The Great Australian Science Book

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SCIS: 5482745

ISBN: 9781486316595

RECOMMENDED FOR: Mid to Upper Primary

SYNOPSIS

How do we measure the universe? How do our bodies repair themselves when we are ill? What species will exist on Earth in a million years' time?

Discover the answers to these questions and a lot more in *The Great Australian Science Book*. We'll go on an incredible scientific journey from the very, very BIG to the very, very SMALL.

Starting with the universe itself, we will travel through the galaxies and stars, onto our very own planet Earth and across its fabulous features, into our wonderful bodies and all their cells, and on down to the very elements and atoms that make up all things.

Discover how Australia has made huge contributions to science and do a few experiments yourself as you learn to think like a scientist.

ABOUT THE AUTHOR

Luke O'Neill is Professor of Biochemistry at Trinity College Dublin. He has a PhD in Pharmacology (the science of medicines) and hopes that his research might lead to new treatments for inflammatory diseases.

ABOUT THE ILLUSTRATOR

Linda Fährlin is a visual artist with extensive experience developing artworks and illustrations. Originally from Stockholm, she worked in Australia for many years. Linda often draws inspiration from science and believes that art and science can both change the way we see the world.

THEMES

- Scientific method
- Development of theoretical knowledge
- Science career paths

STUDY NOTES

BEFORE READING

- Most students will be innately curious about nature and technology. Start a conversation with the class over big questions they'd love answered by sharing your own curiosities. Perhaps you can describe a question you had as a child that was answered, or a question you still have today. Write the question on a sheet of paper using a marker so it can be easily read. Invite each student to do the same. Their question can be on any topic—encourage them to use their imagination, and not feel intimidated. Explicitly discourage any other student from answering or speculating on another's question. Once every student has a question, come together to share them as a class.

- Ask the students whether some questions have features in common. Here are some questions you could dicuss:
  - Are some about living things?
  - Are others about space?
  - Are there any about computers or machines?
  - Are some about people?

  Discuss how science is a process for discussing answers to these questions. Explain to the students how it is divided into different fields as well, such as biology for studying living things, physics for investigating movement and change, and astronomy to explore the stars and space.

AFTER READING

Science

- Good science always starts with a good idea. Explain to students that science is a methodology—a way of telling if a method for testing a guess (called a hypothesis) is useful or not. A bad idea is a hypothesis that can't be tested. Invite students to come up with their own 'guess' to questions asked in the pre-reading. Ask whether each guess could be tested in some way.
  - Read pp 2–3 of the book and discuss how an idea becomes a theory.
- Invite students to read pp 8 and 9. Two of the big mysteries in physics currently are dark matter and dark energy. Ask the students to explain why we should consider these discoveries as facts about the universe, even if we have no idea what they are (yet!).
- A lot of astronomy involves searching for signs of life elsewhere in the universe. Invite the students to read p 16, and ask them whether they think it's a worthwhile goal of science to search for life on other planets. Ask them whether such a discovery might benefit human lives here on Earth in any way.
- Read pp 26–27, emphasising the paragraph about the five organisms humans couldn't live without. Invite students to discuss why any environmental crisis that affects a large number of living things puts our current way of life at risk. Invite them to speculate what might happen if flowers couldn't be pollinated, should the world no longer have bees.
- Ask students to discuss whether humans are still evolving or not. Invite them to read pp 28–29, reminding them of how our bodies are also the result of millions of years of natural selection. Invite them to imagine the kinds of changes our bodies might undergo in the future. How will humans evolve over the next few million years?
- Climate change is a pressing issue in today's world. Ask students to read p 34 and to do the quiz on p 35. Discuss how Earth's climate has changed before, but the speed of change today—combined with the impact it has on us as a species—is significant. Invite students to share their quiz scores, and whether living sustainably is important to them personally.
- Instruct students to read pp 39–59 on the human body. Explain to the students that the human body is like a factory, where each part serves a special role. The brain, for example, is like a board of directors or bosses who take in information and tell others what to do with it. Ask the students to come up with metaphors of people, machines or processes in a factory for other parts of the body.
- Read pp 67 and 84 and discuss with students how future particle colliders will be bigger and more powerful, while also being very, very expensive. Tell them there's no guarantee they'll be powerful enough to reveal new particles. Should we still spend so much money on big projects in science if there is no certainty that they'll provide big discoveries? Is finding nothing still worthwhile science?
- Ask students to read 'Be a Scientist!' on pp 17, 37, 61 and 85, and to list all of the fields. Remind them that this is just a small sample of all of the different areas of research available. Invite them to pick one area of science they would study, if they had to be a researcher. Students can choose a field not mentioned in the book, or even combine fields if

they wish. Ask them to discuss why that area of science appealed to them.

Swinging Experiement

- This activity works best if different variables—the length of string, number of washers and angle of the swing—are individually tested by different groups of students in each class. For safety, instruct students to stand back while swinging the pendulum.

