SCIENCEOXFORD

Thinking Doing Talking Science

Primary Science Teaching Trust

Focused recording

Thinking Doing Talking Science

Creativity

Practical Prompts for Thinking

Questions - pupil & teacher

Practical Investigations

talking

Higher order thinking

doing

Bright Ideas Time

Practical Problem solving

Theme: Forces

Thinking Doing Talking Science

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

Curriculum: Forces

Pupils should be taught to:

- compare how things move on different surfaces
- notice that some forces need contact between two objects, but magnetic forces can act at a distance
- observe how magnets attract or repel each other and attract some materials and not others
- explain that unsupported objects fall towards the Earth because of the force of gravity acting between the Earth and the falling object
- identify the effects of air resistance, water resistance and friction, that act between moving surfaces
- recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect.

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.

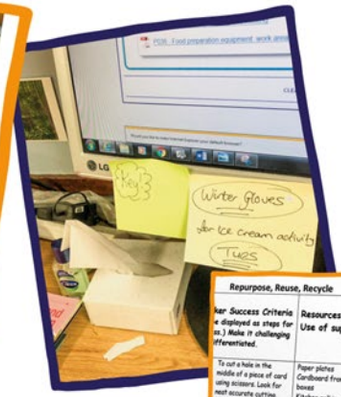
www.cleapss.org.uk	www.sserc.org.uk
primary@cleapss.org.uk	enquiries@sserc.scot
01895 251 496	01383 626 070

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

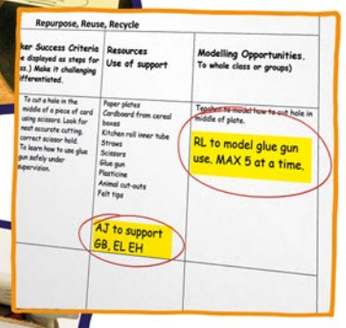
It is your employer's responsibility to provide you with suitable advice and training so that you can manage any risks arising in your lessons appropriately.

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

Practical Prompts for Thinking

Practical

Which shoes have the best grip?

Plan and carry out an investigation

Which shoes have the best grip?

That was fun
but…
where was the
higher order
thinking?

Bloom's Taxonomy

High:

evaluation - judging, rating and giving opinions

synthesis - hypothesising, showing originality by creating, inventing and composing

analysis - categorising and comparing; distinguishing between fact and opinion or relevant and irrelevant information

Middle:

application/use - transferring knowledge from one situation to another similar one

Low:

comprehension - summarising and putting ideas or information into other words

knowledge - remembering, reciting or listing facts

What would be the learning objective(s)?

NC links to draw from?

Compare how things move on different surfaces

Identify the effects of … friction, that act between moving surfaces

Planning…

Recording data & results

Taking measurements…

Using results to make predictions to set up further comparative and fair tests

etc….

Focus the recording on the learning objective

What and how do I record?

Focusing the recording releases the time for the thinking, doing and talking.

Focusing the recording produces sharply assessable work

Crafting a lesson

BI time chosen for lesson topic

Bright Ideas Time

Practical

Skills *and* understanding

The different elements of a TDTScience lesson fit together

To plan a comparative test to find out which shoes have the best grip

To record the results clearly

To predict which shoes will have the best grip, using my science understanding

Some examples of learning objectives

To draw conclusions from my results, based on my science understanding

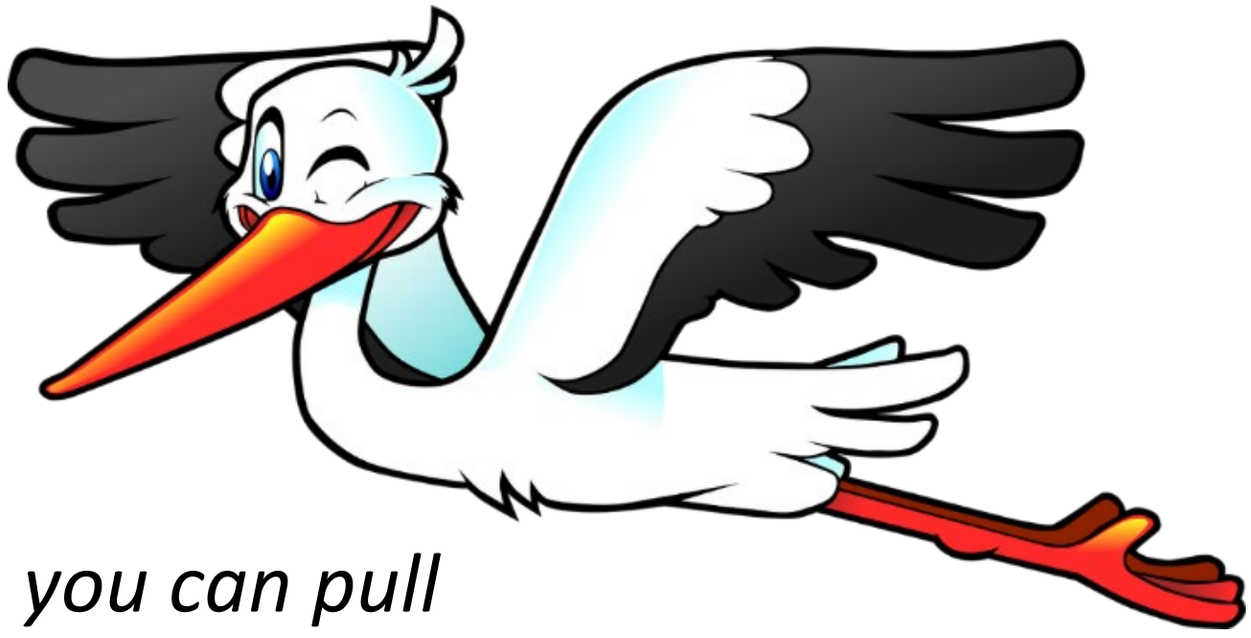
To explain why shoes have different grips

The science of forces

A force is:

a push

or a pull



You can push, you can pull

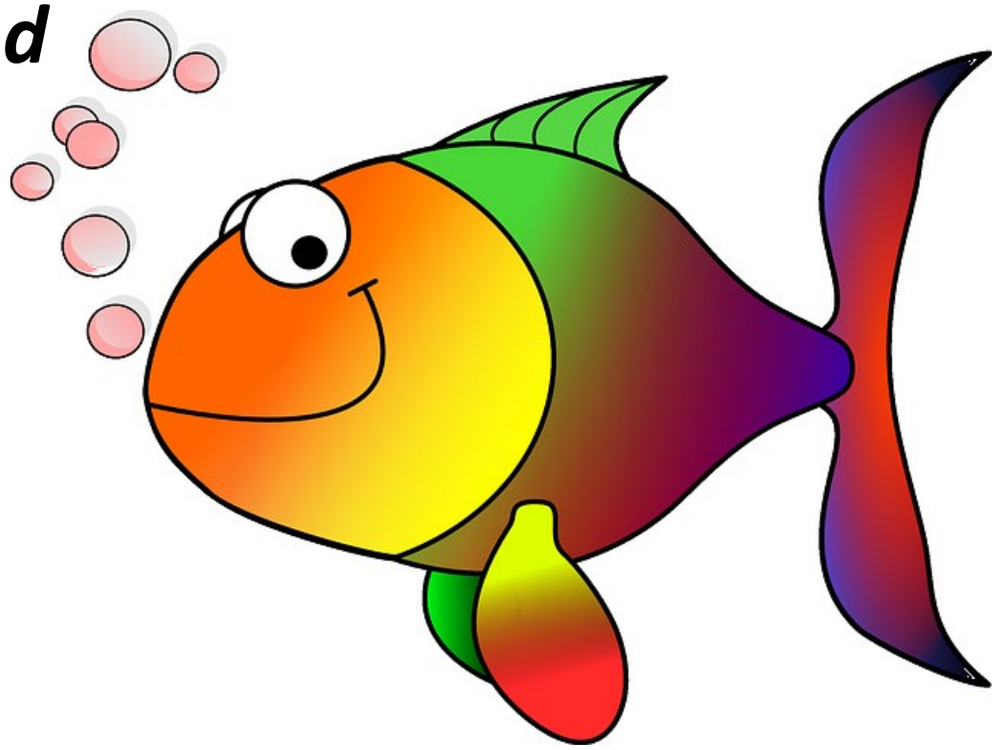
To move things around

But gravity ***pulls you down to the ground***

(Repeat)

A bird in the air, a fish in the sea

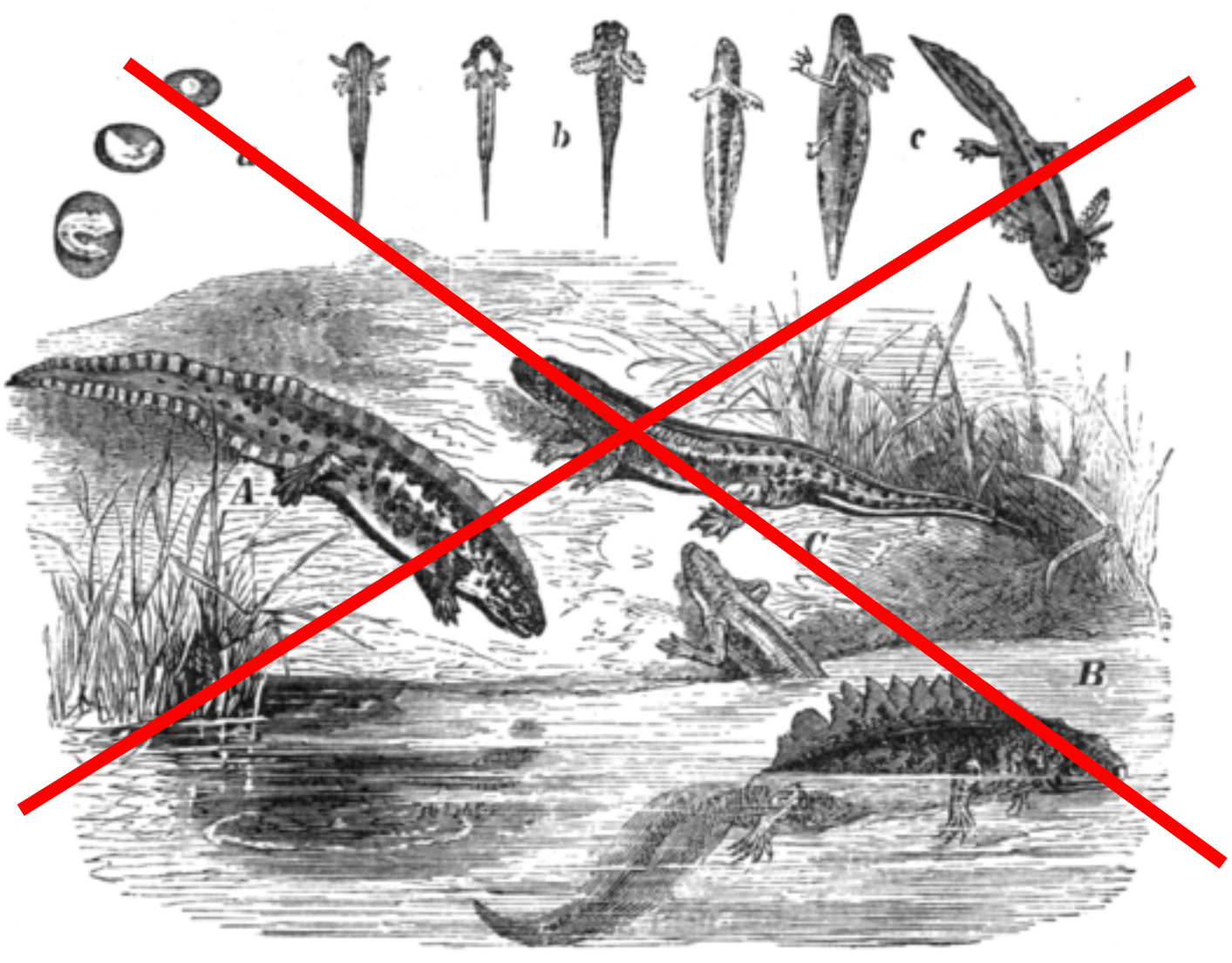
Are all affected **by gravity**!

