SCIENCEOXFORD

Primary Science Teaching Trust

# Thinking Doing Talking Science

## Focused recording

Creativity

Questions - pupil & teacher

Practical Prompts for Thinking

Practical Investigations

Higher order thinking

talking

doing

Bright Ideas Time

Practical Problem solving

# Sound and light

The strategies are generic and for all curriculum areas – we are exemplifying them through this topic

Sound is in Year 4 of NC (England)

But, most importantly, principles can be applied across all ages

Light is in Years 3 & 6 of NC (England)

Also, not statutory when you cover what, as long as all completed by end of Key Stage 2

Remember:

There are subject knowledge notes in your **TDTScience Teacher Resources** folder.

Login and download here:
https://tdtscience.org.uk/user-registration-primary

You will find the subject knowledge files in the **General Resources** folder.

## Year 4

**Pupils should be taught to:**

- identify how sounds are made, associating some of them with something vibrating
- recognise that vibrations from sounds travel through a medium to the ear
- find patterns between the pitch of a sound and features of the object that produced it
- find patterns between the volume of a sound and the strength of the vibrations that produced it
- recognise that sounds get fainter as the distance from the sound source increases

## Health & Safety

The activities you will be undertaking today have been risk assessed using guidance provided by CLEAPSS.

When planning to repeat any of the activities we are showcasing today, you must consult the risk assessment advice provided by your employer and adjust it to suit the needs of your class.

It is likely that your employer has identified CLEAPSS (England, Wales and NI) or SSERC (Scotland) as the source of H&S advice they want you to follow.

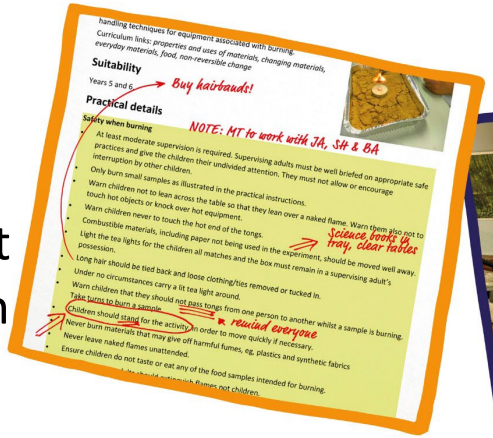
| | |
|---|---|
| www.cleapss.org.uk | www.sserc.org.uk |
| primary@cleapss.org.uk | enquiries@sserc.scot |
| 01895 251 496 | 01383 626 070 |

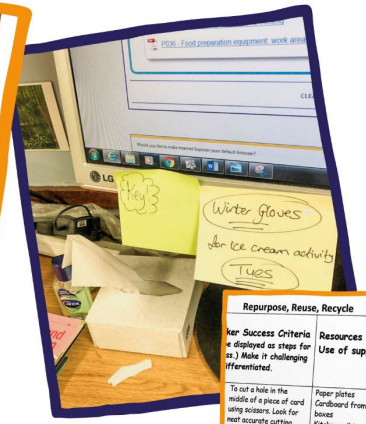
If you do not know who provides your school with health and safety advice, ask your Headteacher, employer or business manager.

It is your employer's responsibility to provide you with suitable advice and training so that you can manage any risks arising in your lessons appropriately.

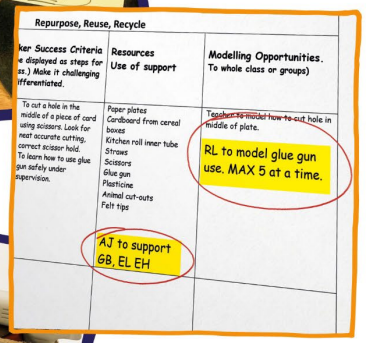
# Health & Safety – Risk Assessment

Annotated CLEAPSS safety notes document with steps taken appropriate to the cohort




Post-it note reminders of steps to be taken to keep the cohort safe




Planning annotated with steps to be taken e.g. additional supervision/ small group work

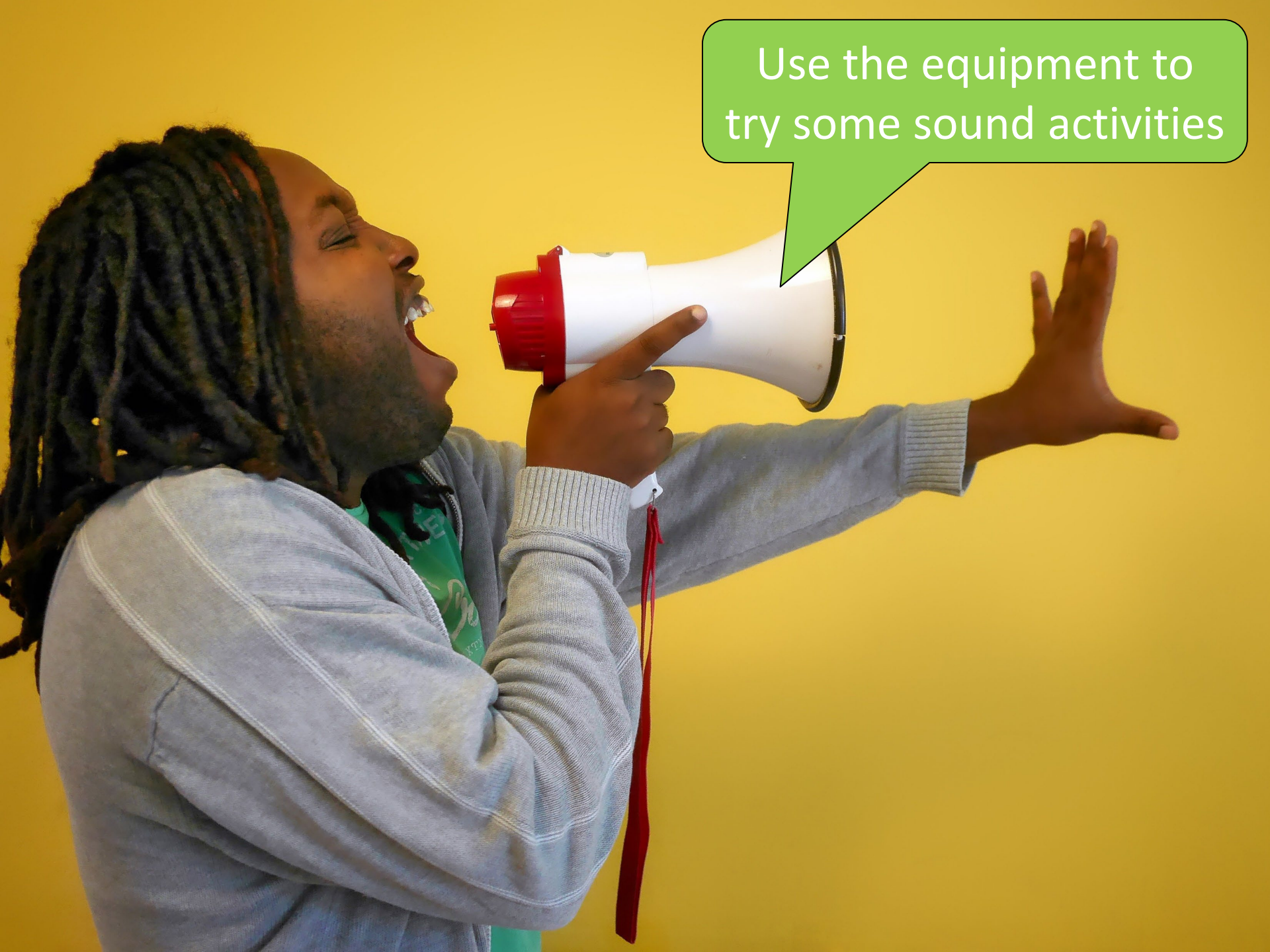
IWB of PPT safety procedure slide reminder



Safety reminder sign placed on tables to be seen whilst doing the activity

https://primary.cleapss.org.uk/Resource/P137-How-to-do-a-risk-assessment.aspx

Images courtesy of CLEAPSS


Use the equipment to try some sound activities

# Sound: Teaching the Key Concepts

Exemplifies a TDTScience approach to teaching sound and includes ***illustrative*** practicals

Reinforcing children's knowledge and understanding

See **Day 4 Teacher Supplements** folder

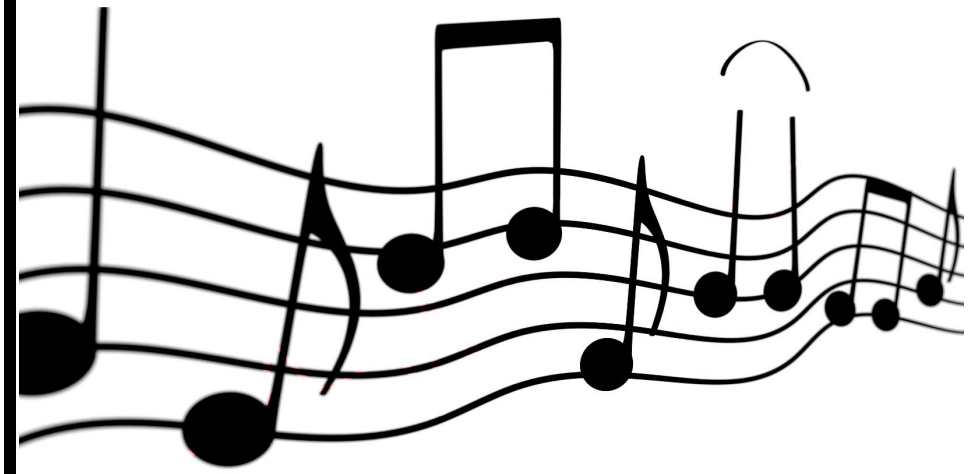
## Key question

- Is the aim of the lesson to develop the children's skills; knowledge and understanding; or both?
- What will be the focused learning objective(s)?
- What will the children record?
- What and how will you assess?

# The science of sound

Don’t forget your subject knowledge notes

High



Low

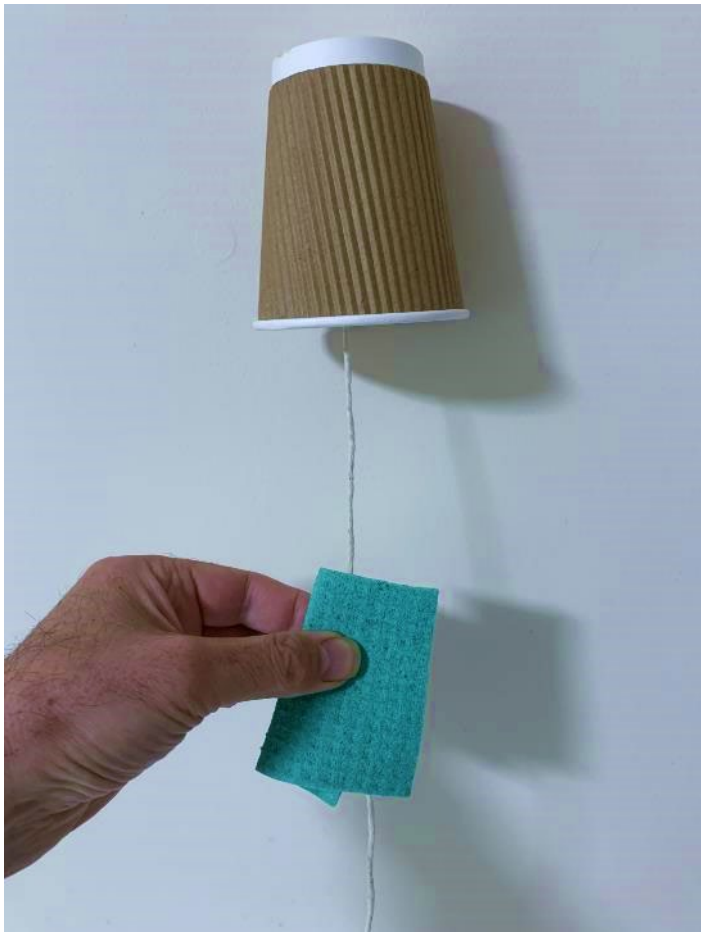
Loud

Quiet

# How sound travels

# Practical: Clucking cups

See the handout in your pack



**Possible Learning Objective:** To draw a conclusion, based on your results

## What would be the learning objective?

## How would you assess the learning objective?
## What would the children record?

# Key questions

- Is the aim of the lesson to develop the children's skills; knowledge and understanding; or both?
- In order to carry out the *practical* successfully:
  - what do the children already need to know/understand?
  - and/or what skills do they need to have?

