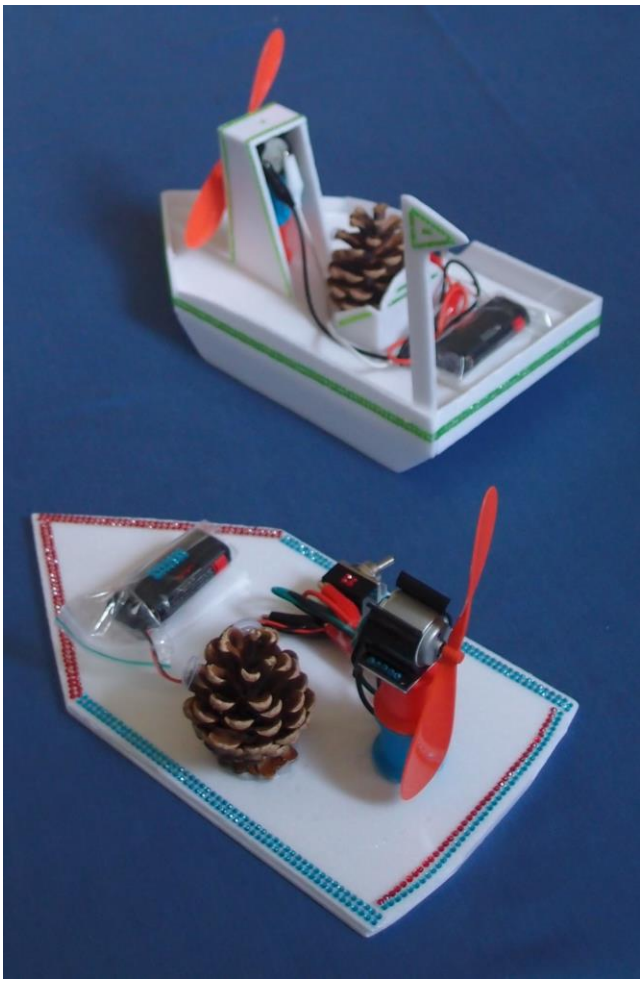

Fan Boats

Lesson Plan

www.tts-shopping.com

Product Code: TE10006

Fan Boats Summary

Recommended level – Years 4-6
Time taken – 6 hours
Pupils to work individually
Additional adult help is useful (ideally 1 adult per 6-8 pupils – you could invite in parent helpers)
Expectation – to complete working fan boats
Associated resources:
Fan boats PowerPoint
Fan boats workbook
Fan boats question sheet
Fan boats question sheet - suggested answers
How to make a fan boat blog
How to make a fan boat video

STEM Links

- Science: electrical circuits, materials, forces
- Technology: mechanical systems, electrical systems, designing and making
- Engineering: design, build, test and improve products, how a fan boat works
- Mathematics: drawing 2-D shapes, measurement

Curriculum Learning Objectives – it is recommended to cover these topics prior to the exercise so that the pupils are reinforcing their knowledge and understanding, rather than meeting the topics for the first time.

Science: Electricity
(Years 4 & 6)

Pupils should be taught to:

- construct a simple series electrical circuit, identifying and naming its basic parts
- recognise that a switch opens and closes a circuit
- recognise some common conductors and insulators, and associate metals with being good conductors
- use their circuits to create simple devices
- use recognised symbols when representing a simple circuit in a diagram
- pupils should be taught about precautions for working safely with electricity

Science: Materials
(Years 2 & 5)

Pupils should be taught to:

- identify and compare the suitability of a variety of everyday materials for particular uses
- give reasons, based on evidence from comparative and fair tests, for the particular uses of everyday materials

Pupils should think about the properties of materials that make them suitable or unsuitable for particular purposes and they should be encouraged to think about unusual and creative uses for everyday materials.

Science: Forces
(Year 5)

Pupils should be taught to:

- explain that unsupported objects fall towards the Earth because of the force of gravity acting between the Earth and the falling object
- identify the effects of air resistance, water resistance and friction, that act between moving surfaces

Pupils might explore resistance in water by making and testing boats of different shapes.

Design and Technology
(Key Stage 2)

Through a variety of creative and practical activities, pupils should be taught the knowledge, understanding and skills needed to engage in an iterative process of designing and making. When designing and making, pupils should be taught to:

Design and Technology: Design

- develop design criteria to inform the design of innovative, functional, appealing products that are fit for purpose

Design and Technology: Make

- select from and use a wide range of tools and equipment to perform practical tasks
- select from and use a wide range of materials and components according to their functional properties and aesthetic qualities

Design and Technology: Evaluate

- evaluate their ideas and products against their own design criteria and consider the views of others to improve their work

Design and Technology: Technical knowledge

- understand and use electrical systems in their products

Equipment needed

Parts included in class kit (per boat):

- 3 half-sheets of polystyrene foam (total 50 sheets)
- 1 battery holder (total 30)
- 1 snap battery connector (total 50)
- 1 toggle switch (total 30)
- 1 motor (total 30)
- 1 motor mount (total 30)
- 1 propeller (total 30)
- 3 crocodile leads (total 90)
- 2 cotton reels (total 100)
- 1 pine cone (total 1 box 500g)
- 2 googly eyes (total 540)
- Rhinestone craft tape (pack of 10 rolls)

Check you have received all these items in your class kit, and that the propeller fits tightly on the motor shaft. If there are any problems please let TTS know as soon as possible.

