Great Quantum World

What does data tell us about the impact of variables on an investigation?

9 INDUSTRY, INNOVATION AND INFRASTRUCTURE

AGE RANGE: 11-14 years

OVERVIEW

Using 'Izzy Jones's Quantum World' pupils meet the character of Izzy - a young girl trying to find her place in the world. In her search for finding the place that allows her to be her best, the story subtly illustrates how important it is for quantum researchers to control the variables in the environment around the atoms they are working with. This is so that they can get the best performance to create new materials. In this enquiry, pupils investigate how environmental variables affect the performance of paper spinners. The analyse a range of data to draw conclusions, identify anomalous results and the impact of different variables.

LEARNING OBJECTIVES

- Model how air resistance affects the moving objects

WORKING SCIENTIFICALLY

Pattern seeking

- Interpret observations and data, including identifying patterns and using observations, measurements and data to draw conclusions
- Present reasoned explanations, including explaining data in relation to predictions and hypotheses
- Evaluate data, showing awareness of potential sources of random and systematic error

RESOURCES (per pair)

- paper spinner template and paper
- scissors
- paper clips
- metre ruler
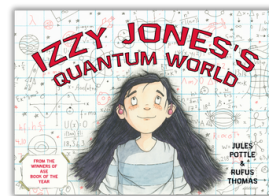
KEY WORDS

- environmental control variables
- experimental control variables

TO SUPPORT TEACHING

- 11-14 Great Quantum World Video
- Izzy Jones story read video
- Book: 'Izzy Jones's Great Quantum World', by Jules Pottle, ISBN:9781739939939 (optional)
- Sample data sets

Great Quantum World Story Read by Jules Pottle
www.greatscienceshare.org @GreatSciShare

Great Quantum World 11-14 years
www.greatscienceshare.org @GreatSciShare

The **Careers Chat** resources give pupils time to learn more about research scientists, Maddy and Jess, as well as author Jules Pottle!

Careers Chat — ABOUT MADDISON COKE

Careers Chat — ABOUT JESSICA BOLAND

Careers Chat — ABOUT JULES POTTLE

Maddy's Video Chat

Jess's Video Chat

Jules's Video Chat

Read Jules Pottle's story *Izzy Jones's Quantum World* or watch the **story read video**.

Questioning

1. Watch the **11-14 Great Quantum World** video

2. Elicit what the pupils recognise as being variables that Izzy was able to control and what was out of her control? Re-listen to the story and ask them to jot a short list, before sharing with a larger group of 3-4 pupils.

Ask the pupils to match their ideas to two headings:

Environmental control variables

Factors in the environment that we find difficult to control.

In the story, this could be:
- the position of the clock
- window opening
- wall coverings
- floor surface
- music
- air temperature
- pigeons

Experimental control variables

Factors in the experiment that we can control.

In the story, this could be:
- rate of breathing
- controlled movements
- eye movements
- angle of plane
- launch

Gathering evidence

3. Explain that the pupils are going to investigate the question:
**What environmental factors affect the landing of a spinner?**

Working individually or in pairs pupils should make a spinner (template provided). Ask them to discuss a plan for this investigation. They will need to consider where they will undertake the investigation, how they will measure and record results, how they will analyse their results etc.

Help: If needed explain that spinners can be dropped in any environment (indoor/outdoor). Use a floor target to drop the spinner towards. Pupils measure the distance the spinner falls away from a target on the floor. They can change the environment to explore its impact. Take repeat readings and explore patterns in data using bar graphs. Standardised changes in the environment can be produced using a hair dryer on different speed settings.

Analyse and interpret

4. Challenge the pupils to apply what they have observed during their exploration time to the data analysis task. Here, pupils analyse and annotate the data provided in the **Sample Data Sets**. Quantum scientists are required to analyse a wide range of data in graphical form, and in this way, pupils should identify:
- **what patterns they notice**
- **if the variable changed was environmental or experimental**
- **if there are any anomalous results and what could be the cause of them**
- **whether there is any evidence of human error, lack of control of other variables**
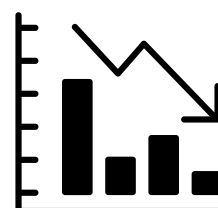
Drawing conclusions

5. Ask pupils to summarise whether they think environmental or experimental variables are easier to control and how they would achieve this in future:
- experimental as you can measure the changes i.e. the length of the wings
- environmental is difficult to control as it depends on external factors, e.g. wind

Relate these considerations back to the book, reinforcing the fact that scientific endeavour requires logical reasoning and resilience. Quantum scientists persevere for many hours, days, weeks and months to control the environmental conditions in order to enable their equipment and atoms to achieve the best performance to make new materials. This work is ongoing!