# Practical: Make a musical instrument

See the **Day 4**
**Teacher Supplements**

# Use the plastic tray as a sound box – think why you need this!

**Your challenge:**

- Make something that produces 4 notes with different pitch
- How could you vary the volume?
- Record your findings in whatever way you wish so that they are really clear

**Learning Objective:**

- to report and present findings clearly

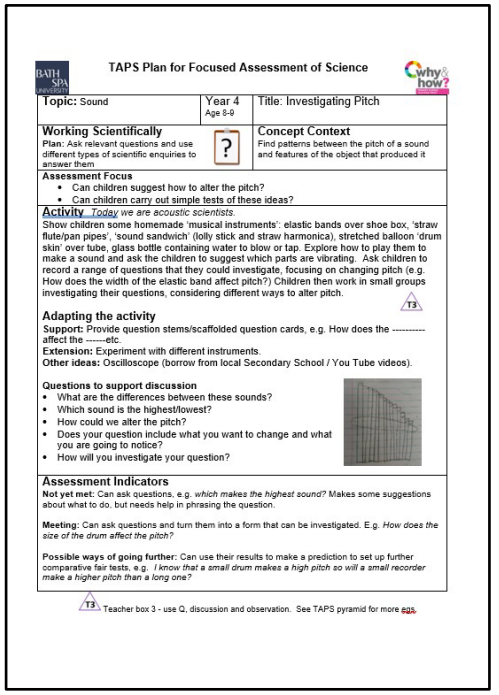
DON'T LIMIT YOUR CHALLENGES

**CHALLENGE YOUR LIMITS**

**Learning Objective:**

- to report and present findings clearly

How would you assess the learning objective?



TAPS Plan for Focused Assessment of Science

**Topic:** Sound | Year 4 Age 8-9 | Title: Investigating Pitch

**Working Scientifically**
Plan: Ask relevant questions and use different types of scientific enquiries to answer them

**Concept Context**
Find patterns between the pitch of a sound and features of the object that produced it

**Assessment Focus**
- Can children suggest how to alter the pitch?
- Can children carry out simple tests of these ideas?

**Activity** *Today we are acoustic scientists.*
Show children some homemade 'musical instruments': elastic bands over shoe box, 'straw flute/pan pipes', 'sound sandwich' (lolly stick and straw harmonica), stretched balloon 'drum skin' over tube, glass bottle containing water to blow or tap. Explore how to play them to make a sound and ask the children to suggest which parts are vibrating. Ask children to record a range of questions that they could investigate, focusing on changing pitch (e.g. How does the width of the elastic band affect pitch?) Children then work in small groups investigating their questions, considering different ways to alter pitch.

**Adapting the activity**
**Support:** Provide question stems/scaffolded question cards, e.g. How does the ---------- affect the ------etc.
**Extension:** Experiment with different instruments.
**Other ideas:** Oscilloscope (borrow from local Secondary School / You Tube videos).

**Questions to support discussion**
- What are the differences between these sounds?
- Which sound is the highest/lowest?
- How could we alter the pitch?
- Does your question include what you want to change and what you are going to notice?
- How will you investigate your question?

**Assessment Indicators**
**Not yet met:** Can ask questions, e.g. *which makes the highest sound?* Makes some suggestions about what to do, but needs help in phrasing the question.

**Meeting:** Can ask questions and turn them into a form that can be investigated. E.g. *How does the size of the drum affect the pitch?*

**Possible ways of going further:** Can use their results to make a prediction to set up further comparative fair tests, e.g. *I know that a small drum makes a high pitch so will a small recorder make a higher pitch than a long one?*

T3 Teacher box 3 - use Q, discussion and observation. See TAPS pyramid for more egs.

TAPS plan – Investigating pitch

LO – to plan

https://pstt.org.uk/download/2168/?tmstv=1676905596

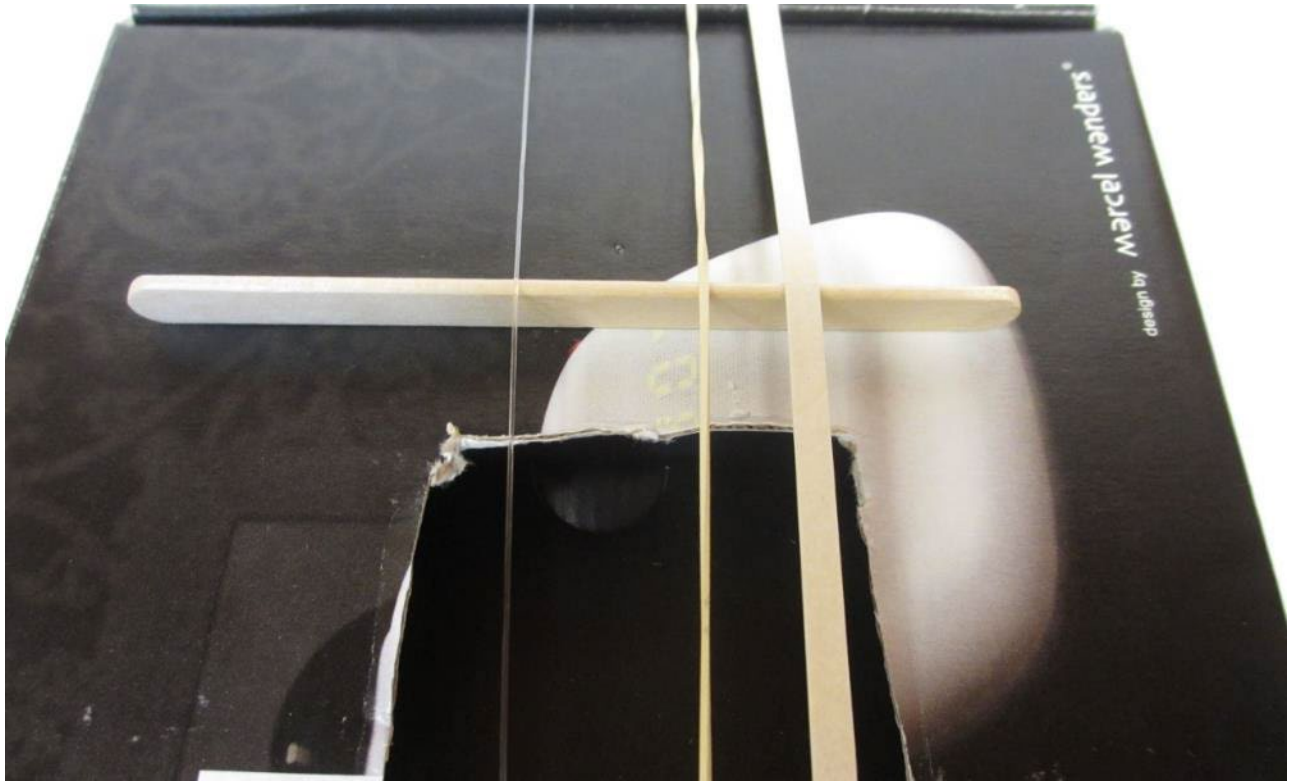
# Resonance Boxes

# String fasteners

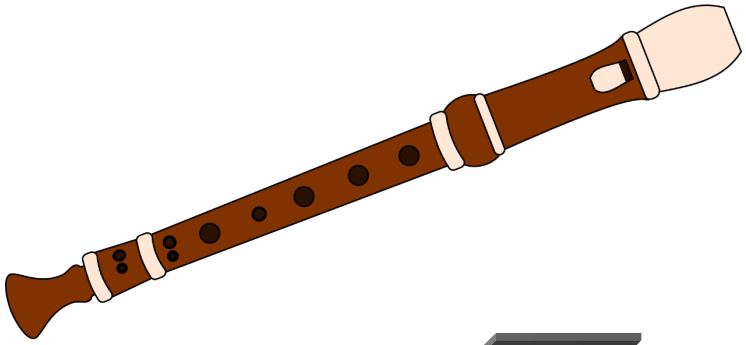


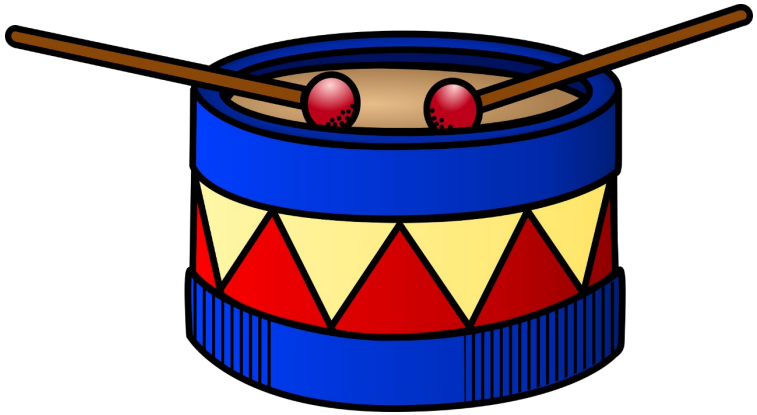
# String tightening


# Creating a bridge



# Odd One Out





# HOT Question

How did the astronauts talk to each other on the Moon?

