THE WORKSHOPS RAIL MUSEUM
IPSWICH

EDUCATION

SIMPLE MACHINES

TEACHER GUIDE

Year 7 Science, Technologies and English Program

This program has been produced and published by The Workshops Rail Museum, North Street, North Ipswich, Qld, Australia 4305.

The Museum's Vision Statement is:

to be recognised as a creative, innovative and exciting journey of discovery into Australia's rail story.

The Mission Statement is:

to harness the significance of the Workshops precinct by delivering international standard cultural and tourism related activities, education and public programs associated with the interaction of rail on people's lives.

For further information and enquiries:
Phone: 07 3432 5100
Fax: 07 3432 5114
Email: info@theworkshops.qm.qld.gov.au
Website: www.theworkshops.qm.qld.gov.au

Teacher Guide

Purpose and overview

This program of work for Year 7 students aims to explore the topic of simple machines and their uses in everyday life and rail-related situations. By examining photographs and objects, and visiting The Workshops Rail Museum, students will investigate a number of simple and compound machines in order to develop their understanding of how these machines work, the forces involved, and their functions in daily life.

This program consists of two documents: a teacher guide and a student workbook. The teacher guide elaborates the curriculum links, and provides suggestions for programming the Museum excursion activities and information about the objects depicted in the workbook. It includes an answer key for the workbook activities. The student workbook contains activities for students to complete on the excursion, as well as pre- and post-excursion tasks. This workbook can be copied and distributed to students.

The pre-excursion activities allow students to demonstrate and develop their existing knowledge of simple machines and forces in their everyday home and school lives. They are also introduced to the role of simple machines in rail-related contexts to prepare them for their excursion.

The excursion-based activities provide an opportunity for students to explore most parts of the Museum in order to search for different types of simple machines within the buildings, locomotives, carriages and wagons. Some tasks involve students locating and examining objects in the images provided in this worksheet, while others allow students to choose objects of their own to investigate. The activities also prompt students to read and view the interpretive panels and audio-visual sources, as they provide opportunities for discussion about nearby displays. Because the activities are organised according to simple machine type rather than Museum zones, it is important that students understand that they will need to visit a number of different zones in order to complete the activities relating to each simple machine.

A number of post-excursion culminating activities are included where students demonstrate their knowledge of simple machines by completing creative, problem-solving challenges. They will also communicate this knowledge through a variety of modes and by working collaboratively. Teachers can choose which post-excursion activities the students are to do.

This program is designed to supplement in-class units of works on simple machines, rather than being a stand-alone unit in itself. The activities are aligned with the Australian Curriculum: Science; Design and Technologies; and English for Year 7 students. The Science content strands addressed are *Science Understanding*, *Science as Human Endeavour* and *Science Inquiry Skills.* The Design and Technology strands are *Knowledge and Understanding*, and *Processes and Production Skills*. The English content strands of *Language* and *Literacy* are also addressed.

Learning Outcomes:

Students will be able to:

- Identify and categorise simple machines
- Identify various simple machines that make up the compound machines used in the railways and other real life contexts
- Understand the role of simple and compound machines in real life and railway contexts
- Explain the roles machines (simple and compound) play in making work easier
- Demonstrate their understanding of scientific concepts, such as force, effort, load, work and mechanical advantage
- Develop their knowledge of forces and motion through the study of simple machines
- Use problem solving skills by applying their knowledge of simple machines to design a prototype to assist in lifting and moving heavy loads
- Communicate their ideas and share their findings with others
- Work collaboratively
- Report on their findings verbally and through written texts

Total Time:

This program can be undertaken over a term in conjunction with in-class units of work on simple machines and forces.

