

MARVELLOUS MACHINES: Forces in Action on the Railways

**Activities to support the teaching of
KEY STAGE 2 SCIENCE**



KEY ASPECTS OF THE SESSION ARE:

- **KEY STAGE 2 SCIENCE:** Forces and Motion; Materials and their Properties.
- Other subject links to Maths, History, Design and Technology and English.
- What is a Dynamometer Car? Why was it used and how does it measure forces?
- What materials are found on the Dynamometer Car and what are their properties?
 - How does a steam locomotive work?
 - What forces are acting on a steam locomotive in motion?
 - Handling and interpreting data.
- Object handling; Developing skills of participation and communication.

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How to use this pack

This information pack for teachers is designed to support a visit to the West Shed Museum, where pupils will participate in museum-led activities that are intended primarily to support the teaching of Science at Key Stage 2. These activities have been developed as part of a Heritage Lottery funded project involving the restoration of one of the vehicles in the Trust's collection - the 1912 dynamometer car. Funding support has also been received from the PRISM Fund of the Museums, Libraries and Archives Council.

Consultation and piloting with teachers and pupils at local primary schools has taken place as part of this project.

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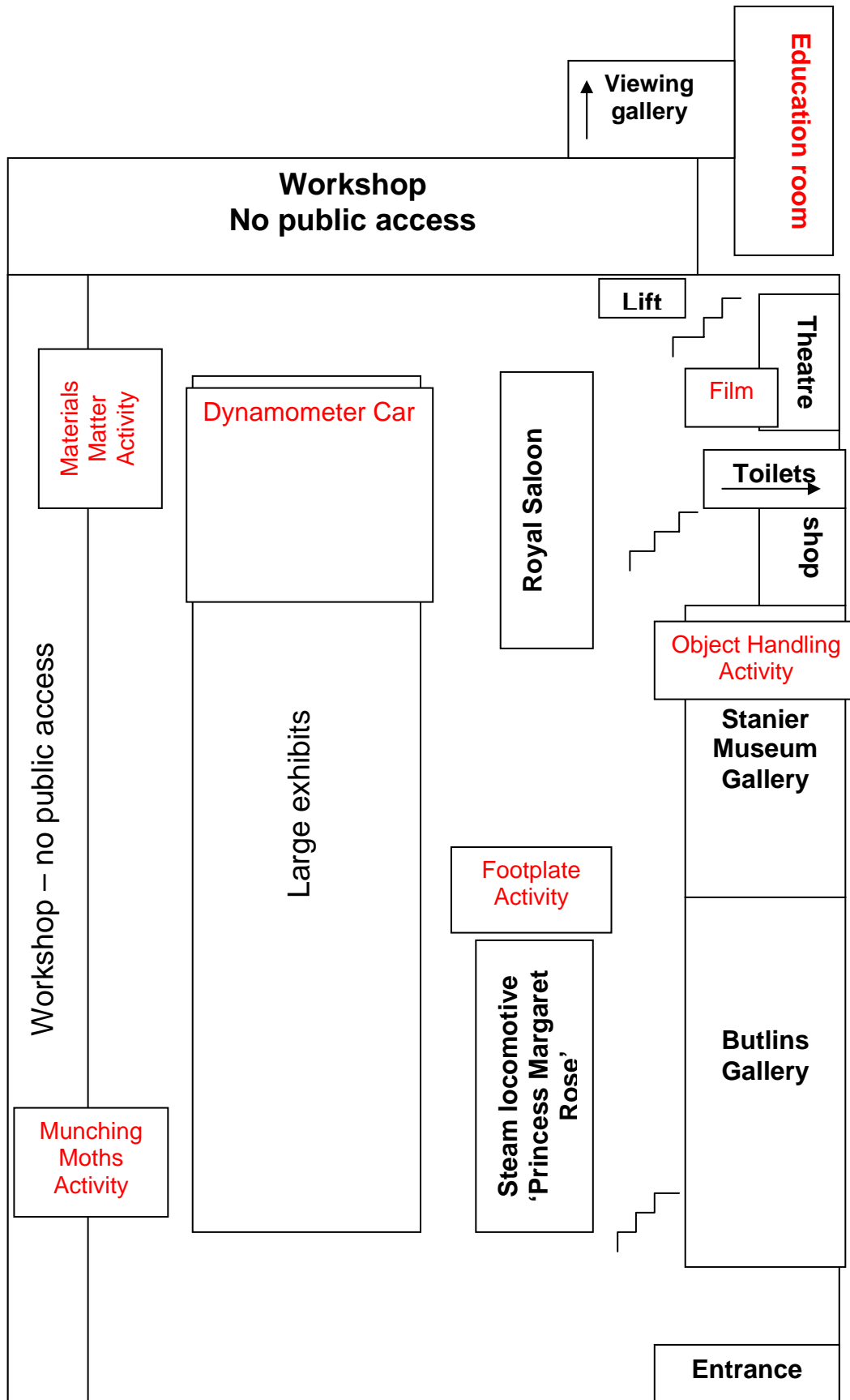
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INTERNAL FLOOR PLAN OF THE WEST SHED



Overview of National Curriculum Links

The links below are the core subjects and skills relevant to the museum-led activities during a visit to the West Shed Museum. It is of course possible to create further links through pre-visit and post-visit activities (see Appendix 3).

Subject	National Curriculum Programme of Study	QCA Scheme of Work (where relevant)
KS2 SCIENCE	<p><u>Sc1 SCIENTIFIC ENQUIRY</u></p> <p>2) Investigative Skills:</p> <p>d) make a fair test or comparison by changing one factor and observing or measuring the effect while keeping other factors the same. e) use simple equipment and materials appropriately. g) check observations and measurements by repeating them where appropriate. j) use observations, measurements or other data to draw conclusions.</p> <p><u>Sc2 LIFE PROCESSES AND LIVING THINGS:</u></p> <p><u>Sc3 MATERIALS AND THEIR PROPERTIES:</u></p> <p>1) Grouping and Classifying Materials:</p> <p>a) to compare everyday materials and objects on the basis of their material properties, including hardness, strength, flexibility and magnetic behaviour, and to relate these properties to everyday uses of the materials.</p> <p>2) Changing materials:</p> <p>b) to describe changes that occur when materials (for example, water) are heated or cooled.</p> <p><u>Sc4 PHYSICAL PROCESSES:</u></p> <p>2) Forces and Motion:</p> <p>c) about friction, including air resistance, as a force that slows moving objects and may prevent objects from starting to move.e) how to measure forces and identify the direction in which they act.</p>	<p>Unit 5B: Life Cycles</p> <p>Unit 1C: Sorting and Using Materials</p> <p>Unit 2D: Grouping and Changing Materials</p> <p>Unit 1E: Pushes and Pulls</p> <p>Unit 2E: Forces and Movement</p> <p>Unit 4E: Friction</p> <p>Unit 6E: Forces in Action</p>

