

How to effectively link Science and Maths

Tom Holloway

Regional Mentor – London and the South
East

Aims

- To explore how Science can support teaching for **Mastery in Maths**
 - Demonstrating ‘embeddedness’
 - Assessment
 - Opportunities to use and apply mathematical skills
 - Providing a meaningful context
- To explore *why* Science and Maths should be linked.
- To provide practical examples of how Science can support children’s learning of **Mathematical skills/knowledge and vice versa**
 - Beyond measuring and data handling!
- To explore the underlying approaches that lead to the effective inclusion of **Maths in Science lessons**

Why link Maths and Science?

- They learnt best when they could see how the science they were studying linked to real world experiences, revealed more about the 'big ideas' in science, **and connected with and supported their learning of other subjects, including English and mathematics.** Learning in this fashion engages and enthuses pupils, develops their natural curiosity, and motivates them to find out more.
- **Maintaining Curiosity, 2013**

Why link Maths and Science?

5. Numeracy and mathematics

- 5.1 Teachers should use every relevant subject to develop pupils' mathematical fluency. Confidence in numeracy and other mathematical skills is a precondition of success across the national curriculum.
- 5.2 Teachers should develop pupils' numeracy and mathematical reasoning in all subjects so that they understand and appreciate the importance of mathematics. Pupils should be taught to apply arithmetic fluently to problems, understand and use measures, make estimates and sense check their work. Pupils should apply their geometric and algebraic understanding, and relate their understanding of probability to the notions of risk and uncertainty. They should also understand the cycle of collecting, presenting and analysing data. They should be taught to apply their mathematics to both routine and non-routine problems, including breaking down more complex problems into a series of simpler steps.

Why link Maths and Science?

- planning different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary
- **taking measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings when appropriate**
- **recording data and results of increasing complexity using scientific diagrams and labels, classification keys, tables, scatter graphs, bar and line graphs**
- using test results to make predictions to set up further comparative and fair tests
- reporting and presenting findings from enquiries, including conclusions, causal relationships and explanations of and a degree of trust in results, in oral and written forms such as displays and other presentations
- identifying scientific evidence that has been used to support or refute ideas or arguments

Why link Maths and Science?

- **Teaching for Mastery**
- Science provides rich and varied opportunities to demonstrate 'embeddedness'
 - Context
 - Time lapse
 - Creativity
- Depth – reinforcement
- Coverage

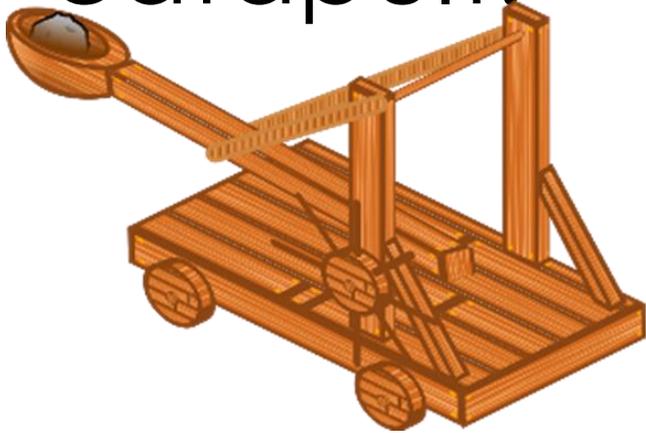
Where are there meaningful links?

- Drawing a graph
- Measurement – length, time, volume, area, temperature
- Collecting data as part of a survey
- Calculating averages from repeated measures
- Sorting and classifying objects into sets
- Adding and subtracting numbers
- Calculating percentages
- Others?

Where are there meaningful links?

- Let's do some science...

• Marshmallow catapult!



- Science provides endless opportunities for children to use their mathematical skills and knowledge in exciting, engaging and motivational contexts.
 - Rich tasks
- **Do your colleagues/pupils talk maths in Science lessons?**
- **Are the use of Maths skills explicitly discussed/taught in Science lessons?**
- **Are opportunities for mathematical learning seized upon?**
- **Scales**
 - What is a scale? Which scale is best to use?
 - Ordinal aspect of number

Where are there meaningful links?

- Year 1

- **Seasonal Change**

- <https://naturedetectives.woodlandtrust.org.uk/naturedetectives/activities/2018/10/conker-maths/>
- **Measuring leaves**
- **Rain gauge/other weather station activities.**

Year 4 – Animals Including Humans – Digestive system...

- How long is your intestine?
- How long is your total digestive system?
- How much can you eat before your stomach explodes?
- How much do different animals poo each day?
 - <https://www.petpooskiddoo.com/blog/showing-much-animals-poop-fruit/>
 - **Pattern seeking**

Where are there meaningful links?

Rich Maths tasks...

- Let's do some science...
- Time to launch some rockets!
- **Where's the Maths?**
- **Beyond measure!**
 - **Do your pupils do Maths in their science books other than measure and data handling?**
 - **Fractions, percentages,**
 - **Mini-beast hunts**
 - **Beyond the bar chart!**

Where are there meaningful links?

Rich Maths tasks...

- Can you put a number on it?

- Qualitative



- Quantitative



Year 6 – Evolution Stunning Start

- This is a Tube-lipped Nectar Bat
- The tongue of a tube-lipped nectar bat (*Anoura fistulata*) is 8.6 cm long.
- That doesn't sound particularly impressive until you find out that its body length is only 5.8 cm!
- It's tongue has to be stored inside its ribcage because it is 150% longer than its whole body!



Year 6 – Evolution Stunning Start

- Imagine if...

Your tongue was 1.5 times your body length. How long would it be? How could you work this out?