PMI

# Life without sound

P = Positive

M = Minus

I = Interesting

Explorify

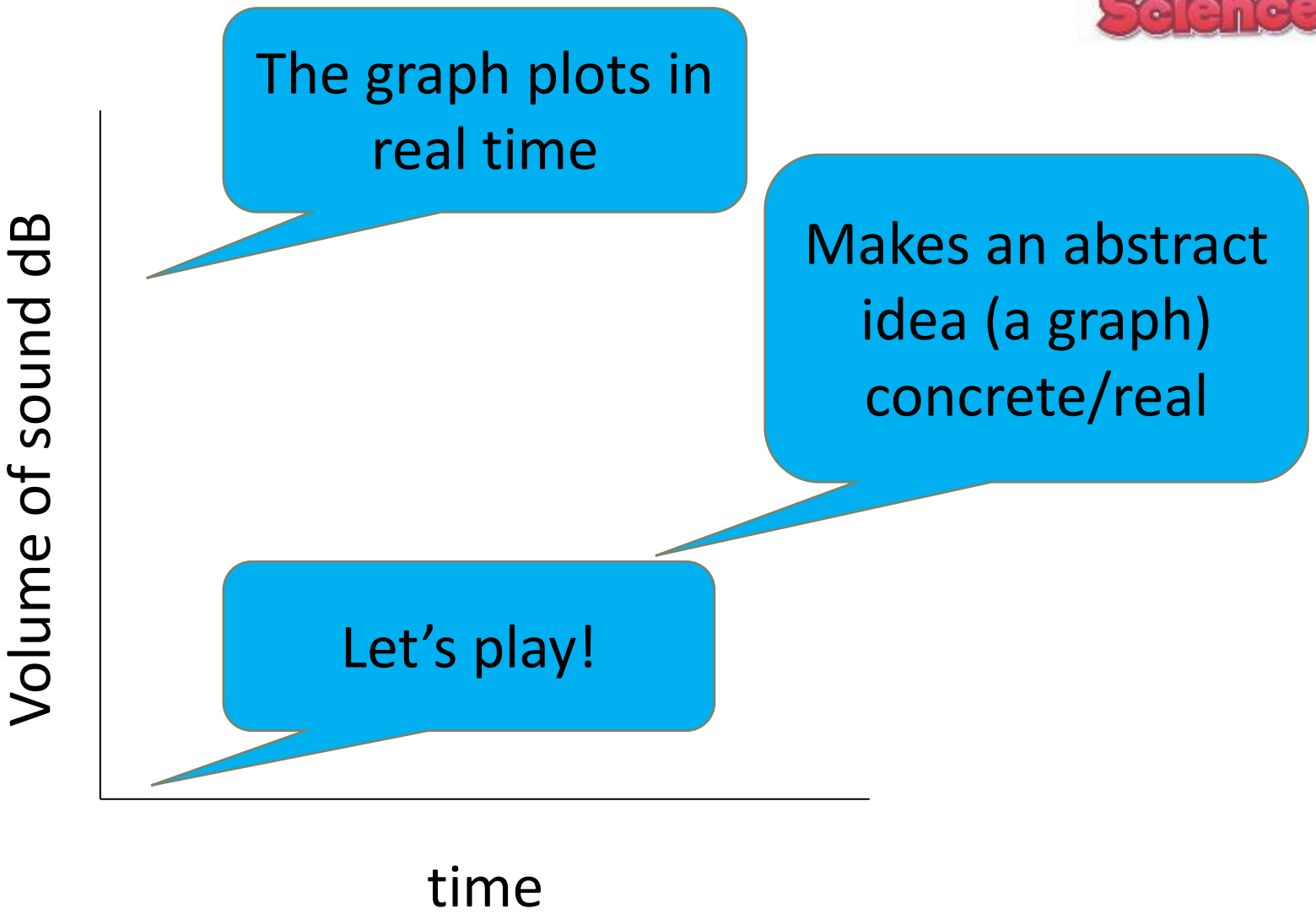
Thinking Doing Talking Science

## Video clip: The Sound of Silence

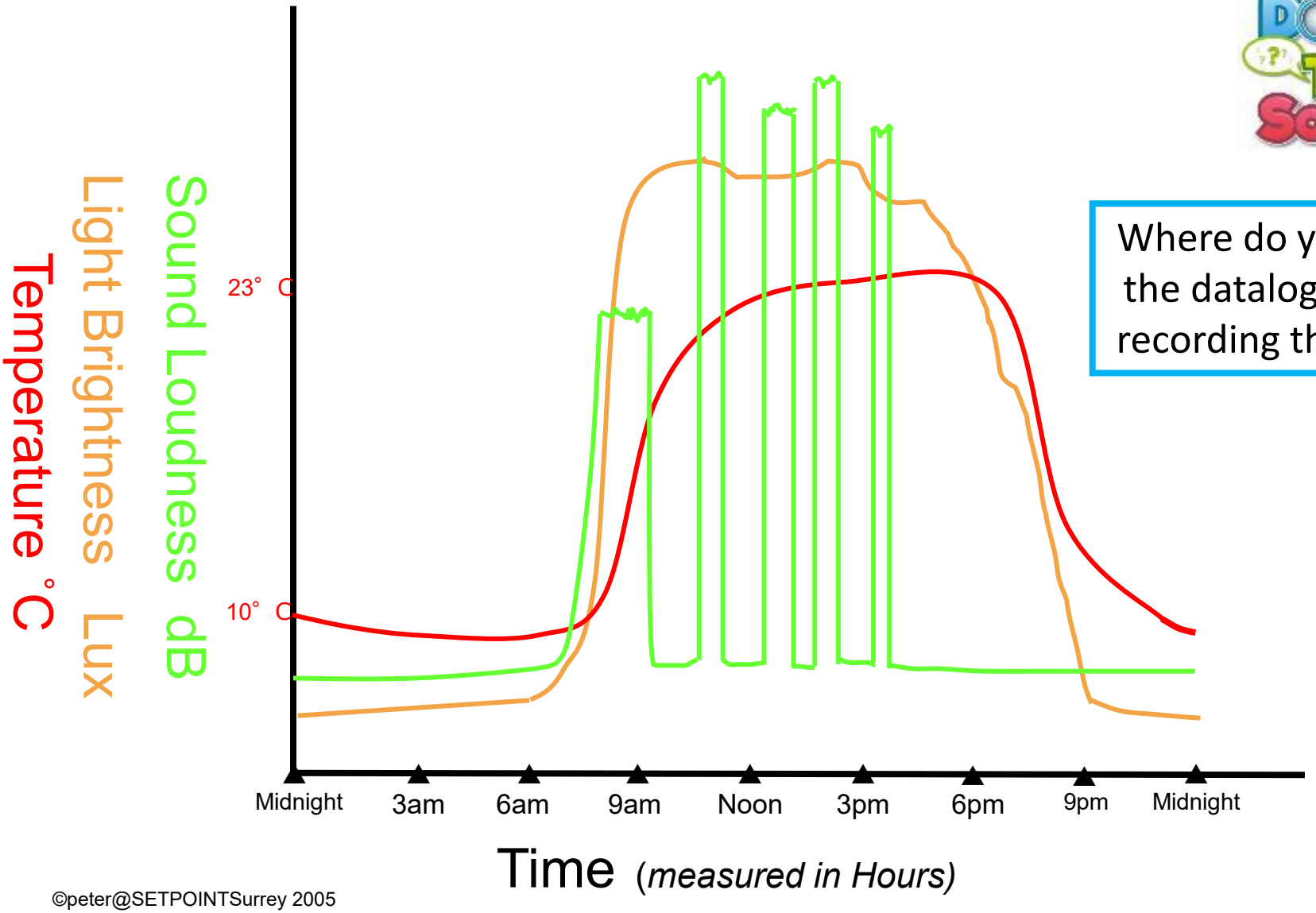
Great as a discussion starter in the Bright Ideas Time

https://explorify.uk/en/activities/whats-going-on/the-sound-of-silence

# Plotting live sound graphs with a data logger

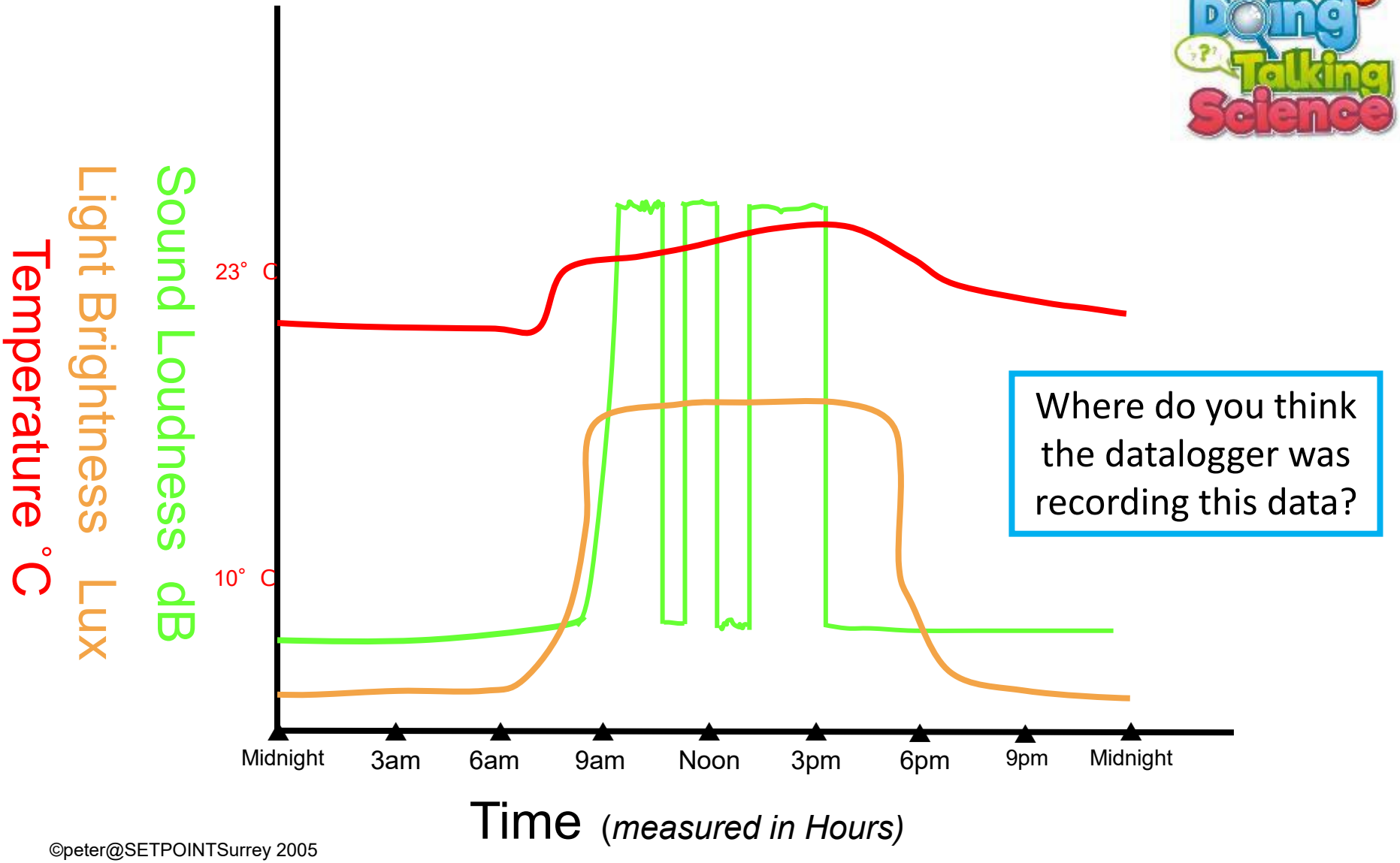


# Example 1: Where in the school?




Where do you think the datalogger was recording this data?

# Example 2: Where in the school?




Where do you think the datalogger was recording this data?

# Sharing of Good Practice

**Repertoire of strategies**

**Try out and evaluate**

**You were asked to:**

- Give feedback on any one science practical and the use of focused recording within it
- note some children's responses
- if possible, bring along examples of children's recording
- reflect on how you thought it went

In groups of four, share how it went in terms of:

- Children's responses
- Children's learning
- Children's behaviour

Share any examples of children's recording that you have brought with you.


Light

## Year 3

**Pupils should be taught to:**

- recognise that they need light in order to see things and that dark is the absence of light
- notice that light is reflected from surfaces
- recognise that light from the Sun can be dangerous and that there are ways to protect their eyes
- recognise that shadows are formed when the light from a light source is blocked by an opaque object
- find patterns in the way that the size of shadows change.

## Year 6

**Pupils should be taught to:**

- recognise that light appears to travel in straight lines
- use the idea that light travels in straight lines to explain that objects are seen because they give out or reflect light into the eye
- explain that we see things because light travels from light sources to our eyes or from light sources to objects and then to our eyes
- use the idea that light travels in straight lines to explain why shadows have the same shape as the objects that cast them.

Darkness is the absence of light

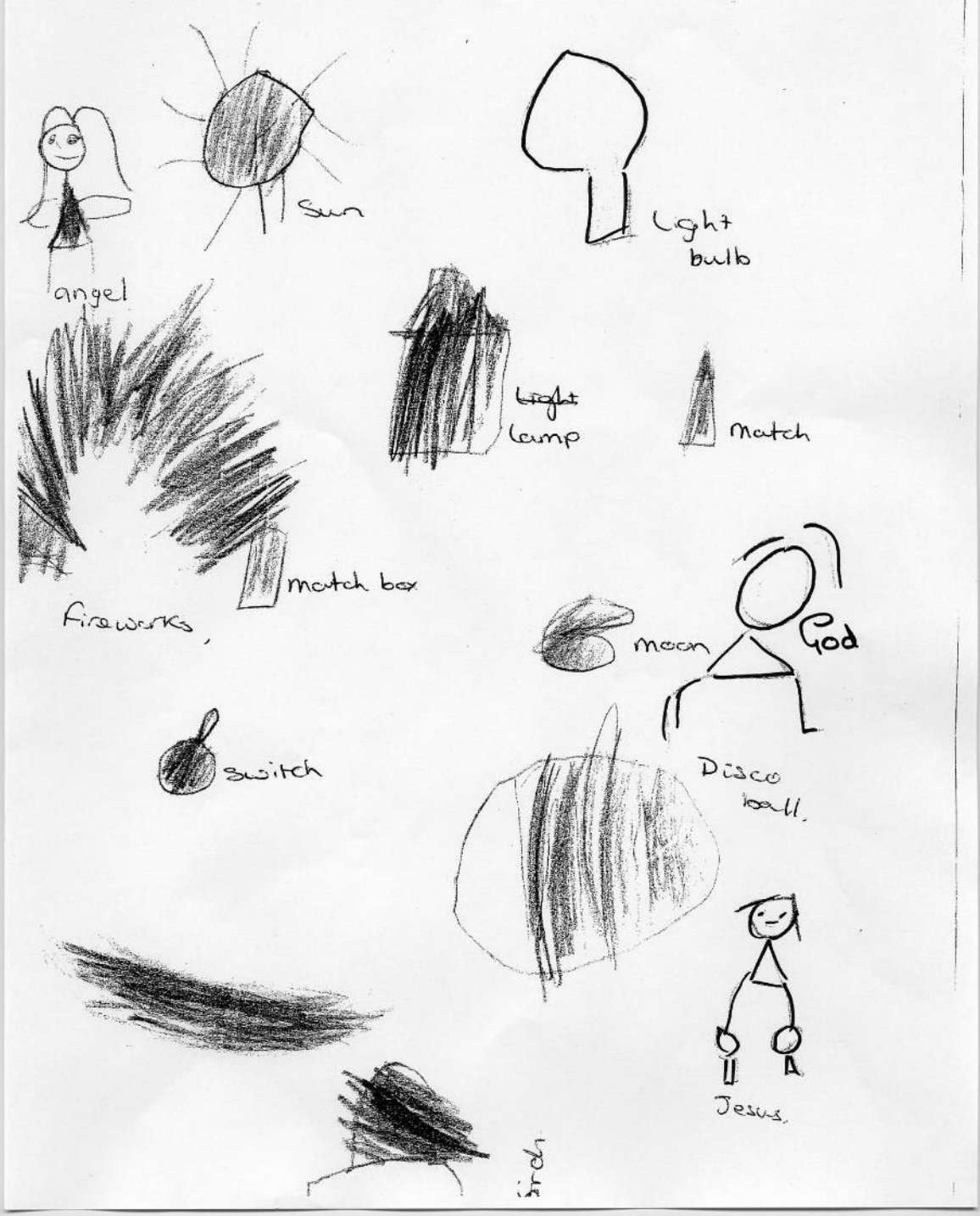
Have you experienced pitch blackness?

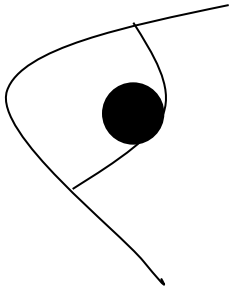
A peep box helps to demonstrate that we need light to see

# The Bright Ideas Time: The Concept Cartoon


Image shared with kind permission from Millgate House Education Ltd

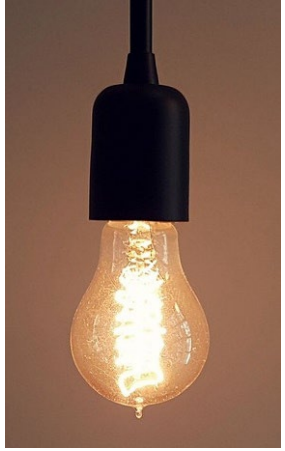
# Year 1 children
# Light sources

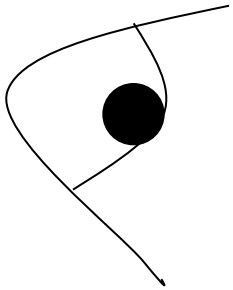




**Eye**

Draw the rays of light to show how the eye sees the candle

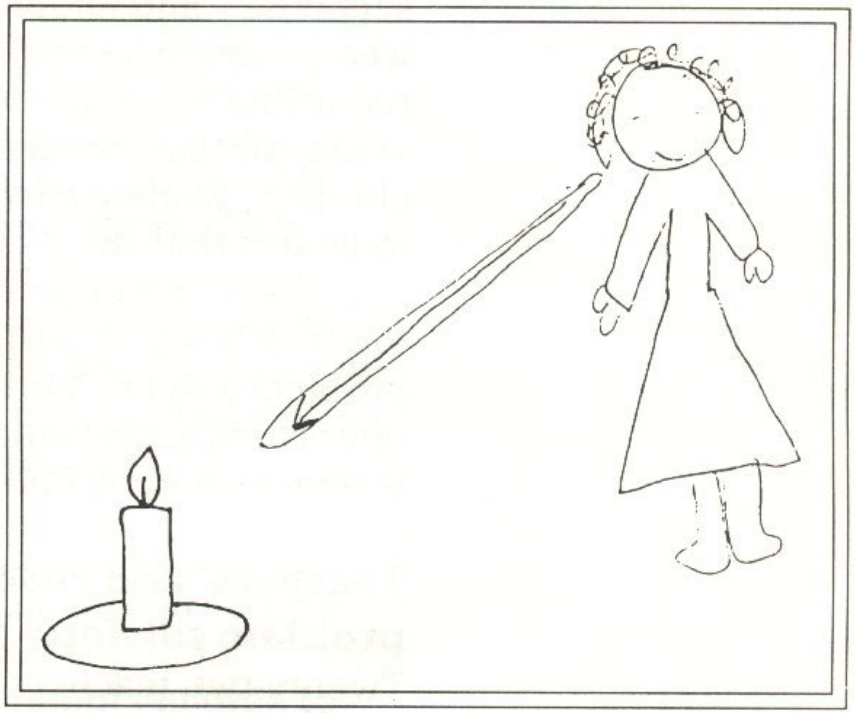




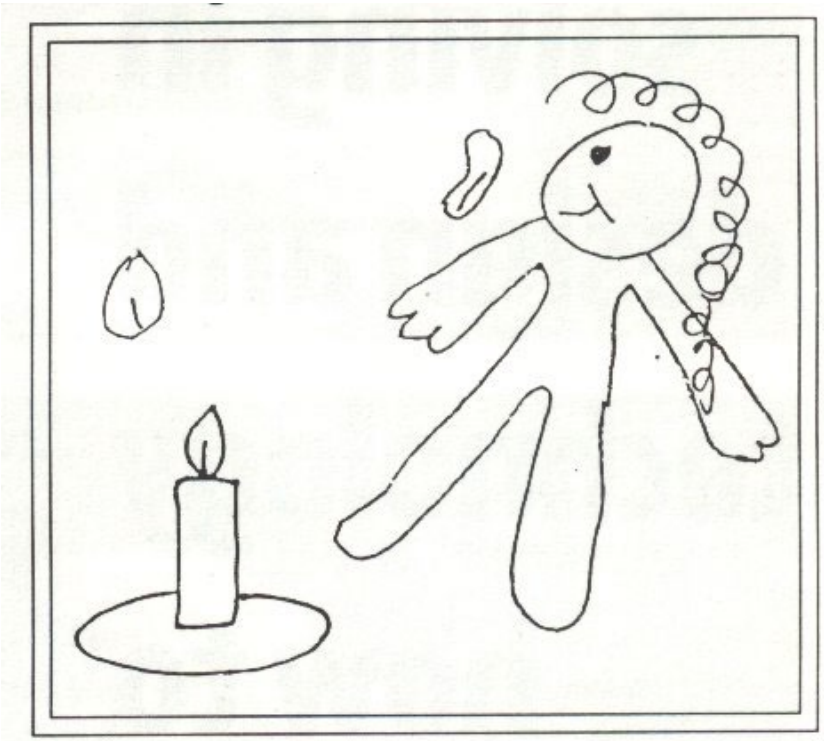
Draw the rays of light to show how the eye sees the dog

## Common misconceptions:

## The active eye model

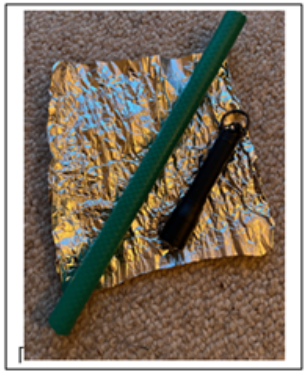


## ‘Bunches’ of light travelling to the eye



# What would demonstrate a more accurate understanding?

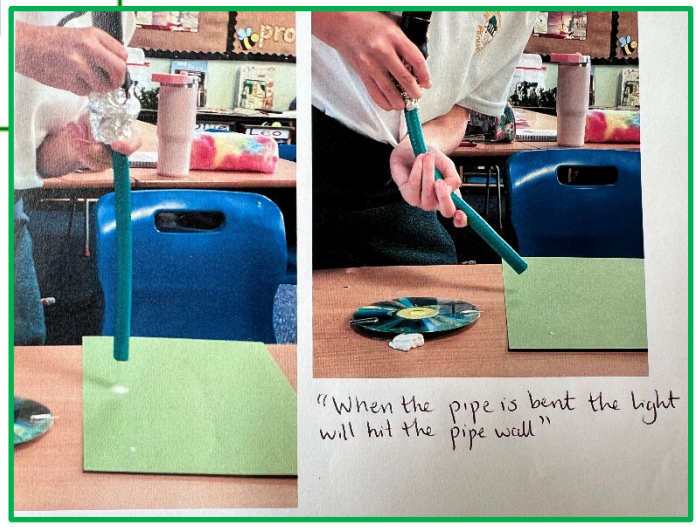
Can you prove that light travels in a straight line with just this equipment?



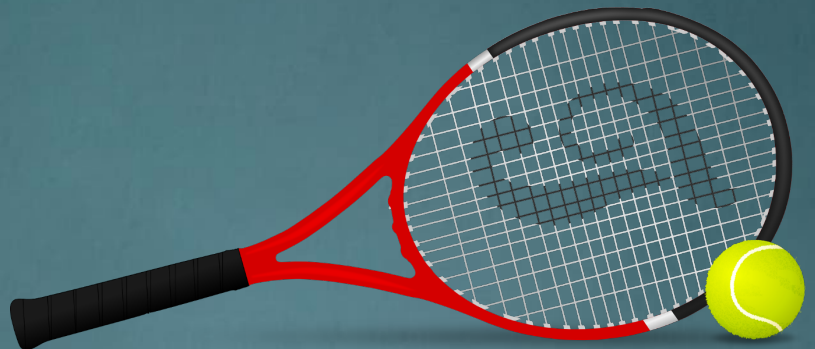
Equipment:

A piece of old (washed) garden hose, a torch and a piece of foil (optional)

Explore the resources – can you convince me that light travels in a straight line?



# Practical Prompt for Thinking



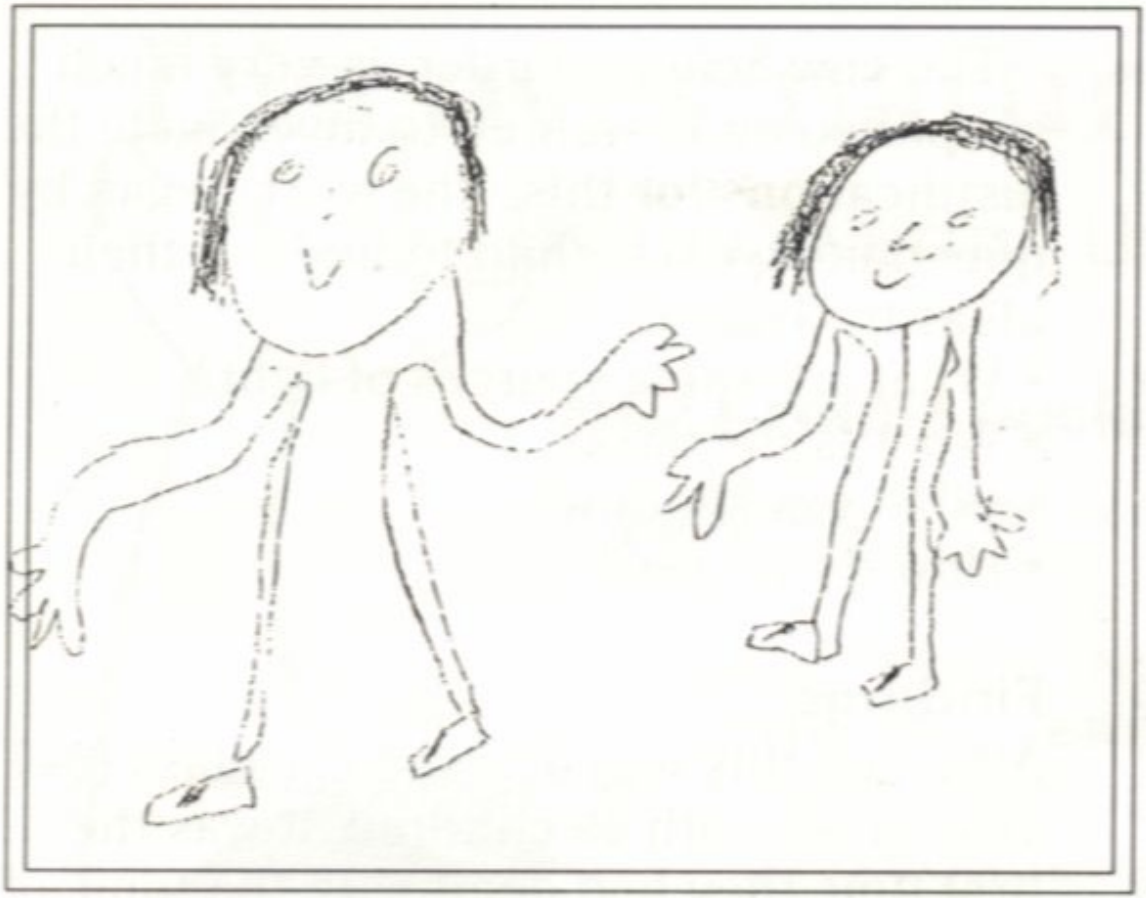
Full details of all Practical Prompts in the **General Resources** folder

In your handouts, there is a list of more **Practical Prompts for Thinking**, with:

- a list of the equipment needed,
- details of how to set them up
- the scientific explanation behind each one.

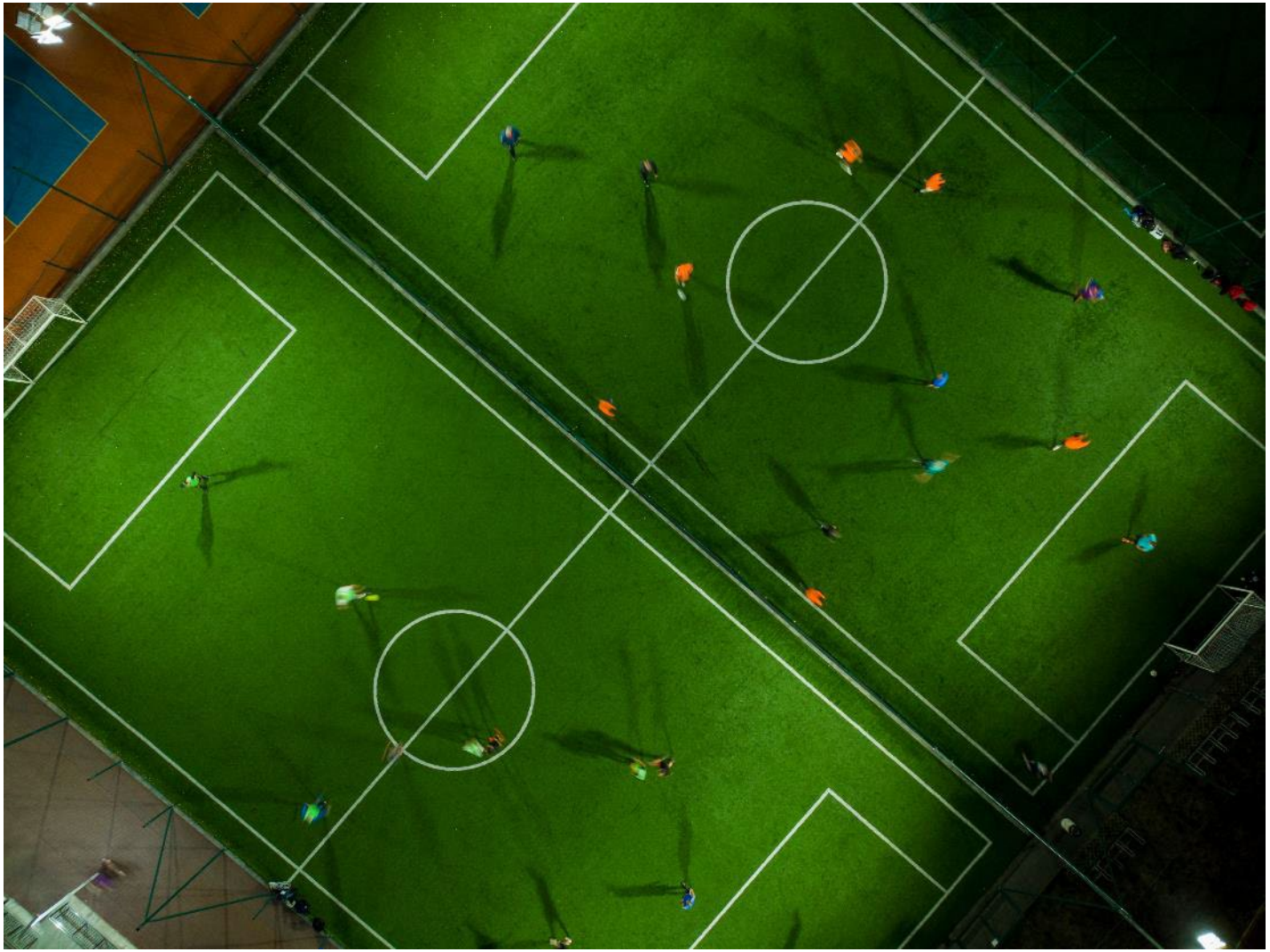
We hope you enjoy trying some of these

# Shadows: what are the misconceptions here?

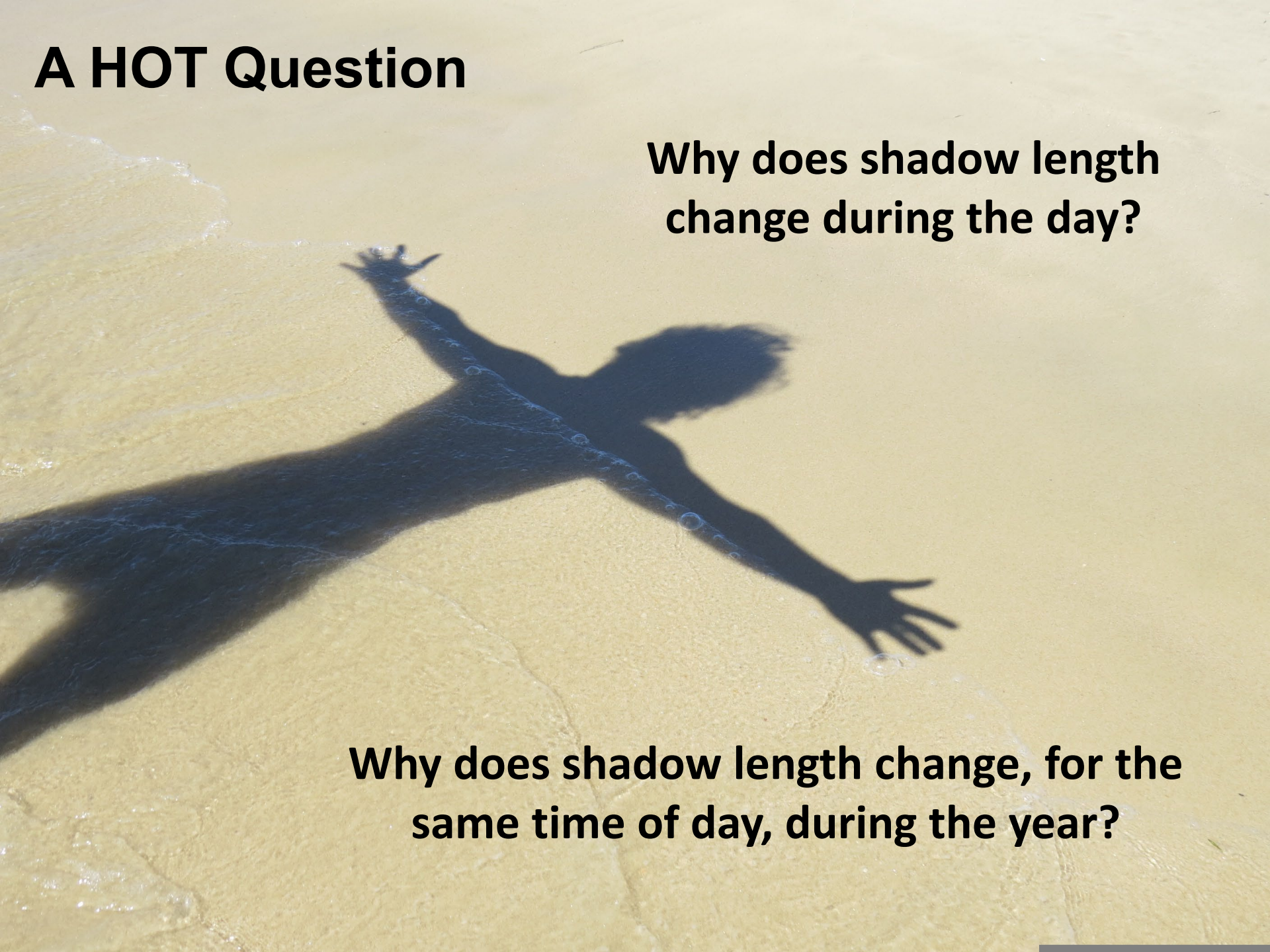


# A HOT Question

Why do the footballers have more than one shadow?



# A HOT Question



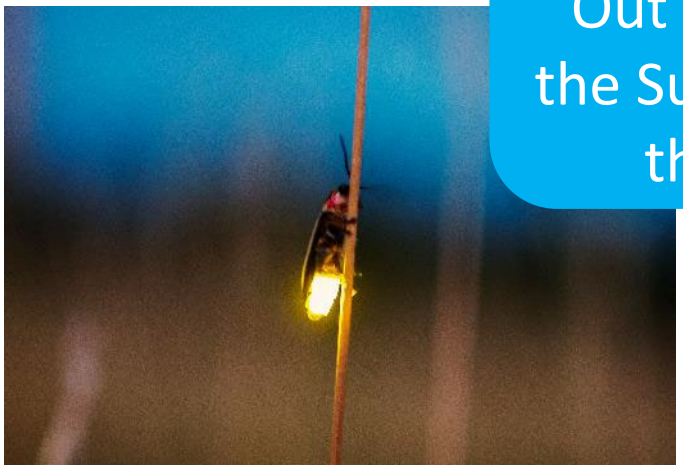
**Why does shadow length change during the day?**

**Why does shadow length change, for the same time of day, during the year?**

Which is the Odd One Out and why?

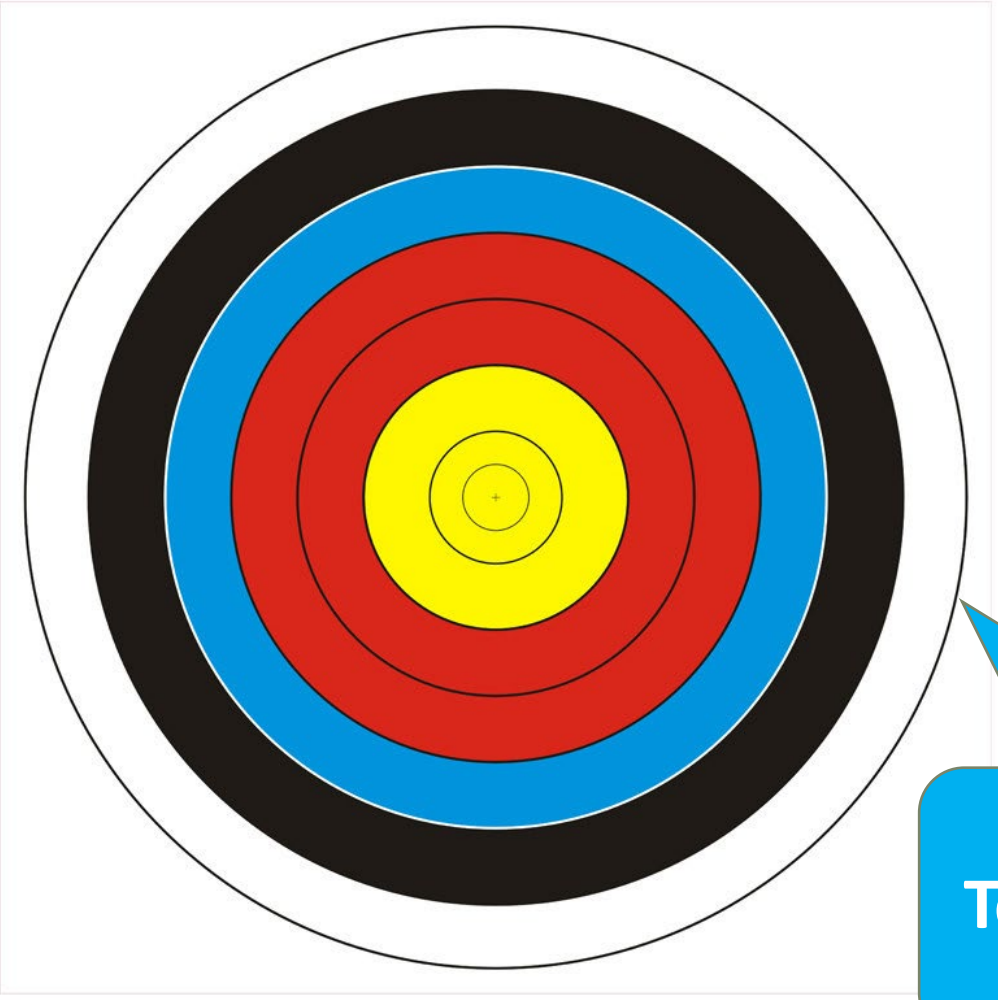
What are the key features of a good Odd One Out and why?

Would this be a better Odd One Out if it included the Sun rather than the Moon?



You (and/or your children) can make up your own Odd One Outs, HOT Questions, PMIs

# Practical: Hit the target



Details in the **Day 4 Teacher Supplements** folder

**Another example of a problem-solving activity, using similar skills but more suited for Design & Technology:**

## Design a lighting system for an Egyptian tomb

Details of **Egyptian Tomb** in **Day 4 Teacher Supplements** folder


Leading TDTScience in your school

Individually describe ‘what TDTScience is’ in one or two sentences.

Please write this on a post-it (and add to the evaluation later).


What about OfSTED?
TDTScience is evidence based

“Inspectors found that, in the majority of primary schools, disproportionate amounts of curriculum time were being spent on English and mathematics, often to prepare for tests. This significantly reduced the amount of curriculum time available to teach science, which in turn led to narrowing of the curriculum.” **OfSTED 2021**


"…teachers' subject knowledge and their depth of planning were not strong enough to ***sequence the knowledge and skills*** that pupils needed to learn before carrying out practical experiments.
Too frequently, ***the activities carried out were not deepening pupils' understanding of the scientific concept***…" **OfSTED 2019**

"Teachers generally had secure subject knowledge." **OfSTED 2023**

# The value of the Bright Ideas Time


"Alongside [clear teacher explanations], pupils benefit from time to discuss ideas, answer questions and practice using the knowledge."
**OfSTED 2023**

"Ensure that pupils have a secure knowledge of what has been taught, before moving on to more content. This should include checking whether pupils have specific misconceptions."
**OfSTED 2023**

# The value of Practical Prompts for Thinking

"… practical demonstrations have been shown to play an important role in helping pupils to learn science, involve minimal costs and can save valuable time." **OfSTED 2023**

"Clear explanations from teachers, alongside carefully selected teaching activities, supported the learning of specific content and played a key role in helping pupils to learn science." **OfSTED 2023**

# The value of purposeful practical work

High quality education:
"The purpose of practical work is clear in relation to curriculum content so that practical activities can be set up and managed to develop pupils' disciplinary and/or substantive knowledge." – *Working scientifically and knowledge & understanding* **OfSTED 2021 & 2023**

# The value of subject-specific CPD

**High quality science education:**
"Teachers … have access to high-quality subject-specific CPD to develop subject knowledge and pedagogical content knowledge. This is aligned to the curriculum." **OfSTED 2021**

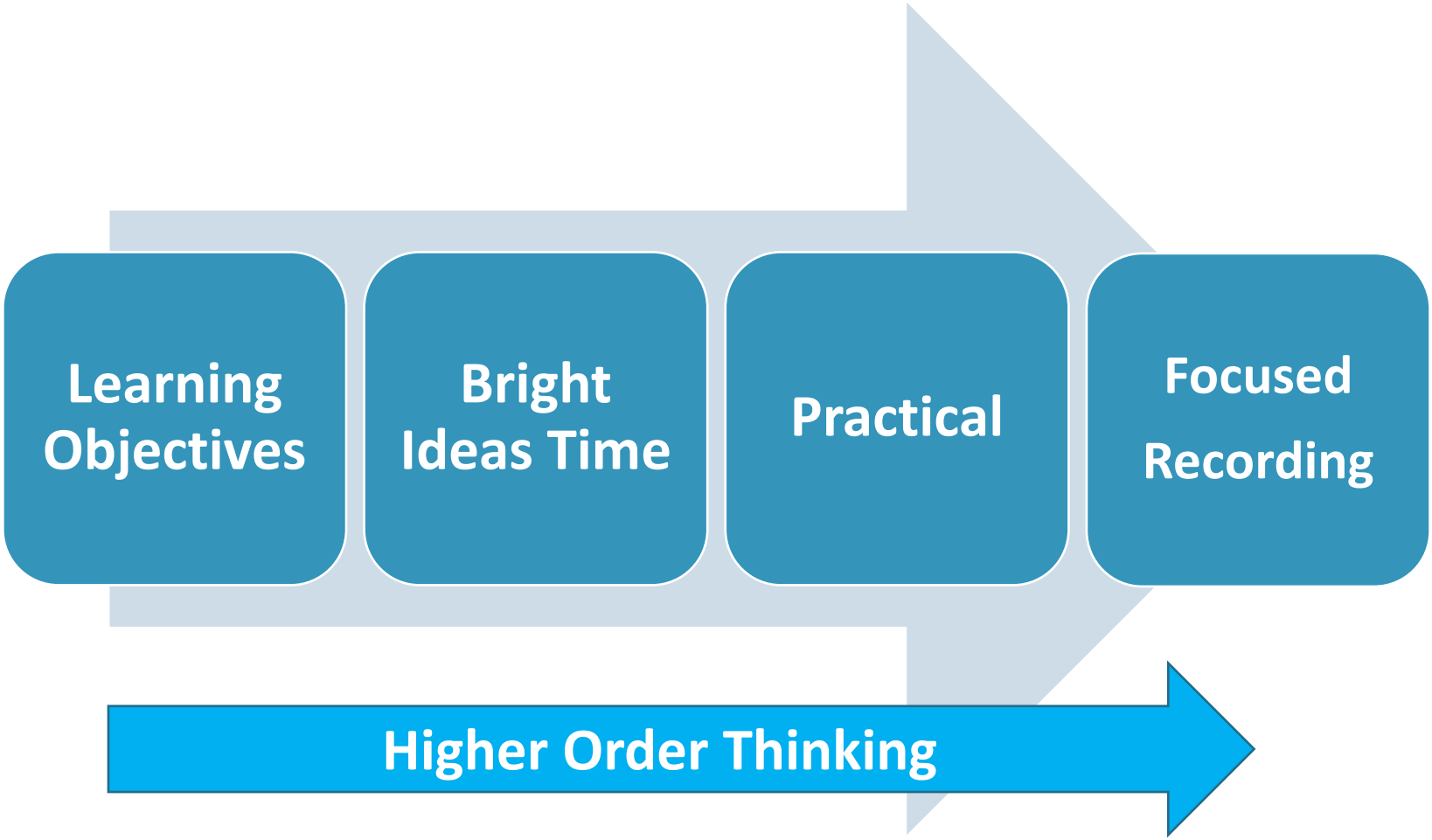
"Access to science-specific CPD is particularly important for primary teachers, given that they frequently teach outside their subject specialism, and that some reported a lack of confidence in teaching science." **OfSTED 2023**

**Subject knowledge has been addressed throughout TDTScience.**

# TDTScience lessons


…on skills development ***and*** knowledge and understanding

# Building up to:
# The TDTScience Way



# Crafting a lesson

HOT

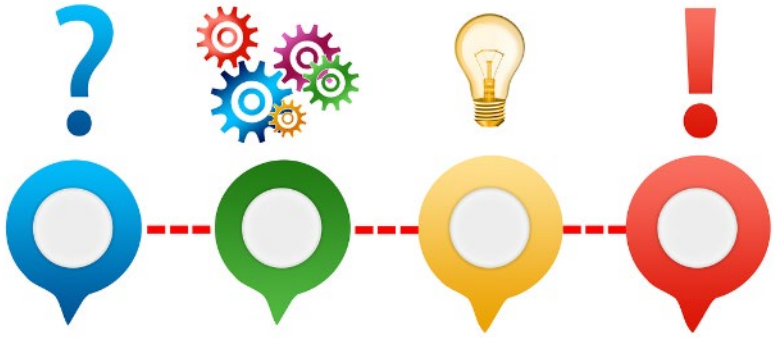
Bright Ideas Time

Practical

Skills *and* understanding

The different elements of a TDTScience lesson fit together

# Key questions we addressed throughout TDTScience



- Is the aim of the *lesson* to develop the children's skills; knowledge and understanding; or both?
- What will be the focused learning objective(s)?
- In order to carry out the *practical* successfully:
  - what do the children already need to know/understand?
  - and/or what skills do they need to have?
- What will the children record?
- What and how will you assess?
- Where and how to encourage children's HOTS?

In **General Resources** folder

# Crafting a Lesson: Planning Support

| A TDTScience lesson | | |
|---|---|---|
| **The focused learning objectives:** | Knowledge and understanding: | |
| | Working Scientifically skills: | |
| **Related Bright ideas Time** | | **Where is the Higher Order Thinking?** |
| **Practical** – possibly a simulation (acting ideas out), research from secondary sources etc | | |
| **Focused Recording method** (assessment of learning objectives) | | |

# Crafting a Lesson: Examples

There are examples of '**Crafted Lessons**' in your **General Resources** folder.

In pairs, look at one of these and use the Planning Support Tool to identify the TDTScience elements and how they are crafted together.

Evidence shows that unguided 'discovery' approaches are not effective. Instead, pupils learning science benefit from systematic teaching approaches that carefully scaffold their learning.
**OfSTED 2021**


Try **'Electricity: structured challenges'** in **Day 4 Teacher Supplements** – a systematic way to teach electricity in Years 4 & 6

There is clear evidence that, done well, ***structured*** discovery enables children to undergo deep learning.