<p>KS2 SCIENCE</p>	<p>BREADTH OF STUDY:</p> <p>1b) Looking at the part science has played in the development of many useful things.</p> <p>2a) Use appropriate scientific language and terms, including units of measurement [for example, metre, newton], to communicate ideas and explain the behaviour of living things, materials, phenomena and processes.</p>	
<p>KS2 MATHS</p>	<p><u>Ma2 NUMBER:</u></p> <p>2) Numbers and the number system:</p> <p>Decimals:</p> <p>i) understand and use decimal notation for tenths and hundredths in context (for example, convert a length such as 1.36 metres to centimetres and vice versa).</p> <p>j) round a number with one or two decimal places to the nearest integer or tenth; convert between centimetres and millimetres or metres, then between millimetres and metres, and metres and kilometres, explaining methods and reasoning.</p> <p>3) Calculations:</p> <p>k) Use a calculator for calculations involving several digits, including decimals; use a calculator to solve number problems.</p> <p><u>Ma3 SHAPE, SPACE AND MEASURES:</u></p> <p>4) Understanding measures:</p> <p>b) recognise that measurement is approximate; use suitable measuring instruments for a task; interpret numbers and read scales with increasing accuracy; record measurements using decimal notation.</p> <p><u>Ma4 HANDLING DATA:</u></p> <p>2) Processing, representing and interpreting data:</p> <p>c) represent and interpret discrete data using graphs and diagrams, including pictograms, bar charts and line graphs.</p> <p>d) know that mode is a measure of average and that range is a measure of spread.</p> <p>f) draw conclusions from statistics and graphs and recognise when information is presented in a misleading way.</p>	

KS2 Design and Technology	4) Materials and Components: a) how the working characteristics of materials affect the ways they are used.	Unit 2a: Vehicles
KS2 History	Chronological understanding: 1a) Place events, people and changes into correct periods of time. Knowledge and understanding of events, people and changes in the past: 2a) Characteristic features of the periods and societies studied. Historical enquiry: 4a) How to find out about the events, people and changes studied from an appropriate range of sources of information. [for example, documents, printed sources, CD-ROMS, databases, pictures and photographs, music, artefacts, historic buildings and visits to museums, galleries and sites]	
KS2 English	Speaking Listening Group discussion and interaction	
Other Skills	Object investigation and enquiry	

ESSENTIAL VISIT INFORMATION

Teachers and support staff/ volunteers

All teachers and supporting adults are free of charge. A minimum ratio of 1 adult per 10 pupils is required, with a minimum of 4 adults (more will be required to support any children with special needs). Activities are led by either museum staff or teachers/ school helpers so adults will be required to actively participate in activities and should familiarise themselves with outlines of activities prior to the visit.

Group structure

The maximum number of pupils for a visit is 50. On arrival at the museum the class will need to split into two equal groups. One group will focus on the Dynamometer Car and the other group will look at a steam locomotive (static exhibit), then the two groups will swap over. Within these two sessions each group will need splitting down again into three equal groups to carousel around three smaller activities. After lunch, the whole group will reconvene to carry out a 'Fun Forces' experiment in the Education Room. Pupils will need splitting into 10 groups of 4s and 5s for this. Please pre-organise these groups before the visit to save time on arrival.

Health and Safety

The PRCLT has produced a hazard guidance sheet to aide teachers in producing the risk assessment for their visit (see Appendix 4). However, this information is intended as a preparatory tool only and does not replace a teacher's own risk assessment or any statutory risk assessments you are required to complete by your school or LEA.

As a 'working museum' vehicles do need to be moved in and out of the West Shed on occasion. Every effort will be made to prevent the necessity of vehicles being moved around during your visit, but where this cannot be avoided our staff will instruct your group in the actions required to ensure their safety. However, teachers/ school staff are ultimately responsible for the safety of their pupils during the visit.

Exhibits

To avoid disappointment, please make pupils aware prior to their visit that the locomotives they will see in the West Shed will not be moving or in steam.

Pre-visit

You are strongly recommended to make a pre-visit to the museum. This provides the chance to talk to staff about any specific requirements you may have, in addition to seeing the site and its facilities. If you have not visited the West Shed before, a pre-visit is essential to familiarise yourself with the site. A pre-visit is **free of charge** for teaching staff and helpers but please book first by contacting the Museum Curator so that you can make the most of your visit.

Costs

Entry to the West Shed museum itself is free but if you wish to participate in the museum-led activities described in this booklet, which includes access to vehicles normally 'closed' to the public, we charge a small fee. The cost is **£2 per pupil** (adults are free). Worksheets for the sessions will be provided. Provision of the activity booklet for pupils is included in the charge and a sample copy of it can be sent to the group leader when a firm booking is made. Clipboards and pens will also be provided for use during the visit. On-site parking is free.

Booking

All group visits must be booked and confirmed through the Museum Curator (contact details are inside the cover). Once you have decided upon a visit it is advisable to telephone the museum to check date availability. A booking form will then be sent to you, via post or email, which must be completed, signed and returned to confirm the booking.

Terms of Booking

A deposit of £20 is payable at the time of booking (by cash, credit/ debit card or cheque payable to 'PRCLT Co. Ltd.'). This deposit is non-refundable if your school cancels less than two weeks before the date of visit. Otherwise, the outstanding balance is payable on the day of the visit, or we can issue you with an invoice. The total fee charged will be for the number of pupils actually attending on the day.

Lunch

There are no refreshment facilities available at the museum so pupils will need to bring a packed lunch with them. Lunch can be eaten indoors within the Education Room.

Clothing

Please ask parents/ guardians to ensure that children are dressed appropriately for their visit. Sturdy footwear is necessary for both the walk from the car park and within the West Shed itself. Coats and warm clothing are required during colder weather as due to the nature of the museum building, parts of the West Shed where activities take place remain chilly in cold weather. Pupils will also be required to walk outdoors from the coach to the museum (approximately 5 minutes walk), so should come prepared in case of inclement weather.

Access

The West Shed is accessible to wheelchair users with a lift allowing access to all floors. However, some of the activities involve going on or in vehicles, which unfortunately will not be physically possible for wheelchair users.

Child protection

Museum staff and volunteers working directly with educational groups have undergone Enhanced CRB Disclosures. However, there may be additional volunteers and visitors on site during your visit, so it is important for group leaders to directly supervise pupils at all times.

Photography

The PRCLT may wish to take photographs of pupils during their visit, which may be used for promotional material for the museum. Prior to your visit, a 'Photographic Consent Form' will be sent for completion, which should be brought to the museum on the day so we know whether we are permitted to take and use photographs.

Toilet facilities

The West Shed has its own toilet facilities. This consists of two female cubicles, two male cubicles and two accessible toilets.

Shop

There is a small shop in the West Shed with a limited range of souvenirs. Due to physical constraints, it is not possible for more than five pupils to look in the shop at once. 'Goody bags' of suitable souvenirs (e.g. pens, pencils, notebooks) for under £2 can be pre-ordered as an alternative – please discuss this prior to your visit.

When can we visit?

The West Shed Museum is open virtually every day of the year but due to staff constraints, Wednesdays are preferable for school visits. However, if you would prefer to visit on a different day, this can be discussed.

SAMPLE TIMETABLE FOR A VISIT

Time	Activity
9.45 a.m. – 10.00 a.m.	Arrive at Swanwick Junction site car park and walk up to the West Shed (led by museum staff)
10.00 a.m. – 10.15 a.m.	Introduction to the West Shed by museum staff – explain the structure for the day’s activities <i>Split into two groups - leave coats and bags in the Education Room.</i>
10.15 a.m. – 11.15 a.m.	First session: Group A - Activity 1; Group B - Activity 2
11.15 a.m. – 11.30 a.m.	Break – refreshments in Education Room; toilet.
11.30 a.m. – 12.30 p.m.	Second session: Group A - Activity 2; Group B - Activity 1
12.30 p.m. – 1.00 p.m.	Lunch break in the Education Room
1.00 p.m. – 1.45 p.m.	Third session – Fun Forces Experiment (whole group)
1.45 p.m.	End of activities – free time for pupils
2.00 p.m.	Depart West Shed and walk back to coach
2.10 p.m.	Depart from Swanwick Junction site

Background Information about the Princess Royal Class Locomotive Trust

The West Shed is home to the Princess Royal Class Locomotive Trust - a voluntary charity organisation (no. 1042090) formed in 1993 to look after and promote the historic locomotives in its care. The West Shed is an Accredited Museum (no.1783).