Your tongue was 150 % of your body length. How long would it be? How could you work this out?

The ratio of your body length to tongue length is 1 : 1.5, how long would your tongue be? How could you work this out?



Use the measuring tape and string to measure out how long your tongue would be.

**Why does the Tube-lipped Nectar Bat have such a long tongue in relation to its body? What reasons could there be for this?
Can you find out?**

Where are there meaningful links?

- Year 5, Living things and their habitats

1.1 Fibonacci's Rabbits

The original problem that Fibonacci investigated (in the year 1202) was about how fast rabbits could breed in ideal circumstances.



Suppose a newly-born pair of rabbits, one male, one female, are put in a field. Rabbits are able to mate at the age of one month so that at the end of its second month a female can produce another pair of rabbits. Suppose that our rabbits **never die** and that the female **always** produces one new pair (one male, one female) **every month** from the second month on. The puzzle that Fibonacci posed was...

How many pairs will there be in one year?

1. At the end of the first month, they mate, but there is still one only 1 pair.
2. At the end of the second month the female produces a new pair, so now there are 2 pairs of rabbits in the field.
3. At the end of the third month, the original female produces a second pair, making 3 pairs in all in the field.
4. At the end of the fourth month, the original female has produced yet another new pair, the female born two months ago produces her first pair also, making 5 pairs.

The number of pairs of rabbits in the field at the start of each month is 1, 1, 2, 3, 5, 8, 13, 21, 34, ...

Where are there meaningful links?

Mains



Battery



**Year 4 – Electricity -
Identifying & Classifying**

**Evidence in science
books?**

Where are there meaningful links?

- **Statistics/Data handling**
- Is Science providing meaningful data for children to represent and interpret in both Science and Maths lessons in your schools?
- **Is it planned for?**
- Data banks
 - Are we becoming a more or less biodiverse school?
- Year 2
- Pupils should be taught to:
 - interpret and construct simple pictograms, tally charts, block diagrams and simple tables
 - ask and answer simple questions by counting the number of objects in each category and sorting the categories by quantity
 - ask and answer questions about totalling and comparing categorical data.

Where are there meaningful links?

- **Year 6 – Light**
- **What is the speed of light?**
- 299,792,458 metres per second!
- **Speed of light place value...**
- Can you say this number to your partner?
- Can you write this number using words?
- **Draw a place value grid to help you (it will need 9 columns!)**

Where are there meaningful links?

Hundreds of millions	Tens of millions	Millions	Hundreds of thousands	Tens of thousands	Thousands	Hundreds	Tens	Units
2	9	9	7	9	2	4	5	8

Where are there meaningful links?

- Year 6 – Light
- How far is the Earth from the Sun?
- The speed of light is 299,792,458 metres per second!
- It takes 8 minutes for the Sun's light to reach the Earth.
- **How would you work this out? Record it in your books!**



Where are there meaningful links?

- Year 6 – Light
- What are the properties of light?
- What type of shape could you make with light beams?

• Polygons

- How would you position your torches to make the following 2d shapes?
- a square, rectangle, a right-angled triangle, an equilateral triangle, an isosceles triangle and a scalene triangle.
- Photograph where you put the torches each time.

Today's learning goals are...

Scientific Knowledge



- To investigate the factors that affect the size of a shadow.
- To take measurements using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings where appropriate.
- To record data and results of increasing complexity using line graphs.
- To calculate the mean as an average.



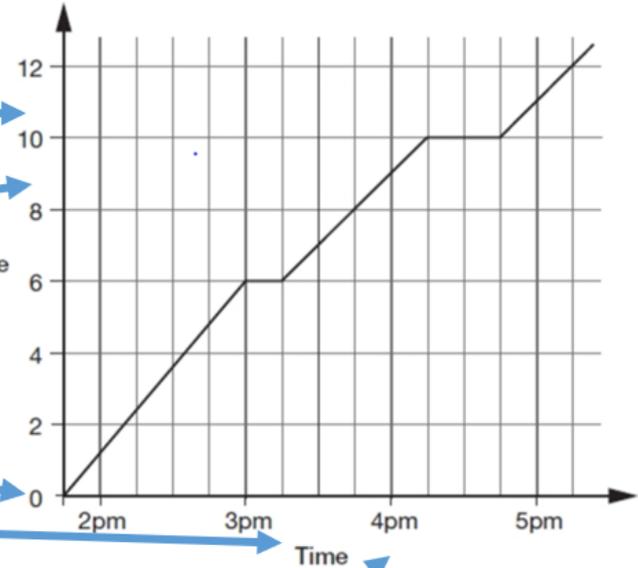
Scientific Skills

To be successful...

1 This graph shows the distance Alfie and Chen walked in an afternoon. They started at 1:45pm and had two breaks.

- Give your line graph a **title**.
- Decide on an **appropriate scale** for your **y axis**.
- **Make sure the gap is the same between each number.**
- Start your scale on **zero**.
- **Label your x and y axis.**
- **Use a ruler!**