Previous knowledge:

Science: Some previous knowledge necessary – basic understanding of simple machines, forces and work

Technologies: Some previous knowledge in design and construction would be beneficial

English: Some previous knowledge in procedural text writing genre and interpreting information texts necessary; experience in collaborative learning and communication skills, and reading and viewing skills

Curriculum Links

The Year 7 curriculum links are elaborated in the following tables:

The Australian Curriculum: Science

Science Understanding	
Physical science Change to an object's motion is caused by unbalanced forces acting on the object **(ACSSU117)**	**Elaborations:** • investigating the effects of applying different forces to familiar objects • investigating a simple machine such as lever or pulley system
Science as Human Endeavour	
Use and influence of science People use understanding and skills from across the disciplines of science in their occupations **(ACSHE224)**	**Elaboration:** • considering how sports scientists apply knowledge of forces in order to improve performance
Science Inquiry Skills	
Questioning and predicting Identify questions and problems that can be investigated scientifically and make predictions based on scientific knowledge **(ACSIS124)**	**Elaboration:** • working collaboratively to identify a problem to investigate
Planning and conducting Collaboratively and individually plan and conduct a range of investigation types, including fieldwork and experiments, ensuring safety and ethical guidelines are followed **(ACSIS125)**	**Elaboration:** • working collaboratively to decide how to approach an investigation
Processing and analysing data and information Construct and use a range of representations, including graphs, keys and models to represent and analyse patterns or relationships, including using digital technologies as appropriate **(ACSIS129)** Summarise data, from students' own investigations and secondary sources, and use scientific understanding to identify relationships and draw conclusions **(ACSIS130)**	**Elaboration:** • understanding different types of graphical and physical representation and considering their advantages and disadvantages **Elaborations:** • using diagrammatic representations to convey abstract ideas and to simplify complex situations • referring to relevant evidence when presenting conclusions drawn from an investigation
Communicating Communicate ideas, findings and solutions to problems using scientific language and representations using digital technologies as appropriate **(ACSIS133)**	**Elaborations:** • presenting the outcomes of research using effective forms of representation of data or ideas and scientific language that is appropriate for the target audience • using digital technologies to access information and to communicate and collaborate with others on and off site
General Capabilities	
• **Literacy:** Comprehending texts through listening, reading and viewing; word knowledge - understanding learning area vocabulary • **Numeracy:** Interpreting diagrams • **Critical and creative thinking:** Inquiring – identifying, exploring and organising information and ideas • **Personal and social capability:** Communicating effectively; working collaboratively; making decisions	

The Australian Curriculum: Design and Technologies (7-8)

Design & Technologies Knowledge & Understanding	
Analyse how motion, force and energy are used to manipulate and control electromechanical systems when designing simple, engineered solutions **(ACTDEK031)**	**Elaborations:** • investigating influences impacting on manufactured products and processes such as historical developments, society, new materials, and control systems • experimenting to select the most appropriate principles and systems on which to base design ideas, for example structural components to be tested for strength • producing prototypes and jigs to test functionality
Design & Technologies Processes & Production Skills	
Generate, develop, test and communicate design ideas, plans and processes for various audiences using appropriate technical terms and technologies including graphical representation techniques **(ACTDEP036)**	**Elaborations:** • using a variety of critical and creative thinking strategies such as brainstorming, sketching, 3-D modelling and experimenting to generate innovative design ideas • developing models, prototypes or samples using a range of materials, tools and equipment to test the functionality of ideas • producing annotated concept sketches and drawings, using: technical terms, scale, symbols, pictorial and aerial views to draw environments; production drawings, orthogonal drawings; patterns and templates to explain design ideas
Independently develop criteria for success to assess design ideas, processes and solutions and their sustainability **(ACTDEP038)**	**Elaborations:** • developing criteria for success to assess the success of designed solutions in terms of aesthetics, functionality and sustainability • considering how to improve technical expertise • evaluating designed solutions and processes and transferring new knowledge and skills to future design projects
Use project management processes when working individually and collaboratively to coordinate production of designed solutions **(ACTDEP039)**	**Elaboration:** • explaining and interpreting drawings, planning and production steps needed to produce products, services or environments for specific purposes
General Capabilities	
• **Literacy:** Communicating ideas, concepts and detailed proposals; developing technical vocabulary for concepts processes and production; presenting information through drawings, diagrams, models, etc. • **Numeracy:** Estimating, calculating and measuring through the process of generating ideas • **Critical and creative thinking:** Considering how systems, materials, tools and equipment (past and present) impact on our lives, and how these elements might be better designed and managed • **Personal and social capability:** Working cooperatively in teams, sharing resources and processes, making group decisions, resolving conflict and showing leadership	

