EA jnr club

Primary

TEACHER RESOURCE KIT

Construct a pull-along toy

This guide includes:

- Lesson ideas
- Project instructions
- How do simple machines help us?
- Machines are all around us
- What is engineering?
- Wheels and axles
- Popular pull-along toys
- Know Want Learnt (KWL) chart
- Think Want Learnt How (TWLH) chart

ENGINEERS AUSTRALIA

Construct a pull-along toy: *lesson ideas*

Science

- Students to brainstorm toys that use a push or pull force to move or operate.
- Students to bring in some toys from home and investigate how they move. Identify and discuss the components of the toy that contribute to, or shape the movement.
- Students to consider the properties of various materials commonly used in children's toys *(e.g. wood and plastic)*. Why are other materials *(e.g. glass)* rarely used?
- Students to complete the **'What is Engineering?'** activity sheet.

Technologies

- Students to create a list of where they have seen wheels and axles at work. Walk around the school and take pictures of any they can find. What work was being done by each of the wheels and axles they observed? Discuss findings.
- Students to complete the **'How Do Simple Machines Help Us?**' activity sheet
- Students to complete the **'Wheels and Axles'** activity sheet.
- Class discussion: Why do we need machines and tools?
- Students to brainstorm as many machines and tools as possible and classify them into categories.
- Students to design their own 'wacky pull-along toy', labelling its unique features.
- Students to go for a walk around the school looking for various types of simple machines. Students to complete the **'Machines Are All Around Us'** activity sheet.

Mathematics

- Using magazines and toy catalogues, students cut out pictures of toys *(include their price)* that they would like to buy. Provide them with a budget to stay within. Students add up the total cost of the toys chosen and calculate how much over or under budget they are.
- Using a hardware store catalogue or online resources, students to calculate how much it is going to cost to create their own pull-along toy.
- Students to conduct a survey of children in a lower primary class to discover what types of pull-along toys they have, or have played with. Discover what the most popular pull-along toy is and discuss why that might be so. Students to complete the **'Popular Pull-along Toys'** activity sheet.

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'** or **'TWLH'** activity sheet.
- Brainstorm types of machines or tools to create a list. Class discussion: Which machine or tool is the most valuable and why? Students then 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 pull-along toy.

Humanities and Social Sciences

History

- The invention of tools and simple machines has had an enormous impact on the way humans have lived, survived and developed over time. 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.
- Students to investigate the history of one of their favourite toys *(from now or their early life)*. Is the item a recent invention or has it been around for many years? Has the item evolved or changed? What significance did *(or does)* the item have for the student.

Geography

- Students to investigate toys around the world. How are they different or similar? Why? How do toys reflect local customs or beliefs and how do they contribute to a 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 throughout all steps of the design, construction, testing and critiquing stages of their pull-along toy. Discuss how students will achieve this collaboration with minimal conflict and how conflicts can be resolved respectfully if they do occur.

The Arts

- 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 is.
- Students to make a diorama of a scene containing a pull-along toy.
- Students to create an illustrated non-fiction book for younger students, explaining how pull-along toys work. Use a book making app, the KidPix program, or just cardboard and paper.
- Students to use pull-along toys from home as characters in a movie production or role play.

Health and Physical Education

- Students to brainstorm how pull-along toys have helped human beings and impacted on our current way of life.
- Create an obstacle course for students to run through with their pull-along toys.

Languages

- Students to learn how to say and write words such as 'toy', 'machine' and 'fun' in various languages.
- Students to research how to say and write the names of various types of simple machines in several languages other than English.

Construct a pull-along toy: *Project instructions*

Important safety information

Allow plenty of time to discuss the safety precautions that are essential when assembling and testing pull-along toys. As a class, discuss how students can keep themselves and others safe.

These ideas should be presented on a class 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 pull-along toy' lessons and activities and complete the associated activity sheets.
- Students to investigate different types of pull-along toys. Encourage students to bring some from home if they have them.

Engage

The pull-along toy will make use of wheels and axles. The wheel and axle is one example of the various types of simple machines that have already been investigated.