Y axis



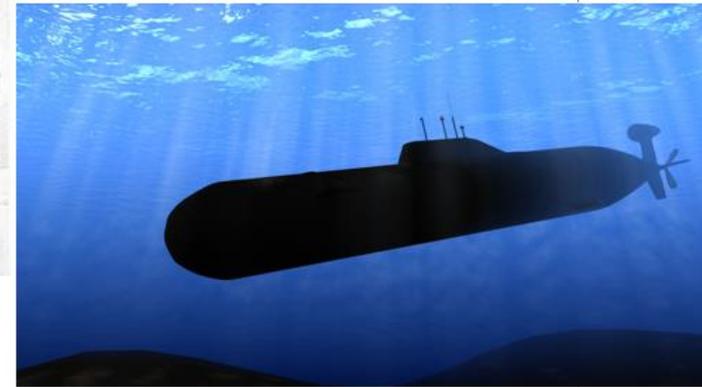
X axis

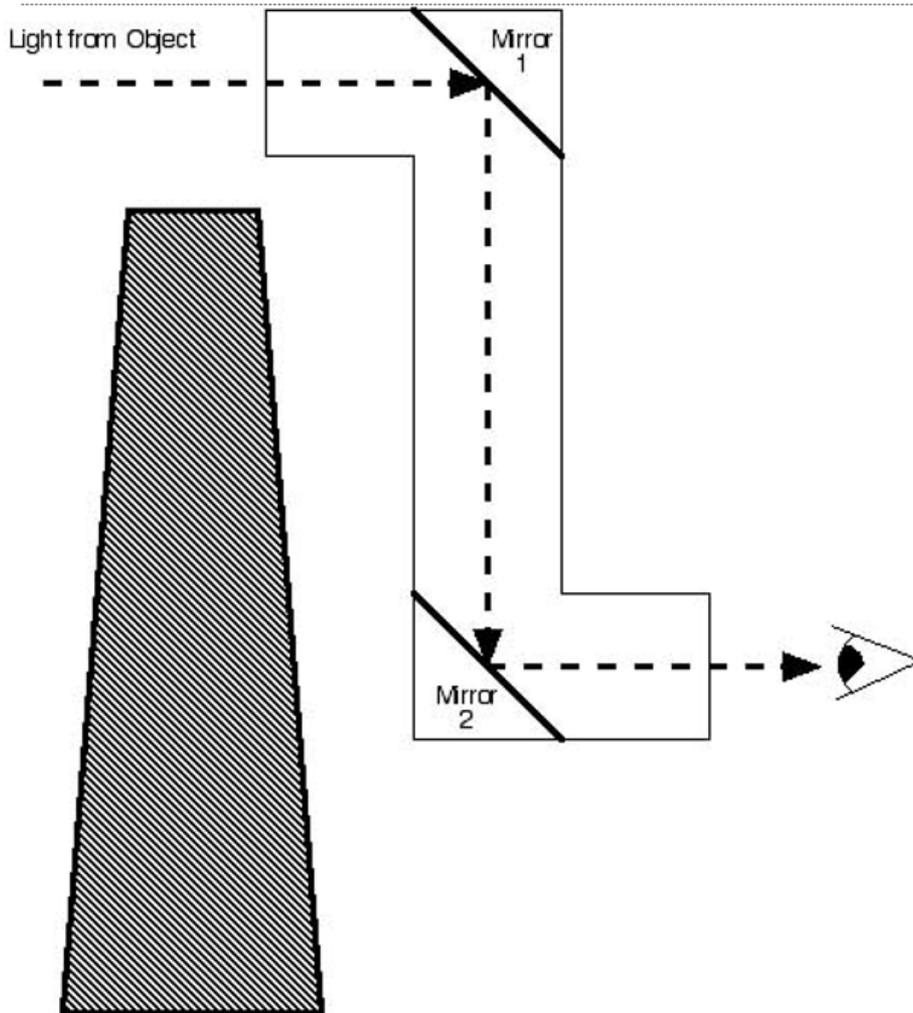
- To recognise that light travels in straight lines.
- To record findings using labelled diagrams.
- To report on findings from enquiries, including oral and written explanations, displays or presentations of results and conclusions.

To be successful...

1. Stand a plastic mirror vertically on a piece of A4 paper and mark its position with a line.
2. Shine a ray of light at the mirror and draw its path and the path of its reflection on the paper.
3. Repeat step 2 for different angles of incidence.
4. **Can you make right angle?**

Time to make your own periscope!





- **Can you explain how your periscope works?**
- Use drawings/labels to help you...
- Use words from the word bank to help you...

Light, light ray, straight, reflect, bounce, right angle, perpendicular, 45 degrees, eye, opening, hole

Year 5 – Earth and Space

- The Sun is so large that the Earth would fit inside it more than a million times. There are more than 100 billion stars in our galaxy and more than 100 billion galaxies in the universe.
- How long does it take to count to 100?
- How long does it take to count to 1000?
- How long would it take you to count to a million?
- If you were to count at a speed of one number per second for 10 hours every day, counting to a million would take you about three weeks.
- If you think that's a lot of counting, to get to a billion you could count for 12 hours every day and it would still take you more than 50 years.

Let's look at some of those large numbers...

