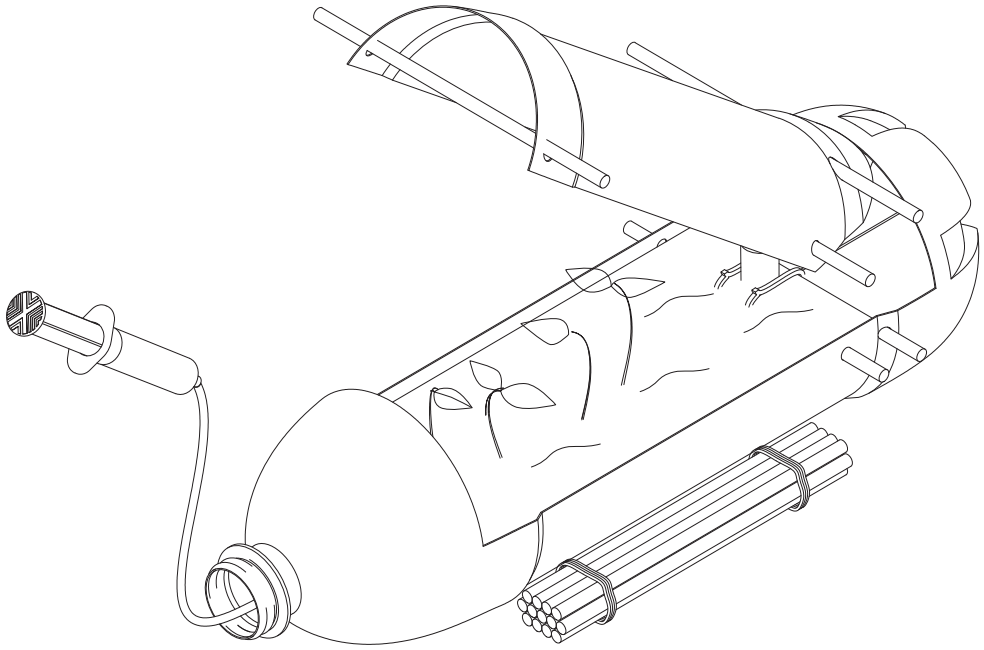


HYDRAULIC PROPAGATOR WORKSHEET

GETTING STARTED

5-10m

Did you know that machines can be powered by fluids? Hydraulic systems use fluids to transfer force, via pressure, through cylinders. This results in energy that powers motors, pistons, joints and arms.

Today, hydraulic systems are used for jobs that humans cannot, or will not do. For example, mining, lifting heavy loads, assembly lines, and even bomb disposal.

This session will teach you how to incorporate hydraulics into your propagator to make growing your own sustainable food easier.

VOCABULARY

Hydraulics - The transfer of liquids through pipes and channels, especially as a source of mechanical force or control.

Prototype - A preliminary version of a device from which other forms are developed.

Volume - The amount of space an object or substance occupies.

Compress - To flatten using pressure.

Pressure - A continuous physical force.

Propagator - A covered container filled with soil, used for germinating or raising seedlings.

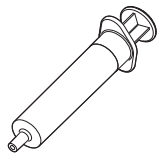
Force - An interaction that, when unopposed, will change the motion of an object.

Sustainability - To prevent the depletion of natural resources in order to maintain ecological balance.

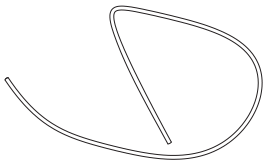
Seedling - A young plant, especially one raised from a seed and not a cutting.

Carbon footprint - The amount of carbon dioxide released into the atmosphere as a result of activities of an individual, organisation or community.