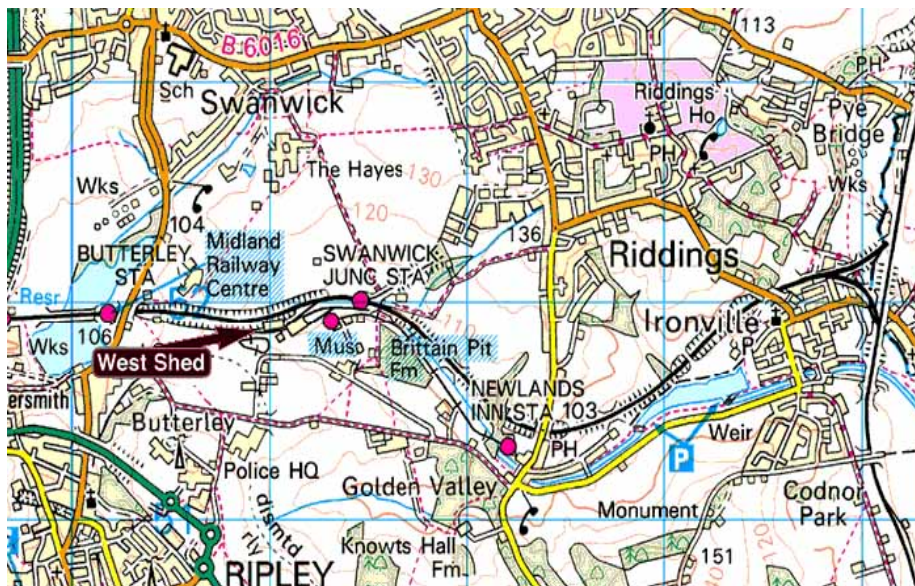
The West Shed museum

The museum is home to a small collection of historic steam locomotives and railway coaches on static display. There are also interpretive display boards, audio commentary domes and a mini-theatre where you can select a short film to watch. You can also meet a moving model of the locomotive designer Sir William Stanier at work in his office and watch current activities in the workshop from the viewing gallery above. The Stanier museum gallery displays part of our collection of locomotive headboards, number plates, models and paintings.

Location and directions

The West Shed is situated on the larger site of the Swanwick Junction museum site of the Midland Railway - Butterley, near Ripley, Derbyshire. The Midland Railway consists of a museum site and a short preserved railway line, used for train rides. The Princess Royal Class Locomotive Trust and its West Shed museum are independent of the Midland Railway and the activities described in this pack are designed to be self-contained within the West Shed. Participation in museum-led activities at the West Shed does not involve looking at any of the other attractions on the Swanwick Junction Site.

General visitors to the Midland Railway usually travel by train along the preserved heritage railway line from Butterley station and alight at the Swanwick Junction site. However, as the activities at the West Shed museum are designed to be independent from the rest of the site, your visit **will not include a train ride** and your group should travel by road directly to the Swanwick Junction site. This entrance to the site is not for general public access so directions will be given to you at the time of booking. Unless specifically requested otherwise, a visit to the West Shed will involve dismounting from transport in the car park at the entrance to the Swanwick Junction site and walking up to the West Shed (approximately 5 minutes walk).



ACTIVITY 1: THE DYNAMOMETER CAR

(60 minutes)

The Dynamometer Car in
the 1930s.



This session will be led by a member of museum staff and teaching/support staff.

OVERVIEW & LEARNING OBJECTIVES

The aim of this session is to show pupils the importance of the Dynamometer Car and how the vehicle works to measure forces. It also introduces pupils to how it was restored, the materials used in building and restoring it and how these materials have been affected by insect pests.

OUTLINE OF THE SESSION

Activity	Led by / Location	Duration	No. of children
Introduction	Museum staff – Dynamometer Car area	15mins	Max. 25
Pupils will then divide into 3 groups and carousel around the following 3 activities:			
Inside the Dynamometer Car	Museum staff – Inside the Dynamometer Car	15 mins	Max. 9
Munching Moths	Teacher/support staff – Dynamometer Car display area	15 mins	Max. 9
Materials Matter	Teacher/support staff – in front of the Dynamometer Car, near the front of the building	15 mins	Max. 9

ACTIVITY 1: THE DYNAMOMETER CAR

Activity	Instructions/ Details
Introduction (15 mins)	Museum staff will lead this session. They will give a general introduction to the dynamometer car, i.e. what it was used for and how it works to measure forces. When this has finished, please help museum staff in organising the children into three groups for the following three activities.
Pupils will then divide into 3 groups and carousel around the following 3 activities:	
Inside the Dynamometer Car (15 mins)	Museum staff will lead this session. The presenter will take the group inside the vehicle and go into more detail about how the dynamometer car worked by demonstrating the test table equipment and describing the different roles of the people who worked on the vehicle.
Munching Moths Activity (15 mins)	Teaching staff/ helpers - please take your group over to the area towards the front of the building where this activity has been laid out for you. Instruct pupils to complete the ‘Munching Moths’ part of their activity booklet (pencils and clipboards will be provided). This activity involves pupils looking at moths and how they contributed to the dynamometer car’s deterioration by eating the seating. Pupils will examine moth specimens and materials under microscopes.
Materials Matter Activity (15 mins)	Teaching staff/ helpers - please take your group over to the Dynamometer Car display area. Instruct pupils to complete the ‘Materials Matter’ part of their activity booklet (pencils, calculators and clipboards will be provided). This activity involves pupils looking at some of the materials used in and around the dynamometer car – glass, coal, horsehair, wood, metal, etc. They will also look at the roadwheel, which measured distance, and do some maths questions based on this.



The Inside of the
Dynamometer Car
today

SUPPORTING INFORMATION

What is the Dynamometer Car?

The dynamometer car is an on-track railway testing vehicle. It was used to carry instruments for measuring the performance of a locomotive. During a test run, the dynamometer car was attached behind the locomotive (with coaches forming a train behind the dyn. Car) and measured the pull exerted by the locomotive.

It is historically and scientifically important as the design marked a significant advance in railway history by enabling the accurate high speed testing of locomotive performance in the 1930s. It has the first example of a mechanical integrator (based on the principles of a mechanical calculator/ computer) fitted to such a vehicle and is an important example of British engineering technology.

Historical Context

- The dynamometer car was built by the Lancashire & Yorkshire Railway Company in 1912 at their carriage works at Newton Heath, Manchester.
- It was designed by George Hughes – Chief Mechanical Engineer at the Lancashire & Yorkshire Railway. He had visited Belgium with a party of fellow railway engineers in 1911 and been greatly impressed by a modern dynamometer car that he saw there.
- It differed from the previous dynamometer cars, built respectively by the Great Western Railway in 1903 and the North Eastern Railway in 1906, in that it was equipped to measure both pulling and buffing forces.
- Other earlier dynamometer cars included one designed by Charles Babbage, the inventor of the first mechanical computing machine in the 1820s. Babbage was a shareholder in the Great Western Railway. He converted a coach into a dynamometer car that could be placed between an engine and a train, and it would record on a continuously moving roll of paper the tractive force of the engine.

How does the dynamometer car work?

<p>The dynamometer car acts like a spring balance on wheels. It is attached between a locomotive and a train of coaches and measures the force exerted by the locomotive, i.e. its pulling power.</p>

HOW?

- There are a pair of springs below the floor of the test table in the dynamometer car, which are connected to the locomotive in front and the train of coaches behind it via a drawbar. The springs are deflected during the movement of the train and it is this deflection that is measured through a table of instruments inside the dynamometer car.
- A roadwheel inside the dynamometer car is lowered down onto the track below – it runs along the track and measures distance travelled. The roadwheel also drives the test table instruments.
- The mechanical integrator on the test table combines the deflection of the springs with the distance travelled – this measures the horsepower generated by the locomotive.

