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AIR AND WATER POWER

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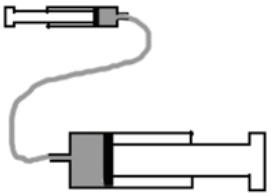


Introduction

The words 'PNEUMATICS' and 'HYDRAULICS' may be unfamiliar to many primary teachers but these simple activities can help teachers and children understand how AIR TRAPPED INSIDE SOMETHING (e.g. a balloon or a tube), or WATER TRAPPED INSIDE SOMETHING (e.g. a syringe and tube) can have quite a strong force.

Pneumatics and hydraulics are very closely connected, so the activities on hydraulics follows on quite naturally from the pneumatics activities.

Two lesson plans are described here:

LESSON 1 investigates pneumatics using plastic bags and balloons.

LESSON 2 investigates pneumatics and hydraulics using syringes and tubing.

Learning Objectives

Strand: Energy and Forces

Strand Unit: Energy

"The child should be enabled to identify and explore how objects and materials may be moved.....
using trapped air pressure (pneumatics);
using trapped liquid under pressure (hydraulics)"

Equipment

Lesson 1 (Pneumatics, using plastic bags or balloons):

Balloons, 40-50 cm. lengths of plastic tubing (approximately 5 mm diameter, available in hardware stores), diluted Milton or other mild disinfectant, plus, for:

Activity 1: A few books, sandwich bag

Activity 2: A light box with a hinged lid (e.g. a teabag box)

Activity 3: A cardboard box, paper fasteners or knitting needle to act as hinges.






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Equipment

Lesson 2 (Pneumatics and Hydraulics, using syringes and tubing):

Activities 4, 5, 6 and 7: Plastic syringes: 2, 5, 10, 20 ml (no needles!), 60 cm lengths of plastic tubing that fit exactly onto the syringes – it has to be airtight (3 mm diameter is the likely size; obtainable from scientific suppliers, some hardwares, or pet shops that keep fish), basin of water.

Suggested class level

5th/6th classes

Preparation

DPSM Junior activity 'Moving Air' would be a good preparatory lesson for understanding the power of air.

This leads on nicely to the power of trapped air (**Pneumatics**) and then to the power of trapped water (**Hydraulics**).

If possible, but not essential, children should have been given the opportunity to play and explore with water, e.g. straws, the power of a water jet from a squeezy bottle, etc.

Background Information

There is tremendous energy both in moving air and in moving water. Moving air has been used for many purposes, e.g. in windmills for grinding corn, making electricity, etc.

Moving water is used in hydro-electric power stations to make electricity. There is huge energy in the ocean – both in tides and waves – and much research is being done to see if the ocean can provide us with electricity.

Trapped air and water can also produce great forces.

Air brakes on buses and trucks, and drills for breaking up roads, are examples of pneumatics.

Hydraulics (using trapped liquids) are used in many heavy machines because of their huge strength, e.g. bulldozers, forklifts, hydraulic brakes.

Once the principles of pneumatics and hydraulics have been understood, children can design and make various toys or gadgets.

Hydraulic dump truck

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Trigger Questions

What is a machine?
(A thing that makes work easier to do).

Can you name some simple machines?
(Scissors, screws, levers, hammers, wheels and axles,.....)

And more complicated machines?
(Lawnmowers, car engines, sewing machines, combine harvesters.....)

Do you think you need electricity to make all machines work?
(No! Human energy or the energy from wind and water can also make machines work).

Do you think air has power?
(Things blown by the wind, windmills, wind turbines that make electricity.....)

Do you think water has power?
(Waves in the sea, waterfalls, currents in rivers, coastal erosion.....)

What causes waves?
(The wind blowing over the ocean).

How is most electricity made?
(From something moving, e.g. water, wind, steam. Something has to move to turn the turbines – big drums that can spin around - that make the electricity).

Trigger Questions for Pneumatics:

Do you know any words beginning with 'pneu' ?
(Pneumonia, pneumatic tyres/drill).

Have you any idea what the 'pneu' part of the word means?
(Connected with AIR. e.g. pneumonia is inflamed lungs and affects the breathing of air).

When you pump up the tyres of your bike what exactly is happening?
(You are pushing in lots of air that becomes compressed. It now has the power to hold up your weight!).

Why do you think most car tyres are called 'pneumatic'?
(They are filled with compressed air).

What is compressed air?
(Lots of air squeezed together into a small space).

So, what is holding the car up?
(AIR!)

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Trigger Questions for Hydraulics:

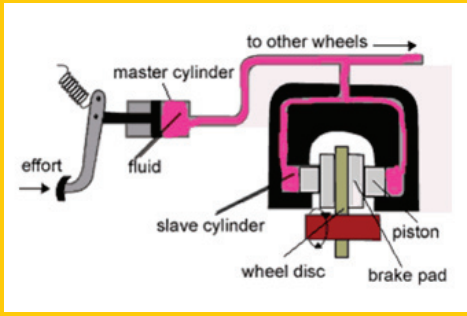
If a word begins with 'hydra' or 'hydro' what do you think it means?
(Connected with WATER. This could be linked with health and dehydration, and the importance of drinking water).

When you pull your brakes on a bike what is happening to the wheels?
(You are pulling pads called 'brake pads' up against the wheels).

Why does this stop the wheels?
(Friction. Refer to DPSM activity 'Friction – Slip or Stick').

Have you heard of 'Hydraulic brakes' on vehicles?

How do you think they might work?
(The brake pedal of the vehicle pushes against the end of a syringe which pushes the trapped fluid –called brake fluid – against the brake pads which rub against the wheels and stop them).