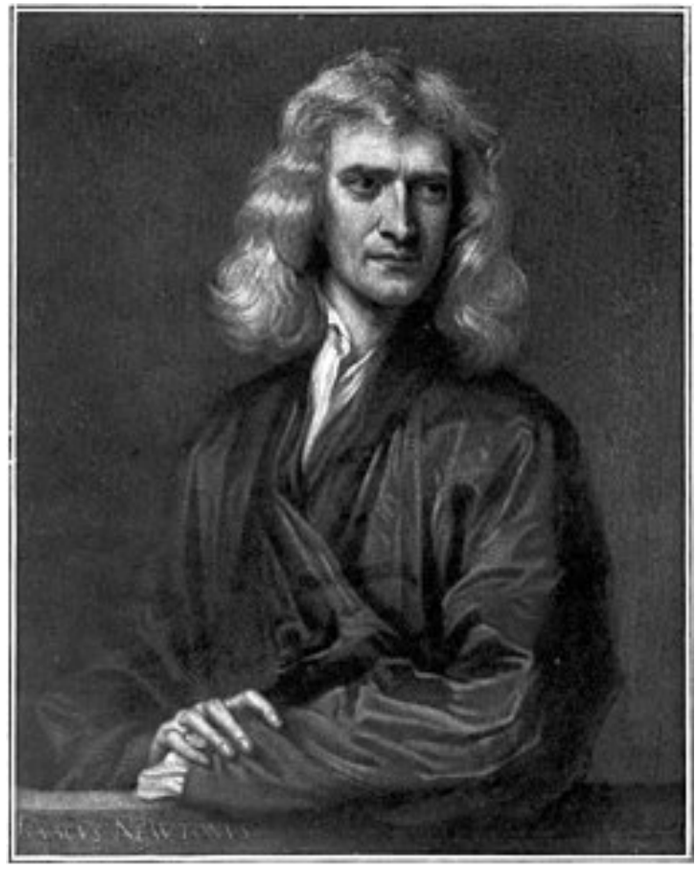


From Floating Point Theatre Company

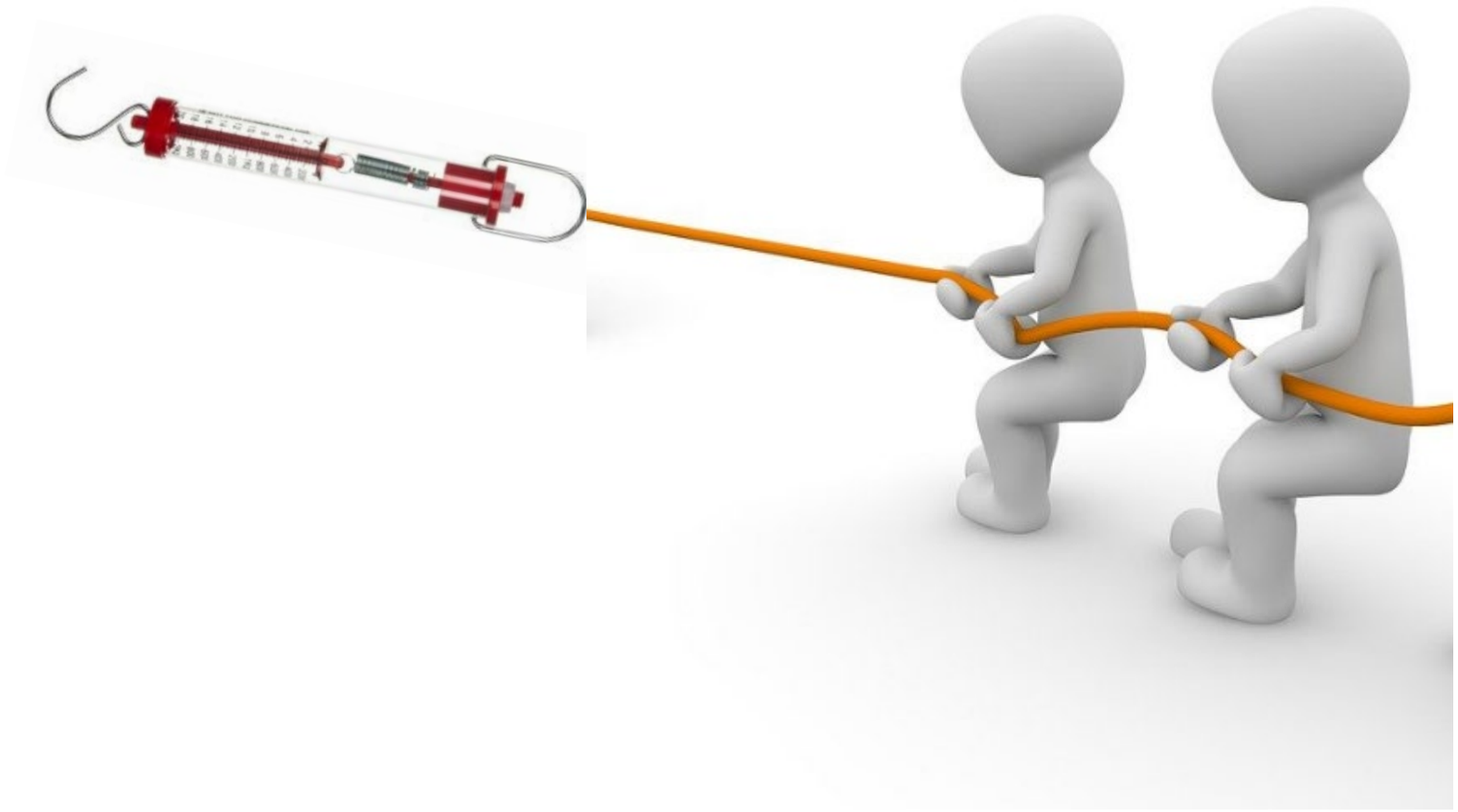
A force is measured in:

Newtons





Give me a pull of 10 Newtons…



Book: Teach it! Do it! Let's get to it!
Goldsworthy and Holmes
Millgate House/ASE bookshop

The size and direction of a force matters.

- size

  and

- direction

Forces can balance

10 N

10 N

Normally motion is opposed by:

- friction
- air resistance

or

- water resistance

Where would this not be the case?

If no overall force acts on something:

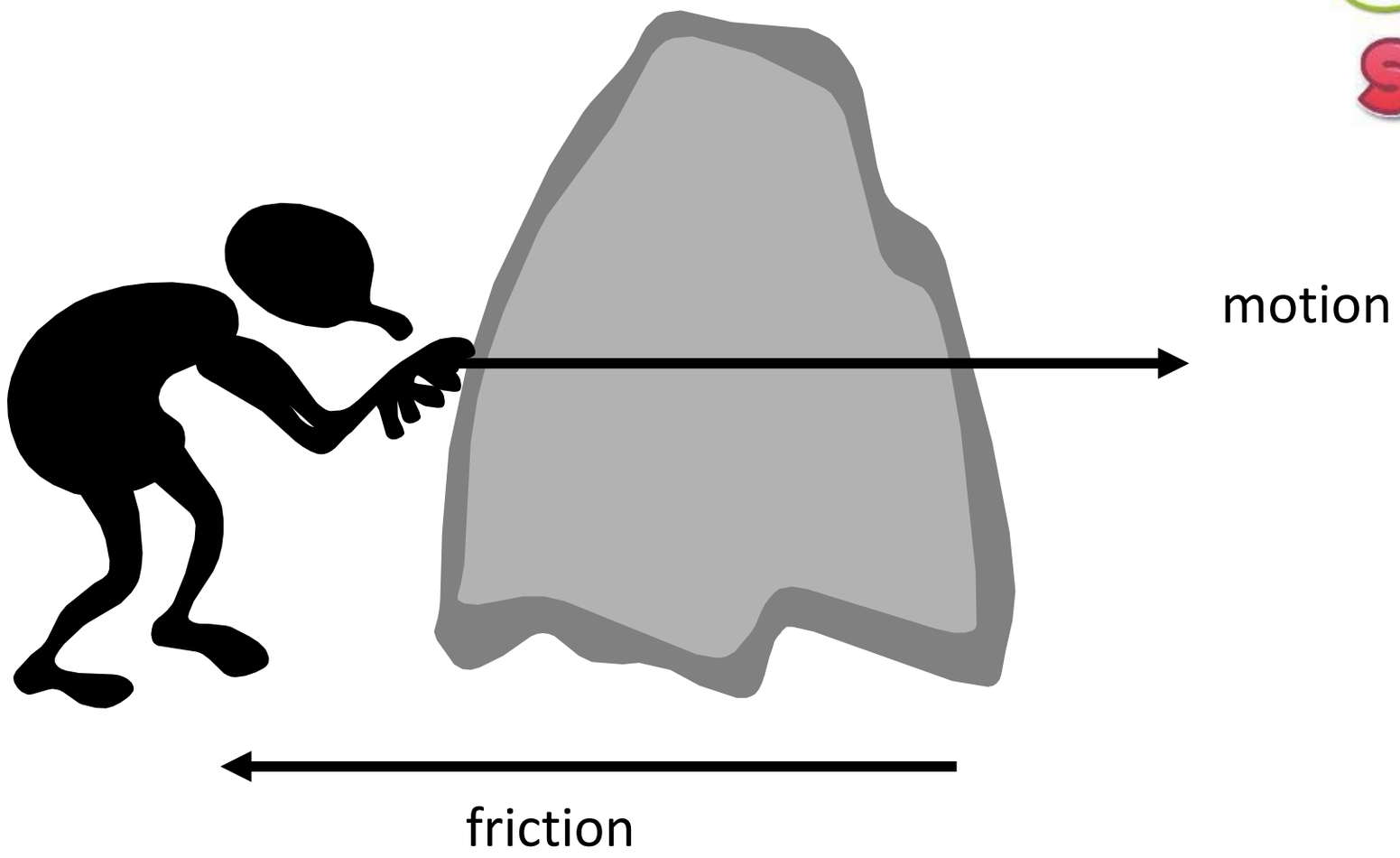
- It remains at rest

  or (the clever bit)

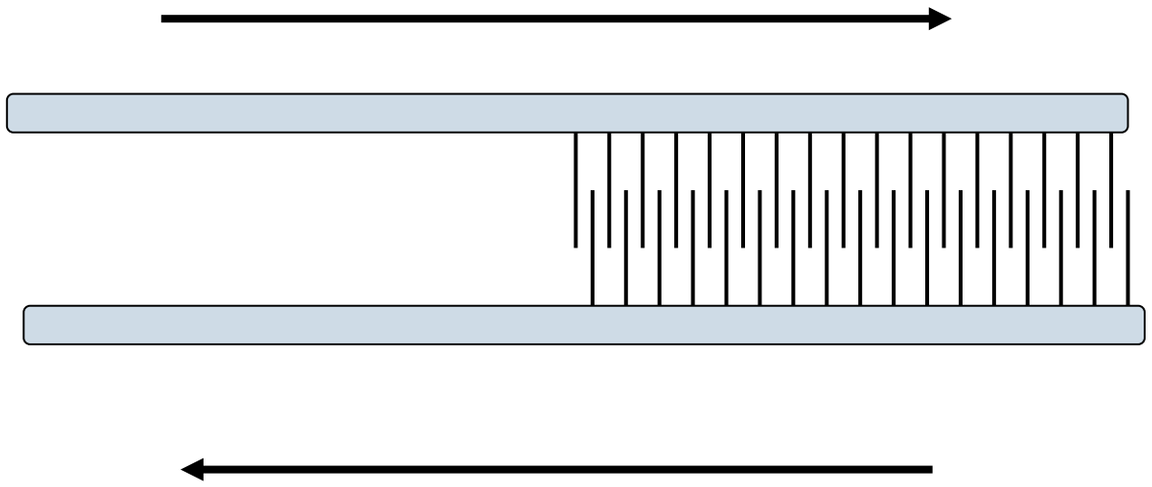
- It travels at a steady speed in a straight line.

No *change* in motion

So supposing astronaut Tim Peake had no jet pack, was not tied to the shuttle and he pushed off into space…


motion
friction

2 hairbrushes - analogous to 2 surfaces in contact



Remember:

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

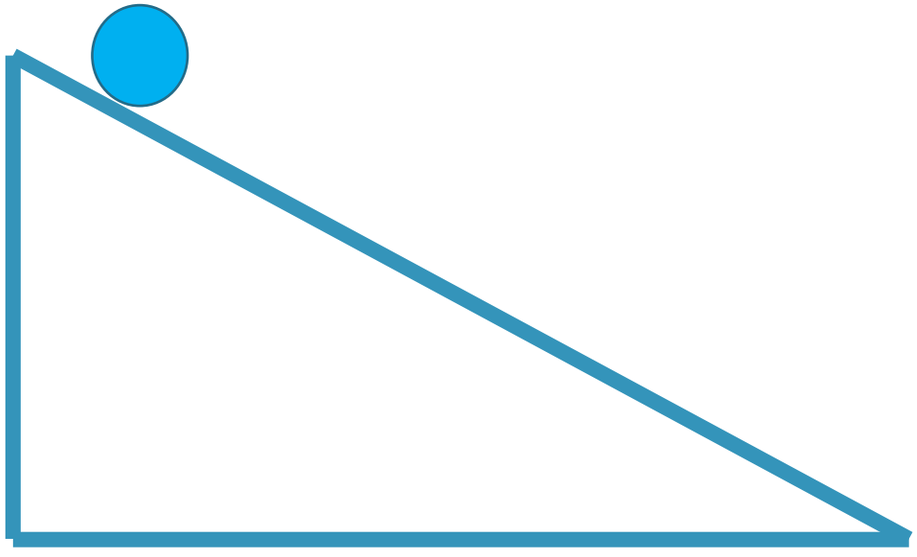
Login and download here:
https://tdtscience.org.uk/user-registration-primary

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

Friction: two further examples

What is the best material for goalie gloves?
How will you test this?

This leads on to our next practical



Rolling a tin down a slope - see how far it travels.

Challenge: use different materials to see who can make tin roll the ***least*** distance.

Practical Prompts for Thinking

Practical

The marble maze

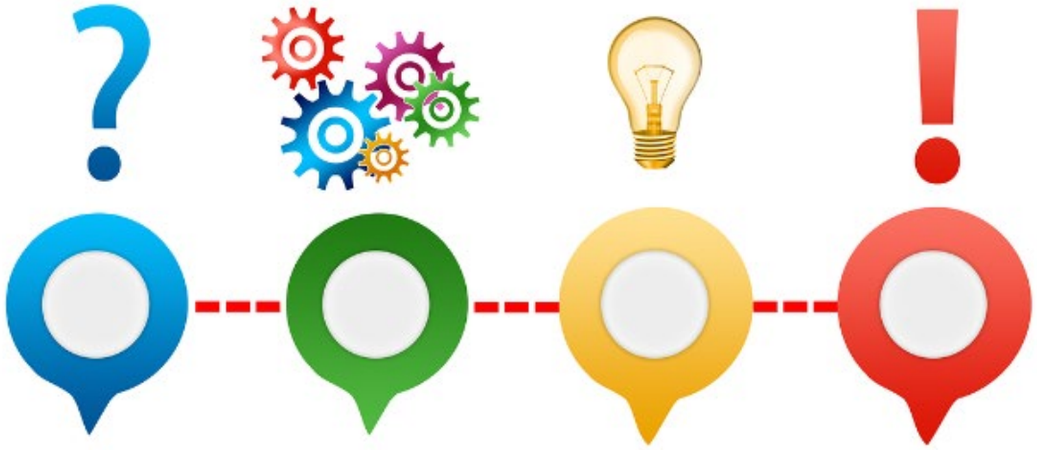
The marble maze

That was fun
but…
where was the
higher order
thinking?

What would be the learning objective?

How would you assess the learning objective?

Key question



- Is the aim of the lesson to develop the children's skills; knowledge and understanding; or both?

Examples of possible Learning Objectives:

- To take measurements with timers with increasing accuracy and precision, and take repeat readings when appropriate
- To make systematic and careful observations and find ways of improving what has already been done
- To understand that objects roll down slopes due to the force of gravity
- To explore the effect of friction on movement and find out how it slows or stops moving objects

Just one or two!

Focused learning objectives are key to a good lesson **but…**

They do not always need to be shared with the pupils at the beginning of the lesson – they can give the game away!

If they are shared at the beginning of the lesson, they may need to be worded differently from that in your planning – e.g. as a question.

Possible objectives to share with the children:

- Be able to explain the challenge using the words ‘force’ and ‘friction’
- Use timers accurately to measure the time the marble takes to reach the bottom of the slope on each occasion
- Make continual improvements to your design so that the marble takes as long as possible to reach the bottom

Discuss these objectives – would they suit your class?

