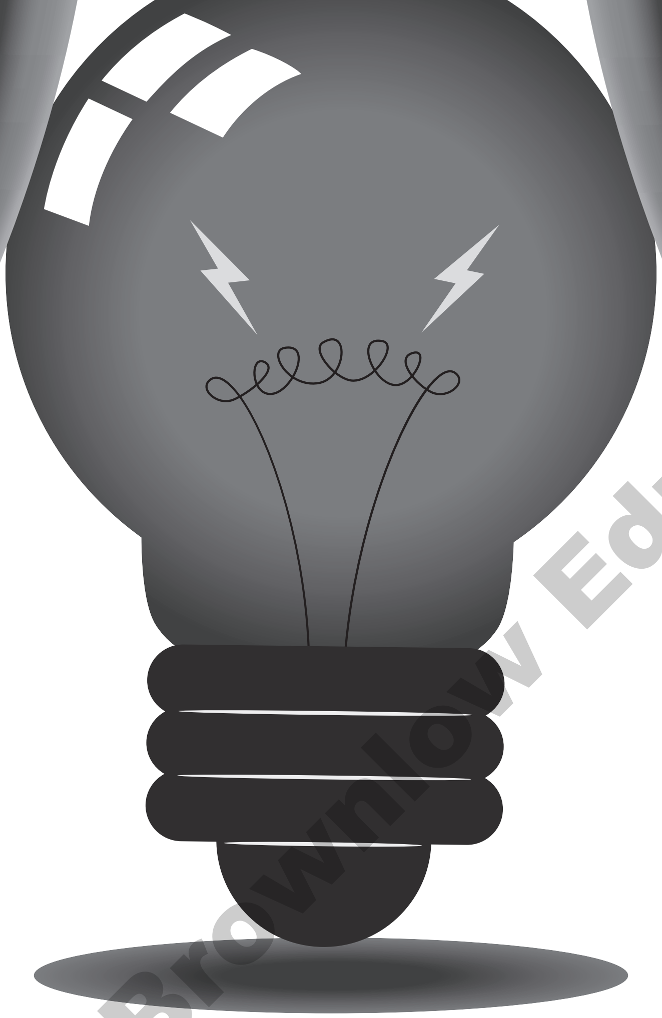

SCIENCE FAIR WARM-UP

» LEARNING THE PRACTICE OF SCIENTISTS «

Years 8–12

JOHN HAYSOM

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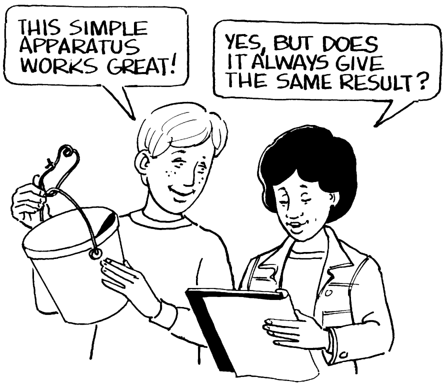

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CURRICULUM CONNECTIONS

Science Fair Warm-Up

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In recent years, the Australian Federal Government has been working closely with state and territory educational offices in an effort to implement a national curriculum for all Australian schools. This Australian Curriculum sets consistent national standards, in an effort to improve learning outcomes for all students, as well as laying the foundations for future learning, growth and active participation in the community.

Effective science instruction is crucial to all students, as the skills they learn and cultivate in the science classroom are not only important tools for use in other subject areas, but also in everyday life. The Australian Curriculum: Science emphasises the need for students to apply their scientific thinking in all aspects of their studies, encouraging exploration, investigation, observation and problem solving. The curriculum also prompts students to look back at the influence science has had on their own lives, as well as society as a whole. Ultimately, the Australian Curriculum: Science is designed to provide students with the knowledge, skills and reasoning abilities to make informed decisions not only about their own lives, but about global issues and concerns.