YOU WILL NEED

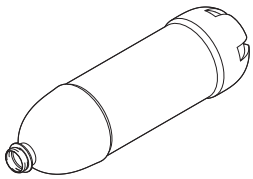


5cl Syringe
2

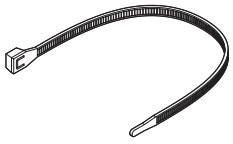


3mm Tubing
1

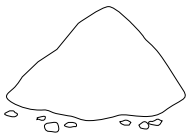
Wooden Dowel
20



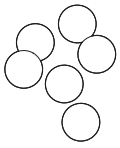
Plastic Bottle
1



Zip Tie
3

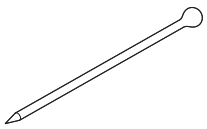


Soil
1

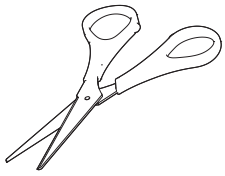


Seeds
20

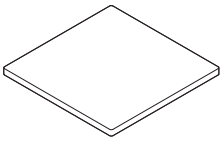
Rubber Band
6



Skewer
1



Scissors
1



Cloth
1

WARM-UP ACTIVITIES

A

5-10m

Natural gas and electricity are used to provide heat and light to greenhouses that grow our food. This has a huge impact on our environment, which is referred to as our carbon footprint.

Consider and investigate the following:

- What else contributes to our carbon footprint?
- Do all the food groups have an impact on the environment?
- How can we reduce the carbon footprint produced by food?
- What benefits are there in growing our own food at home?

Thinking about where our food comes from and the impact it has on our environment will help you understand why sustainability is important.

Now all you have to do is decide what seeds you want to plant! We chose tomato seeds that came from tomatoes we had in the fridge. What will you choose?

B

10-15m

Hydraulics can be found in many different devices across the world, such as cranes and forklifts.

Using online resources, investigate what other types of equipment use hydraulic systems for their operation and the benefits of their use.

This will help you to understand the variety of uses that hydraulics have and also how you can incorporate them into your propagator.

MAIN CHALLENGE

30-40m

Building a propagator for use at home is a great way to grow your own sustainable supply of fresh food.

Firstly, you'll need to decide which type of seeds you want to plant, then design and construct your propagator, whilst incorporating hydraulics to make the growing process easier.

We have provided you with an example of how hydraulics can be added to your propagator to allow easy access to your seedlings, but if you're feeling creative we encourage you to design your own.

Every time an engineer is faced with a problem, they approach it using the Engineering Design Process.

Ask - What's the problem?
Imagine - Choose a solution.
Plan - Design and choose materials.
Create - Make it.
Test - Test your creation.
Improve - Redesign as needed.

Using this design process, see if you can create the most effective hydraulics system for your propagator. Good luck!

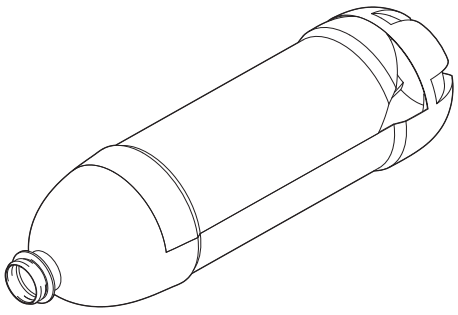
BUILDING THE PROPAGATOR

There are many ways to add a hydraulics system to your propagator, especially if you're feeling creative! Here are the steps we followed to complete ours.

A

Using scissors, carefully cut a rectangle shape in the side of your bottle. Be sure to keep a small section attached at the bottom of the bottle, as this will be your hinge.

If you need help, ask an adult to do this step for you.

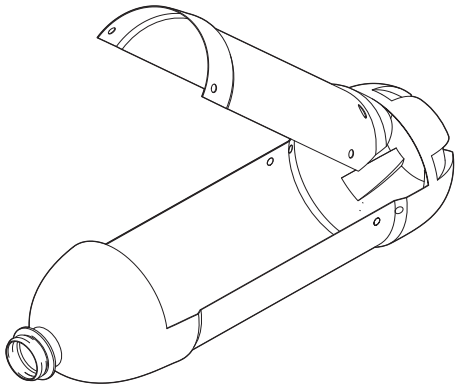


B

Using a skewer, pierce four holes in the bottom end of your propagator, and one hole through the lid near the bottleneck. These should be wide enough to place the wooden dowels through.

You should have something that looks like the image below.

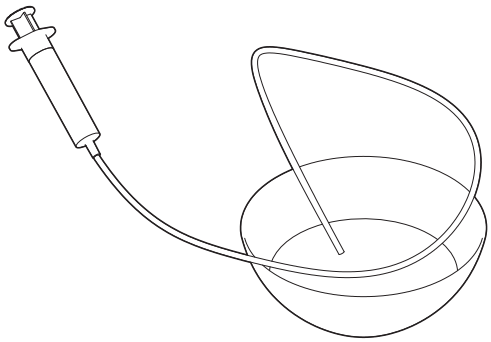
To make the holes safely, place a sponge or cloth under the bottle and push the skewer through. Don't forget to ask an adult if you need help.



