EA jnr club

Primary

TEACHER RESOURCE KIT

Construct a lifting machine

This guide includes:

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ENGINEERS AUSTRALIA

Construct a lifting machine: *lesson ideas*

Science

- Students to conduct an 'Engaging with pulleys' exercise. They will need two broom handles or lengthsof thick dowel, and some nylon rope or cord. Students to:
    - Tie the cord to one broom handle. Pass the cord around the handles a number of times, leaving a loose end hanging down. Have two students hold the handles with both hands, and try to pull them apart, while another student pulls the handles together by pulling on the cord.
    - Experiment with various numbers of turns of the cord around the handles, and record the different effects.
- Students to carry out a variety of experiments to investigate how pulleys can make work easier for us. They could then write a statement which explains the relationship between the number of pulleys used and the amount of effort needed to lift a heavy load.
- Students to complete the **'What is Engineering?'** activity sheet.

Technologies

- Students to design a robot that can lift objects. Students then create a logo and a poster to advertise their robot.
- Students to complete the **'How Do Simple Machines Help Us?'** activity sheet.
- Students to complete the **'Wheels and Axles'** activity sheet.
- Students to complete the 'Levers' activity sheet. They will discover what levers are and where we need them.
- Class discussion: Why do we need machines and tools?
- Students to go for a walk around the school looking for different types of simple machines. Students to complete the **'Machines Are All Around Us'** activity sheet.
- Students to brainstorm as many machines and tools as possible, then classify them into categories.

Mathematics

- Conduct an 'Explore and Explain' activity on 'simulated pulleys'. Use the metal legs of a chair or a table turned on its side, and some nylon cord, to make a 'pulley system'. Students to:
    - Fix one end of the cord to one leg. Pass the cord through the handle of a plastic juice bottle full of water which is on the floor. This is the 'load'. (*A 2L bottle of water will weigh 2kg.*) The handle of the bottle acts as a 'moving pulley'.
    - Pass the cord over the top of the table leg (*which acts as a 'fixed pulley'*), and suspend an empty plastic juice bottle from it. This bottle is going to become the 'effort'.
    - Discover how much water you need to add to the 'effort' bottle in order to begin to lift the 'load' off the floor. You can calculate the approximate weight used for the effort from the volume of water (*each litre of water weighs 1kg*). Is there a 'mechanical advantage'? Use a ruler or a measuring tape to compare how far the 'effort' bottle needs to fall in order to raise the 'load' bottle by a height of 20cm. Record all the results of the investigation. Try to explain the results in terms of simple machines.
- Students to complete the **'Pulleys Investigation'** activity sheet. Relate this effect to the use of pulleys to gain a mechanical advantage.

English

- Students to brainstorm as many engineering words as possible and then create a page in their Science books on which to record these words (with definitions). Students will add to this as they learn new words.
- Students to complete the **'KWL Chart'** or **'TWLH Chart'** activity sheet.
- Class discussion: Which machine or tool is the most valuable and why? Write an exposition text based on this question, giving at least three reasons for their answer.
- Students to write a procedure of how to make a lifting machine.
- Students to research the origin of the word 'machine'.

Humanities and Social Sciences

History

- The invention of tools and simple machines has had an enormous impact on the way humans lived, survived and developed. As a class, discuss how our lives would be different if we had no machines or tools. In groups, students to prepare a speech for the class in response to this discussion.

Geography

- Students to research some international companies that design machines. Compare one or more of these companies with an Australian company that designs machines. What are the similarities and differences? How have the machines that these companies produce contributed to the local, national or global community?

Civics and Citizenship

- Engineers are valuable members of society. Students to investigate ways in which engineers have contributed to their local community.
- Students to work together, each with defined roles throughout all steps of the design, construction, testing and critiquing stages of their lifting machine.

The Arts

- Students to view pictures of lifting machines and draw their own 'wacky lifting machine', labelling its unique features.
- For a drama activity, provide students with a card that has the name of a simple machine on it. In pairs, students to think of a mime which portrays the movement of that simple machine. The class has to guess what simple machine it might be.
- Students to create an illustrated non-fiction book for younger students, explaining how lifting machines work. Use a book-making app, the KidPix program, or just cardboard and paper.

Health and Physical Education

- Students to brainstorm how lifting machines have helped human beings and impacted on our current way of life.

Languages

- Students to learn how to say and write words such as 'lifting', 'machine' and 'weight' in various languages.

Construct a lifting machine: *Project instructions*

Important safety information

Allow plenty of time to discuss the safety precautions essential while assembling and testing the lifting machine. As a class, discuss how students can keep themselves and others safe. These ideas should be presented on a poster and displayed in the classroom. All students should agree with these rules before starting and the safety precautions and guidelines should always be observed.