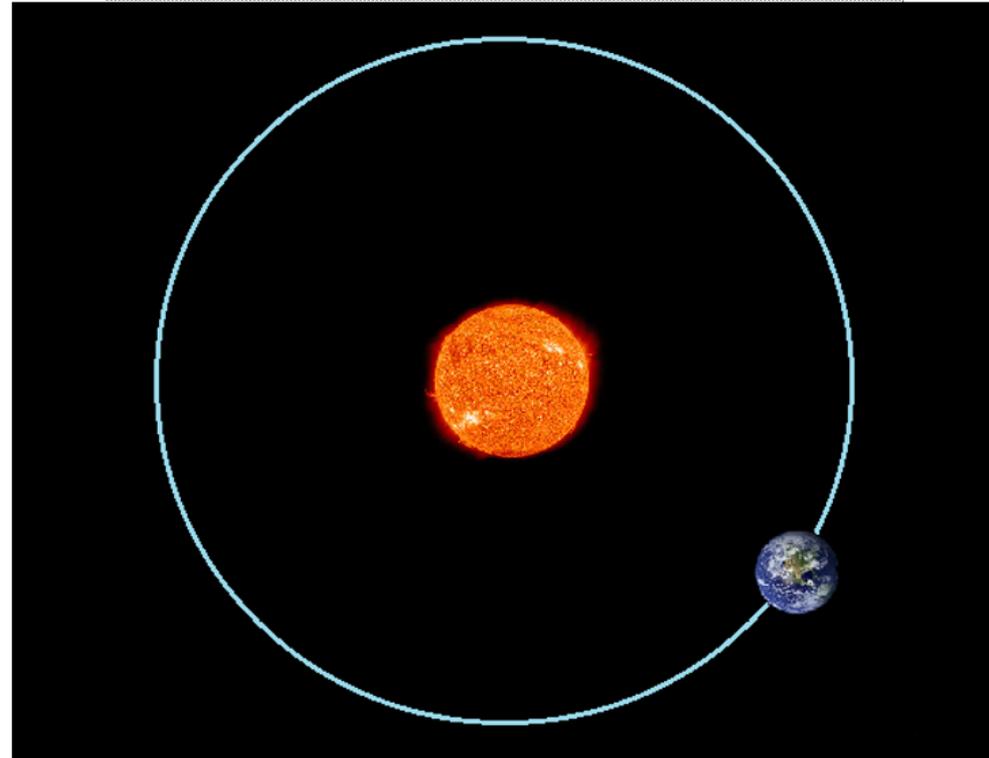
Billions (B)	Hundreds of Millions (H M)	Tens of Millions (T M)	Millions (M)	Hundreds of Thousands (H Th)	Tens of Thousands (T Th)	Thousands (Th)	Hundreds (H)	Tens (T)	Units (U)
	1	5	0	0	0	0	0	0	0

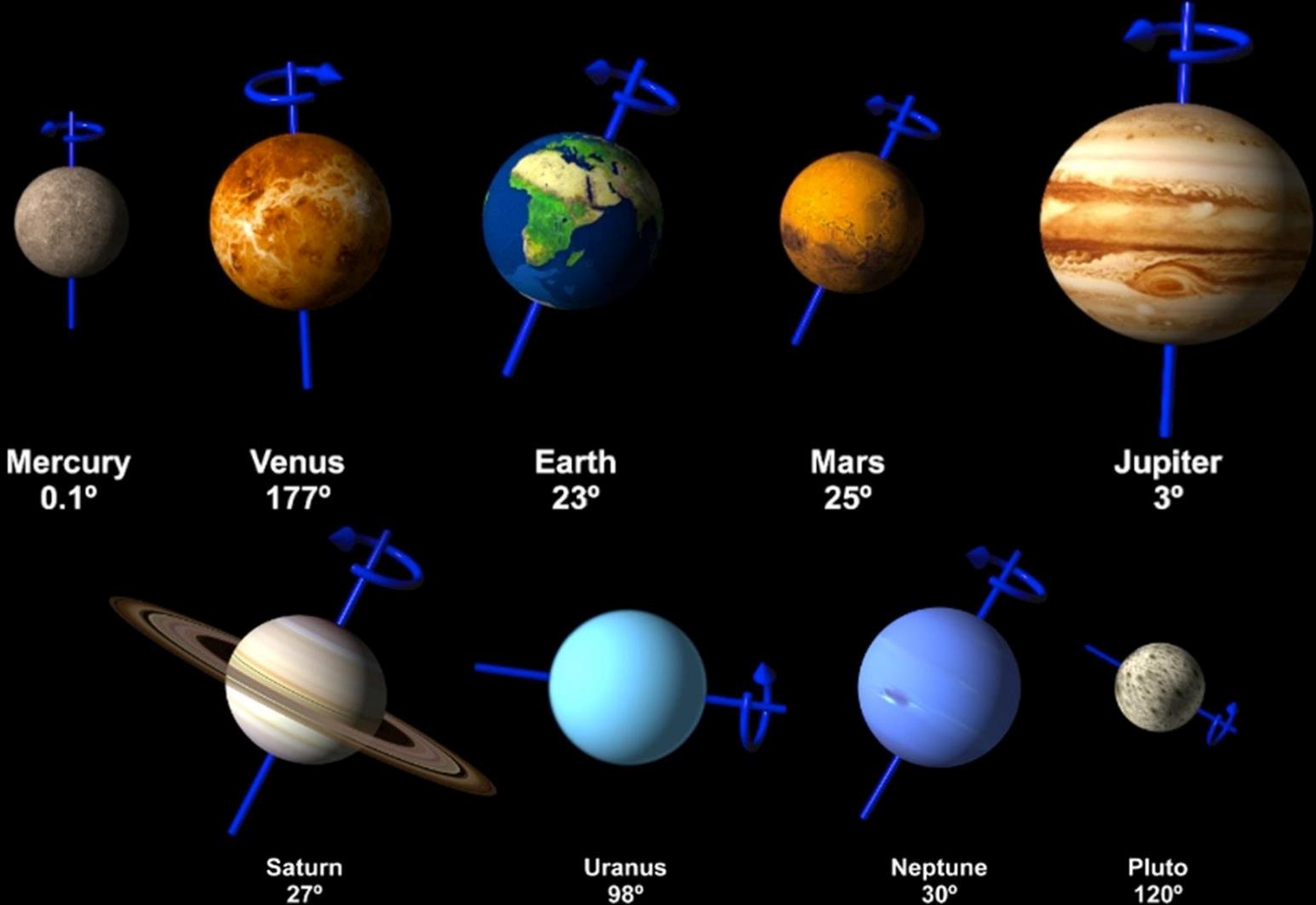
**This is how far Earth is from the Sun in Km!
Can you say this number?**



- The Earth takes about 365 days to go round (orbit) the Sun. Does every planet take the same amount of time to go round (orbit) the Sun?