C

Next, we need to add the water. Using a bowl, suck water into the tubing and syringe. You may need to do this a few times to get all of the air out.

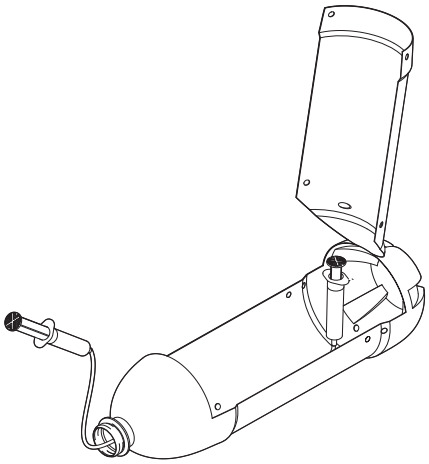
We added a small drop of food colouring so that we could see the water passing through the hydraulic system. This step is optional.



D

Thread the tubing through the bottle neck and attach the empty syringe to the other end of the tubing. Make sure both syringes are attached to the tubing securely.

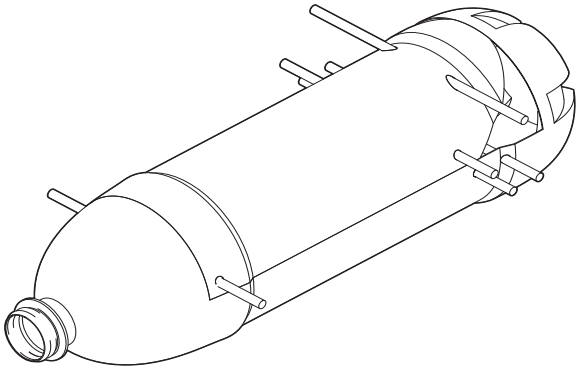
Test the system by pushing the syringe in the bottle down. You should see the other syringe move up.



E

Take your wooden dowels and insert them through the holes you have just made.

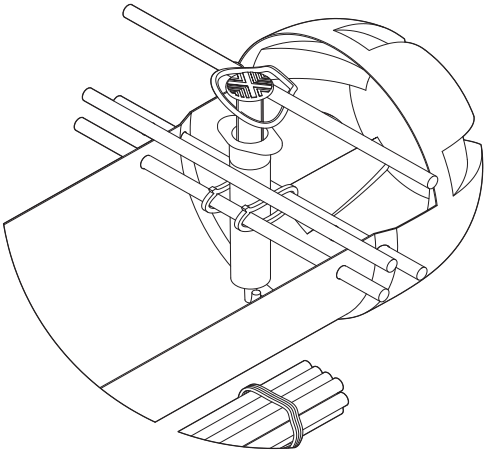
These will hold your syringe in place.



F

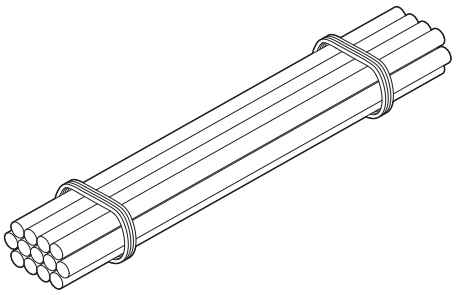
Insert the syringe between the wooden dowels and secure by placing zip ties either side. This will form the hinge that will open and close the lid.

You should have something that looks like the image below.



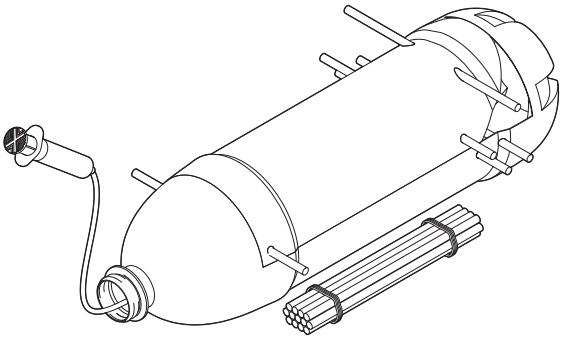
G

To add stability to your propagator you need to make feet. Simply wrap two elastic bands around 13 wooden dowels. Repeat this step to make sure you have two feet in total.