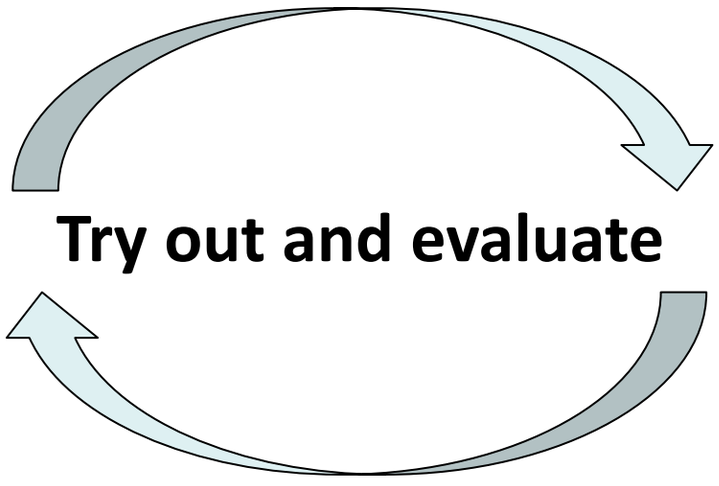
Full details of the **Marble Maze** practical, including ideas for LOs, are in the **Day 2 Teacher Supplements** folder

LO and behold…

Can *sometimes* keep the Learning objective(LO) hidden and reveal at the end of the lesson – the children could predict what it was, compare it with what they actually learnt etc.

Sharing of Good Practice

Repertoire of strategies



You were asked to:

- Try one Odd One Out with your class and come to Day 2 ready to give feedback

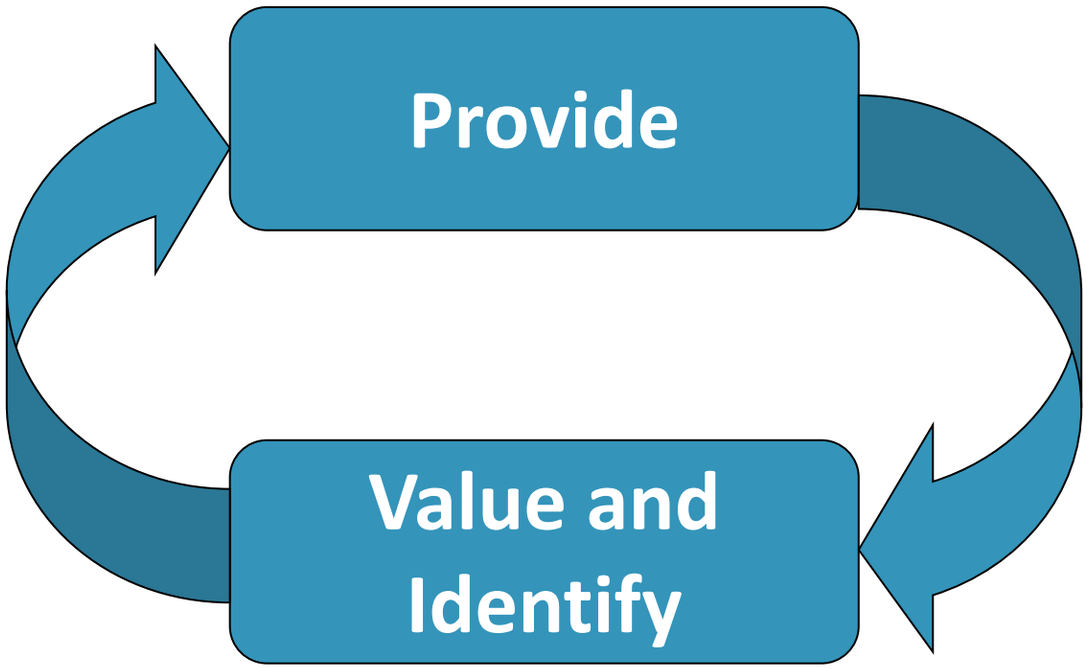
In groups of four, share which Odd One Out you tried and how it went in terms of:

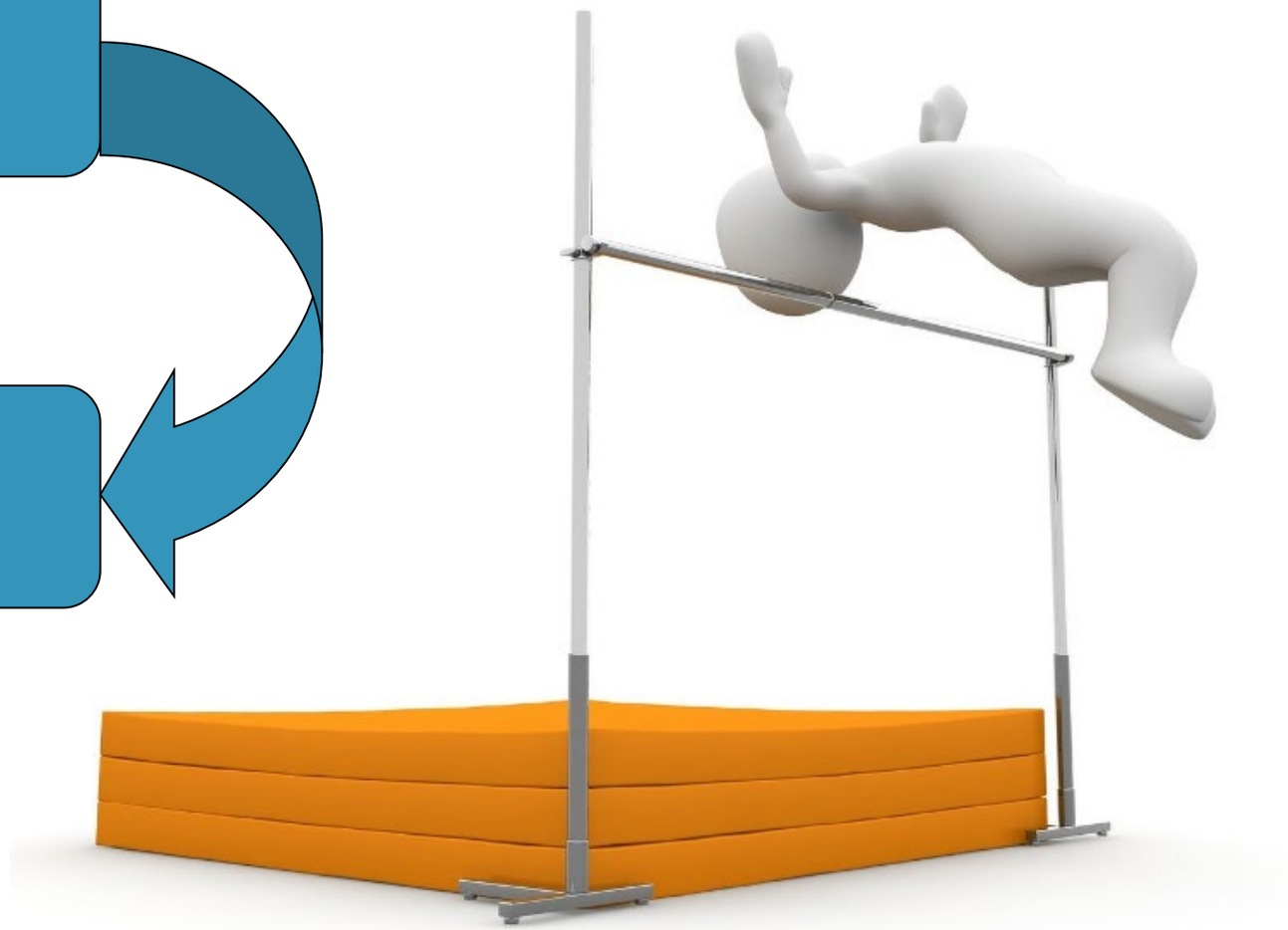
- Children's responses
- Children's learning
- Children's behaviour

Have you ever been surprised by who rises to the challenge in science?

Teaching the TDTScience way often results in excellent engagement from all children

Sports Model (Freeman)





It is through inclusive challenging lessons that children can show their ability

Higher Order Questioning

Revision questions and those requiring only the representation of known material (simple comprehension) attract lower order answers; while questions that ask students to **deduce, hypothesise, analyse, apply, synthesise, evaluate, compare, contrast or imagine** attract higher order responses.

Kerry & Kerry: The Centrality of Teaching Skills in Improving Able Pupil Education

Skinny questions:

- Check pupils' knowledge
- Often one word answers
- Seeking facts

Rich questions:

- Open ended
- Needs time to think – can't usually answer immediately
- Answers generally require one or more sentences
- Sometimes pupils need to ask other questions to work towards main question
- Tend to prompt further questions
- Need to make links, apply ideas, give reasons

Science Inside the Black Box

Black & Harrison, nferNelson

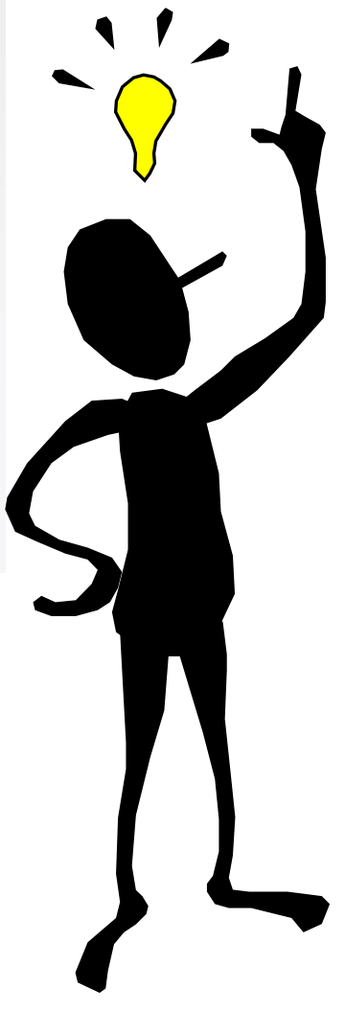
Squeeze the thinking from the curriculum:

The questions are there for the asking…

Bloom's Building Blocks
& Associated Action Verbs

Using the action verbs in questions and task setting encourages children's thinking

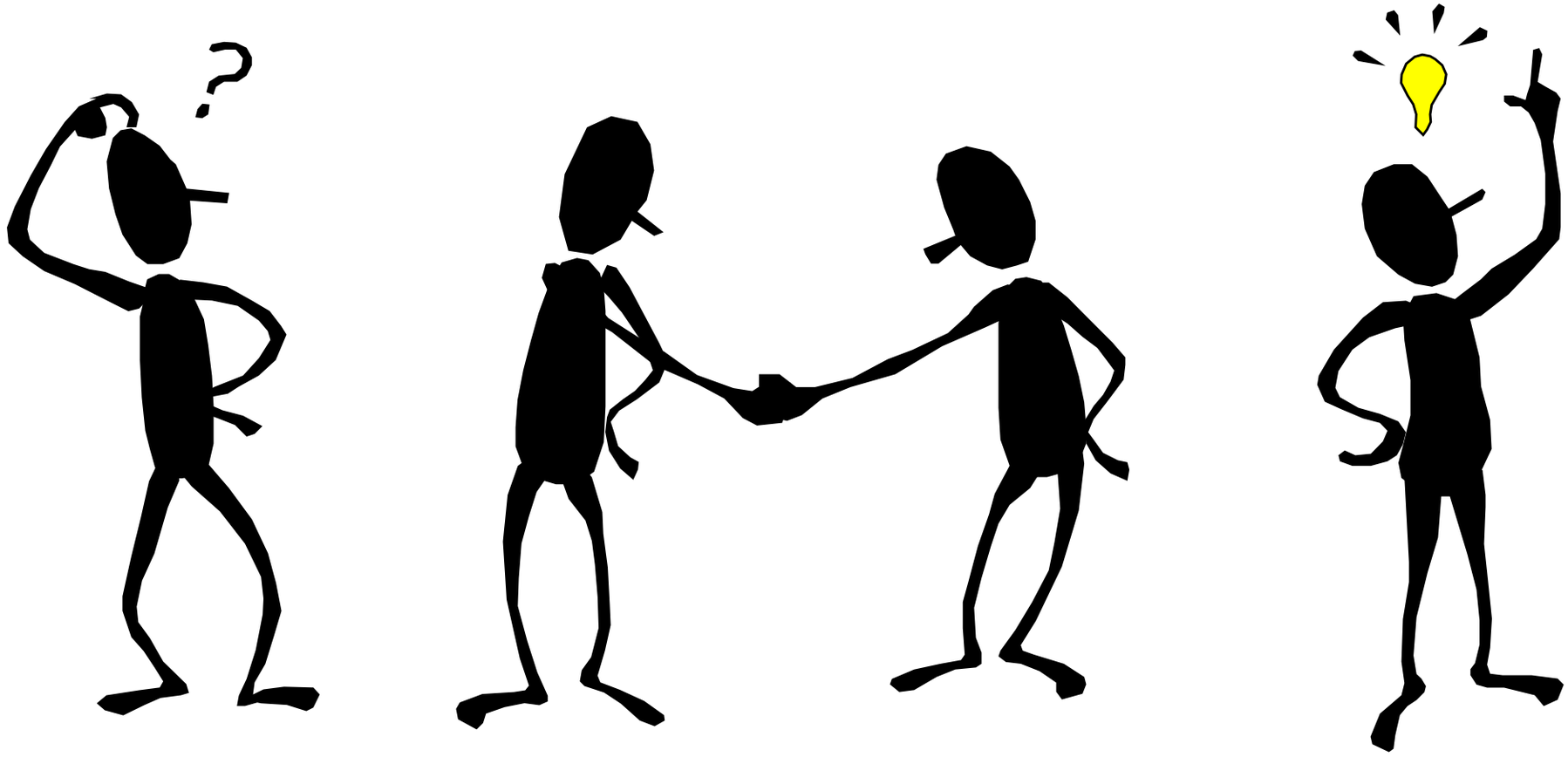
The Bright Ideas Time: the HOT Question



There are many opportunities for asking questions and the Bright Ideas Time is one of them