In order to engage students in thinking about wheels and axles, have them investigate various ways of constructing them from a range of household and readily-available materials such as:

- cardboard
- particle board
- lids from various containers
- cotton reels
- satay skewers
- dowel
- straws

Students could investigate and test which designs are most effective. They could consider designs where the wheels spin freely on the axles, and designs where the axles are fixed to the wheels so that the wheels and axles turn together.

Explore

Why use wheels and axles? The wheel and axle underpin most modern technology and could be considered to be one of the greatest of human inventions.

This activity investigates how wheels are an effective machine to help move objects.

What you will need:

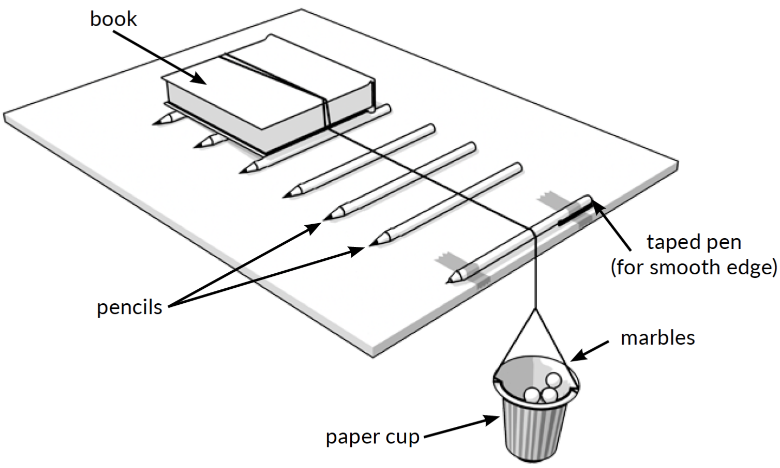
- a 'load' such as a block of wood, or a large book
- fishing line
- round pencils *(rollers)*
- wheels and axles that can be placed under the load
- a 'force measurer' such as a spring balance is ideal, but if one is not available a plastic or paper cup that can be suspended from the string, and a bag of marbles that can be added one by one to the cup will do.

Students can use these materials to investigate how much force is needed to make the load begin to move when it is resting on various surfaces. They could do this by attaching the line to the load and measuring the pulling force that is needed to just get the load to start to move.

If they do not have a spring balance, they can pass the line over the edge of the table (using a pen as a smoother edge) and suspend the paper cup from the line. They can then count how many marbles (or other identical weights) need to be added to the cup to make the load just begin to move.

The load can be tested on various surfaces (e.g. benchtop, paper, carpet etc.) Rollers (e.g. some pencils placed under the load) can then be added and tested, followed by wheels.

Students can record their findings and present them in an appropriate way (perhaps as tables and/ or graphs). They should then be encouraged to draw conclusions about what they have discovered in their investigations.



Explain

Students can research an explanation for their findings in the 'Explore' activity. This should include an understanding of 'friction'.

Understanding friction

Friction is the resistance between two surfaces as they move against each other. Whenever two surfaces are in contact there is friction between them. If a force *(a push or a pull)* tries to move one surface *(a book)* over another *(a table top)*, friction provides a force in the opposite direction that resists this movement. The pushing force has to be strong enough to overcome the friction between the two surfaces before the object will start to move. This is sometimes called 'static' friction. Once the object begins to move there is still some friction between the surfaces which resists the movement, although not as much. This is called 'kinetic' friction.

Wheels and axles are very useful in helping to make things move because they greatly reduce friction.

Elaborate

This phase includes two stages: the design stage and the construction stage

The design stage

The teams should now design their pull-along toy. In this stage, students will need to consider:

- The size of the toy.
- The materials they plan to use and their availability.

- How many wheels they will use and what type they will be *(free wheels or wheels fixed to an axle)*.
- How the wheels can be arranged so that the toy will pull along in the intended direction. *(Axles need to be parallel with each other, but at right angles to the intended direction of movement.)*
- How the materials will be joined together.
- How to make the moving surfaces smooth, so as to reduce friction.
- The final finish and appearance of the toy. It must be safe for young children. It cannot have sharp points or edges that could cause injury, no small parts that could be removed and swallowed, and no toxic or harmful materials.
- The length of the cord, to make the toy easy to pull along.