H

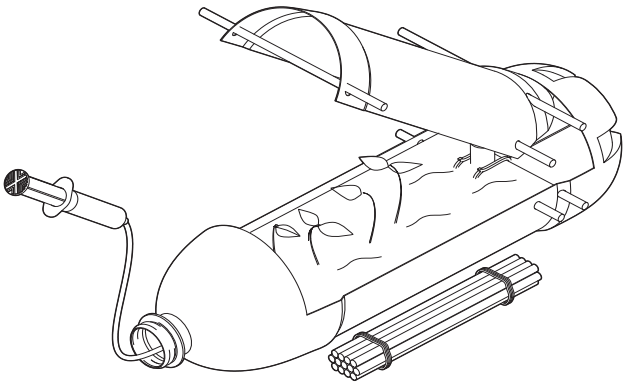
Place the feet on either side of your propagator. These feet will hold the propagator in position just as they are, but you can also use glue to fix them to the bottle if you want them to be more secure.



I

Add in the soil and plants and test that the mechanism works.

Now all you have to do is wait for your seedling to grow. Don't forget to water them, and make sure they get plenty of sunlight!



DID YOU KNOW?

You may think that the use of Hydraulics is a modern engineering concept, but evidence of basic water power used for irrigation dates back to Mesopotamia and Ancient Egypt!

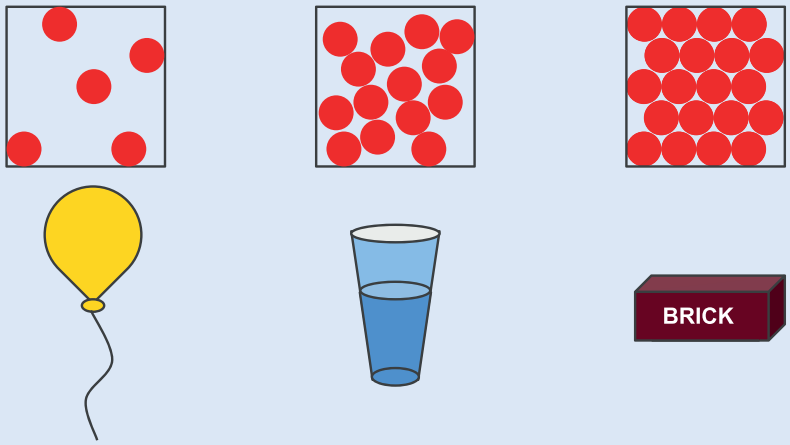
HYDRAULIC PROPAGATOR

POWER THROUGH WATER

10-15m

KS1/2 PROOF OF CONCEPT

We know that there are three main states of matter: gases, liquids and solids.



These three states act differently when we compress or squeeze them to fit into a smaller container or volume. To figure out which one we should use to power our system, we need something that cannot be compressed, but can also move freely.

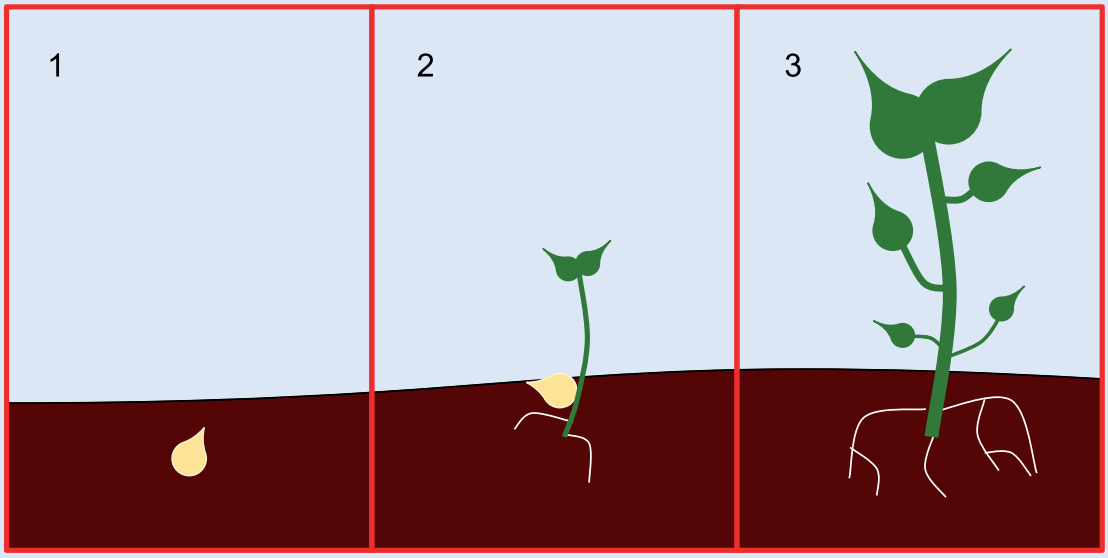
Since the molecules are further apart in gases, we are able to compress them in order to fit into a smaller volume. This means that gases wouldn't be suitable for our project.