https://pstt.org.uk/resources/curriculum-materials/bright-ideas

Thinking time

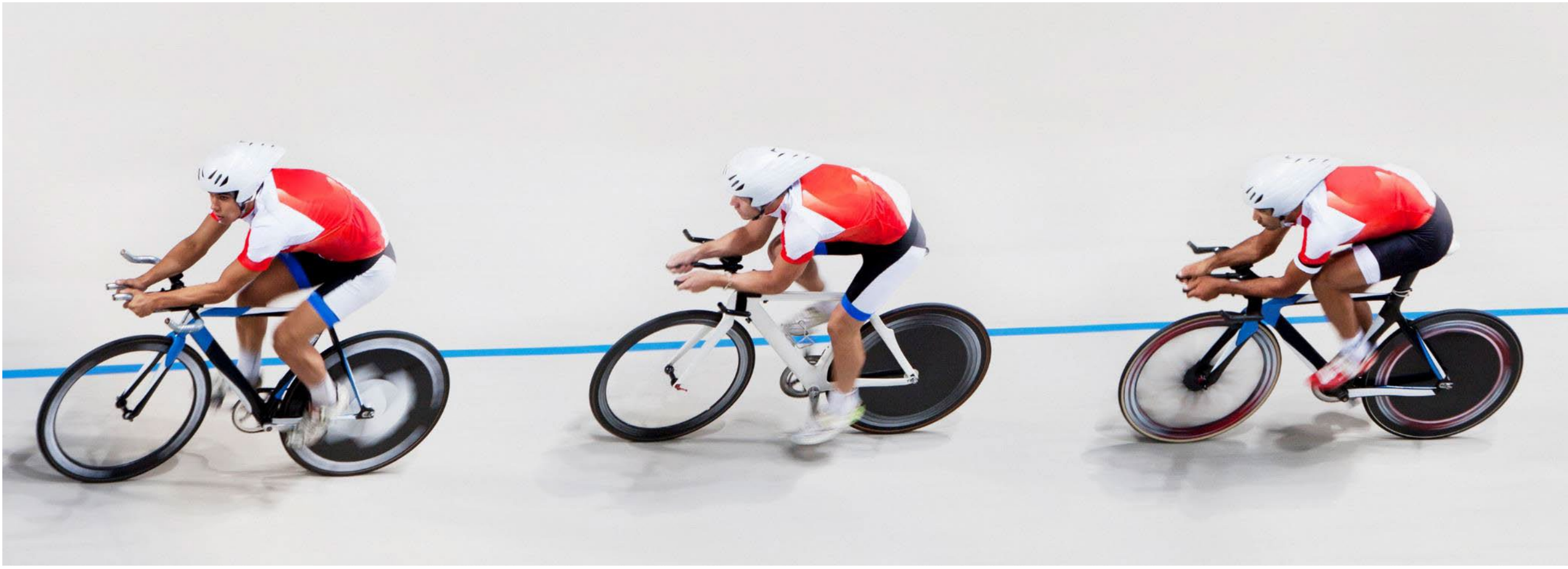


Think Pair Share

Thinking Doing Talking Science

A HOT Question

Why do the cyclists and their bikes look like this?



Skinny questions:

- Check pupils' knowledge
- Often one word answers
- Seeking facts

So was that a big/rich question?

Rich questions:

- Open ended
- Needs time to think – can't usually answer immediately
- Answers generally require one or more sentences
- Sometimes pupils need to ask other questions to work towards main question
- Tend to prompt further questions
- Need to make links, apply ideas, give reasons

Science Inside the Black Box

Black & Harrison, nferNelson

A HOT Question

What are the disadvantages of being this shape?

What are the advantages of a penguin being this shape?

A HOT Question?

Why don't Australians drop off?

Not really a rich question, but wait for it….

A HOT Question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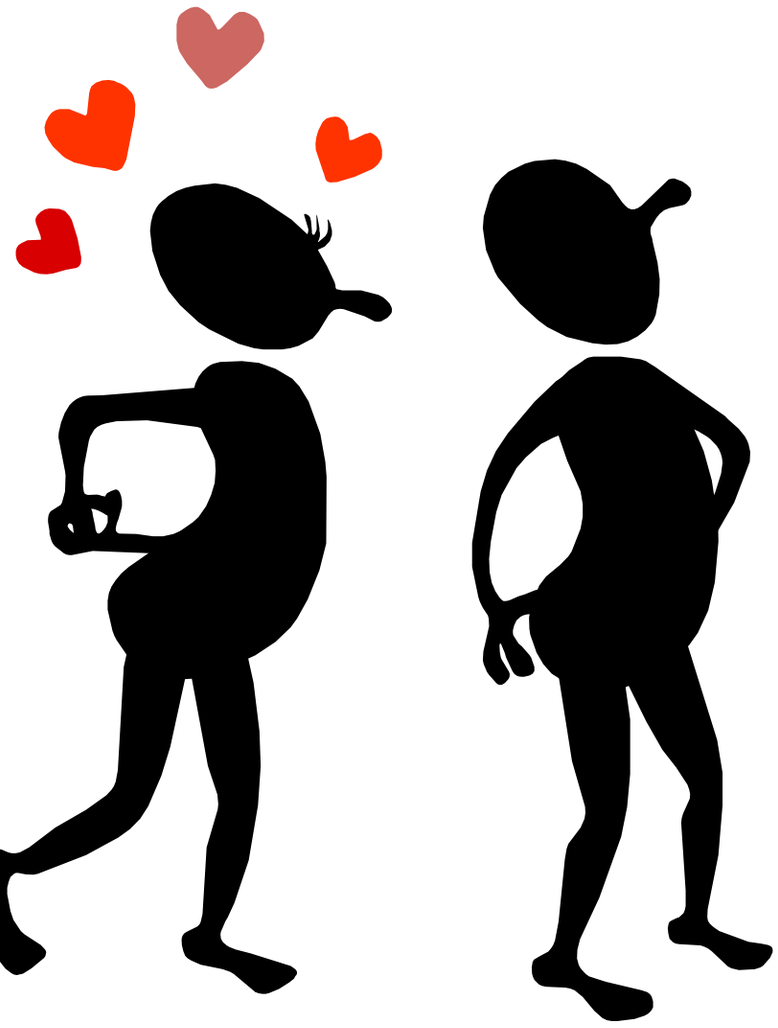
Science

Sorry…no excuse



Some Yr 5&6 children's responses to 'What causes gravity?

'Pencils produce gravity but not enough to attract anything.'

'If you push the two books out in a space craft, in a few days they would gradually pull together…where there's no friction.'

'I think it's a force that grows in outer space and it picks up rubble and pulls it together.'

There are more examples of the HOT Questions in the **General Resources** folder.

Go to: **More examples of Bright Ideas Time** (file)

These are organised by age group (KS1 and/or 2) and subject area, with background subject knowledge notes.

You can also make up your own examples

Explorify

Most of the ‘Big Questions’ here are not for Bright Ideas Times, but are springboards to investigations

Thinking Doing Talking Science

Great resources – we have worked with Explorify, so it includes strategies from TDTScience

https://explorify.uk/

Practical: Investigate Paper Helicopters

See our lovely helicopter template!

What are you going to test?

What are you going to record?

This practical, like many of the others, can be differentiated to suit any age group

Questions to bear in mind *if* it is a fair test

What will you change?

What will you measure?

How fair is your test?

What will you keep the same?

What would be the learning objective(s)?

How would you assess the learning objective?

NC:
recording data and results of increasing complexity using scientific diagrams and labels, classification keys, tables, scatter graphs, bar and line graphs

Possible Learning Objective:
Make a graph to present your results.

What would they record?

What type of graph is right for this?

Line graph?

Bar chart?

Line graph:

- only when ***all*** the points on the line can be read & mean something
- Only when there are 2 continuous variables (have units, e.g. kg, secs)

Bar chart:

- Gaps between bars meaningless
- Need just 1 continuous variable (has units, e.g. kg, secs)

Results

Paper helicopter dropped from one flight of stairs

Median (middle result) used for simplicity

What sort of graph is right here?

Number of paper clips	Time 1 secs	Time 2 secs	Time 3 secs	Median secs
1	2.20	2.30	2.46	2.30
2	1.94	1.93	2.00	1.94
3	1.83	1.81	1.99	1.83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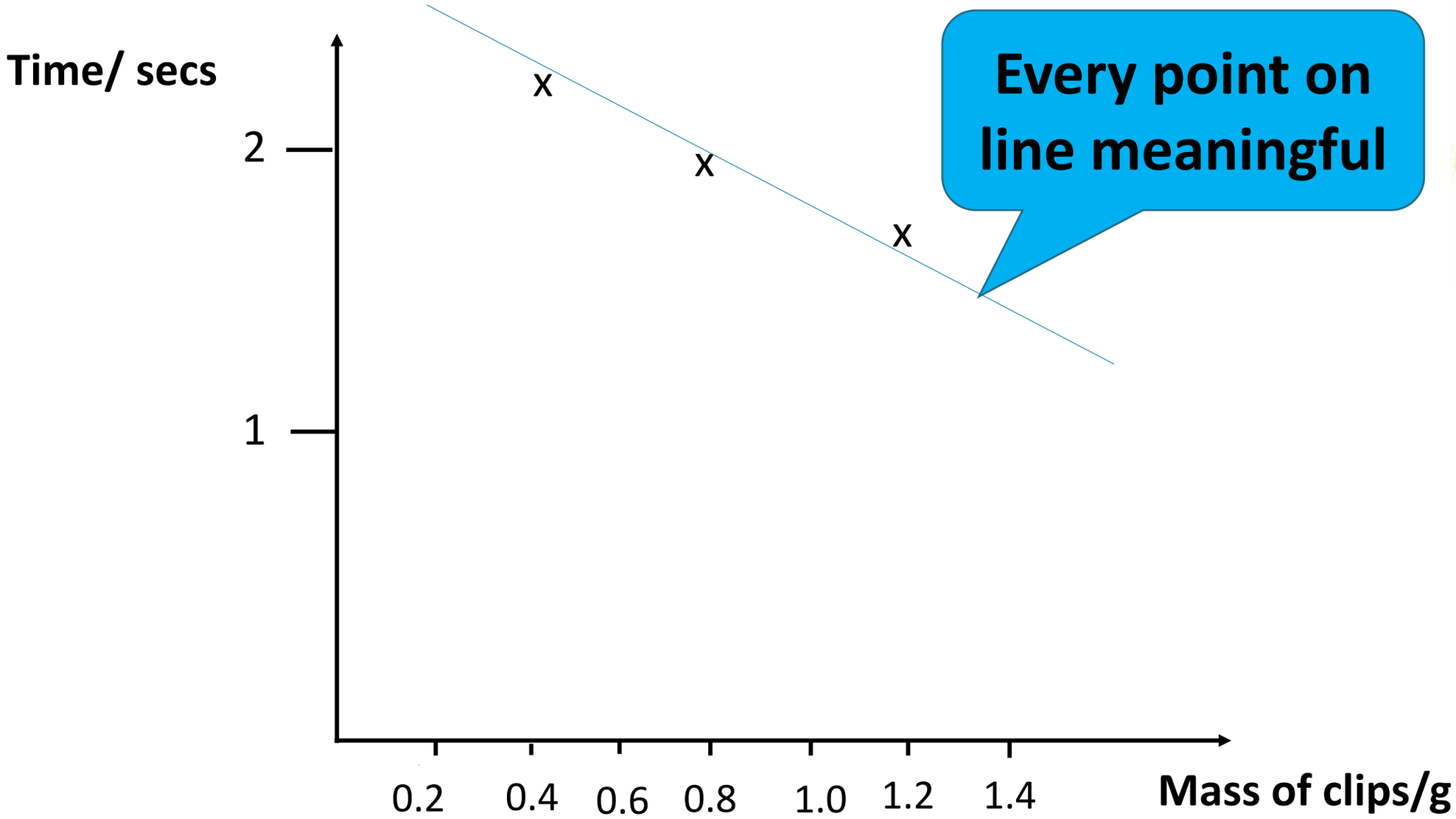


Every point on line meaningful

Mass of paper clips g	Time 1 secs	Time 2 secs	Time 3 secs	Median secs
0.4	2.20	2.30	2.46	2.30
0.8	1.94	1.93	2.00	1.94
1.2	1.83	1.81	1.99	1.83

The science of paper helicopters

…is quite complicated!

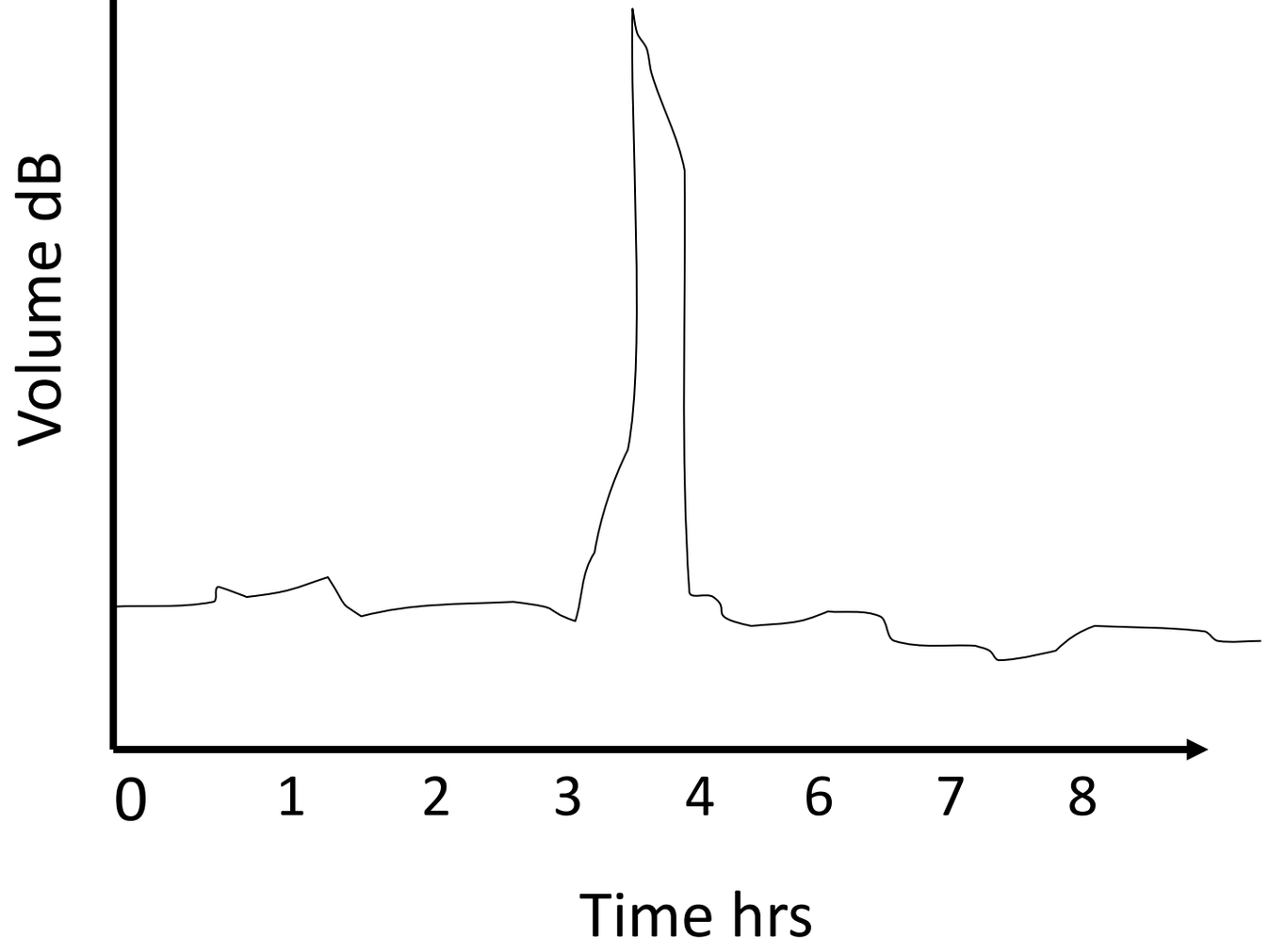
What causes air resistance?

