1. Year Groups

Years 3/4

2. Aspect of D&T

Mechanical systems

Focus

Pneumatics

3. Key learning in design and technology

Prior learning

- Explored simple mechanisms, such as sliders and levers, and simple structures.
- Learnt how materials can be joined to allow movement.
- Joined and combined materials using simple tools and techniques.

Designing

- Generate realistic and appropriate ideas and their own design criteria through discussion, focusing on the needs of the user.
- Use annotated sketches and prototypes to develop, model and communicate ideas.

Making

- Order the main stages of making.
- Select from and use appropriate tools with some accuracy to cut and join materials and components such as tubing, syringes and balloons.
- Select from and use finishing techniques suitable for the product they are creating.

Evaluating

- Investigate and analyse books, videos and products with pneumatic mechanisms.
- Evaluate their own products and ideas against criteria and user needs, as they design and make.

Technical knowledge and understanding

- Understand and use pneumatic mechanisms.
- Know and use technical vocabulary relevant to the project.

4. What could children design, make and evaluate?

tipper truck jack-in-the-box class display
moving creature shop window display
moving toy other – specify

5. Intended users

themselves peers younger children
older children shoppers visitor to school
other – specify

6. Purpose of products

celebration event information educational
play advertising interests and hobbies
campaign other – specify

7. Links to topics/themes

Toys and Games Our Community
Forces and Movement Mini-enterprise
other – specify

8. Possible contexts

shop home school leisure culture
enterprise environment local community
other – specify

9. Project title

Design, make and evaluate a _____ (product) for _____ (user) for _____ (purpose).

To be completed by the teacher. Use the project title to set the scene for children's learning prior to activities in 10, 12 and 14.

10. Investigative and Evaluative Activities (IEAs)

- Children investigate, analyse and evaluate familiar objects that use air to make them work e.g. bicycle pump, balloon, inflatable swimming aids, foot pump for inflating an air bed. *What does the air do? How has it been used in the design of these products? How can air be used to move heavy objects?*
- Construct a simple pneumatic system by joining a balloon to 5mm tubing and then to a washing-up liquid bottle. *What happens to the air when you squeeze the bottle? What happens when you let go? Can you lift a soft toy or a note pad using a balloon?*
- Demonstrate lifting an object and ask the children to think about ways in which this might be used in a product. *Who might it be for? What is its purpose? What part moved and how did it move? What materials have been used? How effective do you think it is and why? What else could move?*
- Demonstrate a range of pneumatic mechanisms using prepared teaching aids including two syringes joined by plastic tubing; three syringes connected using a T-connector and using different sized syringes. Ask the children: *What happens when the plunger of one syringe is pressed in? Why do the syringes move at different speeds?* Note: take care as the syringe may come out with force. Discuss why, when pressing a large syringe, it can take time and feel 'squishy' before the smaller syringe is moved.

11. Related learning in other subjects

- **Spoken language** – participate in discussion and evaluation of examples of products that use pneumatics. Ask relevant questions to extend knowledge and understanding. Build technical vocabulary.
- **Science** – identify and compare the suitability of a variety of everyday materials for particular uses.

12. Focused Tasks (FTs)

- Demonstrate how to assemble the systems using syringes, tubing, balloons and plastic bottles. Introduce ways in which pneumatic systems can be used to operate levers.
- Demonstrate the correct and accurate use of measuring, marking out, cutting, joining and finishing skills and techniques.
- Provide the materials and ask the children to try out and draw the three systems they have been shown: a) Balloon connected to a washing-up liquid bottle. *What happens when you squeeze the bottle? What happens when you let go?* b) Two syringes of the same size connected together. *What happens when you press the plunger of one syringe down? How far does the other syringe move?* c) Two syringes of different sizes connected together. *How far do these syringes move when pressed?*

  Note: take care as the syringe may come out with force.

13. Related learning in other subjects

- **Spoken language** – ask relevant questions to extend knowledge and understanding.
- **Mathematics** – measure, compare, add and subtract: lengths, volume and capacity.

14. Design, Make and Evaluate Assignment (DMEA)

- Develop a design brief with the children within a context which is authentic and meaningful.
- Discuss with children the purpose of the products they will be designing and making and who the products will be for. Ask the children to generate a range of ideas, encouraging creative responses. Agree on design criteria that can be used to guide the development and evaluation of the children's products.
- Using annotated sketches and prototypes, ask the children to develop, model and communicate their ideas.
- Ask the children to consider the main stages in making before assembling high quality products, drawing on the knowledge, understanding and skills learnt through IEAs and FTs.
- Evaluate the final products against the intended purpose and with the intended user, where safe and practical, drawing on the design criteria previously agreed.

15. Related learning in other subjects

- **Spoken language** – ask relevant questions to extend knowledge and understanding. Build technical vocabulary. Consider and evaluate different viewpoints.
- **Art and design** – use and develop drawing techniques. Use colour, pattern, line, shape.
- **Science** – when evaluating, make systematic and careful observations and take accurate measurements.

16. Possible resources

examples of products and books, photos and videos showing pneumatic systems

washing-up liquid bottles, 5mm plastic tubing, sterile syringes, T-connectors, balloons

card, plastic sheet, PVA glue, masking tape, parcel tape, sticky pads, pipe cleaners, elastic bands, syringe clips,

left/right handed scissors, snips, card drills, cutting mats, hole punches, finishing media and materials

17. Key vocabulary

components, fixing, attaching, tubing, syringe, plunger, split pin, paper fastener

pneumatic system, input movement, process, output movement, control, compression, pressure, inflate, deflate, pump, seal, air-tight

linear, rotary, oscillating, reciprocating

user, purpose, function, prototype, design criteria, innovative, appealing, design brief, research, evaluate, ideas, constraints, investigate

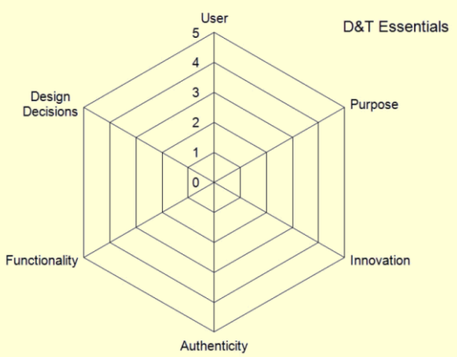
18. Key competencies

problem-solving teamwork negotiation
consumer awareness organisation motivation
persuasion leadership perseverance
other – specify

19. Health and safety

Pupils should be taught to work safely, using tools, equipment, materials, components and techniques appropriate to the task. Risk assessments should be carried out prior to undertaking this project.

20. Overall potential of project



Years 3/4

Mechanisms
Pneumatics

Instant CPD

Tips for teachers

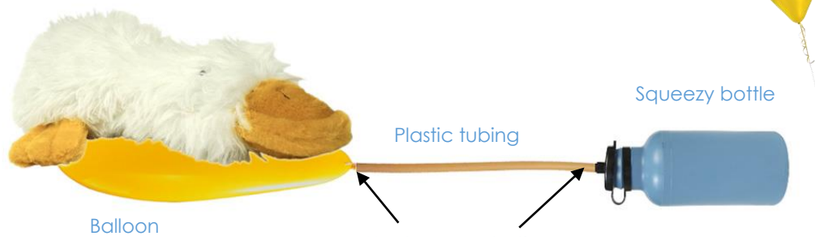
- ✓ Card from recycled packaging is a cost-efficient way of providing enough material for children to experiment with different arrangements and to make mock-ups and prototypes.
- ✓ To help develop children's technical knowledge, research images and videos of pneumatics in action, including Lego models and hydraulic systems used in construction machines.
- ✓ Tell the children that while air can be compressed, liquids cannot, which is why the syringe can feel squishy with a pneumatic system.
- ✓ Do not use syringes unless they are supplied in a sealed package.
- ✓ Take care – a large syringe can push out a small syringe with great force.
- ✓ Build up a collection of washing-up liquid bottles, egg boxes and other boxes well before starting the project. Make sure they are empty and properly cleaned before using them.
- ✓ Takeaway shops may give away a few clean food containers which can be covered in papier-mâché and painted.
- ✓ Get the children to blow air on their hands and feel the flow of air.
- ✓ Use a cycle pump to try to knock over a card structure, and then repeat using the air from a stronger pump or balloon.
- ✓ Balloons need to be securely fixed to the tubing. Use a tight elastic band wound several times or use masking tape.
- ✓ Display technical vocabulary and encourage the children to use it when discussing mechanisms and when designing and making.
- ✓ To ensure safety and hygiene, balloons should not be blown up by mouth.