Science Fair Warm-Up emphasises the need for students to understand where early scientific discoveries originated, linking the experiments they are conducting in the 21st century with discoveries made by prominent scientists hundreds of years ago. In this way, it fulfils an important cross-curriculum priority in the Australian Curriculum framework, placing students' science studies in an historical context: It is important that students learn that science and technology have grown through the gradual accumulation of knowledge over many centuries; that all sorts of people, including people like themselves, use and contribute to science. Historical studies of science and technology in the early Egyptian, Greek, Chinese, Arabic and Aboriginal and Torres Strait Islander cultures extending to modern times will help students understand the contributions of people from around the world. (ACARA 2015)

This revised Australian edition of *Science Fair Warm-Up* strongly correlates with two of the three strands – Science as a Human Endeavour and Science Inquiry Skills – of the Australian Curriculum: Science, featuring comprehensive practice in making predictions, conducting experiments and reporting results in every activity. While the concepts in certain activities in this book specifically correlate with multiple content descriptions in the physical and chemical science sub-strands, every activity is underpinned by the Science as a Human Endeavour and Science Inquiry Skills content of the Australian Curriculum: Science.

While the content in *Science Fair Warm-Up* focuses on Years 8–12, it should always be assumed that students engage in appropriate prerequisite work prior to those year levels and meaningful review and extensions subsequent to those year levels.

While it is recommended that teachers use the science activities in this book with their Australian Curriculum: Science instruction, the activities featured in *Science Fair Warm-Up* can just as easily be used with other educational frameworks at the state or institutional level. For a full overview of the Australian Curriculum please visit *http://www.australiancurriculum.edu.au/.*

Chapter 5:
Variables and Their Controls

***ISOLATING VARIABLES: REDUCING COMPLEXITY

The Best Design for the Hull of a Racing Dinghy

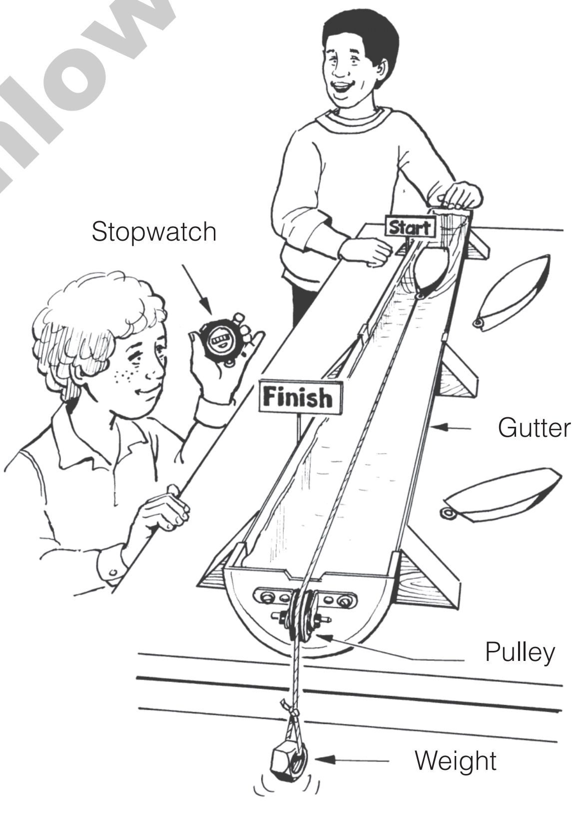
Terry and Tom were sailing fanatics. Their ambition was to design and build their own racing dinghy. Right now, they were concerned about hull designs and producing the most hydrodynamic shape – the shape that minimised water resistance. They decided to investigate. They had been warned that this would not be an easy task, but they did not give up!

The breakthrough came when Terry had a brilliant idea for testing the effect of different shapes. "We could make a tank out of gutter and pull along model boats with a weight," Terry suggested.

"And we could time how long it takes to go from one end to the other," Tom added.

"Then we could try out all sorts of shapes," Terry said.

This was indeed a breakthrough. The apparatus worked beautifully. But designing the apparatus was just the beginning. The challenge now was to plan a series of experiments to find out all they could about the effects of shape on water resistance or drag.



Your Task

Put yourselves in Terry's and Tom's shoes. What experiments would you do? Get together with one or two friends and design a series of experiments.

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How Scientists Approach Challenging Problems

Determining the best hull design is a challenging problem. How might scientists go about designing a hull that minimises water resistance?

Scientists proceed systematically. Drawing on their experience, they would probably begin by trying to make a list of all the factors (variables) that could possibly affect the speed at which the boat travels, such as the following:

- Weight of the boat
- Length of the boat
- Angle of the bow
- Height of the waterline (how much of the boat is in the water)
- Seawater or freshwater
- Smoothness of the surface

Can you identify any more? You likely could identify as many as 10 variables that might make a difference as to how fast the boat travels.