Air resistance plays its part and is an upwards force

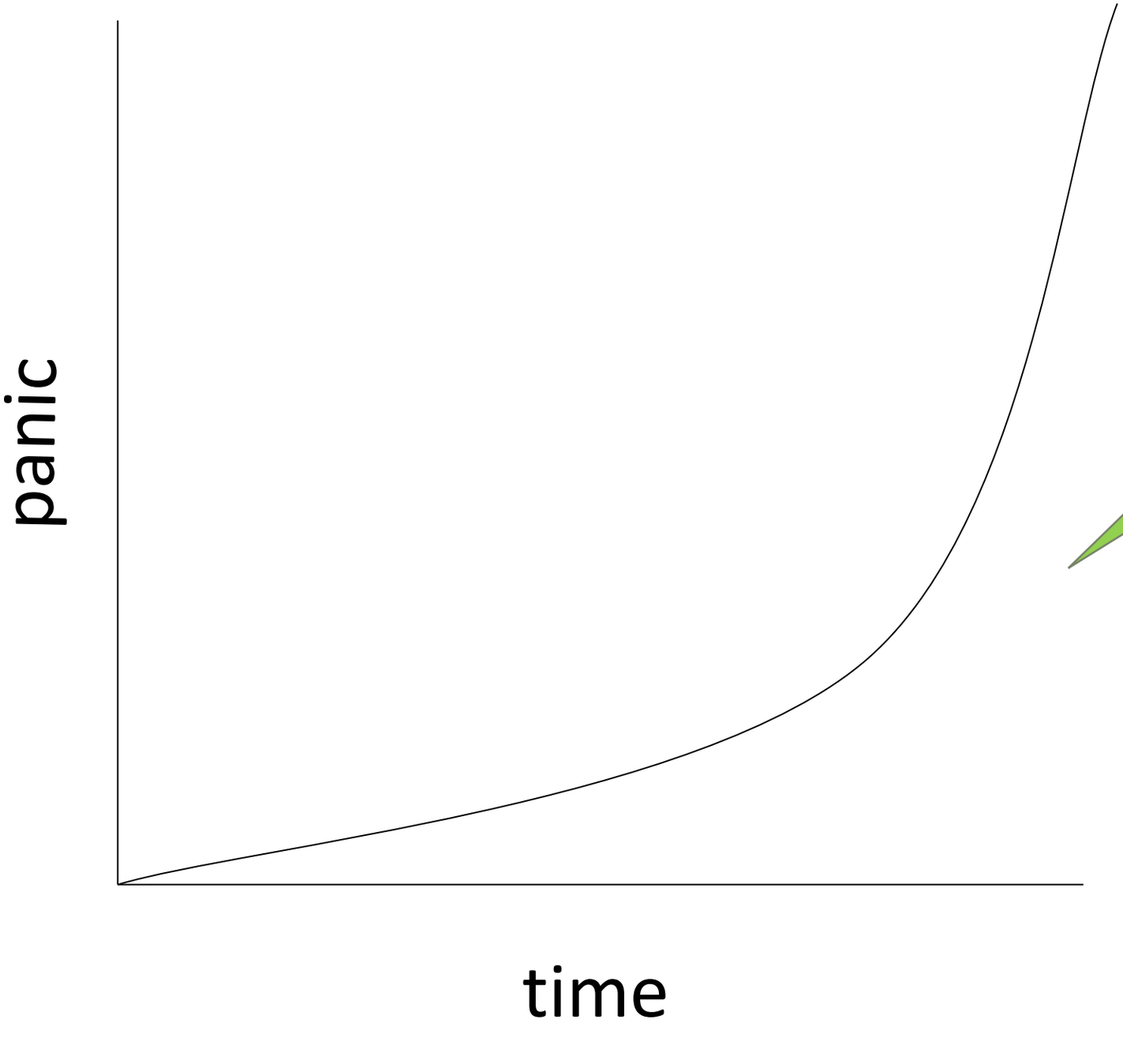
The spinning **also** creates an upward force

Hint: don't worry too much about the complications!

The mystery of the incident in the greenhouse during the night

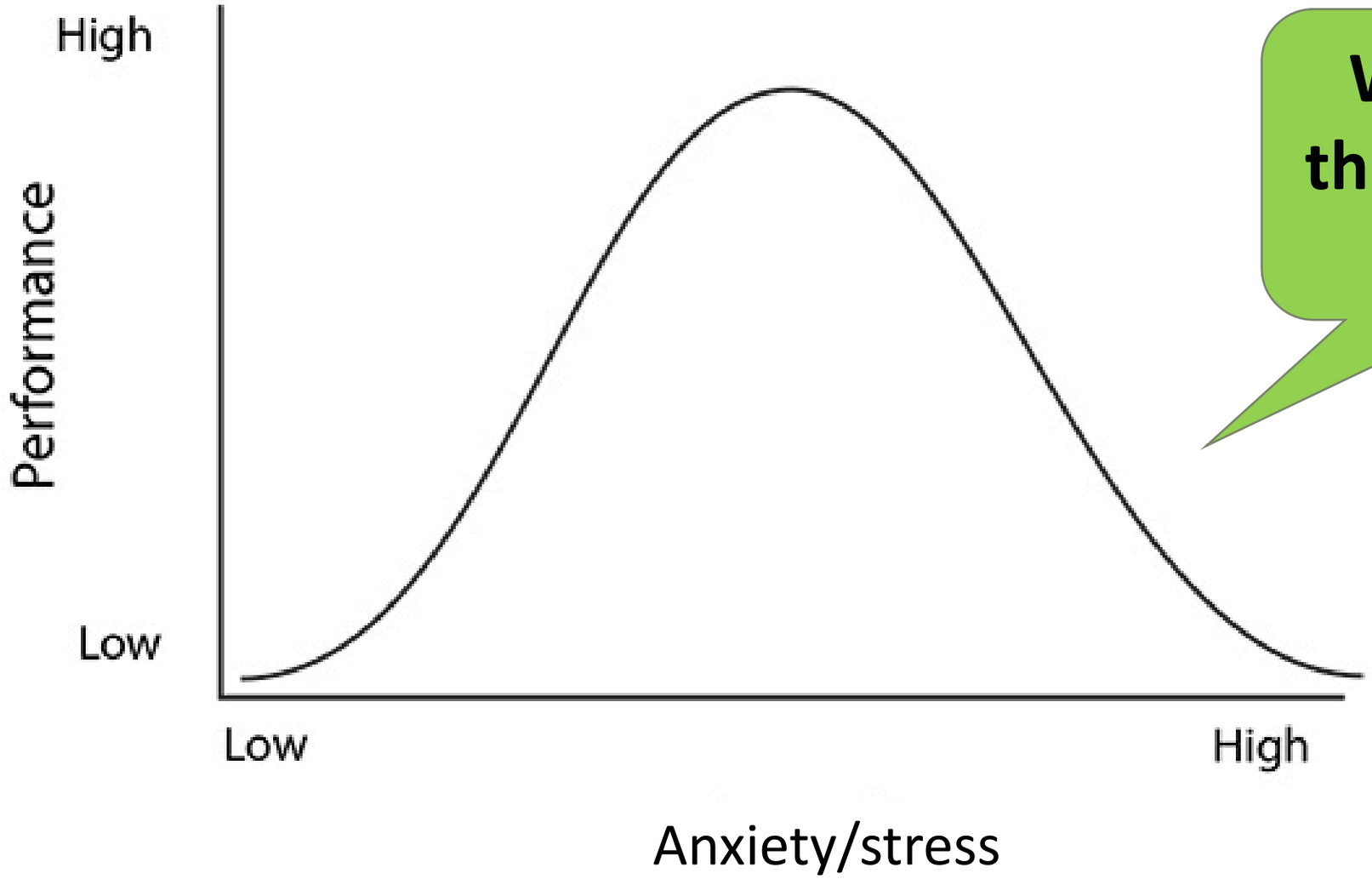


Interpreting Graphs



Tell the story of the graph

Yerkes Dodson's Law

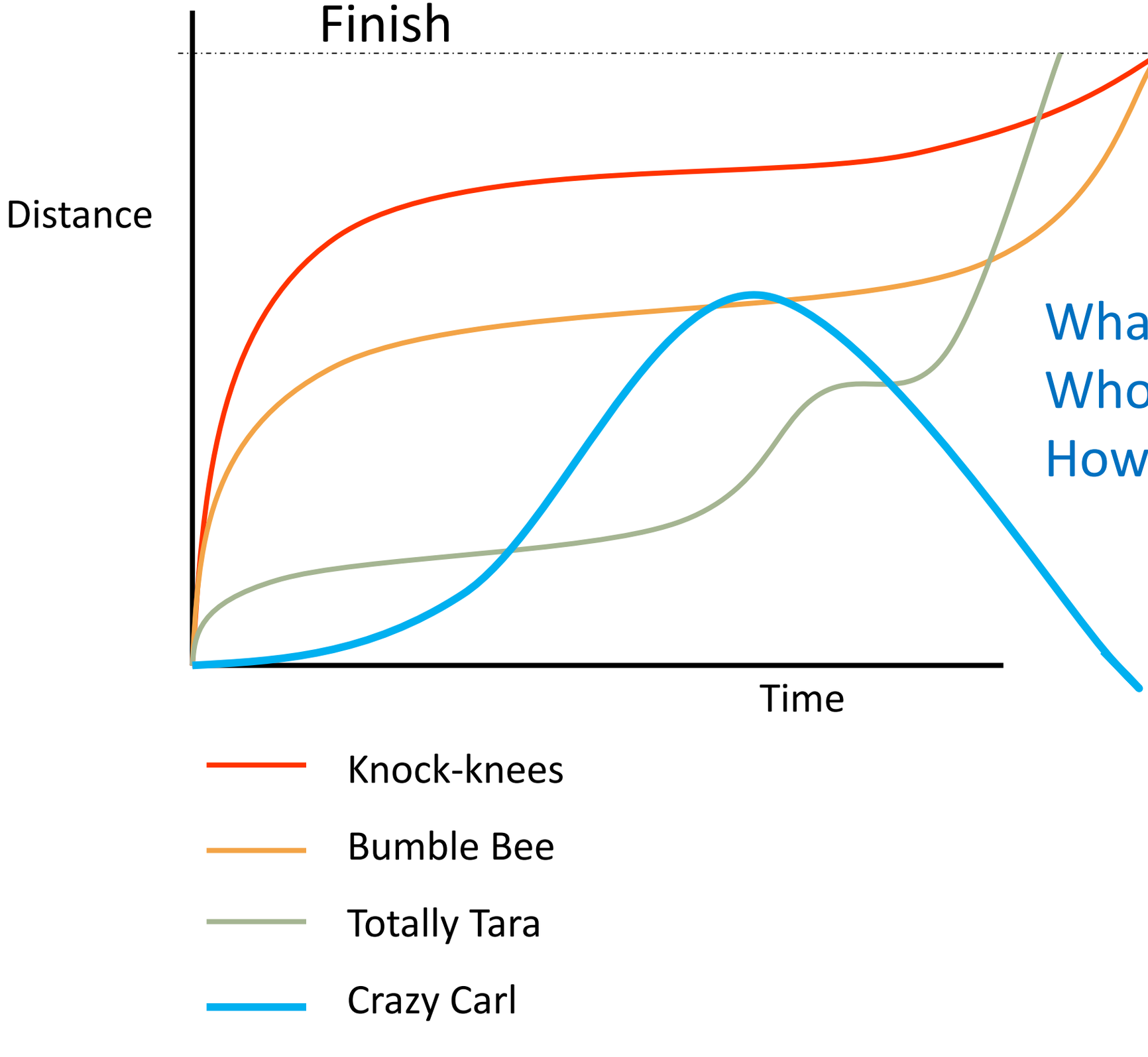


What does this graph tell us?

Yerkes Dodson’s Law

3.30 Graphic Stakes at Disaster

A steeplechase with horses racing over jumps



What happens?

Who wins the race?

How do you know?

