black Rock Station at:	10.15	10.45	11.15	11.45	12.15

C - Sidings

Train departs Aquarium Station at:	Train departs Station A at:	10.00	10.24	10.48	11.12	11.36
Train departs Black Rock Station at:	Train departs Station B at:	10.12	10.36	11.00	11.24	11.48

C - Passing loop

Train departs Aquarium Station at:	Train departs Station A at:	10.00	10.15	10.30	10.45	11.00
Train departs Black Rock Station at:	Train departs Station B at:	10.00	10.15	10.30	10.45	11.00

D - Single track, two coaches

Train departs Aquarium Station at:	Train departs Station A at:	10.00	10.30	11.00	11.30	12.00
Train departs Black Rock Station at:	Train departs Station B at:	10.15	10.45	11.15	11.45	12.15