Encourage pupils to make a 60 second reel or social media video about their enquiry. Upload onto Instagram, Facebook or an appropriate stream. If using X, tag @GreatSciShare

Share with us

The Data Sets explained

Data set 1 shows an **experimental control variable** with results that have a small range and there is an **anomalous result** on trial 5 as it is significantly larger than the other results.

Data set 2 shows an **environmental control variable** with results that show the distance from the target increased outside. The range of data for inside is small compared to the data outside which has a much wider spread. There is an **anomalous result** on trial 3 for inside as the number is larger than the rest of the results.

Data set 3 shows **environmental control variables**. The conditions the data was collected in on each day can be identified as:
Monday - outdoors, cloudy
Tuesday - outdoors, rainy
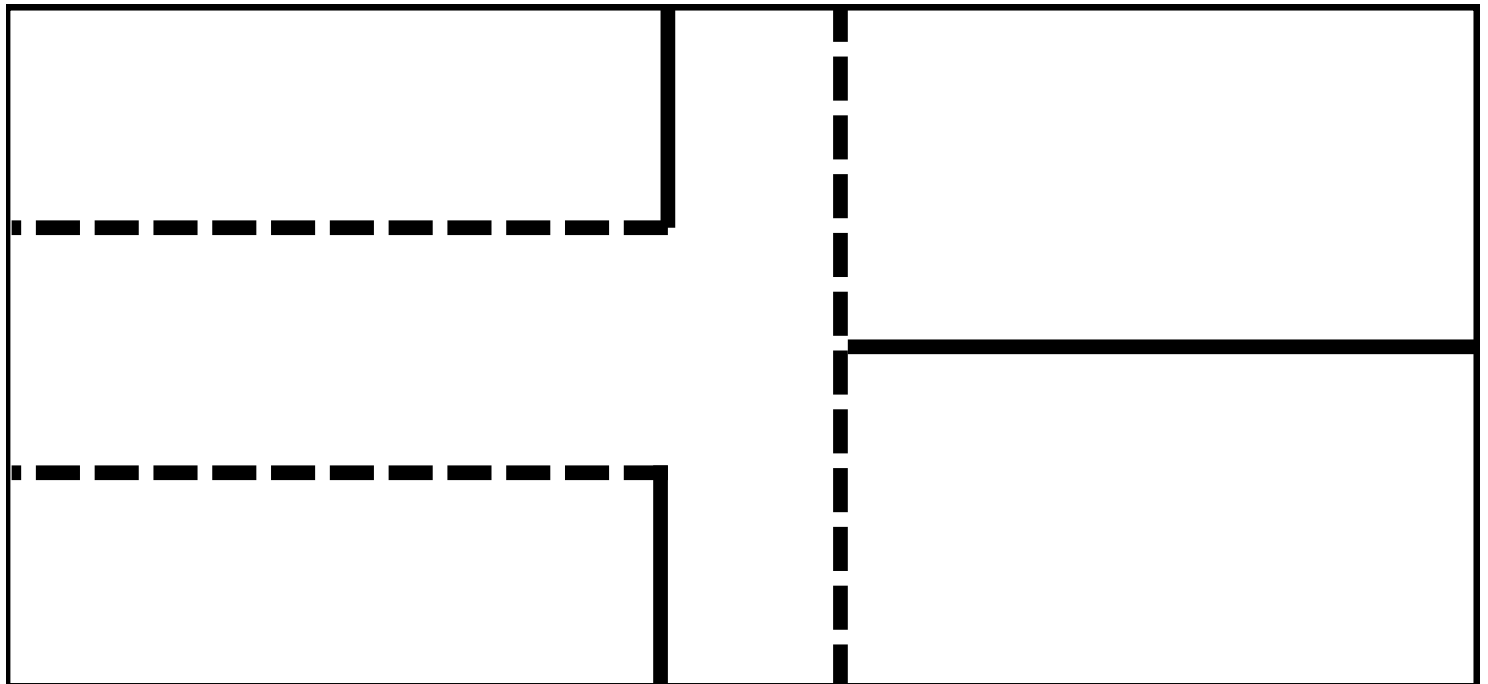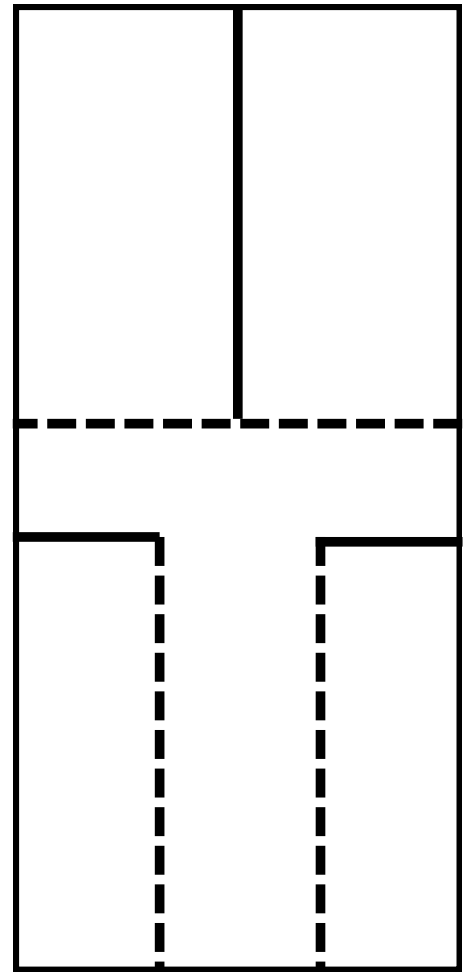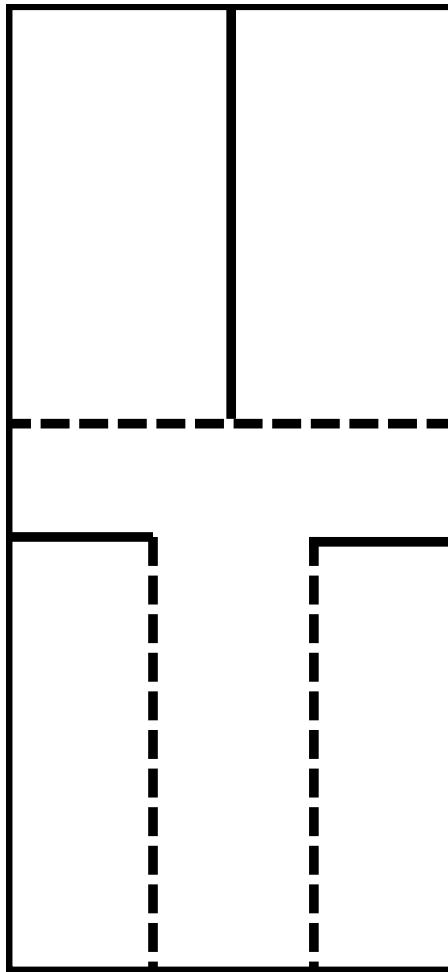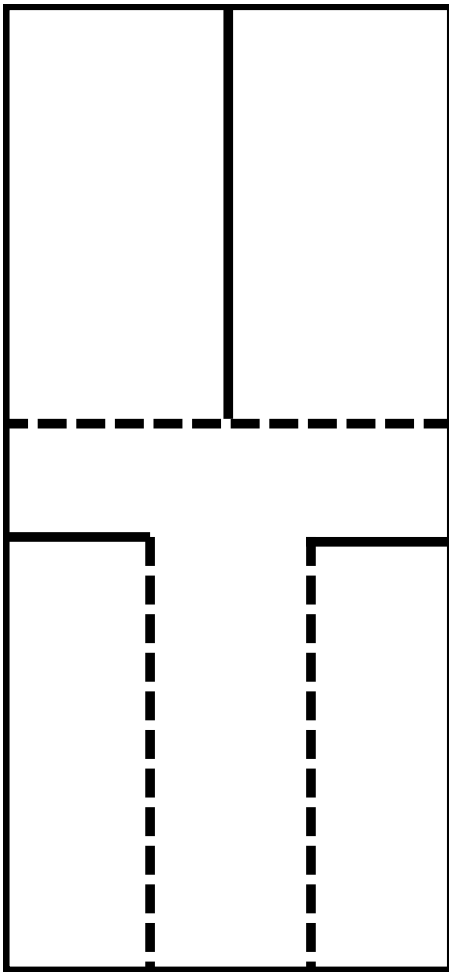Wednesday - indoors
Thursday - outdoors, windy