The Australian Curriculum: English

<table>
<tr><th colspan="2">Language</th></tr>
<tr><td>Text structure and organisation
Understand that the coherence of more complex texts relies on devices that signal text structure and guide readers, for example overviews, initial and concluding paragraphs and topic sentences, indexes or site maps or breadcrumb trails for online texts (ACELA1763)</td><td>Elaboration:
• writing structured paragraphs for use in a range of academic settings such as paragraph responses, reports and presentations</td></tr>
<tr><td colspan="2">Expressing and developing ideas
Investigate vocabulary typical of extended and more academic texts and the role of abstract nouns, classification, description and generalisation in building specialised knowledge through language (ACELA1537)</td></tr>
<tr><th colspan="2">Literacy</th></tr>
<tr><td>Interacting with others
Use interaction skills when discussing and presenting ideas and information, selecting body language, voice qualities and other elements, (for example music and sound) to add interest and meaning (ACELY1804)</td><td>Elaborations:
• participating in pair, group and class and listening situations, including informal conversations, discussions and presentations
• using effective strategies for dialogue and discussion in range of formal and informal contexts, including speaking clearly and coherently and at appropriate length, clarifying and rephrasing comments of others
• choosing vocabulary and spoken text and sentence structures for particular purposes and audiences, adapting language choices to meet the perceived audience needs</td></tr>
<tr><td>Creating texts
Plan, draft and publish imaginative, informative and persuasive texts, selecting aspects of subject matter and particular language, visual, and audio features to convey information and ideas (ACELY1725)

Edit for meaning by removing repetition, refining ideas, reordering sentences and adding or substituting words for impact (ACELY1726)</td><td>Elaborations:
• compiling a portfolio of texts in a range of modes related to a particular concept, purpose or audience
• using appropriate textual conventions
• writing and delivering presentations with specific rhetorical devices to engage an audience

Elaboration:
• using collaborative technologies to jointly construct and edit texts</td></tr>
<tr><th colspan="2">General Capabilities</th></tr>
<tr><td colspan="2">• Literacy: Using knowledge of text structures and text cohesion; using knowledge of sentence structures; understanding learning area vocabulary; using language to interact with others; composing texts
• Critical and creative thinking: Identifying and clarifying information and ideas; organising information and ideas
• Personal and social capability: Communicating effectively</td></tr>
</table>

Support materials and references

Internet sites:

To obtain information regarding Queensland Museum loans kits (for classroom use of rail-related artefacts and resources):
http://www.theworkshops.qm.qld.gov.au/Learning+resources/QM+Loans

The Workshops Rail Museum exhibitions and displays information:
http://www.theworkshops.qm.qld.gov.au/Events+and+Exhibitions/Exhibition

The Workshops Rail Museum learning resources:
http://www.theworkshops.qm.qld.gov.au/Learning+resources

Simple Machines sites:

http://edheads.org/activities/simple-machines/

http://www.forteachersforstudents.com.au/site/themed-curriculum/simple-machines/facts/

http://www.engquest.org.au/students-sm-up.cfm

http://www.cosi.org/downloads/activities/simplemachines/sm1.html

http://www.sciencetech.technomuses.ca/english/schoolzone/Info_Simple_Machines2.cfm

Books:

Merrell J, 2003, *Hands on minds on science: Simple machines*, Hawker Brownlow Education, Cheltenham, Victoria.

Stannard, P & Williamson, K, 2004, *Science world: Book 1*, Macmillan Education Australia, South Yarra, Victoria.

Excursion information:

The following provides suggestions for completing the excursion activities in the student workbook. These activities are based on simple machine type rather than the Museum zones, so students are required to visit a number of different zones throughout the Museum to complete the information relating to each machine. Ideally, the activities should be done in pairs or small groups to encourage the sharing of ideas and collaboration.