- Is there a pattern between the distance the planet is from the Sun and the time it takes to orbit it?
- Is there a pattern between the size of the planet and the time it takes to orbit the Sun?

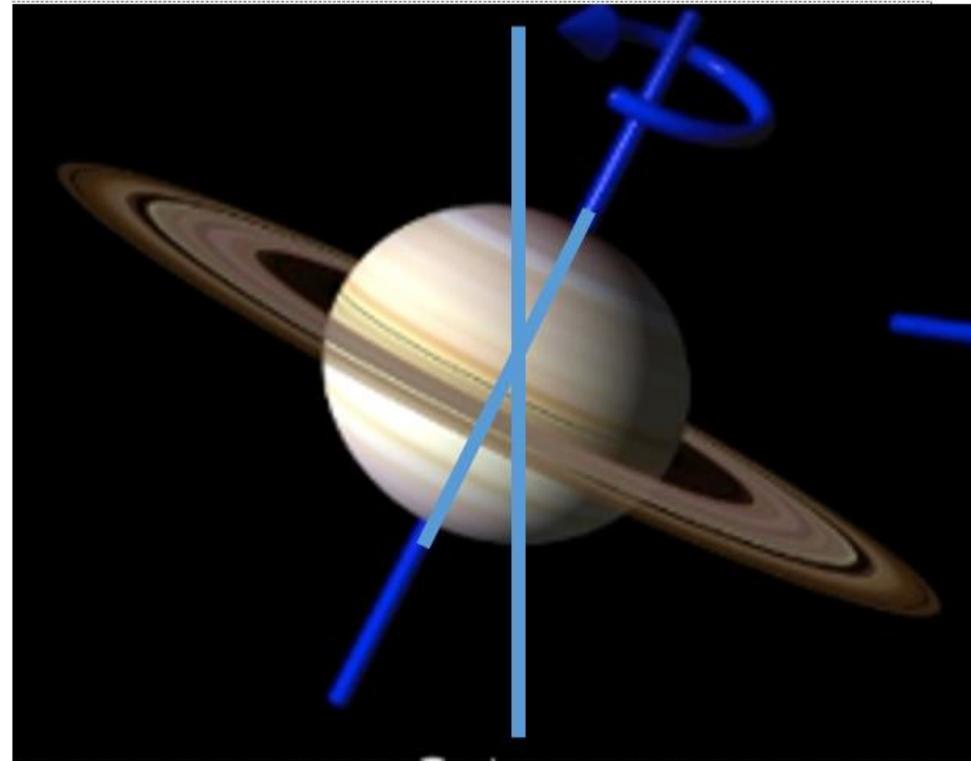
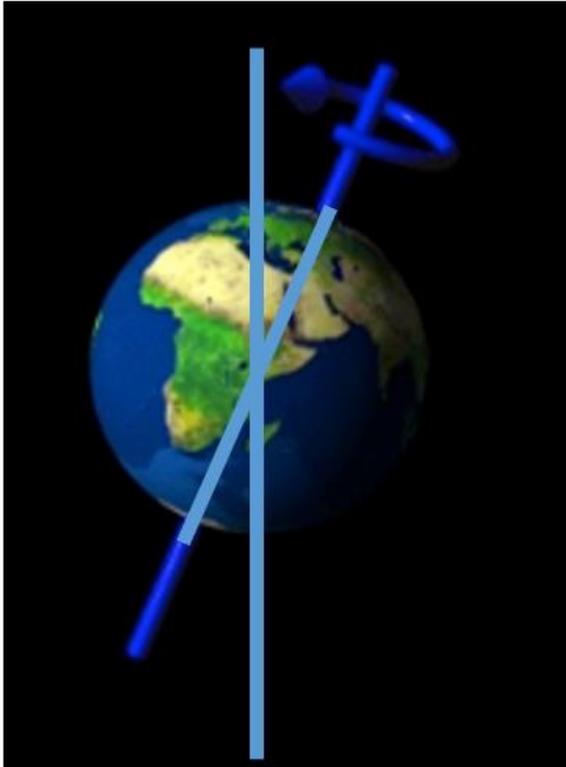




Obliquity of the Nine Planets

© Copyright 1999 by Calvin J. Hamilton

How much do different planets tilt?



What percentage of the Moon's surface is illuminated by the Sun's light?



Year 5 – Earth and Space

- **Negative numbers**

<https://solarsystem.nasa.gov/resources/681/solar-system-temperatures/>

http://www.bbc.co.uk/bang/handson/super_cool.shtml

Find the area of the sail – air resistance investigation

- This activity could easily be used for parachutes as well.



- 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
- Phizzi News – Edition 4.
 - https://www.ogdentrust.com/assets/general/4_Phizzi-News-autumn-2015.pdf

How to link Science and Maths

- Mind-set
 - Where's the Maths in that?
 - Actively identifying and planning for rich mathematical tasks in Science lessons
 - Long-term/MTP
 - Plenary
 - Making the Maths explicit – talking Maths in Science
 - Embedding throughout
 - Seizing the mathematical moment
 - Looking beyond measure and data
 - Fractions, percentages, decimals, ratio, place value, rounding, Venn and Carroll diagrams
- Valuing Science as a source of assessment evidence
 - Moderation
- Linking or discrete?
- **Raise the profile of science – is it valued? Is your science curriculum up to the task?**
 - Cross curricular links – ever followed?