Useful resources at www.data.org.uk

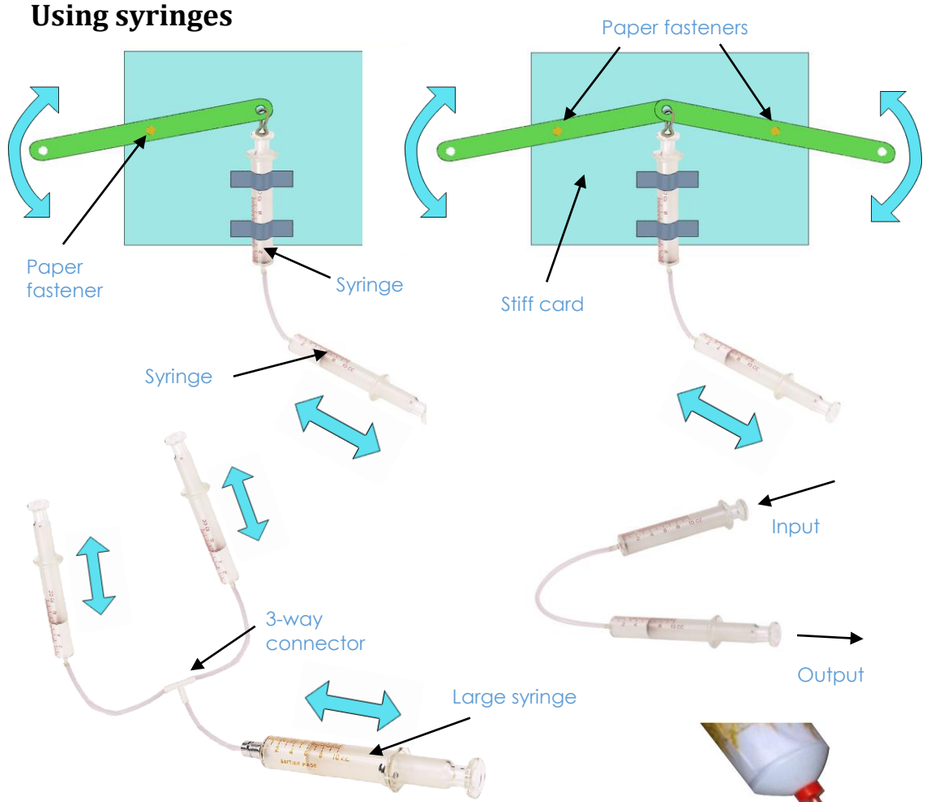
- Mighty mascots
- Working with plastics
- Working with materials

Teaching aids to demonstrate pneumatic systems

Squeeze the bottle (input movement) to inflate the balloon (output movement) and raise the toy.



Using syringes



Design decisions

- Children might use a squeezy bottle and a balloon in a container to raise or lower an object or a lever.
- They might choose to use three syringes connected by a T-connector so that two objects move backwards and forwards.
- Adding levers and linkages allows children to design and make more complex mechanical systems.

Designing, making and evaluating a moving 'creature in a box' toy for small children

An iterative process is the relationship between a pupil's ideas and how they are communicated and clarified through activity. This is an example of how the iterative design and make process *might* be experienced by an individual pupil during this project:

THOUGHT	ACTION
What sort of moving toy shall I make and who will it be for? How will it fit into the box? How will it move? Which parts will move?	Discussing ideas, drawing annotated sketches, generating design criteria.
Which pneumatic system will work best?	Modelling possible systems. Discussing and evaluating mock-ups and prototypes against the design criteria.
What materials will I need?	Discussing, exploring and trialling materials.
Who will I work with? How long will it take? What order will I work in? What tools and techniques will I use?	Negotiating, developing and agreeing a plan of action.
How will I finish it so that it looks attractive?	Discussing, exploring and trialling materials.
More thoughts … appraising, reflecting, refining.	More actions … building, testing, modifying.
Will the finished toy meet the needs of the user?	Evaluating the toy with the intended user and against the design criteria.

Glossary

- **Compressed** – something that is squashed, such as air in a tube.
- **Input** – what goes into a system.
- **Output** – what comes out of a system.
- **Pivot** – a point about which a lever turns.
- **Lever** – a beam which turns about a point.
- **Pneumatic** – a system that works using gases (air).
- **Hydraulic** – a system that works using liquids (water).
- **Pressure** – the force used on an object or surface.
- **Inflate** – fill something with air or a gas to make it swell up.
- **Deflate** – remove the pressurised air to allow an object like a balloon to shrink.
- **Syringe** – a tube with a nozzle and plunger for sucking and blowing air or liquids.
- **System** – a set of related parts or components used to create an outcome. Systems have an input, process and an output. In a pneumatic system, the 'input movement' is where the user pushes or pulls a syringe or pump. The 'output movement' is where the object at the end of the tube moves.