Each simple machine section has an information box referring students to the relevant Museum zones. It is recommended that students read the entire excursion component of their worksheets to familiarise themselves with the tasks so that they can address a number of different simple machine questions within a zone. This will avoid them continuously going back and forth between zones, and hence losing time, in order to gather information.

Teachers should consider the needs of their learners and time constraints in determining how to complete the excursion activities. The following options are provided to assist with this planning:

Option 1: all groups or pairs of students do all simple machine activities.

Option 2: allocate one or two different simple machines to different groups or pairs to investigate. After the excursion, they work with other students who investigated different machines to share their information.

Option 3: half of the groups or pairs investigate the lever family simple machines, while other groups or pairs investigate the inclined plane family. After the excursion, students work with people who investigated the other simple machine family to share information.

There are extension activities for students who complete the excursion tasks quickly. Students may do part of these activities while on the excursion, such as sketching and naming objects and recording the relevant Museum zones, with the option of doing the remainder post-excursion.

The Museum offers an optional Simple Machines presentation (free) and/or a Lego workshop (charges apply) conducted by the Learning, Events and Activities Officer as part of your excursion activities. Please enquire when booking your excursion about either of these options.

For more information on the different Museum zones, please refer to the *Teacher's Guide to The Workshop Rail Museum* available at:

http://www.theworkshops.qm.qld.gov.au/Learning+resources/Schools+and+groups/Teacher+resources

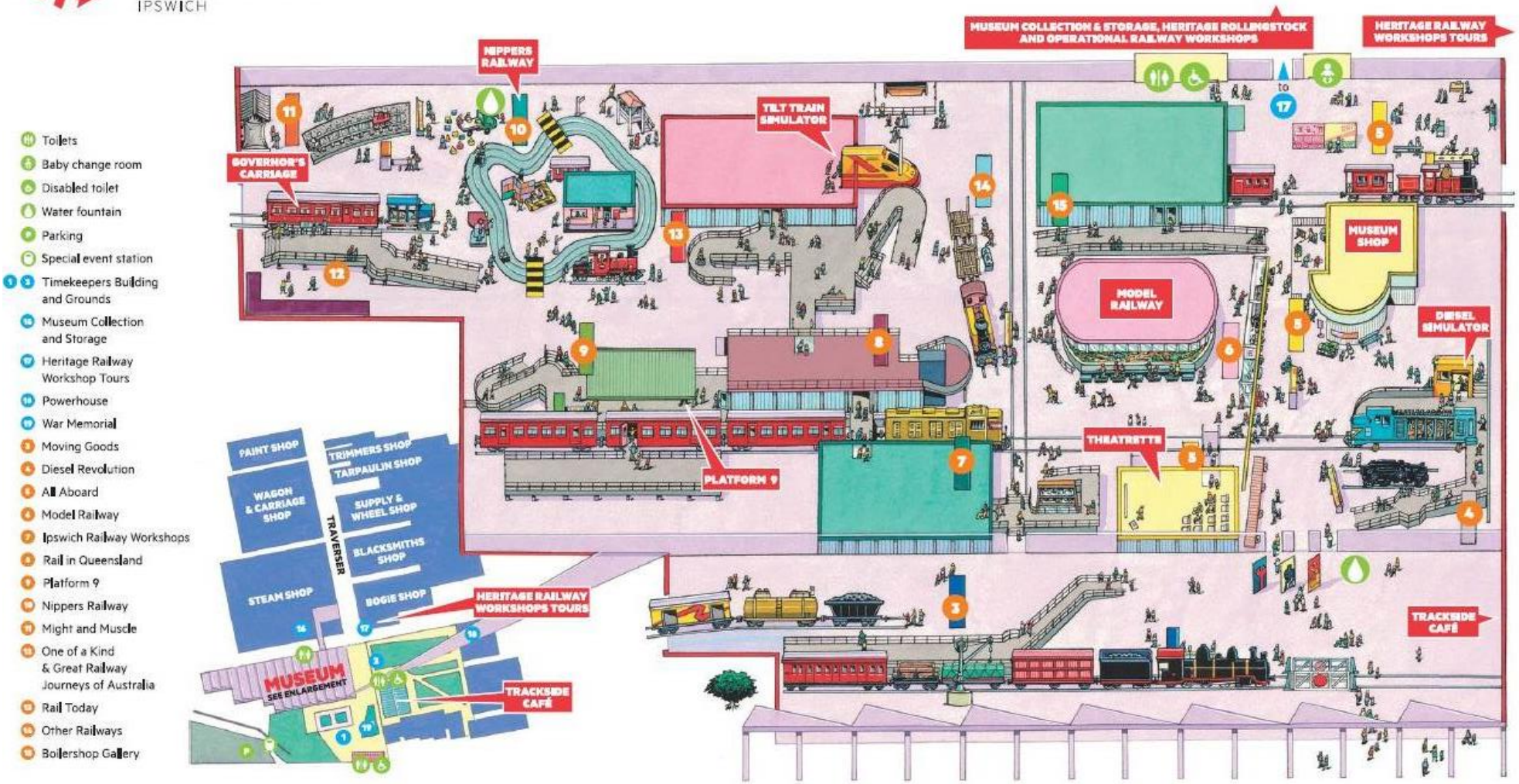
On the following page is a map of The Workshops Rail Museum. You can refer to this map to help orientate yourself throughout the program's activities.