Bloom's Taxonomy

High:

evaluation - judging, rating and giving opinions

synthesis - hypothesising, showing originality by creating, inventing and composing

analysis - categorising and comparing; distinguishing between fact and opinion or relevant and irrelevant information

Middle:

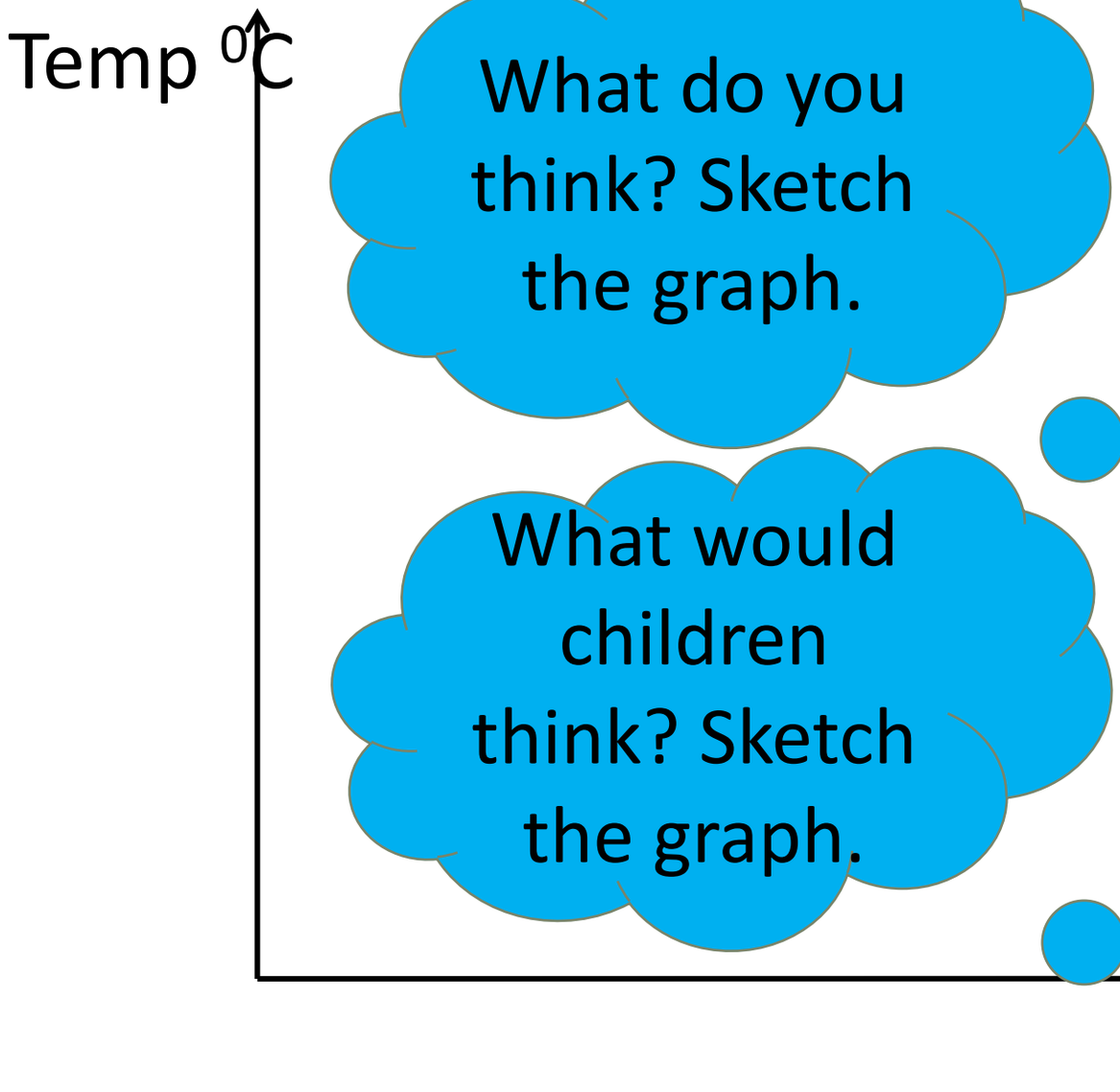
application/use - transferring knowledge from one situation to another similar one

Low:

comprehension - summarising and putting ideas or information into other words

knowledge - remembering, reciting or listing facts

The story: a temperature sensor is placed in a saucepan of water. The saucepan is put on a cooker hob, which is switched on and kept on for a while after the water has begun bubbling vigorously.



Predict: the shape of the resulting graph of temperature vs time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Practical Prompts for Thinking

The science of forces contd.

If something experiences an overall force, acceleration happens, which means it:

- speeds up
- slows down

or

- changes direction
- changes shape

i.e. something changes

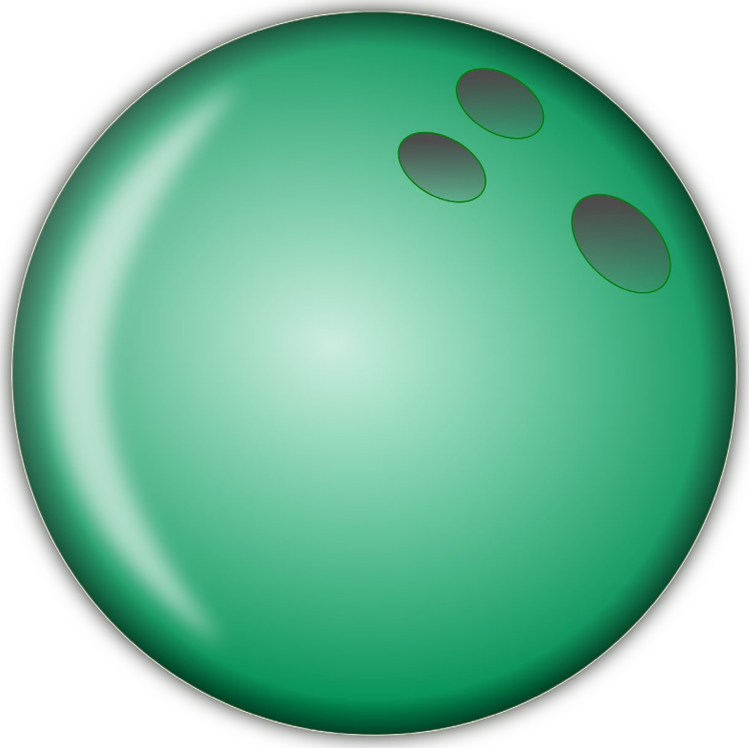
The science of falling

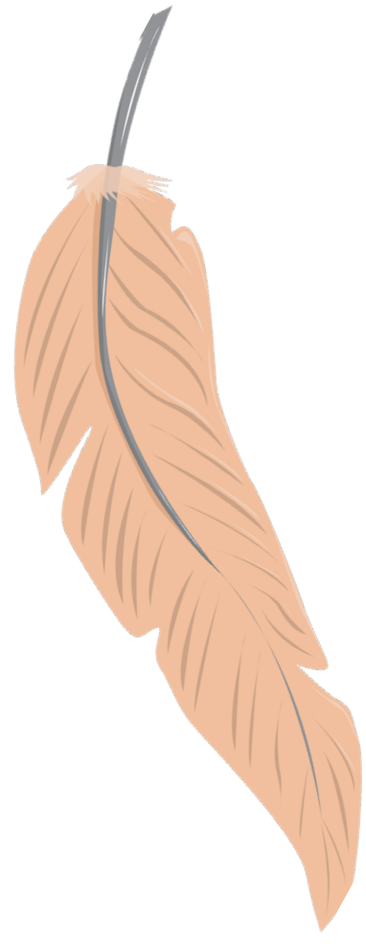
There is an overall downwards force, so the ball accelerates (speeds up)

The science of falling

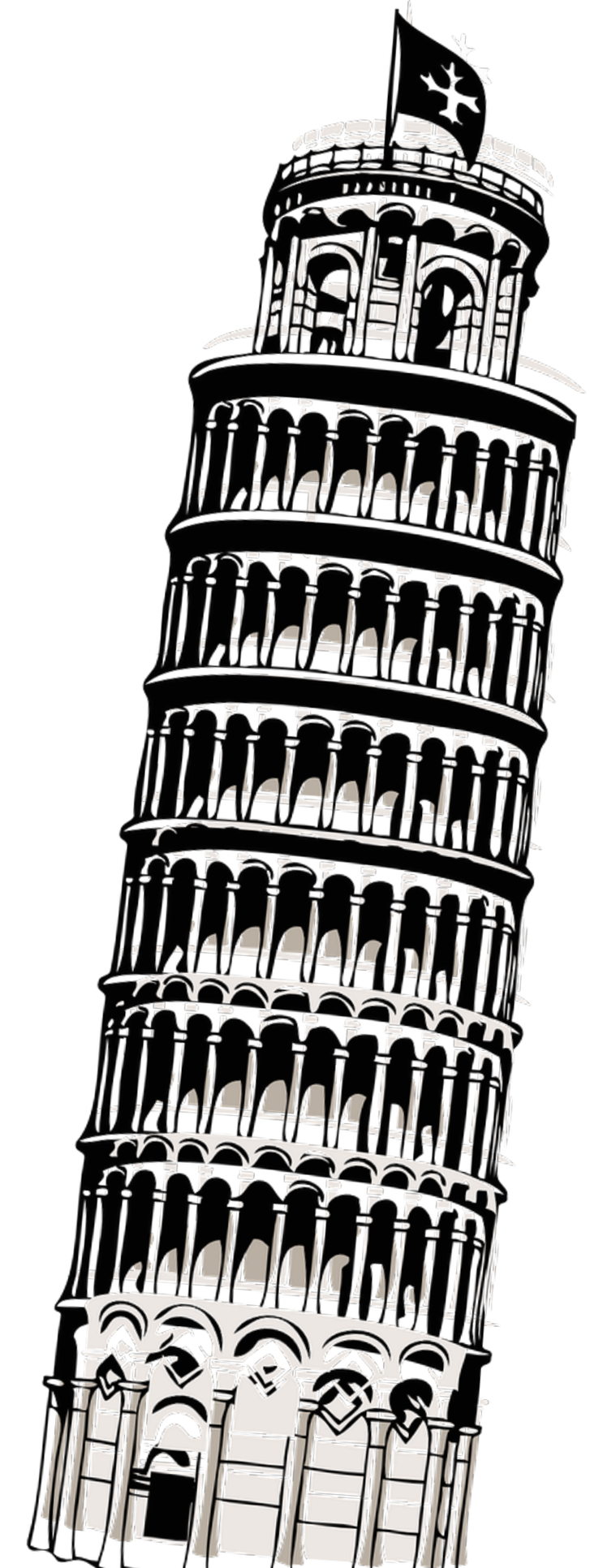
A bowling ball and a feather dropped in a very large vacuum chamber

What happens next…?





https://www.youtube.com/watch?v=E43-CfukEgs Stop at 3.45 mins



The science of falling

So heavier things do not fall faster – as long as air resistance does not complicate things, which it usually does on Earth!

Read the **forces subject knowledge** notes if you want to understand this in more depth – find them in the **General Resources** folder

Changing shape

Investigate bouncing with a:

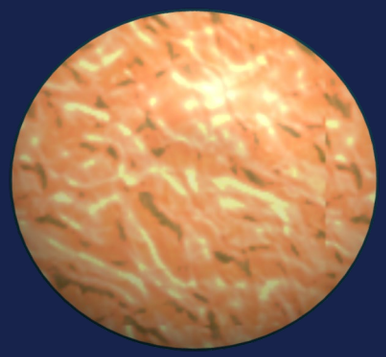
- tennis ball
- playdough ball
- ‘bouncy’ ball
- table tennis ball

Drop one at a time from the same height

Close observation

What do you notice? Ideas why?