If the students wish to include an interesting secondary movement, there are some ideas in the construction stage.

The designs should be recorded on plans that include calculations of the size of the pieces of materials 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 1:2 *(i.e. half the size of the actual toy)*. Alternatively, they could be drawn at full size on large sheets of paper.

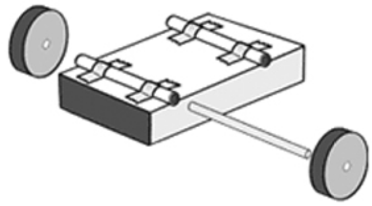
The construction stage

Having completed the plans, the next stage is for the teams to construct their pull-along toy from the selected materials. Some teams may need assistance with this phase, and it is likely that at least some of the teams will see a need to reconsider and modify their designs.

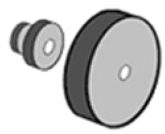
The toy can be constructed out of any commonly available materials, such as timber, plywood, particle board, or plastic sheeting. The materials could be joined using adhesives, nails, screws etc.

Here are some suggestions for making wheel and axles.

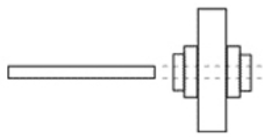
- Cut wheels out of particle or fibreboard and glue dowel axles into holes in the centre. This is an inexpensive option, but the wheels and the holes in the middle need to be cut accurately. This method works well for wheels that have offset axles *(e.g. waddling toys)*.



- Consider the use of plastic straws or short pieces of thin plastic tubing as bearings for the wheels and axles. The tubing can be fitted *(fixed or glued)* to the bottom of the toy and the axles pass through the tubing.
- Use 'spacers' to reduce friction. In some designs the wheels can rub against the sides of the body of the toy, producing unwanted friction. The use of 'spacers' between the wheels and the body of the toy can greatly reduce this. The spacers are like washers that fit loosely over the axles, keeping the wheels away from the body of the toy.

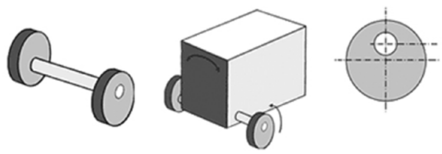


- Wheels made of sheet material such as cardboard or thin particle board sometimes have trouble in staying upright on the axle. This problem can be overcome by gluing extra layers of material to the hub of the wheel to make it thicker.



Here are some suggestions for creating the secondary movement of the pull-along toy:

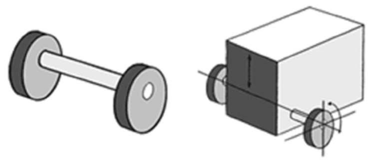
- **Waddling:** A toy that waddles from side to side *(such as a duck)* needs two wheels at the front that have the axles mounted off-centre on the wheels. The wheels and the axle need to be fixed so that they all turn together *(see diagram)*.



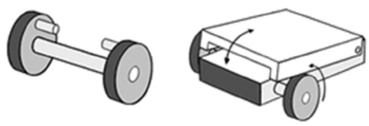
  As one side rises, the other one falls, producing the waddling motion. The amount of waddling will depend on how far the axles are offset from the centres of the wheels -the greater the offset, the more exaggerated the waddling motion.

- **Happy feet:** Attaching sheet rubber or plastic cut-out feet to the outside of the wheels produces a flapping motion and sound.

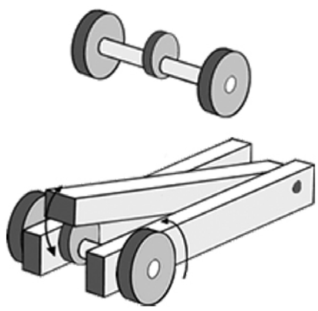
- **Bobbing up and down:** A toy that bobs up and down, such as a kangaroo *(up and down or reciprocating motion)* is similar to the waddling toy, except that the offsets of the wheels/axles are arranged so that both sides rise and fall at the same time.