Please provide a copy of this map to the students.

THE WORKSHOPS RAIL MUSEUM

IPSWICH

MUSEUM MAP



Answer and information key

This section contains information about the Student Workbook activities and possible responses to these tasks. Many tasks are open ended in nature and encourage student discussion so a number of responses may be acceptable with reasonable justification or explanation.

Pre-excursion Activities:

Introduction and Background activities:
Both activities: students own responses

Simple Machines activities:

Activity 1: Terminology task

Term	Meaning
Work	The result of a force being applied to an object over a distance - if the object moves, then work has been done but the direction of the force and the movement must be the same
Machine	A device that makes work easier by changing the size or direction of a force, and by changing the speed or direction of an object's motion
Mechanical Advantage	The difference between the force you apply and the work you achieve, that is, using a machine to do more work with less effort
Simple Machine	A simple tool that is made up of one or two parts that helps make work easier
Compound Machine	A machine that is made up of two or more simple machines
Load	The object or amount of weight that needs to be moved
Force	Any influence that can change the speed, direction or movement of an object
Effort	The amount of force required to do the work

Activity 2: Simple Machines – KWL
Students own responses

Activity 3: Types of simple machines

- Images: Wedge; Pulley; Wheel and Axle; Inclined Plane; Screw; Lever
- 2nd and 3rd columns of table: Students own responses

Activity 4: Simple machines classroom audit
Students own responses

Activity 5: Simple machines home audit – Homework activity
Students own responses

Activity 6: Simple machines in the railways
Photo 1: Gears; Wheel and axles; Lever
Photo 2: Pulley; Wheel and axle
Photo 3: Wheel and axle; Screws
Photo 4: Gears; Wheel and axle
Photo 5: Levers; Screws

Excurison Activities

Lever Activities:

Activity 1: What type of lever is that?

Picture 1:

1. This is a door and handle on the passenger/guard's van at the end of the Moving Goods trains located at the front of the Museum
2. It is an example of a second class lever
3. Force is applied by pushing on the handle which moves the load (the door) on its fulcrum (the hinges)
4. Students own responses
5. Screws + students own responses

Picture 2:

1. This is a spider barrow used for moving passengers' luggage and parcels to and from trains
2. It is a second class lever
3. Force is applied by lifting the handles which lifts the load (suitcases, etc.) in the centre and it balances on the fulcrum (wheels)
4. Students own responses
5. Wheel and axles, inclined plane + students own responses

Picture 3:

1. These are railway tongs used to lift and move rails
2. It is an example of two first class levers working together
3. Force is applied to the handles which pivot on the fulcrum where the two levers join and the load is where the two ends meet to grip the railway track
4. Students own repsonses
5. Wedge (at the load ends), screws + students own responses

Picture 4:

1. This is a camelfoot lifter used to remove old dogspikes from wooden sleepers by levering them out
2. It is an example of a first class lever
3. Force is applied to one end (the handle) and it moves on its fulcrum (the curved part) to lift the load (the pronged end)
4. Students own responses
5. Wedges (at the pronged end) + students own responses

Activity 2: Labelling a lever

1. Load: barrel (centre); Effort: lifting the handles; Fulcrum: wheel
2. Students own responses
3. Wheel and axle

Activity 3: Lifting a lever

All questions: Students own responses

Wheel and Axle and Gear Activities:

Activity 1: What's that wheel?