You Will Need

- 70 centimetre length of cotton string
- 50 centimetre length of wooden dowel
- Plasticine or masking tape
- Two chairs
- 5 × large steel washers
- Ruler
- Protractor
- Stopwatch
- Pen and paper

What to do

1. Measure 10 centimetres on the 70 centimetre length of cotton string. Use those 10 centimetres of string to tie 1 large steel washer onto the string (it's okay if there is some string left over).
2. Measure 10 centimetres from the other end of the cotton string. Use those 10 centimetres to tie the string to the length of wooden dowel. Your 'pendulum' should be 50 centimetres long.
3. Place two chairs back to back, about 30 centimetres apart.
4. Place the wooden dowel on the top of the back of each chair with string and the washer hanging down from the centre. Use masking tape or plasticine to secure it in place if necessary.
5. Using a protractor to measure the angle, pull the string back so it makes an angle of 20 degrees with the dowel.
6. Before you conduct the trials, form a hypothesis in the following format:

   As I increase/decrease [the number of washers/the length of string/the angle of the swing], the average time it takes the pendulum to swing will [increase/decrease/stay the same].
7. Once each student has their hypothesis, press 'start' on the stopwatch as you let go. When the pendulum returns to the same side it started for the fifth time (five complete swings back and forth), press stop and record the time.
8. Do this five times. Find the average (add up the times and divide the number by five).

- Conduct the above experiment another five times, with some changes in each 'trial', such as:
  - Increase the number of washers, adding an extra washer in each trial.
  - Decrease the length of string, from 50 centimetres to 40, 30, 20 and then 10 centimetres.
  - Increase the angle between the dowel and the string, from 20 degrees to 30, 40, 50 and 60 degrees.

Evolutionary Scrabble

You Will Need

- Scrabble® letters (1 set per 10 students—these can also be written letters on cards, so long as the ratios of letters are similar)
- A bag or box
- A six-sided dice
- Pen and paper

What to do

1. Divide the class into groups of five students. If there is a group left smaller than five, divide the remaining students across other groups so they each have six.
2. Place all of the letters into a bag or box.
3. Ask each student to draw a single letter from the assortment. Together, they then need to combine letters within their group to form a two, three, four or even five letter word. Tell them to quietly write their words down.
4. Roll the dice. If it comes up with a '1', re-roll. If it is a number between 2 and 5, any groups with those numbers earn

a point. If it is a 6, nobody gets points but each group can pick one more letter, after which, roll the dice again.

5. After 10 rounds, add up the points to determine a winning team.

English

- Read p 67, inviting a student to read the words aloud. If they ask how to pronounce ‘quark’, instruct them to read it as they think it is pronounced. Read them the passage the physicist, Murray Gell-Mann, borrowed it from:

  “Three quarks for Muster Mark! Sure he hasn’t got much of a bark and sure any he has it’s all beside the mark. But O, Wreneagle Almighty, wouldn’t un be a sky of a lark to see that old buzzard whooping about for uns shirt in the dark and he hunting round for uns speckled trousers around by Palmerstown Park?” (from Finnegans Wake by James Joyce)
  - How do they think quark was pronounced?
  - Ask them if they can guess what nationality the author of the text might be.
- Discuss how words and scientific language evolves over time as different uses and cultures borrow and translate words, and even change the way they sound.
- Read pp 86–87, focussing on the motto of the Royal Society: ‘Nullius in verba’ (Take nobody’s word for it). Discuss how we decide what texts we should trust, and which ones we shouldn’t. What signs are important in text that show an author is likely to be knowledgeable and ought to be believed? What signs might indicate an author is confused, wrong or even lying?
- Invite students to read ‘The Universe’ on pp 5–16. Have a short discussion about rovers left on Mars (p 16) and the endless journey of the distant Voyager spacecraft (p 13). Explain to the students how Voyager 1 and 2 are each carrying a ‘golden record’ of information about humanity. Direct them to search for more facts about the information on these records, which includes details of Earth, humanity and even songs that represent our culture.
  - Ask the students to come up with their own version of a ‘golden record’ that could be carried on a spacecraft that is left on another planet or moon, or is destined to fly towards the stars. What might they want to include on there? What should we tell a distant civilisation in the far future? How should it be communicated? Is it best to include a lot of detail, or just a few important bits of information?

Mathematics

- The universe is a very big place. So big, we need big ways to describe its size. Read pp 5 and 6 and ask students to discuss why light years might be the best unit for measuring vast distances between stars and galaxies. Could we use the same unit to measure the distance between school and home? What about the size of a pencil? Why don’t we normally use light years for measures on Earth?
- Read pp 82 to 83. Ask students to explain what they think the equation $E = mc^2$ might mean. Point out that laws in physics often come in the form of a formula like this. Give force (f) = mass (m) × acceleration (a) as another example. Ask why laws tend to all look very mathematical. What might happen if they rearrange the equations to read differently, such as $m = E/c^2$? Do they think this is still true? How might this be useful to scientists?
- Ask students to guess how long it would take them to count to a hundred. What about a million? How about a billion? Write these numbers on the board. After each number, write how many times 10 would need to be multiplied to get to that number (10 × 10 = 100, so you’d write ‘2’; for a million, it’s 10 × 10 × 10 × 10 × 10 × 10, so ‘6’). Describe this number as a power, showing how it can be written as a smaller number to the upper-right of 10, like 10^2 and 10^6.
  - Invite students to see how long it takes to count to 100. Tell them to multiply this measurement by 10 to estimate how long it would take for them to count to 1000. Use this method to estimate bigger numbers, such as 1 million and 1 billion.
  - Suggest ever-increasing sizes of numbers using the ‘power of 10’ notation as a shorthand. How long might it take to count to each? Explain how the universe is around 13.7 billion years old. Use this to compare the time it might take to count some awfully big numbers.