And Electricity subject knowledge notes in **General Resources** folder

# Electricity via structured challenges – see Day 4 Teacher Resources

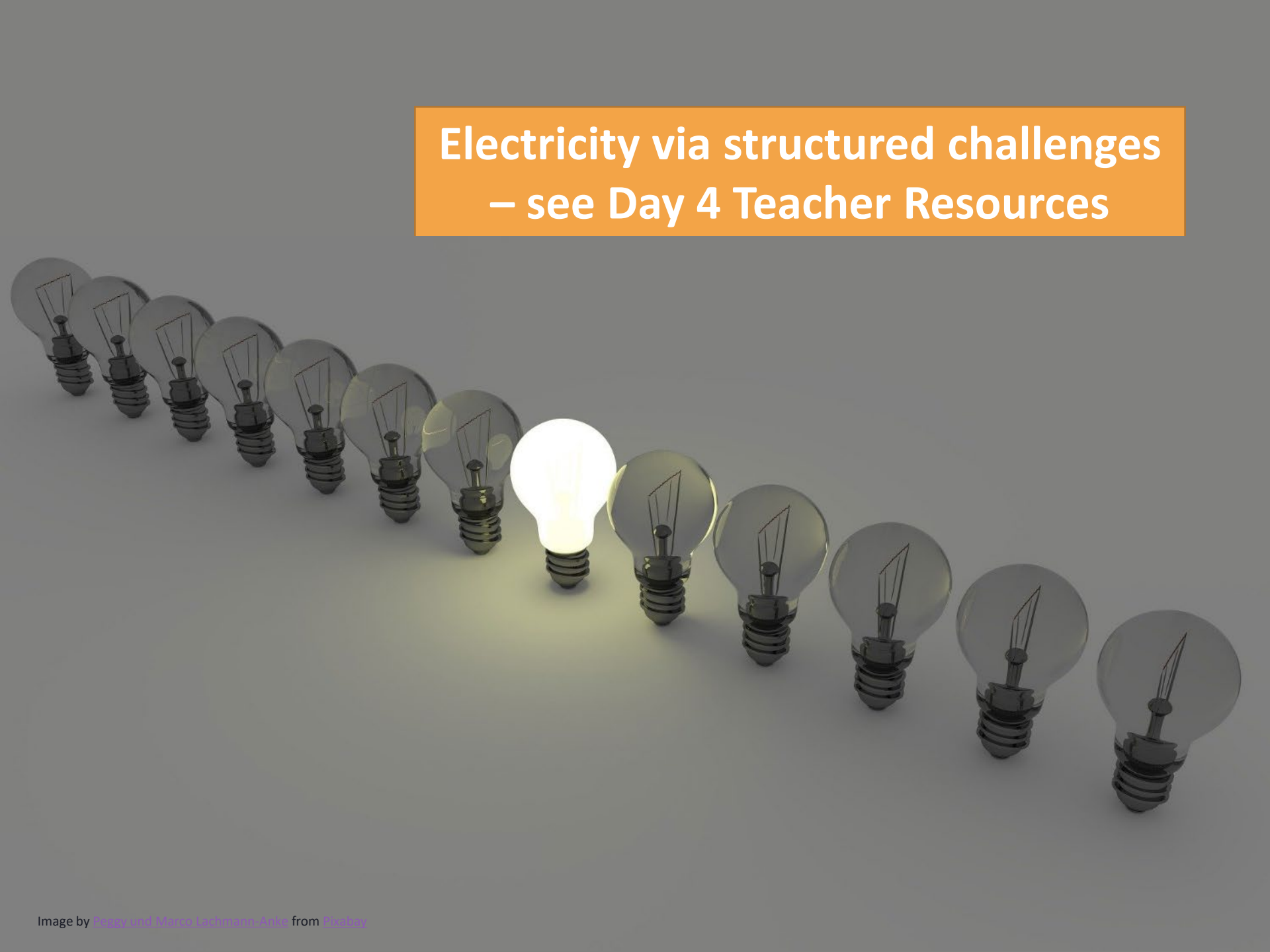


Image by Peggy und Marco Lachmann-Anke from Pixabay

# Electricity

## Year 4 – pupils should be taught to:

- identify common appliances that run on electricity
- construct a simple series electrical circuit, identifying and naming its basic parts …
- identify whether a lamp will light in a simple series circuit …
- recognise that a switch opens and closes a circuit …
- recognise some common conductors and insulators ...

## Year 6 – pupils should be taught to:

- associate the brightness of a lamp or the volume of a buzzer with the number and voltage of cells used in the circuit
- compare and give reasons for variations in how components function …
- use recognised symbols in a simple circuit diagram

Using only the kit given to you, make the bulb light

Image by Peggy und Marco Lachmann-Anke from Pixabay

Don’t forget the safety talk!

What type of practical was this?

Was the aim to teach National Curriculum skills or understanding, or both?

What might be a learning objective?

# Leading TDTScience in your school


Image by Peggy und Marco Lachmann-Anke from Pixabay

Improving Primary Science

## Summary of recommendations

Education Endowment Foundation

**01 Develop pupils' scientific vocab**

- Identify science-specific vocabulary.
- Explicitly teach new vocabulary and its meaning, creating opportunities for repeated engagement and use over time.

**02 Encourage pupils to explain their thinking, whether verbally or in written**

- Create a collaborative learning environment.
- Capitalise on the power of dialogue.
- Cultivate reasoning and justification.

**03 Guide pupils to work scientifically**

- Explicitly teach the knowledge and skills required to work scientifically, guiding pupils to apply this in practice, with opportunities for discussion and reflection.

**04 Relate new learning to relevant, real-world contexts**

- Consider real-world contexts.
- Engage with science concepts supported by virtual models.

**05 Use assessment to support learning and responsive teaching**

- Plan teaching that builds on existing knowledge and experiences.
- Monitor pupils' learning to inform responsive teaching, feedback, and next steps.
- Summarise what pupils have learned against planned criteria.

**06 Strengthen science teaching through effective professional development, as part of an implementation process**

- Use a range of information to identify development priorities and professional learning needs.
- Consider factors of high quality professional development to plan or evaluate provision.
- Reflect on senior leadership support at the strategic to classroom level.


**Bright Ideas Time** and focus on thinking and talking

**HOT** is at the heart of the TDTScience approach

**TDTScience in a nutshell** – literally what it says on the tin!

Strategies such as **PMI** and **problem solving** provide real-world context

**Focused recording** supports assessment and TDTScience links to Assessment for Learning (AfL).

TDTScience is CPD with **evidence of impact** on children's attainment**.**

https://educationendowmentfoundation.org.uk/education-evidence/guidance-reports/primary-science-ks1-ks2


**Purposeful practical work in primary science**

Earle, Read, Bianchi & Jordan

Nuffield Foundation (2025)

Thinking Doing Talking Science

## Definition for practical work in primary science:

Children observe, manipulate, communicate and connect their science thinking through sensory learning experiences with physical objects and phenomena.

## Pedagogical model for practical work:

- Hands-on sensory engagement
- Minds-on cognitive engagement
- Multimodal communication

= Doing, Thinking, Talking Science?

https://data.bathspa.ac.uk/articles/online_resource/Purposeful_practical_work_in_primary_science/28615676?file=53105915

# Small Changes...

- Deeper thinking
- More discussion
- More questioning
- More practical activity (clear purpose)
- Less writing (focused recording)

e.g. a Bright Ideas Time in every science lesson in the school is a good first step

# Big Impact

Excellence in teaching is the single most powerful influence on achievement.

*John Hattie 2002*

# Dissemination tactics

**Discuss**: Key elements of an effective staff meeting?

**Some key elements of an effective staff meeting**:

- valuing colleagues as professionals
- ownership
- relevant
- interactive
- manageable
- practical
- feedback
- enjoyment

## Other tactics:

More ideas?

Staff meeting

Academy group

Year group/Key Stage planning

Meet science co-ordinator

Observation

Team teaching

Chat to friend over coffee

Plan jointly with one other teacher

N.B. Revisit – not one-offs!

## Think about your situation:

- plan dissemination tactics

**Actions**

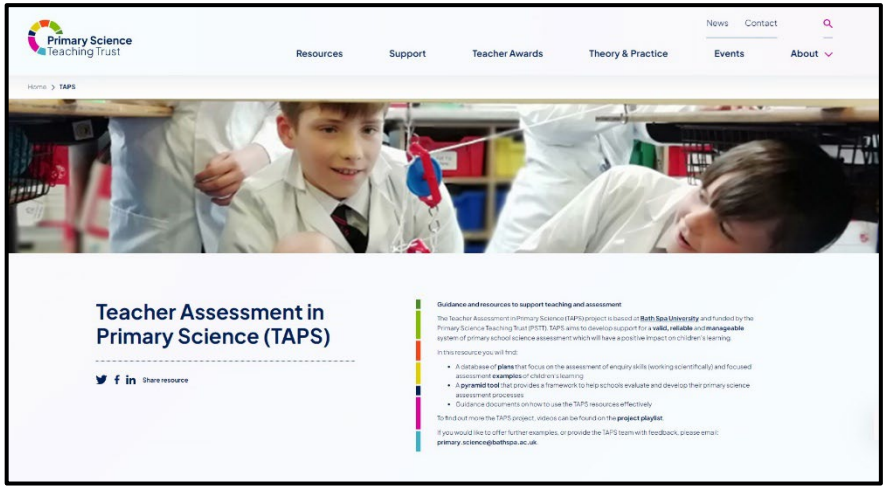
**Time scale**

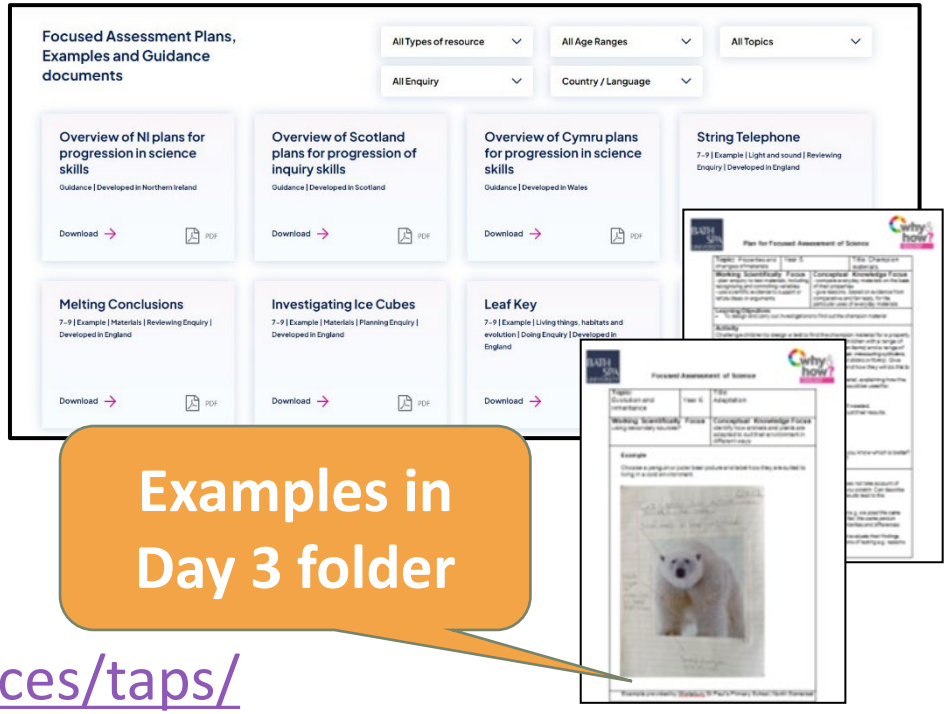
**Monitoring**

# Useful resources:
# Teacher Assessment in Primary Science (TAPS)

**Valid, reliable** and **manageable** science assessment
Free online resources:

- Focused assessment database with **plans**
- **Examples** of children's learning