Content

SCIENCE: Forces

MATHS:
Measures:
Length
Ratio
Capacity

Skills

Predicting
Experimenting
Observing
Designing and Making

Cross-Curricular Links

Geography: Coastal Erosion, windmills in Holland

History: The power of water was very important in the Industrial Revolution.
Steam Engine
Windmills for turning millstone for grinding corn.

Art

Lesson 1

PNEUMATICS: using plastic bags and balloons

Trapped air *(e.g. inside a plastic bag or balloon)* can lift things up.

Activity 1

How many books can the children lift by using trapped air?

- Put a large airtight plastic bag on the desk and put a book on top of it, leaving the open end sticking out. Keeping the opening as small as possible, blow into the bag. What happens to the book?
  (You may need to put something against the end of the bag to keep the book from sliding off).
- Keep adding more books. How many books can the bag hold up?
- What is holding the books up? *(Compressed air i.e. squashed up air).*

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Lesson 1

PNEUMATICS: using plastic bags and balloons

Trapped air *(e.g. inside a plastic bag or balloon)* can lift things up.

Activity 2

Can the children lift the lid of a cardboard box (e.g. a teabag box) by using trapped air?

- (The connection between the tube and the balloon must be airtight; sellotape may be needed).

Activity 3

Can the children design and make a monster whose jaws are opened and closed by blowing into a balloon?

- How will they hinge the lid of the box? *(paper fasteners)*

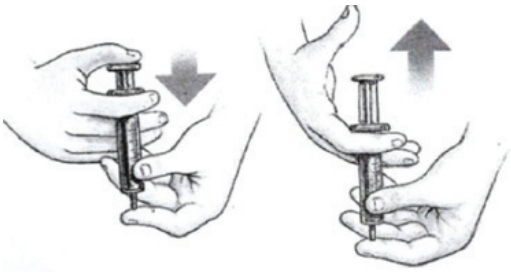
Lesson 2

PNEUMATICS using syringes and tubing

Activity 4

Feeling compressed air

- Take the syringe and lift the plunger. What happens? *(The syringe fills with air).*
- Cover the other end of the syringe with a finger, and press down hard on the plunger. What do you feel? *(It is easy to push in a little bit, but gets harder as the air gets more compressed).*
- Now let the plunger go. What happens? *(The plunger shoots back up and then stops).*
- Why do you think this happens? *(The compressed air pushes harder against the walls of the syringe, so that when you let the plunger go the air expands back to its original state).*



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Lesson 2

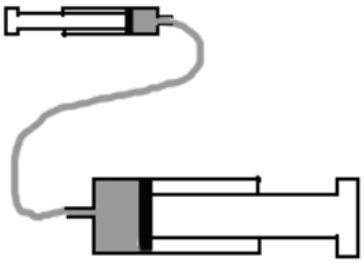
PNEUMATICS using syringes and tubing

Activity 5

Controlling movement using a syringe attached to each end of plastic tubing.

a) Using 2 syringes of the same size:

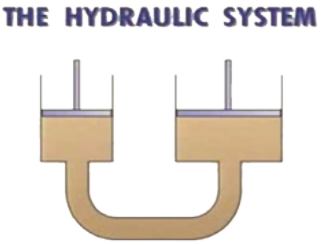
- Push the end of one syringe fully in, and attach the tubing to it.
- Push the end of the other syringe only partly in, and attach the tubing to it.
  (This is to make sure that the syringes are not pushed out of the tubing).
- Predict what will happen to the other syringe when you push one syringe in and out?
  Now try and see! *(The other syringe moves out).*
- Why does this happen?
  (The trapped air has the power to move things).
- Can you compare the distances both syringes move?
  (Approximately the same).



b) Repeat the above activity using two different sized syringes.

- Do you think the syringes will move the same distance this time?
  Try and see! What do you notice?
- Is there any connection between the size of the syringes and the distances they move?
  (A small syringe pushes a bigger syringe a smaller distance.
  A large syringe can push a small syringe out a much larger distance).

HYDRAULICS using syringes and tubing



Trapped water *(e.g. inside a tube attached to syringes)* can have a great force.

Hydraulics Activities:

Activity 6

Repeat the above two syringe activities under 'Pneumatics' (5a and 5b, i.e. using the same size syringes, and then two different size syringes), but this time with water instead of air in the syringes and tubing.

- Put water into the tubing and syringes as follows, using a basin of water:
- Put two syringes and tubing (not connected) under the water (to prevent air bubbles).
- Keeping them underwater, attach one fully compressed syringe to the tubing.
  Pull out the plunger until the syringe is almost full of water.
- Compress the other syringe fully and attach it to the other end of the tubing.
- Did you notice any difference between air and water inside the tubing, when pushing in the syringes?
  (Smoother and stronger movement)

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PNEUMATICS using syringes and tubing

Activity 7

Design a toy that uses hydraulics to make something move (suggestions: a mouse going in and out of a hole, jack-in-the-box.....)

Maths

1. When using the two different-sized syringes, calculate the ratio of the sizes of syringes. Then measure the distances the two syringes moved. Is there any connection between these two ratios?

2. Investigate which combination of syringes gives the greatest movement.

Safety

Hygiene: (1) Clean the end of the plastic tube with dilute Milton solution (or equivalent) after each child.
(2) Always use sterile syringes that have not been used for medical purposes.

Be careful with the sizes of syringes – a big syringe could push out a small syringe with great force.

Be careful with knitting needle if using it as lever for monster's jaws.

Follow-up Activity

Can children design and make something which needs to be controlled by moving backwards and forwards or up and down, e.g. a jack-in-the-box, moving scenery for a puppet theatre, Santa coming out the top of a chimney....

Design and make a hydraulic lift.