Picture 1:

1. This is the bogie or undercarriage of a steam locomotive tender (where coal and water are stored)
2. Allows the tender to move along the rails without friction + students own responses
3. Students own responses
4. Screws, levers + students own responses

Picture 2:

1. This is a tricycle that travelled on rails and was used by railway workers to inspect the lines
2. Allows the tricycle to move along the rails without friction + students own responses
3. Students own responses
4. Levers, gears, screws + students own responses

Picture 3:

1. This is a tarpaulin trolley used for sewing tarpaulin and other canvas items used on rolling stock – the tarpaulin would be stretched over it and then the trolley moved along the rails rather than trying to move the material
2. Allows the trolley to move without friction + students own responses
3. Students own responses
4. Screws + students own responses

Picture 4:

1. This is a pumper trolley used by workers to move along sections of track from their camp to worksite when building/repairing the lines
2. Allows the trolley to move without friction, and workers to move without walking + students own responses
3. Students own responses
4. Levers, gears, screws + students own responses

Activity 2: Gears Science Station

All questions: Students own responses

Activity 3: What is it?

1. It is part of the undercarriage of the Panhard Rail Motor (wheel and axles and gears)
2. Panhard Rail Motor: 
3. The rail motor was used to carry passengers and goods on a small trailer along the Normanton-Croyden line in far north Queensland during the early part of the last century
4. Students own responses

Pulley Activities:

Activity 1: Pulley "I Spy"

Picture 1:

1. This pulley is part of the whip crane located near the Moving Goods train at the front of the Museum and was used to load goods onto the wagons
2. Goods attached to the hook and winched up and moved into position then lowered into wagon + students own responses
3. Students own responses
4. Gears, levers, wheel and axles + students own responses

Picture 2:

1. This is in the coal train section of the model railway layout and it is a crane lifting shipping containers
2. Container was attached to the hook and winched up and moved into position then lowered into position on ship or wharf + students own responses
3. Students own responses
4. Inclined plane (ladder), wheel and axle + students own responses

Picture 3:

1. These pulleys were used to open the furnace which was used to heat flat plates of steel used in making steam engine boilers, and to heat copper used to make fireboxes
2. Pulling down on the chains would make the door rise to open it + students own responses
3. Students own responses
4. Levers, screws, wheels and axles + students own responses

Picture 4:

1. This is part of the crane used to lift and move heavy objects around the Workshops. It is located in the Erecting Shop (at the exit of the Steam Shop Heritage Workshops Tour) and it is up near the ceiling above the large roller doors
2. Object was attached to the hook and winched up and moved into position + students own responses
3. Students own responses
4. Levers, screws, gears, wheel and axle + students own responses

Activity 2: A model pulley

All questions: Students own responses

Inclined Plane Activities:

Activity 1: Name that inclined plane

Picture 1:

1. This is in the section of the model railway layout and it is a coal silo conveyor ramp – coal moves from the silos to the crushing plant
2. By moving coal along the sloped conveyor belt, it is easier to move larger and heavier quantities that trying to lift it straight out of the silos and lower it into the crushing plant + students own responses
3. Students own responses
4. Not obvious, possibly gears, wheels and axles + students own responses

Picture 2:

1. Level crossing in the children's play area, Nippers Railway – ramp that allows vehicles to easily cross over train lines
2. It is easier to go up and over a ramp to cross the tracks than to lift something over them + students own responses
3. Students own responses
4. N/A

Picture 3:

1. Ramp to a display at the back of the Museum – to allow wheelchair and stroller access to the displays
2. Easier to access parts of the Museum by a ramp if in a wheelchair or pushing a stroller rather than trying to lift these things + students own responses
3. Students own responses
4. N/A

Activity 2: More inclined planes

Encourage students to look for ladders, carriage steps, other types of staircases, and to explore the model railway for other examples

Activity 3: Inclined plane analysis

Students own responses

Wedge Activities:

Activity 1: Where are the wedges?