  A cam mounted on an axle can also be used to produce up and down motion as the wheels turn. For example, it could be used to make a clown or other figure bob up and down, ring a bell, or make a figure bang a hammer or drum. This is using the principle of a 'cam and cam follower'. The cam is providing the force for the up and down motion, while the 'follower' rests on the cam, and moves up and down in response.

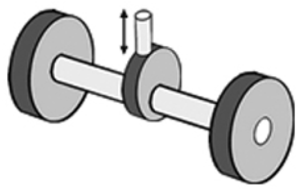


- **Opening and closing:** A toy that has an opening and closing motion *(for example, crocodile or hippopotamus jaws)*. This can be done in two ways. Both require the opening and closing piece to be hinged at one end. One way to produce the up and down motion is to have pegs fixed to the insides of the wheels, which push the hinged piece up and down as the wheels go round.

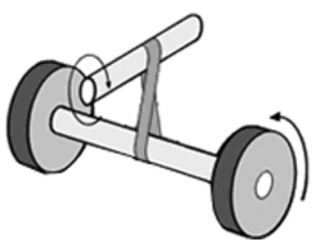


  Another way is to have a 'cam' fitted to the axle, which also raises and lowers the hinged piece as the wheels and axle turn. The motion can be varied by changing the shape of the cam.

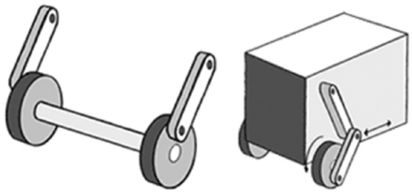
- **Rotating motion:** The rotating motion of the axle can be used to make another shaft rotate. For example, the wheels could drive the paddle wheels of a paddle steamer, the rotor of a helicopter, or the propeller of an aeroplane. The driving axle can connect to the second shaft by way of gears or a belt. It is suggested that for the purposes of this project the use of gears is probably too difficult. However, the use of rubber band belts to transmit rotation from the main axle to another shaft is more easily managed. The rubber band would need to be stretched tightly and kept under tension, so that it does not slip on the axles. Larger diameter axles make this easier.



  The rubber band belt can also be used to change the direction of rotation. For example, the rotating axle can be used to drive a vertical shaft *(e.g. helicopter rotor)* or a forward-facing shaft *(aeroplane propeller)*.



- **Arms, legs and connecting rods:** Connecting rods or linkages can be added to models, using pins that allow some movement within slotted holes. Examples include linkages that represent the legs of a cyclist, and connecting rods between the wheels of a locomotive. These could be tested and trialled before construction by using strips of cardboard cut to scale and joined with paper fasteners.



Evaluate

Critiquing the designs

Having constructed their pull-along toy, the students will then test them to see how well they work. After the test, time should be provided to make any modifications before carrying out another test. The test, critique and modify cycle can be carried out a number of times *(depending on time available)*. The observations, modifications and observed results should be recorded in a journal. When the students are happy with their toy, they can add the final touches *(paint, decorations etc.)*.

Assessing the projects

On completing the construction and the testing of their pull-along toys, students should be engaged in assessing the successes of their projects. They should consider:

- Which particular designs were more successful? Why?
- Which methods of transferring kinetic energy from the wheels to the other moving parts of the toy worked best? Why?
- How are the designs that the students created also used in machines and other technologies that we see in everyday life?
- What have they learned whilst doing the project?
- What else would they like to learn about toys, friction, force etc.?
- What would they do differently if they undertook the project again?

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		

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?

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

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

Popular pull-along toys

Name: ______________________________

Conduct a survey of younger students. Ask them what pull-along toys they have, or have played with. Record your results below. What was the most popular pull-along toy? Turn your results into a graph.

Pull-along toy	Category	Tally	Total

Know Want Learnt (KWL) Chart

Name: ______________________________

What I **KNOW** about pull-along toys	What I **WANT** to know about pull-along toys	What I have **LEARNT** about pull-along toys

Think Want Learnt How (TWLH) Chart

Name: ____________________

What we **THINK** we know about pull-along toys	What we **WANT** to know about pull-along toys	What we have **LEARNT** about pull-along toys	**HOW** we learnt it