Next Steps

- NCETM materials
 - <https://www.ncetm.org.uk/resources/46490>
- NRICH Science materials
 - <https://nrich.maths.org/9154>
- Start with your own practise
 - Colleagues
 - Next science topic
- Staff meeting
 - Share some rich tasks
- End the madness!
 - You need Science!
 - SLT
- **Effectively linking science and maths will improve both Maths and Science teaching and learning**
 - **Planned for**
 - **Celebrated**
 - **Valued**



- **Why link science and literacy?**

- **Why link science and literacy?**
- How have you linked science and literacy?
- Why should we?

• Why link science and literacy?

- Maintaining Curiosity, Ofsted, 2013.

Key findings

- Teachers who coupled good literacy teaching with interesting and imaginative science contexts helped pupils make good progress in both subjects.
- Explicit connections between science and literacy, when teachers made them, showed clear evidence of better science and literacy outcomes for pupils. Imaginative teaching allowed pupils to use their science work as a purpose for their reading and writing, in effect doubling the time available to teach both subjects.

• Why link science and literacy?

- The National Curriculum

Language and literacy

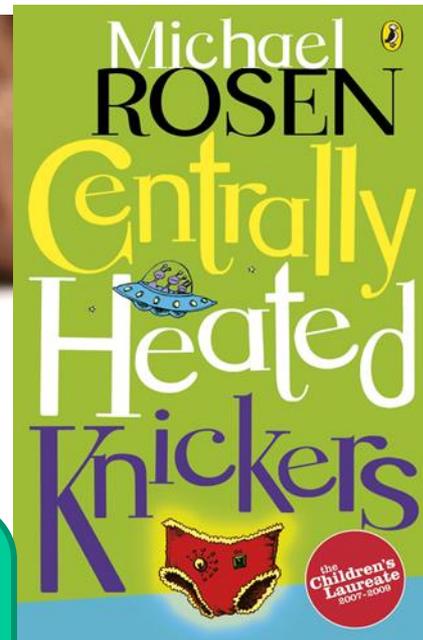
Teachers should develop pupils' spoken language, reading, writing and vocabulary as integral aspects of the teaching of every subject. ...Fluency in the English language is an essential foundation for success in all subjects.

Spoken language

Pupils should be taught to speak clearly and convey ideas confidently using Standard English. They should learn to justify ideas with reasons; ask questions to check understanding; develop vocabulary and build knowledge; negotiate; evaluate and build on the ideas of others; and select the appropriate register for effective communication. They should be taught to give well-structured descriptions and explanations and develop their understanding through speculating, hypothesising and exploring ideas. This will enable them to clarify their thinking as well as organise their ideas for writing.

• Why link science and literacy?

- Chocolate by Michael Rosen



- Star Science, Technology and Reading – ASE Bookshop

- **Why link science and literacy?**
- <https://www.stem.org.uk/teaching-science-through-stories>
- **Text could:**
 - **Link English and Science**
 - **Be discrete to Science**
- **Long-term planning key to success.**

•Why link science and literacy?

Using well known books and characters



Dear students,

I hear that you are experts at material matters and there are rumours that even the Ministry of Magic are impressed! You must be fantastic wizards. The Ministry don't even know about Hermione and she is a cleverest wizard I know. I have some problems with Fred and George; they keep playing tricks on me! Mum and dad are too busy fighting the Dark Wizards to help me so I am hoping you can. I really need to know what tricks they are planning next.

When I was looking, well alright snooping, in their room I found some powders and some funny green liquid with a note saying 'OUR NEXT BIG TRICK!' Hermione has me revising for our OWLS every evening and Harry keeps getting some funny headaches. Please can you investigate what happens when these powders are mixed with the liquid? I want to be prepared for their trick.

I had better go I'm running late for Potions class – Snape is going to kill me! Hope I get your observations soon!

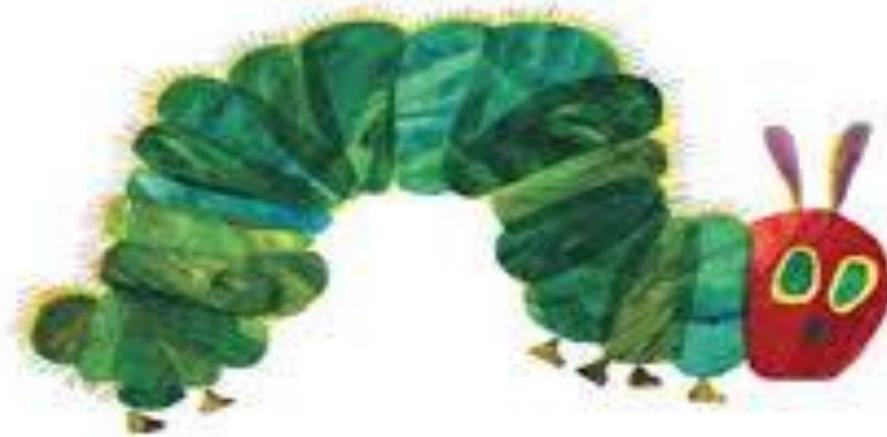
From,

Ron Weasley

• Why link science and literacy?

Adapt/copy a well known text

THE VERY HUNGRY CATERPILLOR™



• Why link science and literacy?

Type of enquiry	Description
Observing over time	Children observe or measure how one variable changes over time.
Identifying and Classifying	Children identify features or tests that help them distinguish between different things.
Pattern seeking	Children observe and record phenomena, carry out surveys or collect data from secondary sources and then identify relationships between data in their findings.
Research	Children use secondary sources of evidence.
Fair and Comparative Testing	Children observe or measure the effect that changing one variable has on another whilst attempting to keep other variables constant.