Tools and consumables (not included):

- 2 AA cells (these are often called batteries). It is very important to use **zinc chloride** type of cells, **not** alkaline or re-chargeable ones. If the pupils accidentally short circuit their battery (which often happens) then alkaline or re-chargeable cells get extremely hot and can cause burns. Zinc chloride type cells are cheap and easily available (e.g. from discount stores).
- Small sealable plastic bag (per boat). This is to put the battery in to help prevent it getting wet.
- Ruler, pencil and felt tip pen (per boat)
- Sheet of A4 card (per boat)
- Large scissors (per boat)
- Sellotape dispenser (per table)
- Low melt glue guns and glue sticks (several needed, e.g. 4-5, as there is likely to be a large queue to use them!). **Note: High melt temperature glue guns should not be used, as they can cause nasty burns.**
- Water tray, paddling pool or plastic box big enough to try out the boats, half filled with water
- Blue roll or cloth for mopping up water spills

Recommended resources for flotation exercise (not included):

- Metal coin
- Wooden lolly stick
- Piece of plastic K'nex
- Glass marble
- Piece of polystyrene foam
- Pebble

Risk Assessment

Conduct a risk assessment before undertaking the activity. A sample risk assessment is given below; you can use this as a starting point when writing your own.

Activity	Identified Hazard	Initial Risk Rating L/M/H	Control Measures	Controlled Risk Rating L/M/H
Use of glue guns	Burns	H	Children should be supervised by a responsible adult at all times when using the glue guns. Explain to children how to use the glue guns. Warn them that the ends are very hot. Use only low melt temperature glue guns. If burned hold under running water for ten minutes. Don't switch on the glue guns until after the safety briefing. In some schools children wear safety goggles when using glue guns.	M
Accidentally short circuiting battery	Burns, smoke inhalation	M	Explain how to avoid short circuits. Use only zinc chloride cells, not alkaline or re-chargeable ones as these can get very hot if short circuited.	L
Use of scissors & Sellotape dispensers	Injury e.g. to fingers	M	Make the children aware of the dangers. Do not give out the scissors until after the safety briefing.	L
Putting rotating fan too close to eye or putting finger in way	Bruising or damage	M	Explain the dangers to the children.	L
Running extension leads along floor for glue guns	Trip hazard	M	Avoid using extension leads if possible. Otherwise make sure extension leads are run where they cannot be tripped over.	L
Damaged or wet extension leads or glue gun leads	Electrocution hazard	H	Conduct a visual check of all electrical items before session to ensure the leads are undamaged. Place water trays away from all electrical appliances and sockets. Allocate a 'drying area' with paper towels to dry boats after testing if using glue guns to make modifications.	L
Water spillages	Slip hazard	M	Use water trays outside where possible. Warn people of hazard. Wipe up water spillages.	L

Vocabulary list

Battery / cell – this converts chemical energy into electrical energy. It is used to 'push electricity around a circuit. If you connect cells together you get more 'push' – a battery consists of two or more cells.

Conductor – an electrical conductor allows electricity to flow through it. Metals are good conductors.

Drag – as a boat passes through water, the water exerts a 'drag' force on the boat which acts to slow it down.

Insulator – an electrical insulator stops electricity passing through. Plastic, wood, rubber and glass are insulators.

Prototype – an early model used to test out a design idea.

Short circuit – an electric circuit which allows the electricity to flow round it with very little resistance, so the battery will drain quickly and get hot.

Streamlined – a boat which has a streamlined shape will be able to pass through the water more easily and quickly than one which doesn't.

Upthrust / buoyancy – when the boat is floating the water gives it an upthrust or buoyancy force which supports the boat against the downward pull of gravity.

Preparation needed

- Build a sample boat to explore any pitfalls, and to demonstrate to the pupils what they will be making and how it works. Instructions are given in both the 'How to make a fan boat' video and blog.

- Cut the polystyrene foam sheet neatly in half before giving it to the pupils. They will need a double thickness base to support their heavy electrical parts. Allow three half sheets per boat – two for the base and one for sides, fins, motor houses, rudders and other variations.

- Print out one fan boats workbook per boat. Print it in landscape, double sided, flipping on the short edge. Fold each sheet in half to make an A5 workbook, with the TTS logo on the front.