Getting started - research activities

- Students to participate in the 'Construct a lifting machine' lessons activities and complete the associated activity sheets.
- Students to undertake some research on the applications of various simple machines, and the combinations of simple machines they might use to help lift a load to a given height. They can then decide on the type of machine to construct for their project.

The design stage

The lifting machine must use a simple machine, or a combination of simple machines (*such as levers, pulleys, inclined planes, wheels and axles, screws and gears*) to lift a load (*weighing at least 2kg*) to a height of at least 50cm. The load could be a packet of food, a bag of sand, a brick, or any other suitable object.

Having decided upon the type of machine to be constructed, the teams will then proceed to design it in more detail. In this stage they will need to consider factors such as:

- The size of the structure
- The materials that will be used. Are they available?
- The structural strength of the materials. Will the planned structure be strong enough to lift the load?
- How the materials will be joined together.
- The safe and supervised use of moving parts such as levers, pulleys, wheels and axles, if these are included in the design.

The designs should be recorded on plans that include calculations of the size of each piece of material used in the construction.

Older students can be encouraged to make their plans 'to scale', for example, the plans could be drawn to a scale of 1:4 (*i.e. one quarter of the size of the actual model machine*).

The construction stage

Having completed the plans, the next stage is for the teams to construct their lifting machines. Some teams may need assistance with this phase.

The machine can be constructed out of any commonly available materials. These could include cardboard, timber, plywood, particle board, or plastic sheeting, and involve the use of wheels, pulleys or other simple machines. The materials can be joined using tape, adhesives, nails, screws etc.

Testing the lifting machines

The completed lifting machines should be tested. The tests could include the following:

- Can the machine lift the required load of 2kg to a height of at least 50cm?
- Is the machine structurally strong and able to do this task repeatedly without breaking or failing?
- Does the machine use the principle of one or more simple machines to do this work?
- Does the machine make the task of lifting the 'load' of 2kg easier? Is the 'effort' that is required less than the 'load'?
- Can you measure the 'effort' that is required to lift the 'load'? (*This might be done by measuring the force that is needed, for example by using a spring balance.*) Is the 'effort' less than the 'load'? Is there a 'mechanical advantage' in using this machine? If so, can it be measured?

Critiquing the designs

It is likely that the teams will see a need to modify some aspects of their designs in order to make improvements (*not only during the construction stage, but also when the design is tested*). They should be given opportunities to analyse their work, come up with suggested improvements and carry out further tests.

Assessing the projects

On completing the construction and testing of their lifting machines, students should be engaged in assessing the successes of their projects.

Some of the specific aspects to explore might include:

- Which designs were more successful? Why?
- Which simple machines seemed to give the best 'mechanical advantage'? Why?
- What have students learnt about simple machines, 'load', 'effort' and 'mechanical advantage'?
- What would students do differently if they undertook the project again?

What is engineering?

Name: _____

Draw a picture or write a paragraph to describe what you think each of these fields of engineering involves.

Civil engineering	Chemical engineering
Electrical engineering	Mechanical engineering
Transport engineering	Hydraulic engineering

How do simple machines help us?

Name: _____

Machines make it easier for us to do work. Simple machines need only one part to do the work. Investigate where we would commonly find these simple machines and how they help us.

Simple machine	Where can we find it?	What does it do?
Pulley		
Lever		
Wheel and axle		
Inclined plane		
Wedge		
Gear		
Screw		

Wheels and axles

Name: _____

A wheel and axle is a simple machine that comprises a smaller cylinder *(the axle)* joined to a larger cylinder *(the wheel)*. A wheel and axle can make it easier to move a load.

Your task is to design a machine with wheels and axles to assist these people in their everyday lives. Label your designs.

Elderly person	Builder
Toddler	**Teacher**

Levers

Name: _____

A lever is a rigid bar that rotates around a fixed point. Where do we see levers in our environment?

Why do we need levers?

You have found a pirate's hidden treasure chest in a cave, but a large rock is sitting right on top of it. Design a lever which will help you safely ease the rock off the treasure chest, with the least amount of effort. Draw a sketch of your lever, with the fulcrum, load and effort labelled. Include detailed instructions for use.

Machines are all around us

Name: _____

Take a walk around your school and the playground. **List all the machines you see.**

Name of machine	Who uses it?	What for?	What else could be used to do the same job?

Pulleys investigation

Name: _____

Activity	Number of pulleys	Weight lifted

What is the relationship between the number of pulleys and the weight lifted?

How do pulleys make work easier for us?

Where have you seen pulleys in use?

Know Want Learnt (KWL) Chart

Name: _____

What I **KNOW** about lifting machines	What I **WANT** to know about lifting machines	What I have **LEARNT** about lifting machines

Think Want Learnt How (TWLH) Chart

Name: _____

What we **THINK** we know about lifting machines	What we **WANT** to know about lifting machines	What we have **LEARNT** about lifting machines	**HOW** we learnt it