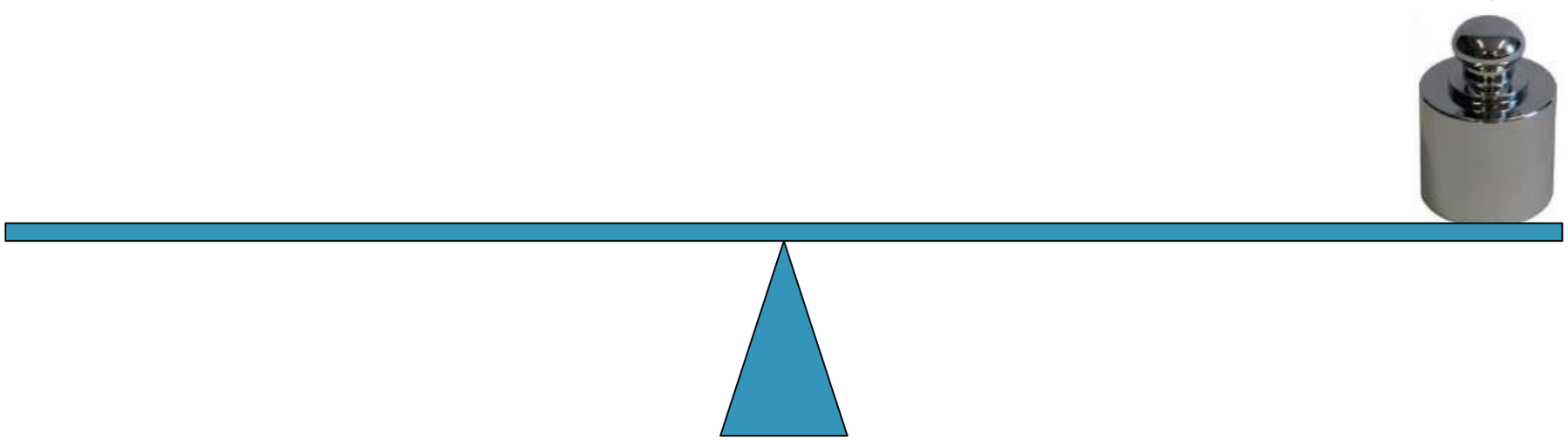
Could be an Odd One Out

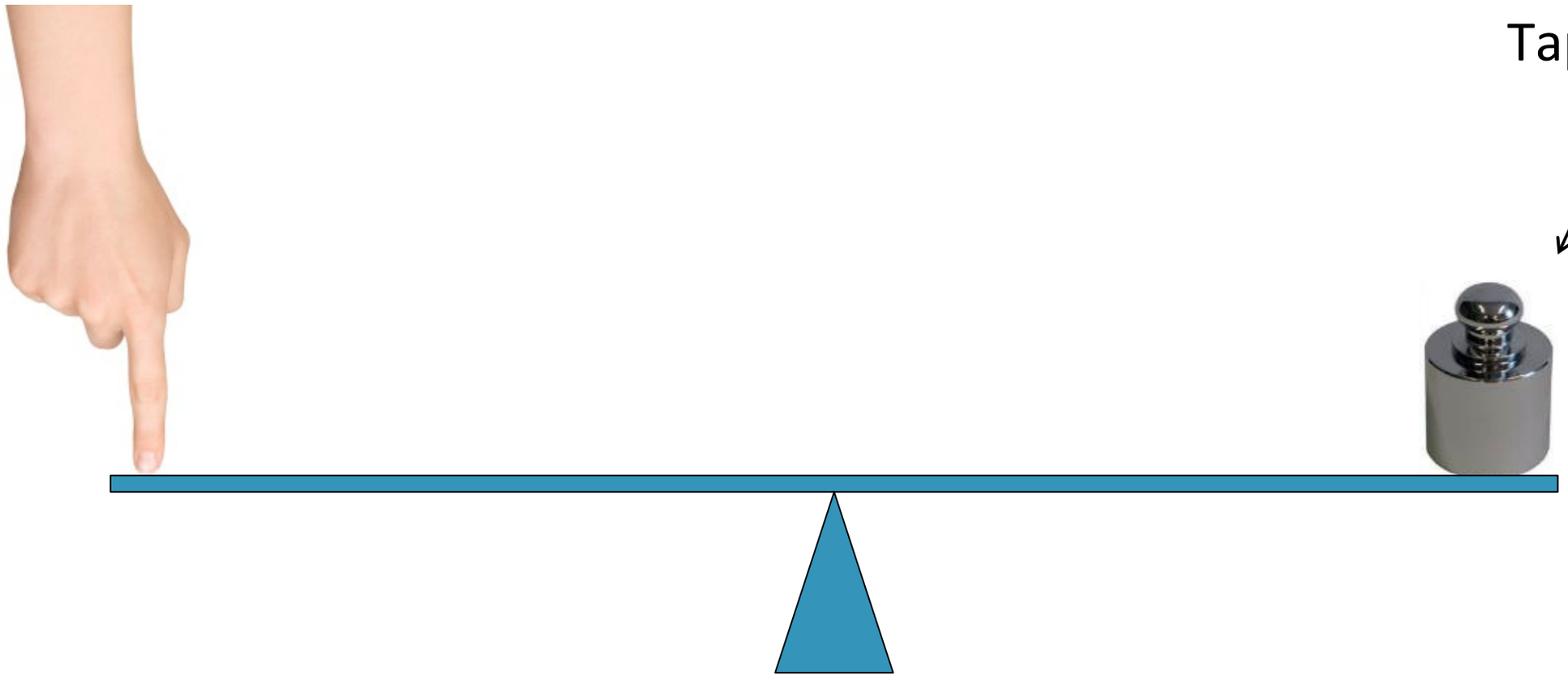


Practical

Investigating levers

Taped in place

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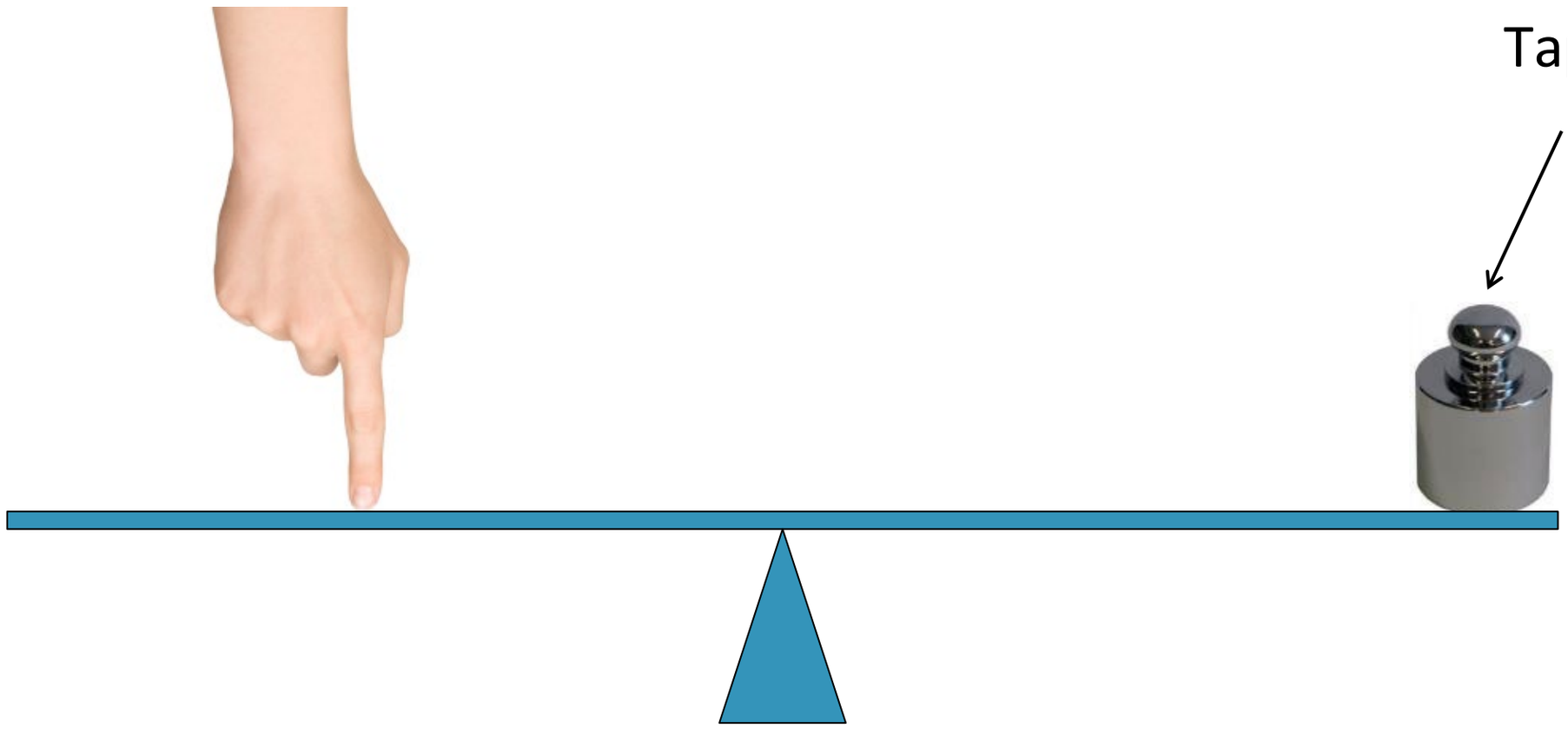
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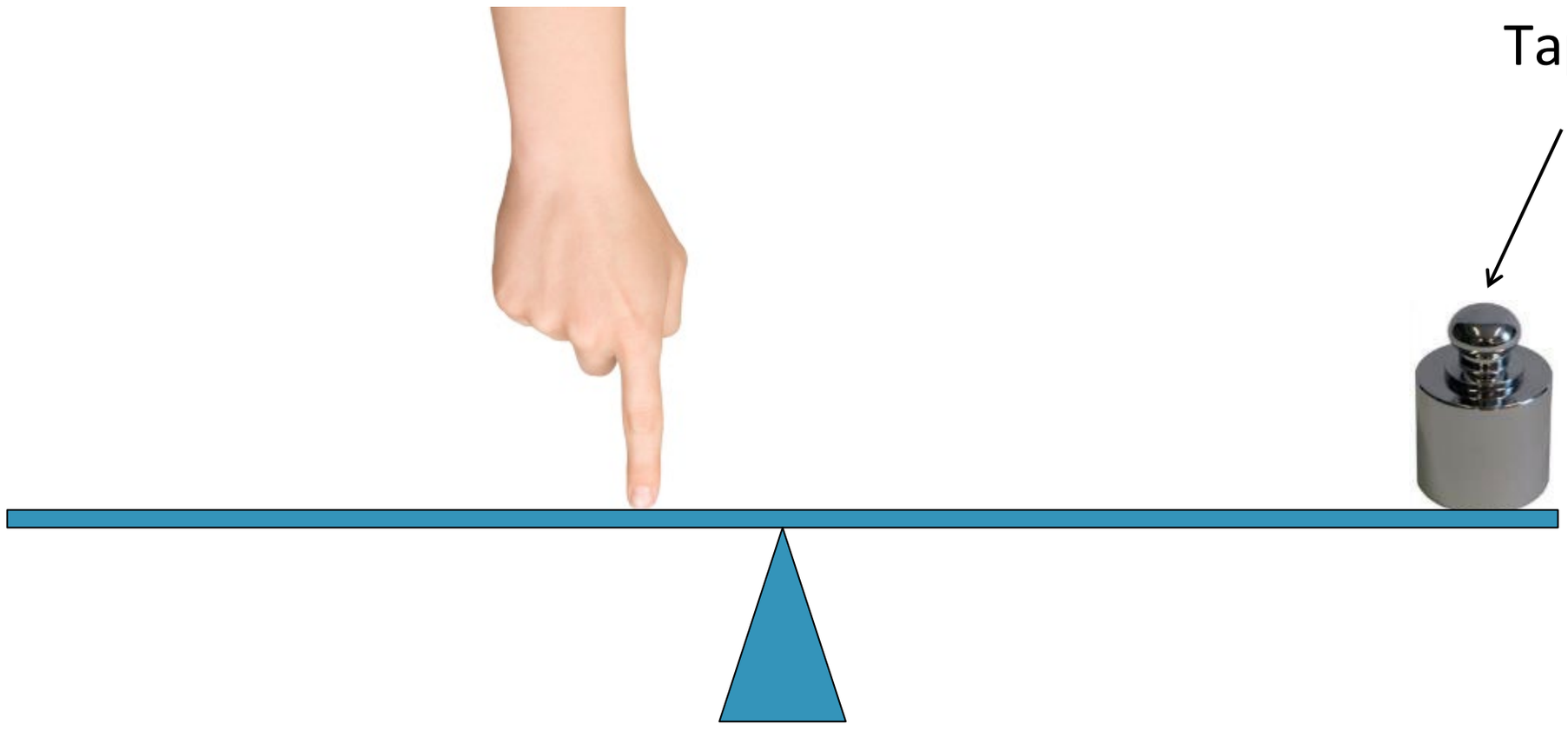
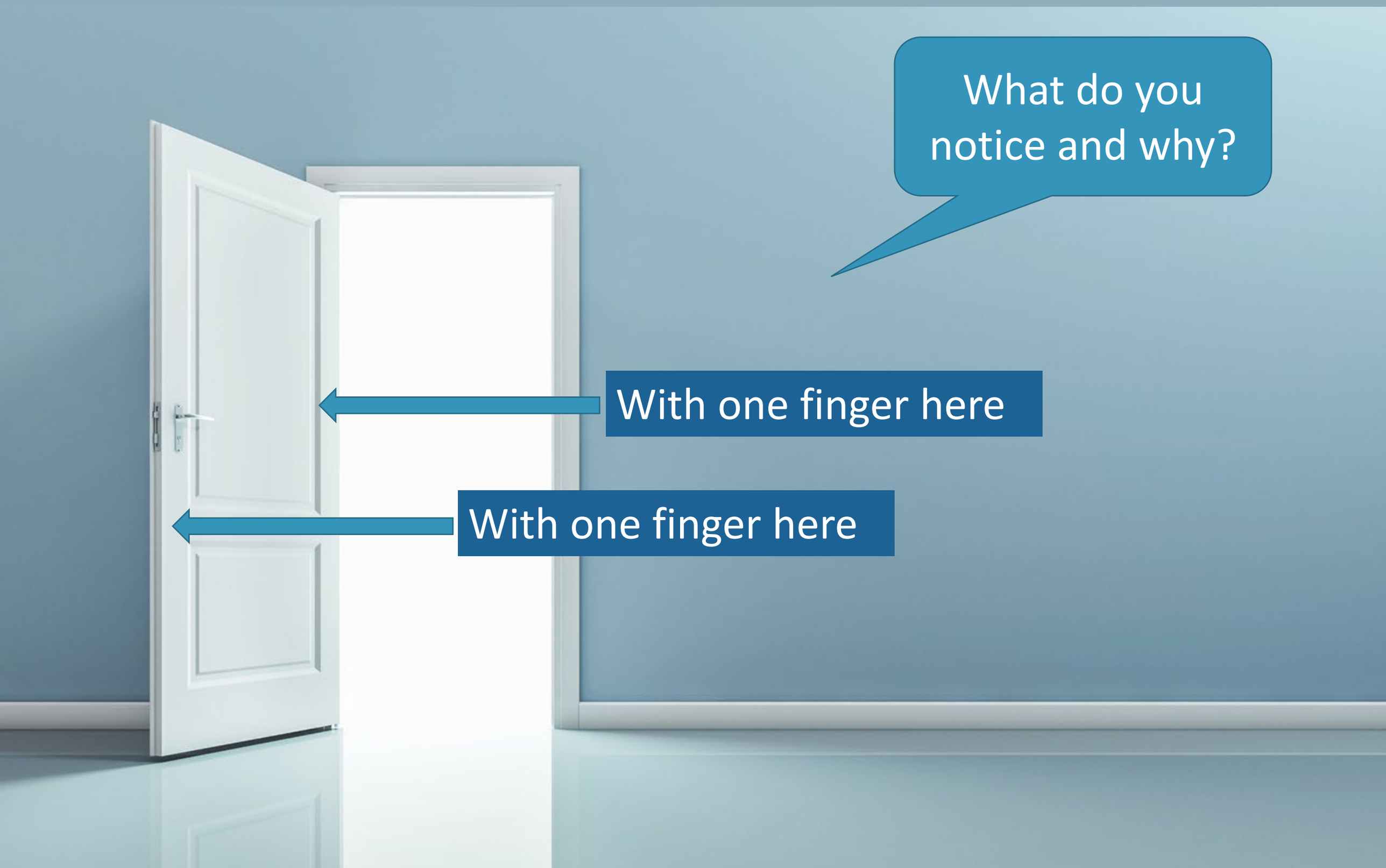