Flotation exercise (PowerPoint slide 3) - suggestions

1. Ask the pupils to identify which of the items are made of metal, glass, wood, rock or plastic, and predict which items will float and which will sink. You can pass the items around so they can feel the weight. Place the items in the water and check whether they behave as predicted.
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2. Question - which of the materials could you use to make your boat, and why? You could use the polystyrene foam because it floats, it is easy to cut and join, it is cheap and you have plenty of it. You could potentially use lolly sticks, which also float.

3. Question - which of the materials would you not use to make your boat, and why not? The metal, glass and rock sink, are difficult to cut and join, and you would have to trap air in them to make them float.

Forces exercise (PowerPoint slide 4) - suggestions

1. Place your sample boat on the water and ask the questions about forces pulling it down and pushing it up. Then switch on.

2. Question - can you explain why the boat moves across the water? When the propeller pushes the air backwards, the opposing force [of the air pushing the propeller] pushes the boat forwards.

3. Question - what is the main force opposing the boat moving? The main force opposing the boat moving is the resistance of the water, known as 'drag'. The air resistance acting on the boat is very small compared with the resistance of the water.

Designing your Boat (PowerPoint slide 7) - suggestions

Ask the pupils to come up with a design of boat which they think will fit their design criteria, and make a prototype using the A4 card. They should try to imagine the resistance of the water and think of a shape which would cut through the water easily. Also they need to work out where their electrical parts will be mounted; the centre of gravity should be near the middle of the boat, and the wires shouldn't get tangled in the propeller.

The propeller will work facing either forwards or backwards. It can be mounted either way round on the motor shaft. It will work much better one way than the other; they may be able to work out which way round to fit it, as it is curved to 'scoop up' the air as it turns. Otherwise they can try it both ways and find out which works best.

You could ask the pupils to suggest what might happen if:

- the base is too small (it might sink)
- the base it too narrow (it might capsize)
- the base is too wide (it might go slowly)
- the cotton reel stack is too short (the propeller blades would rub on the base)
- there is no gap between the propeller blades and cotton reels (the propeller won't go round and the motor might get hot and stop working)
- the crocodile leads get tangled in the propeller (it won't go round)
- the batteries get wet (they might stop working)
- the switch gets wet (it might stop working)
- the crocodiles get wet (they might go rusty and stop working)
- the centre of gravity is not in the middle (the boat might go round in circles, or even capsize)
- you put on lots of heavy decorations (the boat might sink)
- the boat doesn't go in a straight line (you could improve the balance, make sure the motor is attached straight, and perhaps add fins, an air rudder or a keel, or turn it into a catamaran)

Making your boat base (PowerPoint slide 12) – suggestions

1. It is a good idea to retrieve the pencils and the scissors before giving out the polystyrene foam, and give out felt tip pens instead. The pencils indent the foam, so that mistakes are more difficult to correct.
2. A double thickness of foam is needed to support the heavy electrical parts. The two parts should be glued together only **after** cutting to shape.
3. Check that the pupils have come up with a feasible (big enough) prototype before handing out the foam sheet. A minimum width of 14 cm and a minimum length of 25 cm is recommended. The most common mistake is making the boats too small.
4. Pupils can draw round their prototype on the foam if they like. Check the design marked on the foam is big enough before handing out the scissors.

Testing and Improving your Boat (PowerPoint slides 17-18) - suggestions

1. If the boat goes backwards instead of forwards, then try swapping over the crocodile clips attached to the motor terminals, as this will make the motor turn the other way and push the air in the opposite direction.

2. If the propeller stops going round then it could be catching on the cotton reels, or one of the crocodile clips may have come off.

3. If the boat is going very slowly then you could try fitting the propeller the opposite way round on the motor shaft. Check the airflow isn't blocked by features on the boat.

4. If the boat isn't moving even though the propeller is turning, it might be touching the bottom of the water tray.

5. Can the pupils spot any differences in design between the boats which go faster and those which go slower?

6. If the boat turns to one side when you want it to go in a straight line you could try:
Moving the battery so the centre of gravity is not over to one side or the other;
Trimming the boat to make it more symmetrical or pointed at the front;
Adjusting the motor direction if it isn't straight;
Adding an air rudder, fins along the sides or a shallow keel or rudder to help it go straight;

7. Try out the boat after making any modifications to see if they have made any difference to its operation.

Suggested schedule (depending on the timings of the school day):

08:30-09:00 Introduction and safety briefing

09:00-09:20 Flotation exercise

09:20-09:30 Forces

09:30-10:15 Select design criteria, draw your design, make card prototype

Break

10.30-11.00 Electrical circuits

11.00-12.00 Make boats. Test the electric circuit works on the assembled boat (in the dry).

Lunch

1.00-2.00 Finish off boats. Test them in the water trays and see what you can learn.

2.00-2.30 Decorate and improve boats then re-test.

2:30-3.00 Tidy up and plenary.

Following day: Complete question sheets.