•Why link science and literacy?

- Science should not be a reading comprehension lesson in disguise.
- **Make them want to read!**
 - Seize the interest.
 - Exploration – information cards/books.
 - Do they really want to find something out?
- **An amazing guided reading stimulus.**
 - **Reachout Reporter**
 - <https://www.reachoutreporter.com/>
- **Run a Science Reading Challenge!**
 - <https://pstt.org.uk/resources/curriculum-materials/science-reading-challenge>

• Why link science and literacy?

• Writing

• What did we use

- Stopwatch

- Bowl

- Pipette

• Method

1. First we got a stopwatch...

- **Routine, formulaic, lacks purpose.**

- **Drives disengagement**

- **Create a clear, meaningful and engaging purpose for writing in science.**

- **Why link science and literacy?**
- **Writing**

Stage	Exploration
Exploring	Children explore a question, problem, idea, artefact, model, living thing or event as a starting point to enquiry.
Collecting and analysing evidence	Children observe over time, look for patterns, identify and classify, research using secondary sources or carry out a fair test and record and analyse their findings.
Reaching a suitable and satisfying outcome	Children solve a problem, answer a question, develop an explanation, make and evaluate an artefact, model, or system, provide evidence to justify why the outcome is appropriate or raise more questions to investigate.

- **Why link science and literacy?**
- **Writing**
- **Consumer report**
- A consumer report is a report of a science investigation, written as though it is a report on a set of products for a consumer magazine. It will include some kind of evaluation of the things being studied against specific criteria.
- **Provide a meaningful context and a clear purpose for an investigation**
- **Avoids science write-ups becoming routine.**
- **Real-world context.**



•Why link science and literacy?

• Writing

• **Diary entry for a scientist**

- Record the outcomes of a scientific enquiry in the form of a diary entry by a scientist.
- Can be a record of a scientist's speculations/thoughts.
- Context for imaginative/creative writing.
- Linked to literacy lessons on diary writing or a discrete.
- Could be written at the start (AfL) or end of a science topic.

- **Why link science and literacy?**
- Writing
- **Generating instructions**
 - Learners can generate a set of instructions that another person could follow. The instructions set out what someone else has to do to achieve a particular outcome.
 - End of a topic – review learning.
 - Real-world context
 - Germination of seeds
 - Selling seeds to parents
 - Great way of consolidating learning/identifying misconceptions.

- **Why link science and literacy?**
- **Writing**
- **Writing a letter**
 - You can use writing a letter to:
 - Get learners to raise a problem.
 - Describe an idea.
 - Outline the results of an investigation.
 - **Motivating stimulus for writing**
 - **Scope for individuality and creativity.**
 - **Provides an opportunity for learners to review their learning, clarify their thinking and consolidate their ideas.**
 - **'Replies' provide further stimulus for discuss/writing.**

- **Why link science and literacy?**
- Writing
- **News reports**
- In a news report learners present information in the style of a media report of an interesting or hypothetical event.
 - Newspapers
 - TV news
 - 'Disaster' reports
- Text based or a mix of media.
- Record outstanding discoveries or imaginary events.

- **Why link science and literacy?**
- Writing
- **Science fiction stories**
 - Literacy Shed – sci-fi shed
 - <https://www.literacyshed.com/the-sci---fi-shed.html#>
 - What if scenarios...



<https://www.jpl.nasa.gov/news/news.php?feature=7300>

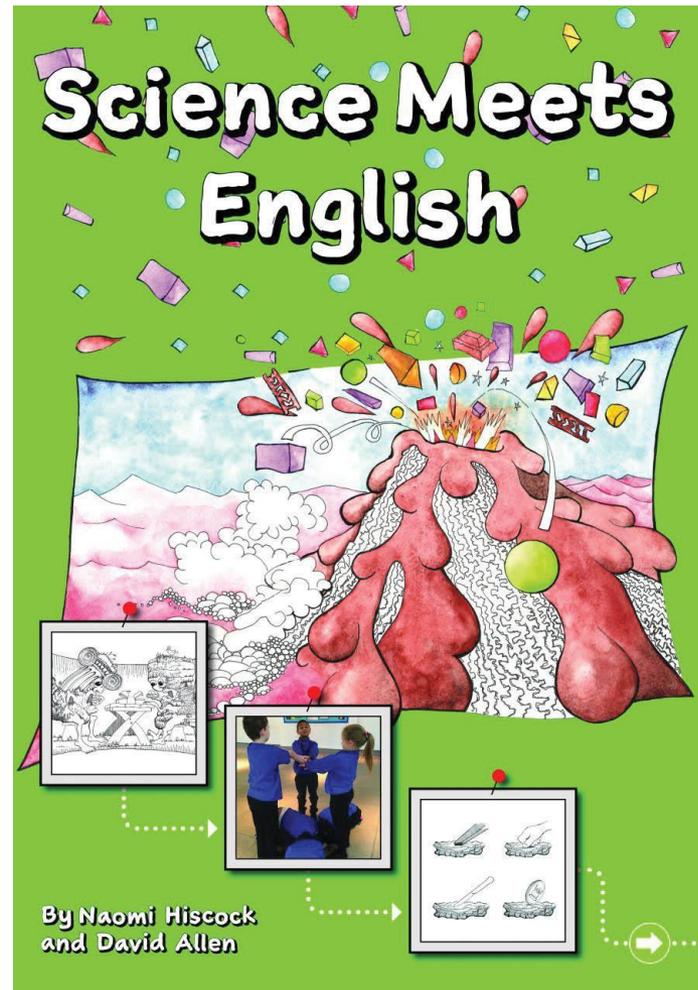
•Why link science and literacy?