- The mechanical integrator disc on the test table records the horsepower produced by the locomotive via a pen trace on a roll of paper (test roll), which moved continually across the test table.

N.B. The term HORSEPOWER was introduced by the Scottish Engineer and inventor, James Watt (1736-1819). 1 horsepower = The amount of work a horse could do over a given distance and time. Related to steam engines, it helped people understand how much work an engine could do.

- There would have been a ‘test team’ of up to 10 people working inside the dynamometer car during a test run. Each person had a specific job role. They annotated the test roll as it came out to enable calculation of the results after the test run so they could write a report.
- Other information recorded on the test roll included time (two second intervals marked on as a result of the timing clock connected), distance (by recording the passing of mileposts), gradient posts, coal consumption and water consumption. The test team members pressed ‘events buttons’ relating to the relevant event, which were linked to six tracing pens to record these things on the test roll paper.

WHY WAS THE DYNAMOMETER CAR IMPORTANT?

Why did the railway companies want to test locomotives in this way?

- Locomotives needed to be tested in order to improve their designs. For locomotives hauling passenger trains in the 1930s, railway companies wanted to make them faster and more powerful. Not only was this to make them more efficient, but there was also rivalry between the different railway companies to have the most powerful locomotives.

Railway Companies

- Before the nationalisation of the railways in 1948, the railways in different areas were owned and operated by different companies who were in competition with each other. Each company had its own crest and livery (the colours that its stock was painted in). In 1923 almost all of the existing companies were merged to form the ‘Big Four’ - these were the London, Midland and Scottish Railway, Great Western Railway, London and North Eastern Railway and the Southern Railway. Only smaller and less important railway companies continued to run separately.
- In 1948 the ‘Locomotive Exchange Trials’ were organised by the newly nationalised British Railways (BR). Locomotives from the former "Big Four" constituent companies were transferred to work on other regions to identify the best qualities of the four different schools of thought of locomotive design so that they could be used in the new BR standard designs. The dynamometer car was used in the 1948 Locomotive Exchange Trials to evaluate various locomotive types previously used by the four main railway companies, to help produce new designs.

ACTIVITY 2: THE STEAM LOCOMOTIVE

(60 minutes)



This session will be led by museum staff and teaching/support staff.

OVERVIEW & LEARNING OBJECTIVES

The aim of this activity is to use the engine ‘Princess Margaret Rose’ (on static display) to explain how a steam locomotive works and the forces that act on it when it is in motion. Museum staff will also give pupils an idea of what it was like to work on the railways as an engine driver or fireman by taking them onto the footplate (driver’s cab). Other activities include object handling and watching a short film.

OUTLINE OF THE SESSION

Activity	Led by / Location	Duration	No. of children
Introduction	Museum staff– Locomotive area	15mins	Max. 25
Pupils will then divide into 3 groups and carousel around the following 3 activities			
A tour on the footplate of the locomotive	Museum staff– Locomotive area	15 mins	Max. 9
Film	Teacher/school helper – Film theatre	15 mins	Max. 9
Object Handling	Teacher/school helper – Stanier Gallery	15 mins	Max. 9

ACTIVITY 2: THE STEAM LOCOMOTIVE

ACTIVITY	INSTRUCTIONS/ DETAILS
Introduction (15 mins)	Museum staff will lead this session. The presenter will give a general introduction to how a steam locomotive works and the forces that occur when the train is in motion. When this has finished, please help museum staff in organising the children into three equal groups.
Pupils will then divide into 3 groups and carousel around the following 3 activities:	
A tour on the footplate of the locomotive (15 mins)	Museum staff will lead this session. On the footplate the presenter will show pupils the various controls of the locomotive that are used by the driver and fireman.
Film - An engine driver's view (15 mins)	Teaching staff/ school helpers - please take the group to the film theatre. Sit the children down and press the button labelled ' <i>The Duchess of Sutherland cab ride featuring driver Bill Andrew</i> '. Watch the film, which lasts 10 minutes. There are other films to watch if you have time left at the end.
Object handling activity (15 mins)	<p>Teaching staff/ school helpers - take the group into the Stanier Room where there will be some mystery railway objects on the table. Please lead the activity by using the resource cards provided to have a discussion with the children about these objects. Each object has a card with questions and answers on the reverse to prompt discussion.</p> <p><u>Suggestions for leading the session:</u> Get pupils to either sit on the floor or gather around the table. Choose an object and use the questions on the reverse of the accompanying card to discuss it, i.e. to get pupils to think about what it was used for, etc. Pass each object around as it is being discussed.</p> <p>Pupils can have a look at/ sit on the miniature engine in this room too.</p>

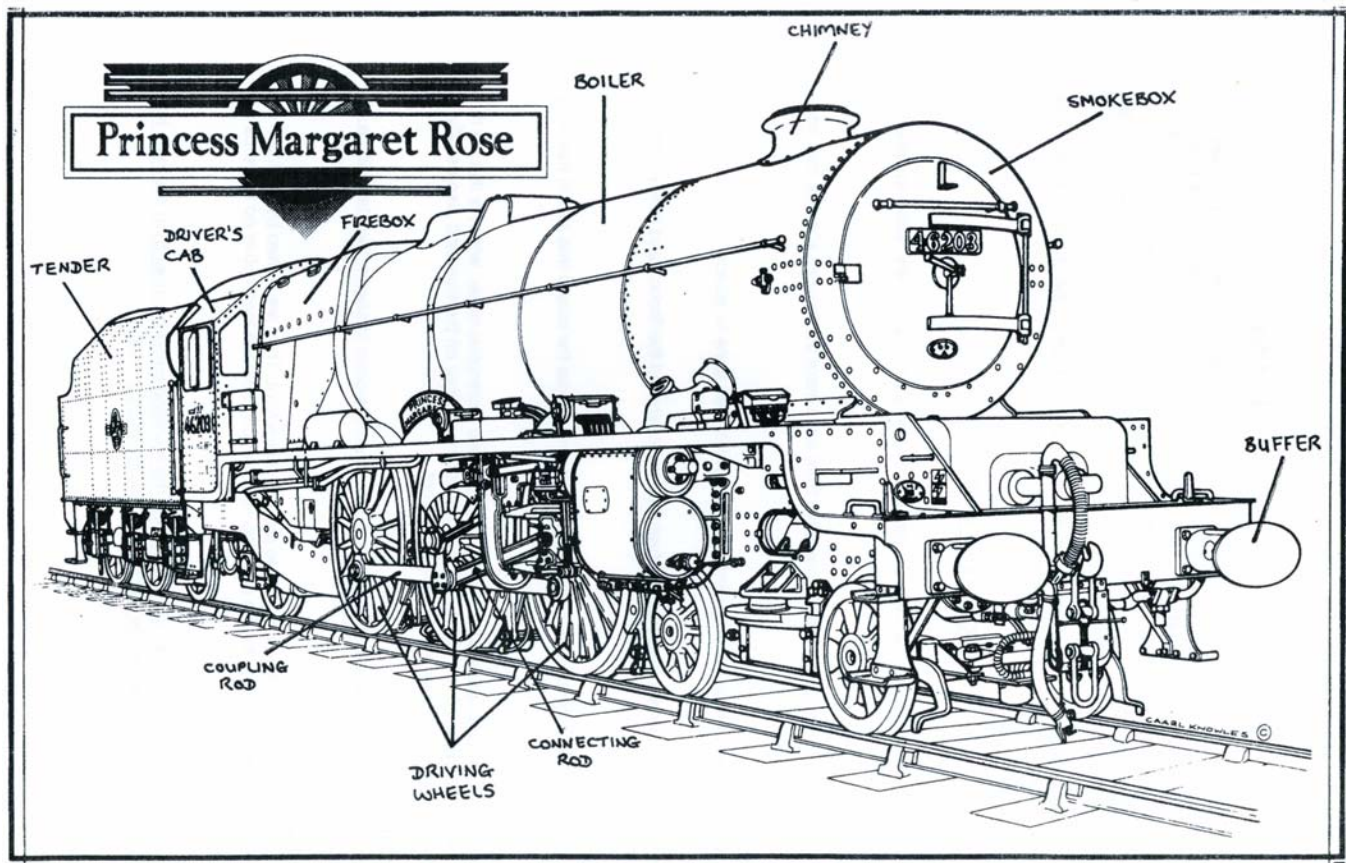
SUPPORTING INFORMATION

Who operates a steam locomotive?