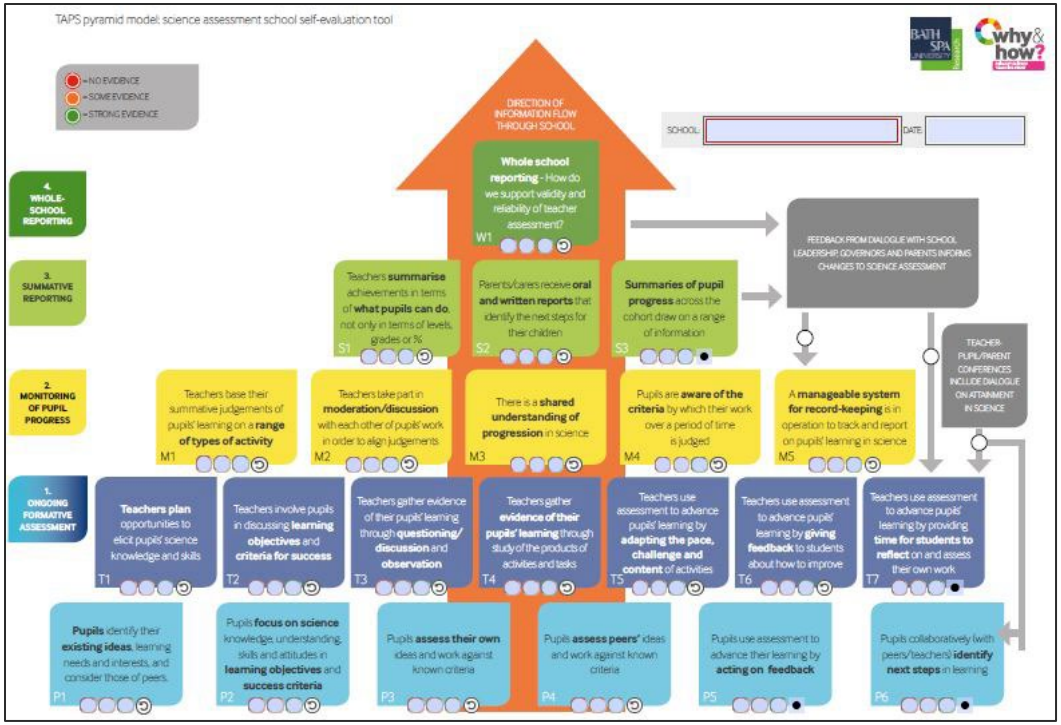



https://pstt.org.uk/unique-resources/taps/

# Useful resources:
# Teacher Assessment in Primary Science (TAPS)

**Pyramid Tool** - school self-evaluation tool - examples of good practice in schools




https://taps.pstt.org.uk/

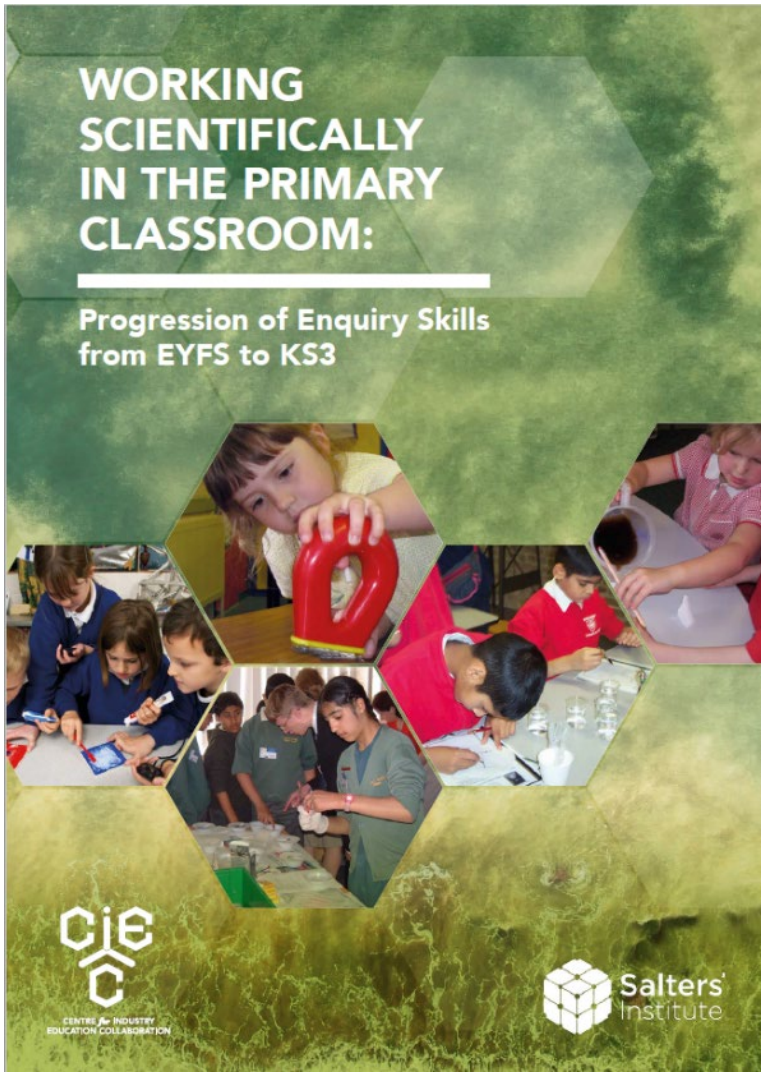
## A helpful planning tool:

https://www.york.ac.uk/ciec/resources/primary/skills-for-science/#working-scientifically

**Download from the website**

This sets out the Progression of Enquiry Skills from Early Years Foundation Stage to Key Stage Three. So, this will help with a ***coherent whole school plan*** that reinforces prior learning and builds on it.

**Grids and posters**



# Another helpful planning tool:
# PLAN Progression in Knowledge &
# PLAN Knowledge Matrices
# PLAN Pupil Profiles

## Forces

| | |
|---|---|
| **Birth to three** | • Repeat actions that have an effect. |
| **Nursery** | • Explore how things work.<br>• Explore and talk about different forces they can feel.<br>• Talk about the differences between materials and changes they notice. |
| **Reception** | • Explore the natural world around them.<br>• Describe what they see, hear and feel whilst outside. |
| **Year 1** | |
| **Year 2** | • Find out how the shapes of solid objects made from some materials can be changed by squashing, bending, twisting and stretching. (Y2 - Uses of everyday materials) |
| **Year 3** | • Compare how things move on different surfaces.<br>• Notice that some forces need contact between two objects, but magnetic forces can act at a distance.<br>• Observe how magnets attract or repel each other and attract some materials and not others.<br>• Compare and group together a variety of everyday materials on the basis of whether they are attracted to a magnet, and identify some magnetic materials.<br>• Describe magnets as having two poles.<br>• Predict whether two magnets will attract or repel each other, depending on which poles are facing. |
| **Year 4** | |
| **Year 5** | • Explain that unsupported objects fall towards the Earth because of the force of gravity acting between the Earth and the falling object.<br>• Identify the effects of air resistance, water resistance and friction, that act between moving surfaces.<br>• Recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect. |
| **Year 6** | |
| **Key Stage 3** | • Magnetic fields by plotting with compass, representation by field lines.<br>• Earth's magnetism, compass and navigation.<br>• Forces as pushes or pulls, arising from the interaction between two objects. |



https://www.planassessment.com/science-subject-leader

# Useful resources:
PSTT symbols

**Comparative / fair testing**
Changing one variable to see its effect on another, whilst keeping all others the same.

**Research**
Using secondary sources of information to answer scientific questions.

**Observation over time**
Observing changes that occur over a period of time ranging from minutes to months.

**Pattern-seeking**
Identifying patterns and looking for relationships in enquiries where variables are difficult to control.

**Identifying, grouping and classifying**
Making observations to name, sort and organise items.

**Problem-solving**
Applying prior scientific knowledge to find answers to problems.

**Asking questions**
Asking questions that can be answered using a scientific enquiry.

**Making predictions**
Using prior knowledge to suggest what will happen in an enquiry.

**Setting up tests**
Deciding on the method and equipment to use to carry out an enquiry.

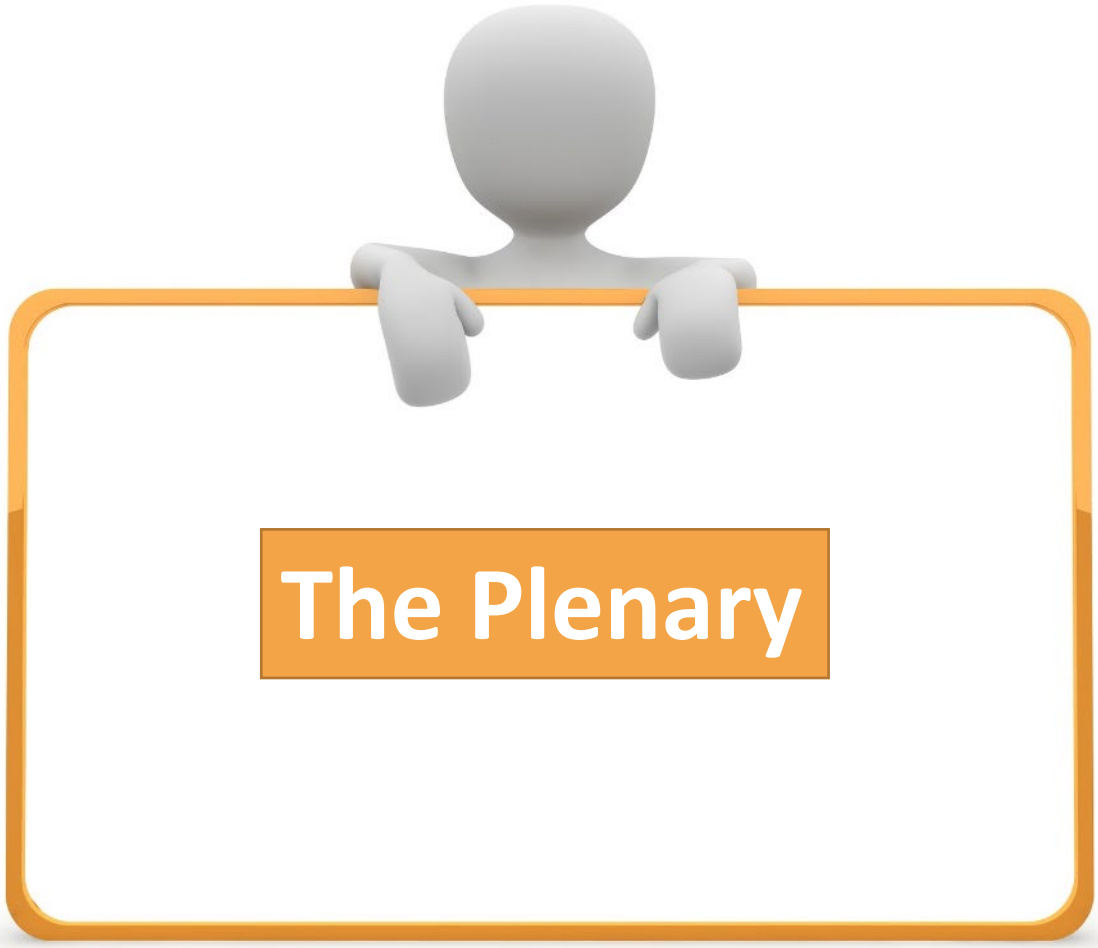
**Observing and measuring**
Using senses and measuring equipment to make observations about the enquiry.

**Recording data**
Using tables, drawings and other means to note observations and measurements.

**Interpreting and communicating results**
Using information from the data to say what you found out.

**Evaluating**
Reflecting on the success of the enquiry approach and identifying further questions for enquiry.

https://pstt.org.uk/resources/enquiry-approaches/ https://pstt.org.uk/resources/enquiry-skills/


The Plenary

It has been great working with you all and we hope that you really enjoy…

Teaching the TDTScience way