- Writing
- **Sales pitch or advertisement**
- Research/present information in an interesting way.
- Gives research-based activities a clear sense of purpose – motivating, creative, engaging
 - Estate agent sales pitch for different habitats/mini-beasts

- **Why link science and literacy?**
- Writing
- Time
- Shouldn't replace the science!
- Ideally science is ***the*** stimulus for literacy lessons.
- Rich assessment evidence.

• Why link science and literacy?

- <https://www.ase.org.uk/bookshop/science-meets-english>
- Equal weight between English and Science.



- **Why link science and literacy?**
- **Speaking and listening**

Discussion in Science:

- Helps children to organise and understand their ideas
- Shows children that their ideas are valued
- Helps develop their vocabulary
- Enables children to share ideas, ask questions and challenge one another and themselves
- Provides opportunities for formative assessment

• Why link science and literacy?

- Speaking and listening

- **Explorify**

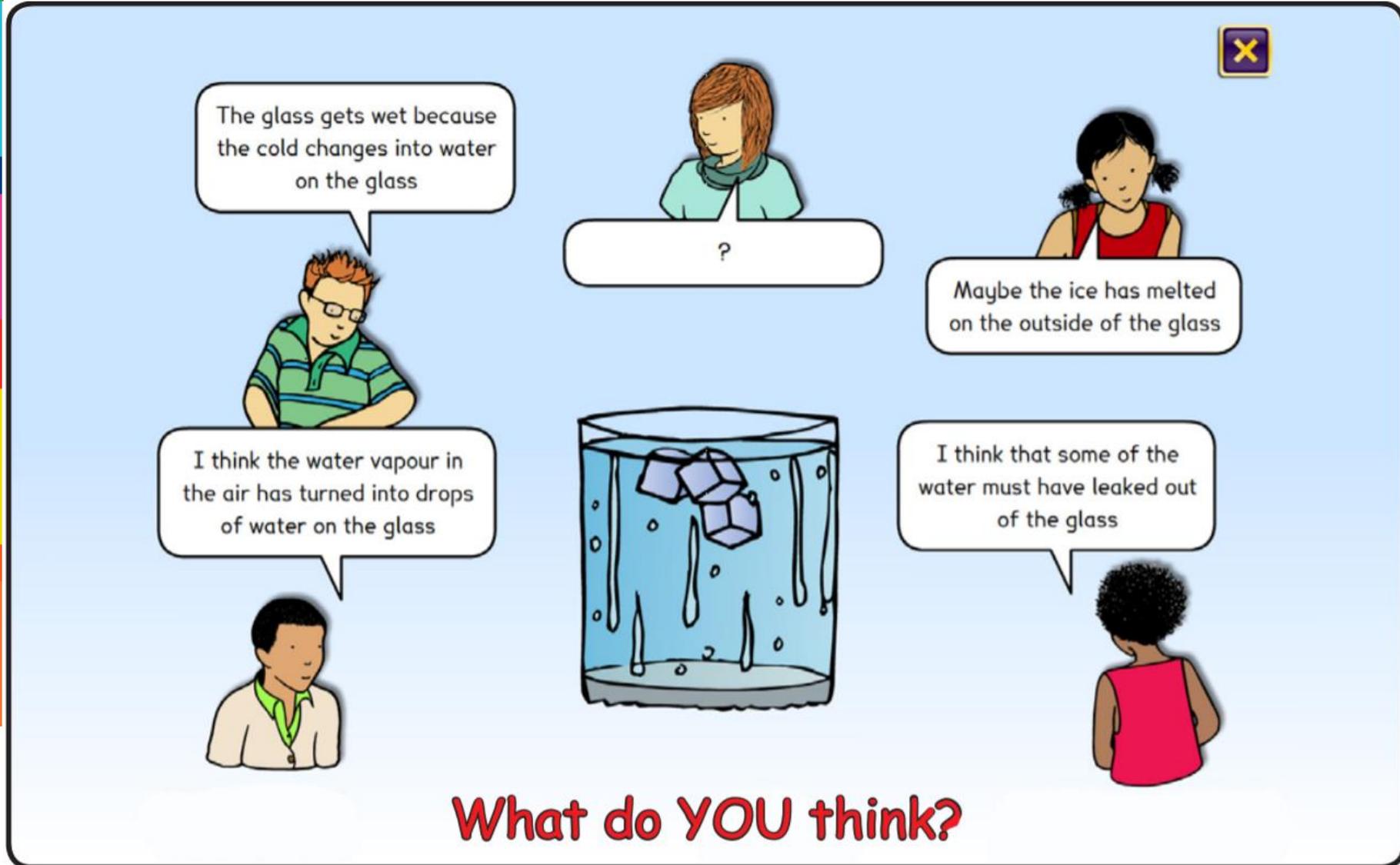
- Odd one out
- Zoom in, Zoom out
- What if?

<https://explorify.wellcome.ac.uk/>

- **Progression in Language Structures**

• Why link science and literacy?

- Speaking and listening
- **Concept cartoons**



The glass gets wet because the cold changes into water on the glass

?

Maybe the ice has melted on the outside of the glass

I think the water vapour in the air has turned into drops of water on the glass

I think that some of the water must have leaked out of the glass

What do YOU think?



**To improve and support
the excellent teaching of
primary science in every
classroom across the UK.**

Tom Holloway

Regional Mentor – London and the South
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email: tom.holloway@pstt.org.uk