- **Driver** - The driver operates the various controls in the driver's cab (the footplate) including the regulator valve, which controls the flow of steam from the locomotive boiler to the cylinders and is used to increase and decrease speed.
- **Fireman** - 'Fires' the locomotive by shovelling coal from the tender (attached behind the locomotive) into the firebox.

How does a steam locomotive work?

The fireman shovels coal from the tender into the boiler's firebox. The fire heats the water in the space around the firebox and in the boiler. The heated water passes through the boiler tubes and then through superheater elements and turns to steam, which builds up pressure to make the engine move. The steam enters the cylinders through piston valves and pushes the piston in each of the four cylinders backwards and forwards. This pushes the four connecting rods and turns the driving wheels, making the locomotive move. The steam then passes through blast pipes and is exhausted through the chimney, making the noise that steam locomotives are recognized by!



GLOSSARY OF WORDS

TENDER

This is the vehicle attached to a steam locomotive that contains the coal and water supplies for powering it.

DRIVER'S CAB

This is where the driver controls the locomotive from and where the fireman shovels coal into the firebox.

FIREBOX

Coal burns in here to heat the water in the boiler, which then turns to steam.

BOILER

The part of a locomotive that produces steam, as water around the firebox and boiler tubes is heated.

CHIMNEY

The exhaust of the locomotive where steam leaves and makes the sound that steam trains are recognized by.

SMOKEBOX

A drum shaped section mounted at the front of a steam locomotive boiler, which is literally the box that smoke comes from. The smokebox has a hinged door on the front and also usually has the locomotive number plate fixed on the front.

BUFFER

The parts on the front and rear of a locomotive that are designed to absorb the shock if it runs into another vehicle.

DRIVING WHEELS

The wheels on the locomotive that turn to provide movement. They are turned by the four **connecting rods** and linked by the coupling rods, which make the locomotive go forwards and backwards.

Key facts about locomotive 46203 'Princess Margaret Rose'

- Designed by William Stanier for the London, Midland & Scottish Railway and built in 1935 at Crewe Works.
- It pulled express passenger service trains for the London Midland & Scottish Railway such as the 'Mid-day Scot' and 'Night Scot' from London to Glasgow, before becoming part of the British Railways fleet in 1948.
- After being withdrawn from service in 1962, Princess Margaret Rose was displayed at a Butlins holiday camp before eventually being restored by the Princess Royal Class Locomotive Trust and steamed again in 1990 for use on the mainline.
- During twenty seven years of service this locomotive covered one and a half million miles.
- On May 3rd 1936 this locomotive attained the speed record for the Princess Royal Class of 102.5 mph.
- Water tender capacity = 4,750 gallons (approximately 21,375 litres).

Naming of locomotives and classes

'Princess Margaret Rose' is a locomotive of the 'Princess Royal Class' type designed by William Stanier and was named after Queen Elizabeth II's sister. Each locomotive of this class was named after a princess or other female member of the royal family, as these locomotives were originally used to pull the express passenger train known as the 'Royal Scot' between London and Glasgow. Mary, Princess Royal (1897 –1965), was the Commander-in-Chief of the Royal Scots – the Royal Regiment after which the passenger train was named. **'Princess Royal'** is a style customarily (but not automatically) awarded

by a British monarch to his or her eldest daughter. The style is held for life, so a princess cannot be given the style during the lifetime of another Princess Royal (in particular, Queen Elizabeth II never held the title). There have been seven Princesses Royal in total.

The other main locomotive in the museum is 'Duchess of Sutherland'. This is a 'Princess Coronation Class' type locomotive and was built at Crewe locomotive works in 1938. This type of locomotive was the most powerful express passenger steam locomotive to operate in the UK. A total of 38 members of the class were built – they were named after royalty, ladies of the British aristocracy and cities in the United Kingdom. The next to the last locomotive built was named after Sir William Stanier (the designer).

OBJECT HANDLING ACTIVITY

Teachers/ support staff will be expected to lead this activity by using the resource cards provided to have a discussion with pupils about the objects. The information below is to give a brief introduction to the objects before your visit. The activity will be set out for you and each object has a resource card with questions and answers on the reverse to prompt discussion.



Paperweight (Midland Railway Company)

This would have been used in an office to hold down paperwork – for example, in the railway drawing office in Derby where designs for steam locomotives and carriages were produced.



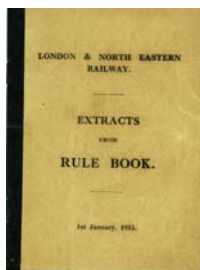
Stationmaster's Cap

This item would have been worn by the person in charge of a particular railway station, known as a 'Stationmaster'. This was a responsible and respectable job and duties included inspecting the office and buildings and overseeing the appearance and conduct of station staff. In the early days of the railways, the stationmaster was provided with a house to live in, on or near the station. During the 20th-century the importance of the stationmaster's role was gradually reduced and authority came under regional offices.



Mashing Can and Plate

These two items were used by the driver and fireman on the footplate of a steam engine. The mashing can carried a drink and the plate was used for eating from – they sometimes even fried an egg on the shovel in the fire!



London & North Eastern Railway Employees Rule Book, 1933 (replica)

This item was given to all railway workers to make sure that they behaved properly and worked safely.



Engine driver's cap

'Grease top' material so that any stray sparks coming out of the fire would not cause the material to catch on fire! It was also waterproof for protection from the weather.



'Pay check'

A wage token, used in locomotive works. On a Friday morning, workers would 'clock in' and be given a pay check with an identity number on it. At the end of the day, they would hand their token in to the pay office and be given their weekly pay packet in cash.



Guard's handlamp (paraffin)

This item was carried by the railway guard and used for giving hand signals in poor light. It can show three colours – red, green and white. There are two coloured lens' – red and blue. As with traffic lights, red means 'stop' and blue (which would shine green when the flame was lit behind it) meant 'go'. For example, the Guard could tell the driver when it was safe for the train to leave the station. The white light could be used for general inspection purposes.



Engine whistle

This engine whistle was located on the footplate and was 'sounded' by injecting steam into it. It was primarily a safety device, e.g. it was used to alert people of an approaching train, etc.

ACTIVITY 3

THE FUN FORCES EXPERIMENT

(45 minutes)



This session will be led by a member of museum staff but all accompanying adults will be required to provide support to groups.

OVERVIEW & LEARNING OBJECTIVES

This activity will take place in the Education Room after lunch. It is designed to sum up what pupils have learned about the Dynamometer Car and how it measures forces. In groups of 4 or 5, pupils will use miniature wooden trains and force meters to investigate how mass and gradient affects force, which replicates how the dynamometer car measured the power of locomotives. Pupils will be asked to record their results, plot results onto graphs and make simple scientific conclusions.