The molecules in solids are already closely packed together, and therefore they cannot easily be compressed any further. As they don't flow freely, we can not use a solid either.

In liquids, the molecules are packed closely enough that they are not easily compressed. A key characteristic of liquids is that they can also flow to fit the shape of their containers. This, therefore, makes a liquid a strong choice for us to use to power our propagator. A system that uses the movement of a liquid to produce power is called a hydraulic system.

HOW DO SEEDS GROW?

Germination is the process where seeds grow into a new plant. Take a look at the images below to see this growth process:



Here, you can see the process in full:

- On the left, we see the seeds as they have just been planted. We then water the seeds, the soil and sun both provide warmth and the seed starts to sprout.
- Once the seed starts to sprout, it gathers oxygen through its seed coat and gains enough energy to sprout a shoot, which can then break the surface of the soil and open its first little leaves. The seed coat then falls off this shoot once the first leaves open up. In this phase, it's been using food stores from within its seed to sustain itself. This is the 'seedling' stage that you can see in the middle.
- Now that the seedling is above ground, it starts to grow bigger leaves to allow it to use photosynthesis to convert light and carbon dioxide into food to help it continue to grow.

KS3/4 DEEPER LEARNING

In our build, we have used the most simple type of hydraulic system - two pistons, or syringes, of equal size that are directly connected to each other with one tube. We are going to have a little look at the science behind this, as well as thinking about some ways that we could optimise it for maximum force!

First, let's look at Pascal's Law:

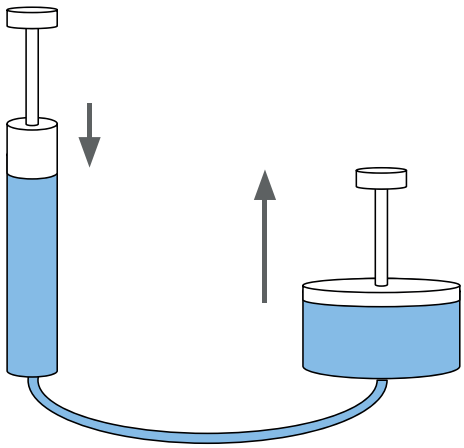
If you increase the pressure at one point within a contained fluid, there is an equal increase in pressure at every other point in the fluid.

This explains how the force is transferred within our closed system. The pressure increase that is observed when one syringe is compressed is equally observed at the other end when the other syringe extends. How might we be able to lift heavier things, or increase the extension? Let's look at the equation below:

$P = F/A$

P is the pressure, F is the Force and A is the Area over which the Pressure is exerted

By combining both of these principles, we can work out that the larger the surface area that the pressure is applied to, the larger the resulting force. Therefore, if we have an asymmetrical system where one syringe is larger than the other, by applying pressure to the smaller side, we can see a higher force on the other. However, if we take volumes into account - the extension on the syringe will be proportionally smaller. Therefore, we would need to do the opposite, in order to increase the extension of a lighter object that would need less force to lift.



QUIZ

15-20m

Why is sustainability important?

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.....

Name two devices that use hydraulic systems.

.....

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What are hydraulic systems powered by?

.....

.....

What is pressure?

.....

.....

What is Pascal's Law?

.....

.....

QUIZ

What are the three states of matter?

.....

.....

What are the steps of the Engineering Design Process?

.....

.....

Why are the steps of the Engineering Design Process important?

.....

.....

What is a Carbon Footprint?

.....

.....

Where have we seen the first examples of hydraulic systems in history?

.....

.....