Picture 1:

1. Axe in the red tool box in the glass case along the back wall of the guard's van in the Moving Goods train located at the front of the Museum
2. Force is applied to the wider back edge and is then distributed to the narrow front edge or wedge to cut things + students own responses
3. Students own responses
4. Lever + students own responses

Picture 2:

1. "Cow catcher" on the front of the locomotive of the Moving Goods train located at the front of the Museum. Its purpose was to clear obstacles from the track
2. Force comes from the wide back part (from the train) and is distributed to the narrow wedge at the front to move or cut through things on the track + students own responses
3. Students own responses
4. Screws, inclined plane + students own responses

Picture 3:

1. Flat nosed shovel used to remove or add ballast between sleepers
2. Force is applied to the back of the wedge (near the handle) and allows the wedge to separate and scoop up ballast more easily because of its narrow edge + students own responses
3. Students own responses
4. Lever + students own responses

Picture 4:

1. Ballast fork used to shovel, clean and pack ballast
2. Each prong is a wedge and is force is applied as with the flat nosed shovel + students own responses
3. Students own responses
4. Lever + students own responses

Activity 2: Wedge object analysis

All questions: Students own responses

Activity 3: Discussion question:

Students own responses

Screw Activities:

Activity 1: Screw search

Picture 1:

1. Brake in the guard's van of the Moving Goods train located at the front of the Museum. It was used to hold the train still during shunting while its airbrakes were not engaged
2. Turning the screw tightens the brakes and keeps them fastened + students own responses
3. Students own responses
4. Lever + students own responses

Picture 2:

1. Screw coupling between two wagons on the Moving Goods train located at the front of the Museum – purpose is to join wagons or carriages together
2. Turning the screw fastens the carriages together securely + students own responses
3. Students own responses
4. Levers + students own responses

Picture 3:

1. This is an augur drill and its purpose was to drill holes into sleepers into which dogspikes could be inserted
2. Using a screw to make the holes uses less force than trying to hammer holes into the sleepers + students own responses
3. Students own responses
4. Lever + students own responses

Activity 2: Screw coupling activity station

1. Screw coupling is joining two wagons or carriages together
2. The shunter would get between the two carriages and put the coupling on the hooks and then wind the screw using the hanging bolt to fasten them securely
3. a. Students own responses; b. Students own responses
4. Students own responses

Extension Activities:

Activity 1: Simple machines search

- Crane: Used for loading goods onto wagons. Simple machines include: levers, wheels and axles, gears, pulley
- Cincinnati Milling Machine: Used to mill metal at the Ipswich Railway Workshops. Simple machines include: levers, wheels and axles, screws
- Miniature steam engine: Used to drive a sewing machine. Simple machines include: wheels and axles, gears, screws, levers

Activity 2: Discussion

Students own responses

Activity 3: Simple machines scavenger hunt

Students own responses

Post-excursion activities

Activity 1: KWL Chart
Students own responses

Activity 2: Simple machines extension task
Students own responses

Activity 3: Simple machines quick quiz:

1. Work is the result of a force being applied to an object over a distance - if the object moves, then work has been done but the direction of the force and the movement must be the same
2. Force is needed for work to be done
3. Using a machines requires less effort or energy on our part – the machine does most of the work
4. Fulcrum and the arm
5. It is easier to move things up or down an inclined plane than trying to lift them, so less force and effort is needed
6. A gear is a type of wheel and axle
7. Lever, wheel and axle
8. Lever family: levers; pulleys; wheels and axles (and gears). Inclined plane family: Inclined planes (ramps); wedges; screws

Activity 4: Load the train challenge
Students own responses

Activity 5: Simple machine prototype challenge
Students own responses

Activity 6: Writing task
Students own responses