APPENDICES

APPENDIX 1

Background Factual Information

The following information is intended to enhance the pupil's visit and could be used to support prior learning and pre/ post-visit activities.

TIMELINE OF SIGNIFICANT EVENTS IN RAILWAY HISTORY

Early beginnings of steam powered engines:

- **Thomas Newcomen** (1663 - 1729) was an ironmonger by profession, but made a significant contribution to the Industrial Revolution with his invention of the atmospheric steam engine. His first working engine was installed at a coalmine at Dudley Castle in Staffordshire in 1712. The engines were rugged and reliable and worked day and night, but were extremely inefficient. Newcomen engines were extremely expensive but were nevertheless very successful. By the time Newcomen died on 5 August 1729 there were at least one hundred of his engines in Britain and across Europe.
- **James Watt** (1736 - 1819) was a Scottish inventor and mechanical engineer, renowned for his improvements in steam engine technology. In around 1764 Watt was given a model Newcomen engine to repair. He realised that it was hopelessly inefficient and began to work to improve the design. He designed a separate condensing chamber for the steam engine that prevented enormous losses of steam. His first patent in 1769 covered this device and other improvements on Newcomen's engine.

1803

The world's first public goods railway was authorised by Act of Parliament – Surrey Iron Railway. The wagons were still pulled by horses.

1804

British engineer Richard Trevithick builds the first steam locomotive (i.e. a steam engine that moved) – it was used to pull wagons at an iron works in South Wales.

1807

The Oystermouth Railway in South Wales became the world's first railway carrying paying passengers. The wagons were pulled by horses.

1808

Richard Trevithick demonstrated his improved steam locomotive 'Catch-Me-Who-Can' in London, where people paid to ride behind it within an enclosed round track.

1812

The world's first commercial use of steam locomotives on the Middleton Railway by the 'Salamanca' locomotive designed by Matthew Murray. The wagons carried coal from the Middleton pits to Leeds.

1824

George and Robert Stephenson (father and son) set up a company in Newcastle to build locomotives

1825

Official opening of the Stockton and Darlington Railway – world's first permanent steam locomotive public railway. The first locomotive to run on the S&DR was Locomotion No 1, designed by George Stephenson, the line's engineer.

1829

The owners of the proposed Liverpool and Manchester Railway needed to decide what sort of locomotives would be best for the railway. They held the Rainhill Trials as a competition to decide, which included giving a cash prize to the winner. The winner was a locomotive called the 'Rocket', which was designed and built by George Stephenson and his son Robert.

1830

Opening of the Liverpool and Manchester Railway – this was the world's first inter-city passenger railway in which all the trains were timetabled and were hauled for most of the distance solely by steam locomotives (the Stockton and Darlington Railway opened in 1825, but sections of this line employed cable haulage, and only the coal trains were hauled by locomotives. Horse-drawn traffic could use the railway upon payment of a toll). The L&MR was primarily built to provide faster transport of raw materials and finished goods between the port of Liverpool and mills in Manchester and surrounding towns in north-west England.

1837

Opening of the Grand Junction Railway – the world's first long-distance railway. It ran between Birmingham and the Liverpool-Manchester Railway.

1842

Queen Victoria made her first train journey

1863

The world's first underground railway opened in London.

1869

A special Royal Train was built for Queen Victoria by the London & North Western Railway.

1872

The Midland Railway Company announced that from then on, all its trains would carry 3rd class passengers. This was a radical change from the original class system whereby railway accommodation was split into 1st, 2nd and 3rd class and some trains only carried 1st and 2nd class passengers.

1874

Improved passenger standards for lower classes - The Midland Railway announced that on and after 1st January, 1875 second class train accommodation would be abolished. This was accompanied by a lowering of the first class rate to one and a half pence per mile (what had been the second class rate) and the upholstering of all seats in third class.

James Allport, the Midland Railway's General Manager, went on a tour of the United States of America in 1872. While there, he was so impressed by George Pullman's sleeping and parlour cars that he had the Midland Railway introduce them to Britain in 1874.

1879

The first electric locomotive is demonstrated in Berlin, Germany.

1883

The luxury train the 'Orient Express' makes its first journey between Paris and Istanbul.

1892

the first diesel engine invented in Germany by Dr. Rudolf Diesel.

1923

Formation of the 'Big Four' railway companies in Britain following the enforced grouping of over 300 separate railway companies.

The 'Big Four' were:

- London, Midland and Scottish Railway
- Great Western Railway
- London and North Eastern Railway
- Southern Railway

1928

The 'Flying Scotsman' locomotive headed the first non-stop express train from London to Edinburgh.

1931

Diesel powered locomotives were used in Britain for the first time, for shunting purposes.

1938

The locomotive 'Mallard', designed by Nigel Gresley, achieved the fastest steam record in the world (126 m.p.h.)

1947

Introduction of mainline diesel-electric locomotives for hauling passenger trains. The first locomotive of this type (LMS No. 10000) was built at Derby Locomotive Works.

Nationalisation of the railways by 'The Transport Act' - the railways, long-distance road haulage and various other types of transport were acquired by the state and handed over to a British Transport Commission for operation. This Act took effect in 1948 and saw the creation of British Railways.

1960

The last steam engine 'Evening Star' was built by British Rail.

1968

The last British Railways steam locomotive hauled passenger train ran in Britain and was then withdrawn from service. However, use of privately owned steam locomotives continued – the first being 'Flying Scotsman', bought by Alan Pegler. Steam locomotives continue to run on the mainline railway network for private charters.

Growth of the Railways in the Victorian Age - Social and economic effects

- The first steam locomotives for carrying passengers were built in the Victorian period. The development of the railway system during the 'railway mania' era (c.1830-1870) created a new way of life, as it was now possible to travel from one end of the country to the other in less than a day, instead of days or a week.
- People were able to travel greater distances for leisure and for work. Seaside resorts developed as the railways made cheap day trips possible, even for the working classes.
- By 1845, over 2000 miles of railway were open and 30 million passengers were being carried. By 1900, over 18,000 miles were in use.
- During the 1850s, thousands of construction workers were employed in building the many new railway lines that crossed the country. Known as 'navvies' (named after workmen who had built the canals, known as 'navigations'), they earned high wages.
- Railway engineering towns grew up e.g. Swindon and Crewe
- Industry grew as the railways needed coal and iron. Railways, in turn, allowed factories to transport their goods to market more quickly.
- Townspeople were able to receive fresh meat, fish, milk and vegetables brought in by the railway.
- Turnpike Trusts, canals and stage-coach companies could not compete with the speed of the railways.

Railways in the 1930s

- Early trains only carried modest loads and travelled at low speeds. The need to improve the efficiency and speed of locomotives was recognised as traffic on the railways increased. There was also a need to build locomotives for specific purposes, e.g. separate engines for hauling passenger trains or freight trains carrying cargo.
- In the 1920s the 'big four' railway companies continued building steam locomotives because coal was cheap and plentiful. There was a degree of rivalry between the companies as to who could build the biggest and most powerful locomotives.
- The locomotives built in the 1930s, such as Princess Royal Class 6203 'Princess Margaret Rose', were a result of improved technology and were faster and more powerful. This type of locomotive was used to haul express passenger trains.
- There were fewer cars than today and people travelled by train more.
- Trains were an important way of transporting goods as there were no motorways or fast roads.

Railway Companies

Before the nationalisation of the railways in 1948, the railways in different areas were owned and operated by different companies who were in competition with each other. Each company had its own crest and livery (the colours that its stock was painted in). In 1923 almost all of the existing companies were merged to form the 'Big Four' - these were the London, Midland and Scottish Railway, Great Western Railway, London and North Eastern Railway and the Southern Railway. Only smaller and less important railway companies continued to run separately.