It's evidently a complicated problem – complicated in at least two ways:

a. There are many variables. Scientists would probably try to reduce the number of variables by working first with simple shapes in artificial situations. Once they have understood how simple shapes behave, they would then be in a better position to tackle more difficult problems.

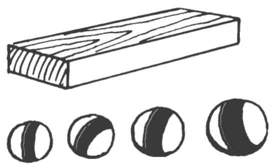
b. Some of the variables are connected to one another. For example, the length of the boat and the angle of the bow are related to one another. If at all possible, scientists would like to study the effects of each separately. *Can you identify any other variables that are connected to one another? Are there any at all that are separate from others?*

Take a look at the test rig in the picture. It shows a length of completely submerged (weighted) dowel rod being towed through the water. Scientists may well find experimenting with this rig to be an attractive idea. It offers the opportunity to control many of the variables. Then follow these steps:

1. Refer back to your original list of variables and tick those that are possible to control.

2. Which variables can you vary systematically?
3. Design a set of experiments that allows you to investigate the effects of manipulating just one variable. Be careful to control any other variables that might have an effect.

Now consider these questions: What next? What about the other variables in your initial list? Are there any other simple shapes worth testing? *What would be the value of experimenting with shapes such as those shown in the picture?*



What next? Slowly, persistently and systematically, the scientists would edge toward a greater understanding of the way shapes move through water. It is a task that involves clear thinking about variables and imaginative thinking about the design of experiments that will enable the effects of an isolated variable to be studied.

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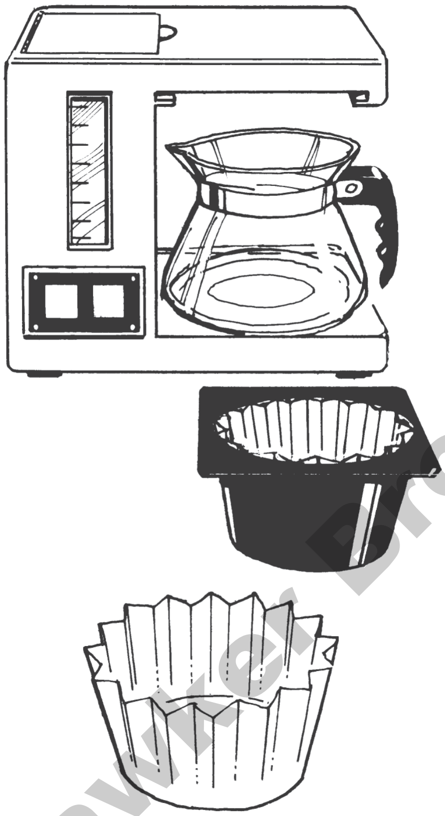
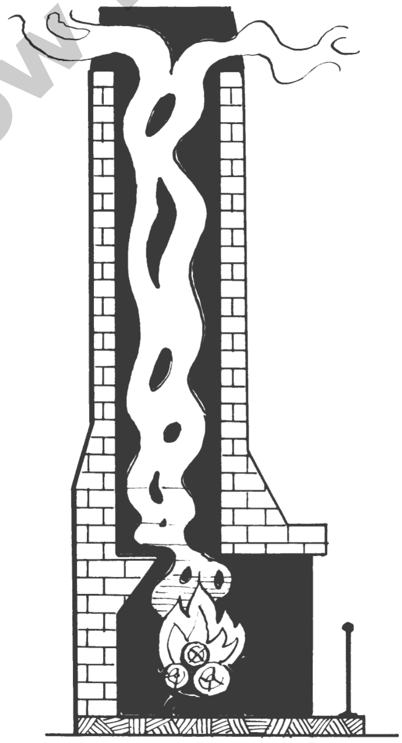
Back to the Project

1. *The Perfect Coffee Filter:* Two young scientists had given themselves the task of improving the design of the coffee filter. How do you suggest they should proceed?



2. *Smoking Chimneys:* Refer to Starting Point 12. Now examine the design of the chimney shown in cross section in the picture. What factors might influence the airflow up the chimney? How does the apparatus design shown in Starting Point 12 reduce the complexity? Do you have any suggestions about how to improve the apparatus? What experiments would you carry out?



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