Taped in place

Or keep your finger in the same place and move the fulcrum

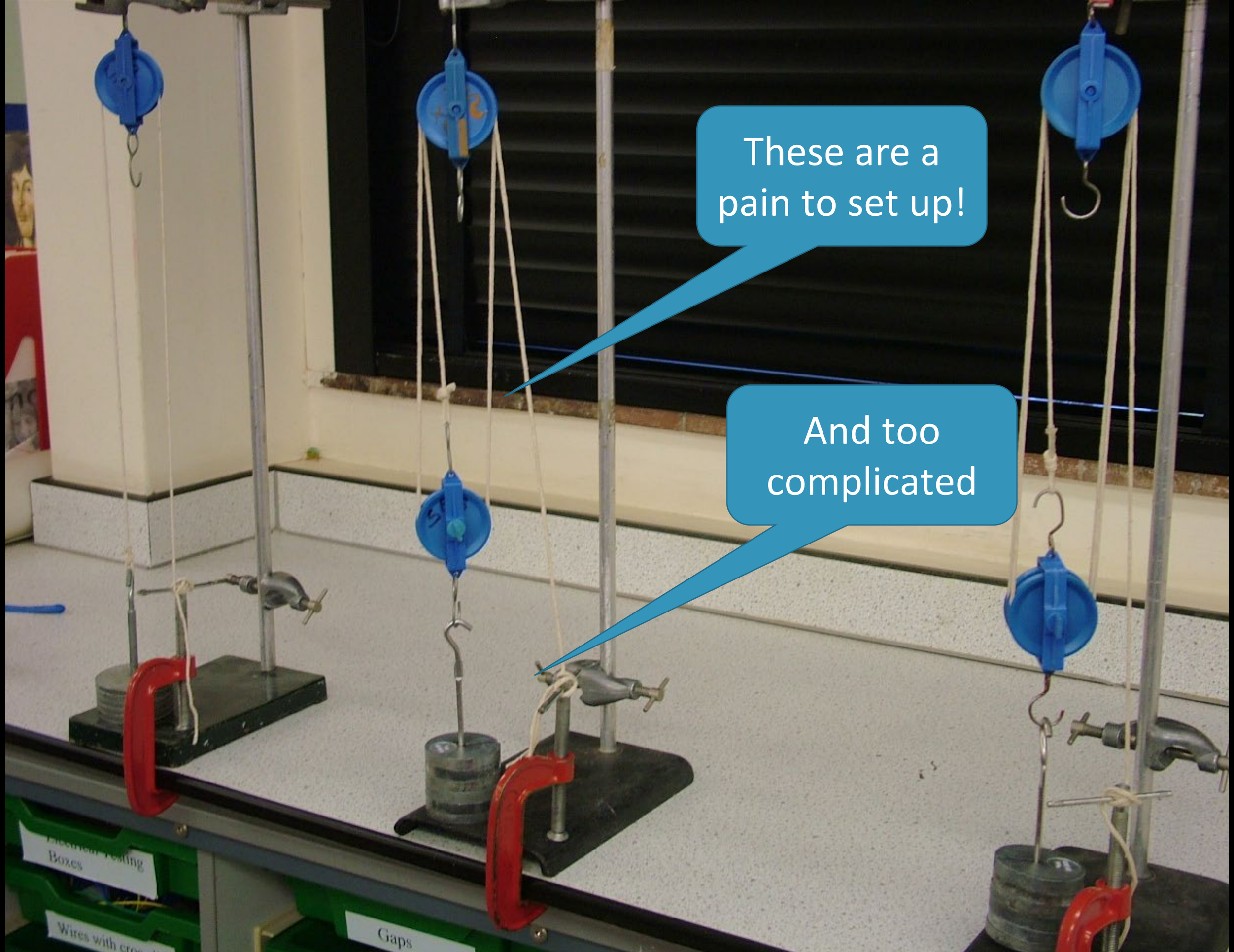
Try pushing open a door



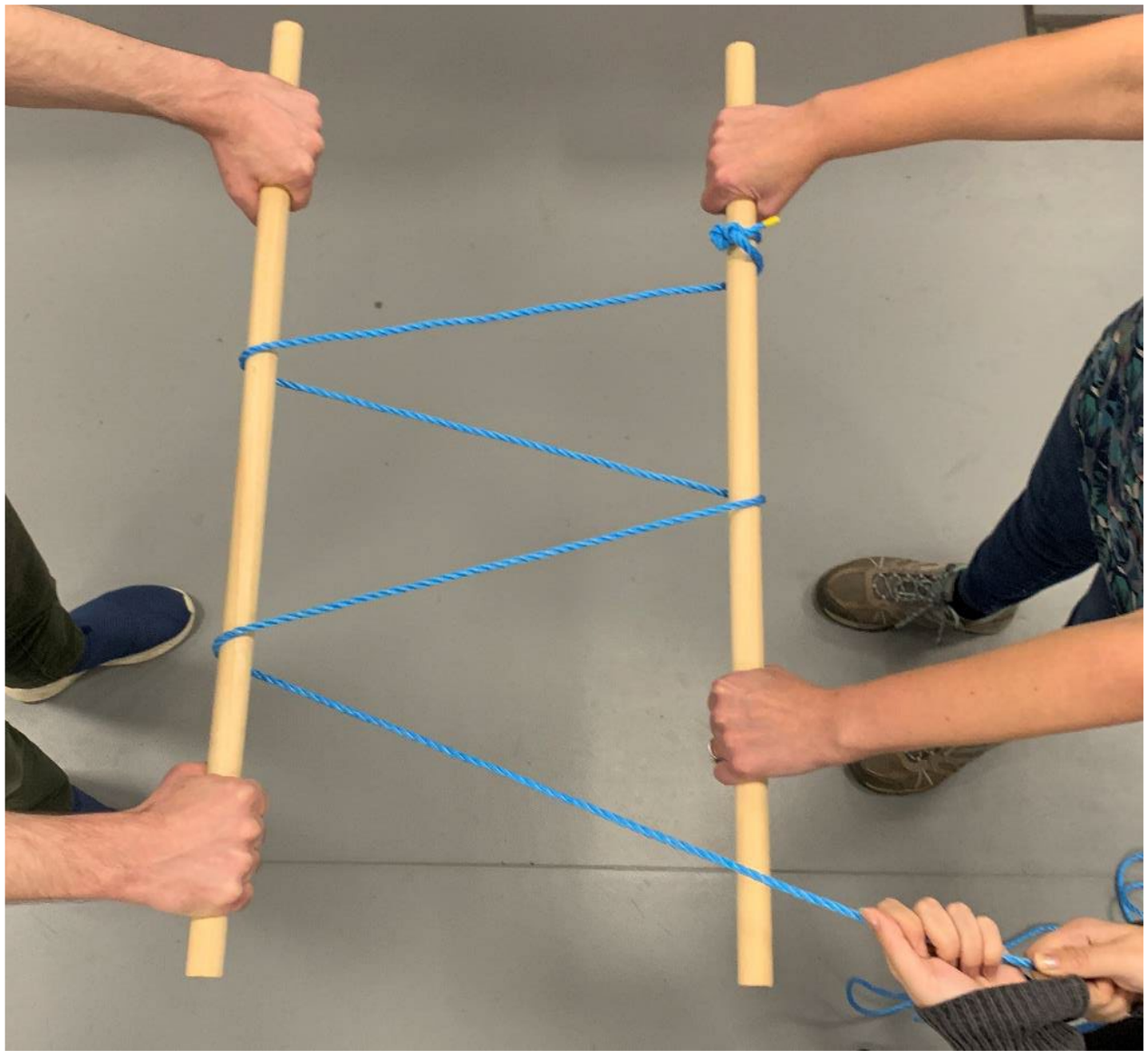
Thinking Doing Talking Science

Pulleys

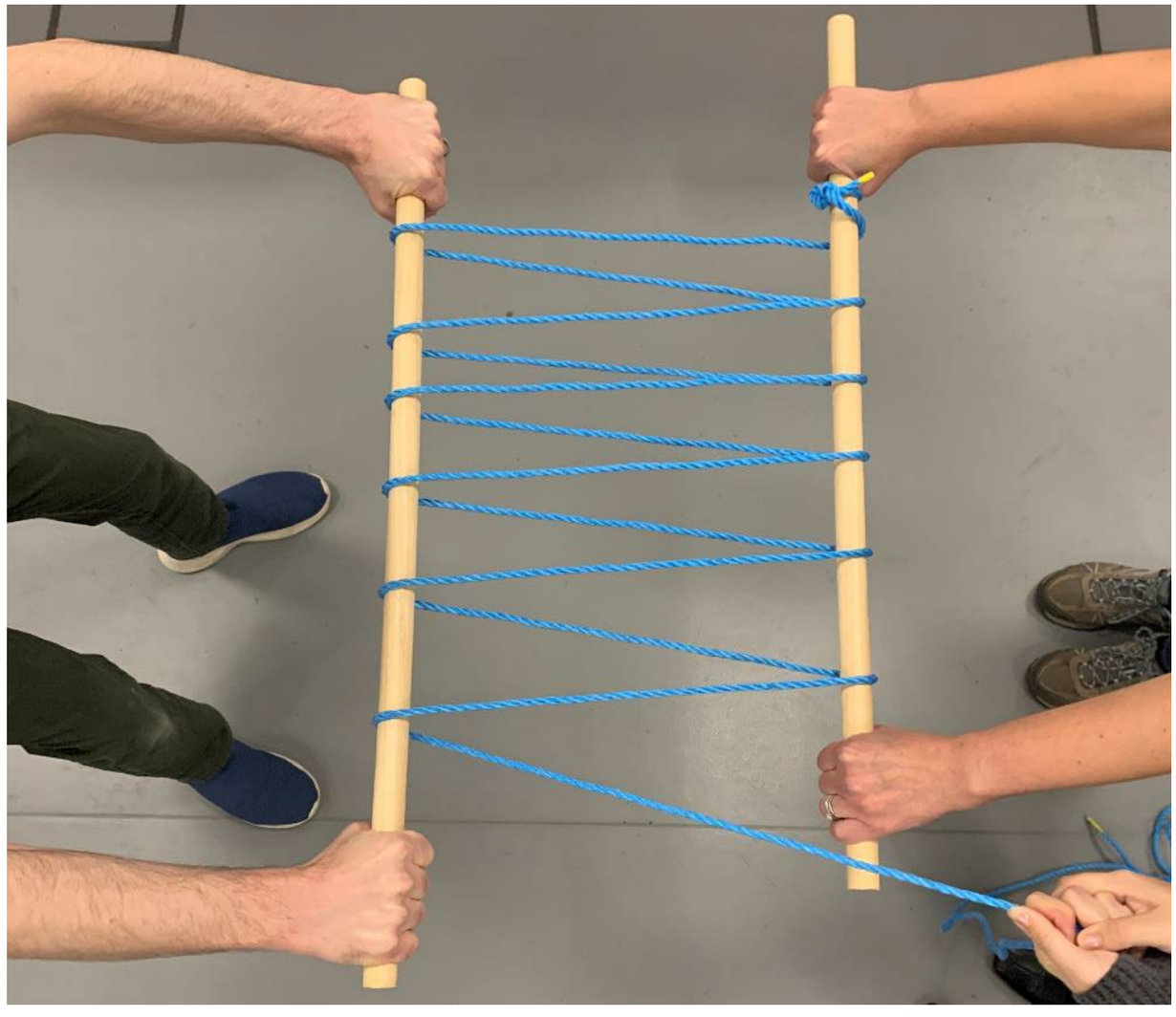
The simple pulley


These are a pain to set up!
And too complicated
Gaps

Much easier: 2 broom handles and a rope



pull



pull

A gardening application of a pulley:
Tree loppers

A helpful video:

The world’s strongest man pulling using pulleys – BBC clip

https://www.bbc.co.uk/teach/class-clips-video/science-physics-ks2-ks3-will-pulleys-let-9-year-olds-beat-Britain%E2%80%99s-strongest-man/zvm4d6f

More examples of practicals

Suitable for all ages
See practical teaching notes in Day 2 of file

More examples of practicals

Suitable for all ages

See practical teaching notes & template in **Day 2 Teacher Supplements** folder

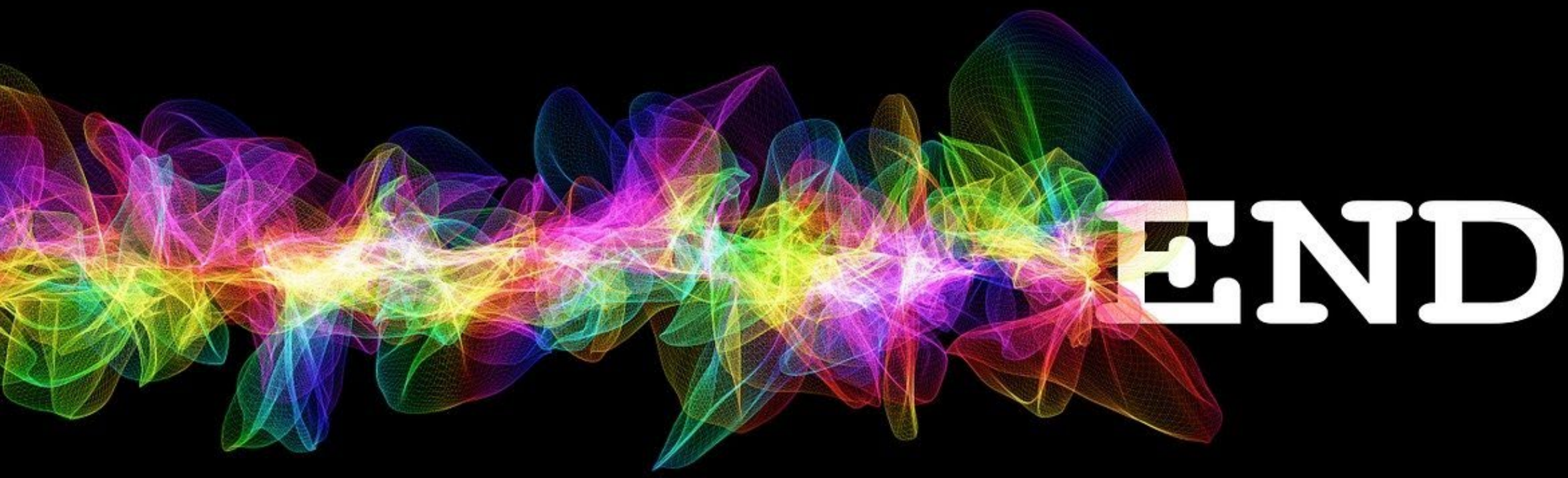
http://www.sciencemuseum.org.uk/educators/teaching_resources/activities/rocket_mice.aspx

See practical teaching notes in Day 2 of file

https://www.youtube.com/watch?v=MkJxtVDKQnE

Which fruit is the most hard wearing after being dropped from a fire escape? What sort of stone makes the biggest splash? How many times do different balls bounce in five seconds? Does weight affect the number of rotations of a paper spinner? Which liquid best protects the egg in a balloon when dropped? Which ball will catapult the furthest? How do different objects affect the flight of a paper aeroplane? Which type of paper makes the best aeroplane? Does the weight of a bungee jumper affect the jump? What shape parachute will take the longest to fall? Is Andrex toilet paper stronger than Cushelle? What material makes a skateboard go furthest? Does the heaviest fruit travel furthest when thrown? Which play surface cushions the fall of a boiled egg the best? Will a car go further on a ramp? If you have longer legs, can you jump further? Which tennis ball goes further, a wet one or a dry one?

THE PLENARY



Don't forget the **HOT Questions** in the **General Resources** folder.
Go to: **More examples of BIT (pp 6-11)**

Before next time:

- Try at least one HOT Question in your classroom.
- Note some children's responses (these will be verbal so think about how to capture some examples).
- Reflect on how it went, for example in terms of learning, participation, engagement, behaviour, opportunities for elicitation, etc.

On Day 3, you will share your reflections on this gap task in small groups.

There is a template for you record this in the **Day 2 Teacher Resources** folder.