The London Midland & Scottish Railway existed between 1923 and 1947 and **William Stanier** was its Chief Mechanical Engineer from 1932 -1944. He was responsible for designing express passenger locomotives such as the Princess Royal and Princess Coronation Class in addition to mixed traffic and freight locomotives. Many of the locomotives he designed were built at Crewe Works.

Derby Locomotive Works

The repair and manufacturing facilities for the three railway companies whose lines met at Derby were originally separate. When the Midland Railway company formed in 1844 with its headquarters in Derby, there was a need for order and standardisation. In 1873, the Midland Railway's directors decided that conditions on the original works site was too cramped and it needed a new carriage and wagon works on a separate site. Thus it separated into the Locomotive Works and the Carriage and Wagon Works.

In 1923, the Midland Railway became part of the new London, Midland & Scottish Railway (one of the 'Big Four'). In 1932, William Stanier was appointed as Chief Mechanical Engineer for the LMS. Many locomotives were now built at Crewe Works but the central drawing office remained in Derby. In 1933, under Lord Stamp (Chairman of the LMS), Derby became a national research centre with the establishment of the LMS Scientific Research Laboratory.

In 1932 Derby Works covered 128 acres and had a staff of 3,400, including 140 females employed as clerks, trimming seats, polishing panelling, etc.

Derby Works was used during the Second World War in the war effort. For example, special trains were built there for use by Allied Forces, also field guns and bomb casings.

In the early 1960s, following nationalisation of the railways, the British Railways Board created the Railway Technical Centre in Derby, to be its technical headquarters.

Where the locomotives at the West Shed museum fit in:

1840s Start of the Victorian 'Railway Mania' era with a huge growth in railways.

1920 Special Saloon 45000 (at the West Shed) was built and became part of the Royal Train fleet.

1923 London, Midland & Scottish Railway formed.

1935 Princess Royal Class locomotive 6203 'Princess Margaret Rose' was built to haul express passenger trains (on display at the West Shed).

1938 Princess Coronation Class locomotive 6233 'Duchess of Sutherland' was built to haul express passenger trains (on display at the West Shed).

1968 The last British Railways steam locomotive hauled passenger train ran in Britain and was then withdrawn from service.

APPENDIX 2

Sources of further information for general railway history and related themes

WEBSITES:

Historic images:

English Heritage - Heritage Explorer: a searchable database of images on various themes. Copyright free for teachers to use in the classroom.

www.heritageexplorer.org.uk/nmrlearningzone

Science and Society Picture Library - a vast searchable database of historic images and prints including railway related photographs and posters, e.g. holidays, use of trains during the Wars, dining facilities, passenger travel and lots more.

www.scienceandsociety.co.uk

Facts and research:

BBC History:

www.bbc.co.uk/history

Specifically World War Two and evacuation (relate to the important role of trains during WW2):

www.bbc.co.uk/history/ww2children

Online encyclopedia articles:

<http://www.spartacus.schoolnet.co.uk/RArainhill.htm> (Victorian railways and engineers)

National Archives – copies of original archival documents and background information:

www.learningcurve.gov.uk

Including – the impact of the railways in Victorian Britain:

<http://www.learningcurve.gov.uk/victorianbritain/happy/default.htm>

National Railway Museum education newsletters:

<http://www.nrm.org.uk/education>

Royal Train information

<http://www.royal.gov.uk/output/Page5024.asp>

Sir William A. Stanier's entry as a Fellow of the Royal Society:

<http://royalsociety.org/Dserve/dserve.exe?dsqIni=Dserve.ini&dsqApp=Archive&dsqCmd=Show.tcl&dsqSearch=RefNo=='EC/1944/17'&dsqDb=Catalog>

Victorian history: www.victorianweb.org

APPENDIX 3

POSSIBLE PRE-VISIT AND POST-VISIT ACTIVITIES & OTHER POTENTIAL NATIONAL CURRICULUM LINKS

Pre-visit Activities

Forces and Transport (Science)

Split pupils into groups and give each group a selection of images of transport e.g. train, car, hovercraft, aeroplane, boat, bicycle, skateboard, rollerblades, scooter. Using each image, get them to discuss where they think a force is occurring and what the force is. Give them some small post it notes and get them to label the forces on the image. They could then be given a second set of images with the forces correctly labelled on them so that they can check their answers.

Post Visit Activities

Labelling Forces (Science)

- Reproduce the drawing of the ‘Princess Margaret Rose’ engine enclosed in the Steam Locomotive session supporting information and ask pupils to colour code the forces that would be acting on this engine as it moves along.

Create your own Dynamometer Car (Science/ D&T)

- Split pupils into groups and challenge them to create a dynamometer car out of card, cotton reels, and a force meter and try to make it move along of its own accord using balloons or propellers.
- Get pupils to make their own force meters – kits with instructions are available from educational suppliers such as ‘TTS’ - see www.tts-group.co.uk

Forces Bingo (Science)

- Play a game of bingo with the whole class where pupils have to match different forces with their respective definitions.

Pupil Activity Booklet

Some of the museum activities that involve pupils completing worksheets in their booklets have sections at the end that can be finished off back at school following the visit if they do not have time to complete the tasks at the museum.

E.g.

- ‘Materials Matter’ activity – calculations based on the road wheel dimensions and pupils could reinforce the concept using a trundle wheel at school.
- ‘Munching Moths’ activity – draw a life cycle of a moth.
- ‘Fun Forces Experiment’ – finish plotting the results from the experiment onto a graph.

KS 2 HISTORY

Breadth of Study: 11a) Victorian Britain

“A study of 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.”

- Pupils could research the lives of railway pioneers such as George and Robert Stephenson and Isambard Kingdom Brunel.

7) Local history study

“A study investigating how an aspect in the local area has changed over a long period of time, or how the locality was affected by a significant national or local event or development or by the work of a significant individual.”

QCA Unit 12: How did life change in our locality in Victorian times?

E.g. Section 3: How did the arrival and expansion of the railways affect our area?

- Pupils could look at maps of areas local to them, plus Derby (as a town with rich railway history). Look at maps in different periods to see how the railways affected these areas and how they changed over time.
- Look at census records to see if the growth of the railways caused changes in population – e.g. more people moving to towns to work, being recorded on the census outside of where they were born.

KS2 Citizenship

National Curriculum guidelines 4b) To think about the lives of people living in other places and times.

Explore more with pupils about what it was like to work on the railways in Victorian or later years, e.g. as a driver or fireman on a steam engine, a train guard, ticket inspector, works engineer, navvie, etc. What were the working conditions like? What rights did workers have? What rules and regulations were in place on the railways? This could lead to a piece of creative writing or drama.

Further potential link to QCA Unit 8: How do rules and laws affect me?