EXTEND THE LEARNING!

Use the Talk Prompts in the Quantum-linked **Great Question Ponder** as part of science and oracy development.

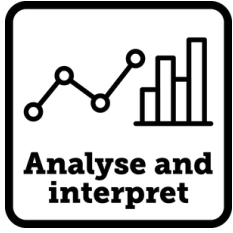**Cut the solid lines, fold the dotted lines**

Data Set 1

Analyse and interpret

Trial		1	2	3	4	5
Distance from target (cm)	Paper	2	1	2	0	2
	Card	1	1	0	2	18

Questions to ask about the data...

- Are there any patterns in the data?

- Is the variable an environmental or experimental? What makes you think that?

- Can you spot any anomalous results? What could have caused them?

- Is there any evidence of human error or lack of control of other variables?

- What type of graph would best represent this data set?

Jot your thoughts here...
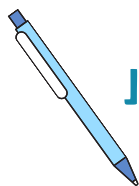
Questions we could investigate next are:

Data Set 2

Analyse and interpret
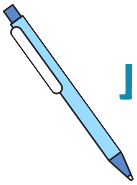
Trial		1	2	3	4	5
Distance from target (cm)	Inside	6	8	23	7	6
	Outside	18	15	24	22	11

Questions to ask about the data...

- Are there any patterns in the data?
- Is the variable an environmental or experimental? What makes you think that?
- Can you spot any anomalous results? What could have caused them?
- Is there any evidence of human error or lack of control of other variables?
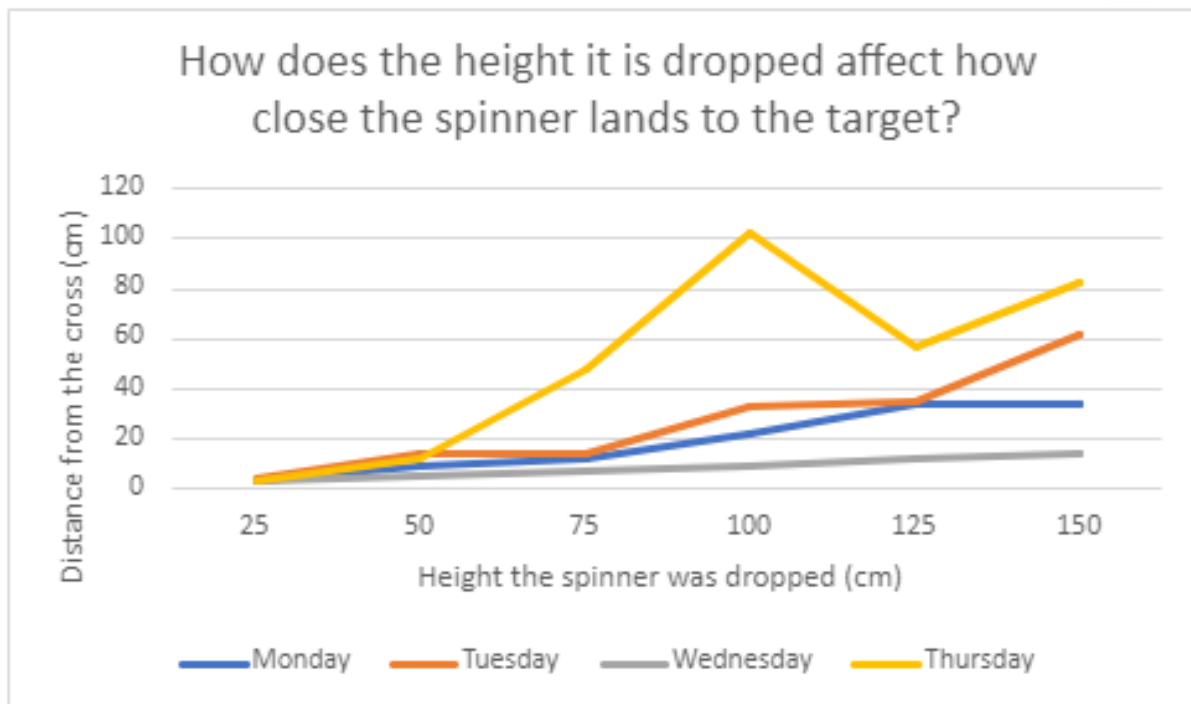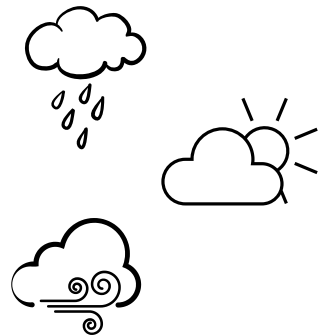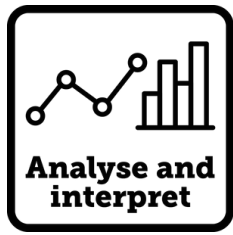- What type of graph would best represent this data set?
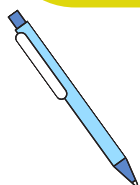
Jot your thoughts here...

Questions we could investigate next are:

Data Set 3

Analyse and interpret

How does the height it is dropped affect how close the spinner lands to the target?

Distance from the cross (cm) vs Height the spinner was dropped (cm)

— Monday — Tuesday — Wednesday — Thursday

Questions to ask about the data...

- Are there any patterns in the data?
- Can you spot any anomalous results? What could have caused them?
- What environmental conditions do you think each test was performed in. Consider if the investigation may have been performed indoors or outdoors – use the weather symbols to help you.

Jot your thoughts here...

Questions we could investigate next are: