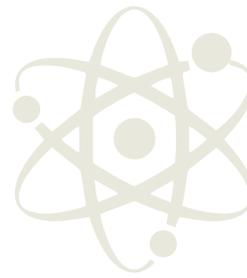




making physics matter



Age  
7-11  
years

# Working scientifically

## Developing children's skills in fair tests

### Introduction

Like comparative tests, fair test enquiries are an opportunity for children to explore cause and effect relationships in science. Children find the answers to 'big questions' in fair test enquiries by planning tests to collect data through changing, measuring and controlling variables. Fair tests involve making systematic changes and analysing data to identify how one variable influences another. Due to the increased challenge in this type of enquiry they are introduced in KS2.

### Big questions

Here are some examples of 'big questions' that pupils can explore through fair tests in KS2. There is almost one for every area of the curriculum so it is easy to plan opportunities for children to revisit this type of enquiry regularly and develop their skills.



Year 3	Year 4	Year 5	Year 6
How does the length of the carnation stem affect how long it takes for the food colouring to dye the petals?	Does the amount of light affect how many woodlice move around?	How does the level of salt affect how quickly brine shrimp hatch?	How does the temperature affect how much gas is produced by yeast?
How does the angle that your elbow/knee is bent affect the circumference of your upper arm/thigh?	How does the mass of a block of ice affect how long it takes to melt?	How does age affect a human's reaction time?	How does the length of time we exercise for affect our heart rate?
How does adding different amounts of sand to soil affect how quickly water drains through it?	How does the surface area of a container of water affect how long it takes to evaporate?	How does the temperature of tea affect how long it takes for a sugar cube to dissolve?	Can exercising regularly affect your lung capacity?
How does the number of layers of transparent plastic affect how much light can pass through?	How does the volume of a drum change as you move further away from it?	How does the angle of launch affect how far a paper rocket will go?	How does the angle that a light ray hits a plane mirror affect the angle at which it reflects off the surface?
How does the mass of an object affect how much force is needed to make it move?	How does the thickness of a conducting material affect how bright the lamp is?	How does the surface area of a container affect the time it takes to sink?	How does the voltage of the batteries in a circuit affect the brightness of the lamp?
How does the distance between the shadow puppet and the screen affect the size of the shadow?	How does the length of a guitar string/tuning fork affect the pitch of the sound?	How does the surface area of a parachute affect the time it takes to fall to the ground?	How does the voltage of the batteries in a circuit affect the volume of the buzzer?

## Working scientifically skills

As with other types of enquiry, fair tests are a great opportunity for children to plan their own tests to collect data. It is through fair testing that children will really learn to understand the different types of variables:

- **the independent variable that they will change in their test,**
- **the dependent variable that they are going to measure so that they can find out how the independent variable affects it, and**
- **the control variables which the children will need to keep the same so that they don't affect their results.**

All fair tests involve the measuring and recording of data that can then be displayed in a scatter graph or line graph. Children will be able to use their data to draw conclusions that identify a causal relationship eg 'when you increase X, Y will always decrease'.

As children progress through KS2, they should become progressively more systematic in how they approach fair tests and, as with the other types of enquiry, increasingly independent. Their written conclusions should also become increasingly sophisticated, with more focus on scientific explanations. Fair tests are a good opportunity for children to focus on their skills in evaluating their scientific enquiries. As they progress through the key stages, children will learn to critique not just their experimental methods but also their data by reflecting on reliability and accuracy.

## Resources

There is a range of equipment that schools will find useful to support fair test enquiries.

Stopwatches/timers (seconds)	Thermometers (°C)	Sound frequency (Hz) measuring app on iPad
Data loggers	Light sensors (lux)	Temperature sensors (°C)
Sound sensors	Newton meters (N)	Protractors (°)
Tape measures/rulers (mm/cm)	Balance (g)	Measuring cylinders (ml)
Access to Excel	Calculators	Squared/graph paper

## Reporting learning

It really isn't necessary for children to write a full laboratory report for every enquiry they carry out; in fact, it is far better to focus on a particular aspect of reporting for each enquiry so that children can focus on developing skills in that area. Fair test enquiries provide opportunities for children to work on all aspects of reporting, from creating written instructions to describe their plan, to tabulating data, graph-drawing, or writing conclusions and evaluating.

Children should be learning to independently plan and draw their own tables for recording data over KS2, making sure that all columns have headings with units and, where repeat measurements are collected, children will learn to calculate the mean average of a set of data. The most common mistakes that children make when creating tables for their data are:

- **not planning for sufficient rows and columns, and**
- **forgetting to include the units of measurement in the column heading.**

The expectation that children should always collect repeat readings and calculate an average when carrying out fair tests in upper KS2 leads to children developing a strong level of confidence in using statistical methods to analyse data sets.

In upper KS2, children will learn how to plot their own scatter and line graphs, plan scales for axes, plot points accurately, and include axis labels and titles. Peer and self-assessment strategies will help children be clear on the success criteria for data analysis strategies and fine-tune their skills. Children will need repeated practice to plan even scales with appropriate ranges for their data sets.

## Additional information

There are many examples of significant fair tests that have taken place over the years, which can be interesting to explore when looking at how ideas change over time.

When the children are learning about the properties of materials it would be quite interesting to learn about Hooke's Law, which was derived from a fair test involving stretching a spring with different forces. Children can repeat Hooke's experiment; and the data they collect can help them to test and create their own mass or force-measuring device.



## Planning

### Curriculum mapping

Identify a potential fair test enquiry in every science topic.

Aim for each class to revisit fair testing five or six times over the academic year.

Plan to include scenarios where children get to suggest their own fair test enquiries.

### Progression planning

Using National Curriculum documents, map out age-related Expectations (ARE) for fair test enquiries.

Establish age specific success criteria for fair test enquiries.

Develop a collection of exemplar outcomes to support consistent expectations (WAGOLL).

### Resource audit

Take stock of science and maths resources, making a comprehensive list of items that would support this type of enquiry.

Provide teaching staff with a list of resources that their pupils should get the opportunity to use over the year.

Put procedures in place for teachers to alert senior leadership when resources are broken, faulty or missing.

### Support and challenge

Ensure that teachers are aware of ARE for the academic years before and after the one they are teaching.

Teachers develop support materials for children working below ARE in their class. Examples include classroom displays, writing frames or sentence starters.

Teachers develop extension tasks for gifted and talented science learners that extend their working scientifically skills.

### Quality assurance

Review children's work to look for coverage of all enquiry types as well as progression and challenge across year groups.

Carry out a 'learning walk' while all classes focus on fair testing – identify good practice and highlight areas for development.

Lead pupil voice work that focuses on working scientifically, exploring children's perceptions on experiences and levels of understanding.

### Celebrate

Have a working scientifically notice board with a display that changes to a new type of enquiry each half term.

Display high-quality examples of fair test enquiry work from each class and identify key features and progression.

As a special whole school focus, put in place a system of reward for individual success in working scientifically.