APPENDIX 4 - RISK ASSESSMENT GUIDANCE FOR TEACHERS

GENERAL SITE HAZARDS

AREA OR ACTIVITY	HAZARDS & RISKS	EXISTING CONTROL MEASURES	ACTIONS REQUIRED BY SCHOOL STAFF
Car and coach park	Accidents with vehicles: The car park and approach road are not part of the public highway but could have other low speed traffic present, including other visitors, staff and operational vehicles.	Museum staff will meet the school group in the car park to lead them up to the West Shed.	Teachers should supervise pupils dismounting vehicles and organise them into groups for walking through the site.
Walking Routes	Slips, trips and falls: The main pathway surfaces are either rolled tarmac or paving slabs, whilst other areas contain grass or stones.	Museum staff will meet the school group in the car park to lead them up to the West Shed. Pupils will be advised to take care in case of uneven surfaces or loose stones.	The school should advise pupils to wear sensible footwear to minimise the risk of tripping or slipping.
Vehicle Movement	The signposted route up to the West Shed takes visitors in front of the Matthew Kirtley museum hall and involves crossing railway tracks where low speed operational vehicle movement may occur.	Museum staff will be leading the group through this area and will remind pupils to use the green cross code of “stop, look and listen”.	Schools should remind pupils before the visit of the green cross code of “stop, look and listen” for areas where vehicles are present.
Station Platforms	There is a metre drop down from the platform to the railway lines. Low speed trains may operate on the lines adjacent to the platform.	Pupils visiting the West Shed will not be walking near platforms on their route to/ from the West Shed Museum, but schools should be aware of this area in case groups wish to	When near platforms school staff should supervise pupils to ensure that they keep away from the platform edge at all times and instruct them not to run ¹ or play on the platform,

		explore the site outside of their visit to the West Shed Museum.	especially when a train is leaving or approaching the station.
Workshops/ machinery	As the site is a working museum, there are a number of restoration projects and maintenance work going on at any time. This type of work will mostly be carried out in workshops, which have no public access. However, some work may be undertaken in public areas.	Museum staff will be accompanying pupils through the site and can point out any hazards to be aware of.	Adequate numbers of school staff to supervise pupils to ensure they do not get too close to any moving machinery or work.

HAZARDS SPECIFIC TO THE WEST SHED MUSEUM

AREA OR ACTIVITY	HAZARDS & RISKS	EXISTING CONTROL MEASURES	ACTIONS REQUIRED BY SCHOOL STAFF
Railway Tracks (outside)	As engines and coaches need to be able to move from the West Shed to the operating railway line, there are railway tracks running from inside the shed onto the external concourse and beyond. Care should be taken around these lines as they present an uneven surface and tripping hazard. It is	Museum staff will lead pupils across the track and tell them how to cross safely – e.g. do not step on sleepers or tracks as they may be slippery.	School staff should assist pupils in crossing tracks to ensure they do so safely – e.g. do not step on sleepers or tracks as they may be slippery.

	necessary to cross the track when leaving the main footpath adjacent to the West Shed.		
Moving vehicles	At times it is unavoidable that engines and stock are moved in and out of the West Shed whilst members of public are present. Staff are qualified to carry out these manoeuvres and any safety instructions given should be obeyed.	If vehicles are to be moved during your visit, museum staff will advise pupils and school staff. E.g. do not cross in front of a moving vehicle; stand well back and wait for the 'all clear' from staff.	School staff should follow any instructions from museum staff and supervise/ instruct pupils e.g. do not cross in front of a moving vehicle; stand well back and wait for the 'all clear' from staff.
Viewing Platforms	Many of the vehicles on display have viewing platforms alongside them. Care should be taken when ascending or descending the platform steps and whilst walking along it to avoid trips and falls.	Step edges are painted yellow for visibility.	School staff to supervise pupils.
Passenger Lift	Care should be taken when closing the doors in case of trapping fingers.	Instructions on how to operate the lift are displayed clearly.	The lift should only be used if necessary, i.e. for pupils with limited mobility to travel between floors. Adults should take responsibility for operating the lift and not let children travel in it unaccompanied.
Presence of Tools & Equipment	Risk of tripping, injury - e.g. trapped fingers if touched, tripping over items left on the floor.	Tools and equipment are generally stored in the workshop, which is not publicly accessible. Museum staff will not take pupils into the workshop. In the unlikely event that any equipment is present in the museum, it should	Schools should supervise pupils around any such equipment and make sure they do not touch it.

		not be touched.	
Floor Surfaces	The floor surface inside the museum is uneven where tracks are present and can present a tripping hazard. Due to the nature of the museum and the vehicles present, there may be spillages on the floor of materials such as oil.	Spillages are cleared up as soon as possible and slippery areas cordoned off, but visitors should pay attention to the surface they are walking on.	School staff to supervise pupils and to reinforce the message of paying attention to the surface they are walking on. No running is allowed inside the museum.
Exhibits	The engines and coaches on display have protruding buffers on the ends, which are a part of their structure – risk of injury if banged into, especially as children’s heads may be at a similar height. The moving parts of steam locomotives are greasy to the touch.	Museum staff will instruct pupils not to run within the museum. Buffers should not be touched as they may have grease on them. Pupils should not touch working parts unless invited to do so by museum staff.	Teachers to brief pupils on possible hazards prior to visit; adequate supervision on-site. Pupils should not walk in the gaps between two vehicles (i.e. when attached behind each other).
Inspection Pits	There are several inspection pits within the museum that constitute a significant ‘hole’ in the ground.	When not in use these are covered up with boards or surrounded by safety barriers, but their presence should be noted.	Teachers to brief pupils on possible hazards prior to visit; adequate supervision on-site.
Toilets	Hot water – scalding risk: The water in the hot water taps gets hot quickly.	‘Caution’ signs in toilets.	Teacher in charge responsible for ensuring that pupils are escorted to the toilet and supervised as necessary.
Emergency/ fire alarm	Fire alarm going off/ need for evacuation.	Fire exits are clearly marked.	In an emergency, follow instructions from museum staff.

Throughout site visit	'Stranger Danger' and potential abuse of children by adults.	All West Shed Museum staff and volunteers who will have unsupervised access to pupils have undergone CRB checks.	As members of the general public may also be present on-site, school staff should ensure that no groups of pupils are left alone.
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HAZARDS FOR SPECIFIC ACTIVITIES

ACTIVITY	HAZARDS & RISKS	EXISTING CONTROL MEASURES	ACTIONS REQUIRED BY SCHOOL STAFF
<p>Looking at the steam locomotive:</p> <p>1. Going on the footplate</p> <p>2. Object handling</p>	<p>Trip/ fall hazard going up the steps/ walkway.</p> <p>Risk of injury from objects that may be heavy or have sharp edges.</p>	<p>Step edges painted yellow for visibility; museum staff supervision.</p> <p>Use of objects with sharp edges will be minimised. Guidelines for handling objects will be provided for the activity leader.</p>	<p>Adequate school staff supervision.</p> <p>The member of staff leading the object handling will handle the object first then pass it around – they should warn pupils of any heavy/ sharp objects.</p>
<p>Looking at the Dynamometer car:</p> <p>1. Going inside the vehicle.</p> <p>2. 'Munching Moths'</p>	<p>Trip/ fall hazard going up the steps/ walkway.</p> <p>Trapping fingers in machinery (test table).</p> <p>Use of lamps to look through microscopes – bulbs get hot.</p>	<p>Step edges painted yellow for visibility.</p> <p>The museum presenter will demonstrate the machinery and advise pupils not to touch it.</p> <p>Pupils advised not to touch bulbs.</p>	<p>The accompanying school staff on that activity should advise</p>

3. 'Materials Matter'	Handling materials – hands may get dirty/ germs.	Provision of wet wipes for cleaning hands.	pupils not to touch bulbs.
Forces Experiment:	<p>Use of painted metal weights – injury risk if dropped on fingers, toes.</p> <p>Use of various equipment – wooden ramp, car, force meter.</p>	<p>Staff leading the activity will advise pupils on how to conduct the experiment.</p> <p>Paint used on weights is non-toxic.</p> <p>Equipment purchased from reputable suppliers.</p>	Adequate school staff supervision.

The information provided is intended as a preparatory tool only and does not replace a teacher's own risk assessment, as required by schools. Whilst measures have been put in place to minimise risks during your visit, pupils remain the ultimate responsibility of the accompanying school staff, who should be adequate in number, and pupils should be supervised at all times.