

SparkLab, Sciencentre

Maker Space: *Air machines*

The Challenge

Push, pull, lift and tilt! Build a simple air-powered machine that can perform a task. What will you make the machine do? Use pressurised air and pneumatics to make your machine move.

Learning Outcomes

- Explore how machines are designed, built, tested and improved to achieve a purpose or do a job, including;
 - The different roles components of a machine play. Some components allow part of a machine to bend or rotate, whilst others push or pull.
 - How new parts can be added to a basic machine to achieve a specific purpose or respond to a need.
- Test how pneumatics and compression of air (gas), can transmit a force (push) which can be used to create movement and do work.
- Incorporate pneumatic systems in your design to make parts of your machine to move.
- Use simple tools and techniques to manipulate a range of everyday materials to create a simple machine.
- Gain confidence in designing a prototype, testing your ideas, identifying areas of the design that need improvement, posing a new design solution, making a change and observing the impact of that change.
- Feel and recognise success in designing and implementing creative solutions to real world challenges.
- Express enjoyment in engaging in the challenge and sharing ideas and understandings.



Catherine's Clothes Crusher

Equipment

- Hole puncher
- Ruler
- Scissors

Design Materials

- Cardboard
- Straws
- Pipe cleaners
- String
- Masking Tape
- Plastic tubing (~4mm diameter)
- Syringes

Optional materials

- Testing objects (things for your machine to pick up, move or lift)
- Try filling your syringes and tubing with water for a hydraulic system.

Set-up steps

1. Think about what you would like your machine to do. Clean your room? Pick up a toy? Make a puppet dance? Try searching Pneumatic or Hydraulic activities online for inspiration!
2. Follow the instructions in the Detailed Setup on page 3 to put together your air-powered system and create the pieces needed to make your machine.
3. After you have put together your machine try using materials like pipe cleaners, string and paper to make specialised parts for your machine.

Design process

This activity follows a design process. Below are some questions that will help at each stage of the process.

Think of some solutions

- In what way do you want the machine to move? How might this affect what you build?
- When you push in or pull out the plunger of a syringe how does the machine move? How could something moving in this way help you perform a task?
- What will you attach to the plungers of the syringes? What parts of your machine will they move?
- What are some real world examples that you have seen before?
- What ideas do you have for your machine and what will you make your machine do?

Make a prototype

- What materials will you use to add new parts to your machine?
- How can you use the different properties of the materials in your own design?
- How can you build parts into your machine that rotate or bend at joints?
- How will you attach parts to your machine?

Test it out

- Test out your air machine by pushing or pulling on the plungers. How well did it move?
- Did your air machine do what you designed it to do?
- What did you observe during testing? Did your machine move in the way you predicted?
- What part of your design worked really well?

Improve your design

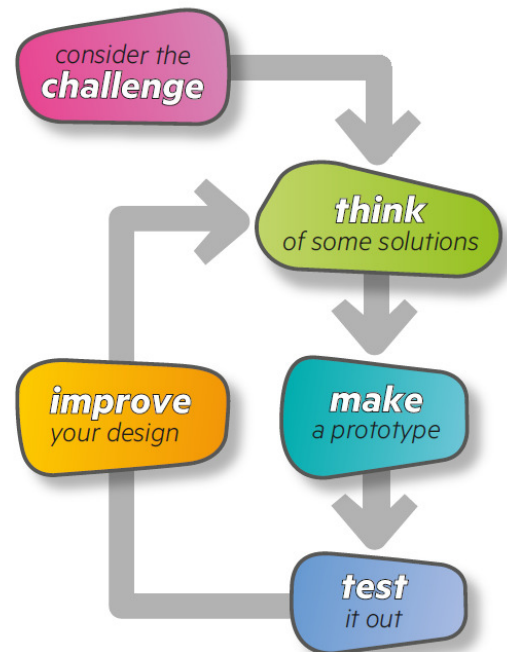
- How could you improve on your design? Are there any areas showing signs of weakness or breaking?
- How can you build on your machine so that it uses more than one plunger and operates as a whole system?
- What ideas could you incorporate from someone else's design?
- If you started again, what would you do differently? What would you do the same?

Background science

If you have a look at a simple machine, for example a crane, you will notice that it can move because it has joints and a power source that makes the joints move. Joints can stretch, squeeze, twist and bend, allowing a machine to lift objects by raising an arm or move objects from one place to another by rotating. Machines can use many different power sources, one of those power sources is air (gas) and this type of power is called pneumatics.

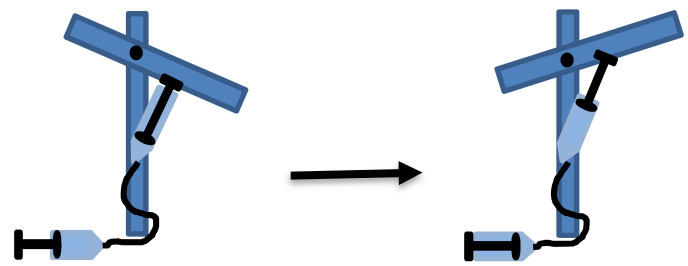


A pneumatic power system can be set up at home using two syringes and a piece of plastic tubing as in the diagram above. The plastic tubing is pushed on the tip of each syringe. The plunger of one syringe is pushed all the way in, while the plunger of the second syringe was pulled out to the last measurement before the plastic tubing was attached. The positioning of these plungers is what gives the air inside the syringes its power. When the plunger of one syringe is pushed in, the air inside that syringe is squished and compressed, forcing it to move through the plastic tube and into the second syringe. This causes the plunger of the second syringe to be pushed out because of the force the compressed air is placing on the plunger and an increase in pressure. Pulling the plunger of the first syringe back out again causes the



pressure inside the syringes to decrease, as a result the plunger of the second syringe, which was just pushed out, gets pulled back into the syringe again.

Pneumatic systems like these can be connected to joints to create movement. If one of the syringe's plungers in the system is fixed to a machine the second syringe can be used to control it. When the plunger of the control syringe is pushed in, it can be used to raise the arm of the machine, and lower it back down again when the plunger is pulled back out.



Replacing the air with water or a liquid would make this a Hydraulic system.

Key Search Terms: Pneumatics, Simple pneumatic machine, Hydraulic activities

Appendix

Detailed Set Up

1. Think about what pieces you might need when building your machine. Draw them out on cardboard using a ruler. Start with rectangles of different lengths. You can add more pieces later!
2. Cut your pieces out using scissors, or ask an adult if they can help.
3. Make some holes in your pieces using a hole punch. You can connect two pieces of cardboard together by threading straws, pipe cleaners or split pins through these holes, creating joints that can move. To begin, try punching holes in your piece like in the diagram. You can add more holes to your pieces or make new pieces while you are building.
4. Set up your air power: you will need two syringes and a 40cm piece of plastic tubing. Push one end of the plastic tubing onto a syringe, making sure the plunger of the syringe is pushed all the way in and it is a tight seal. Before pushing the tubing onto the second syringe pull the plunger out to the last measurement. You should now have two syringes attached to each other by a piece of plastic tube. Make as many of these syringe systems as you need for your build. Try experimenting with the length of your plastic tubing and the size of the syringe.

