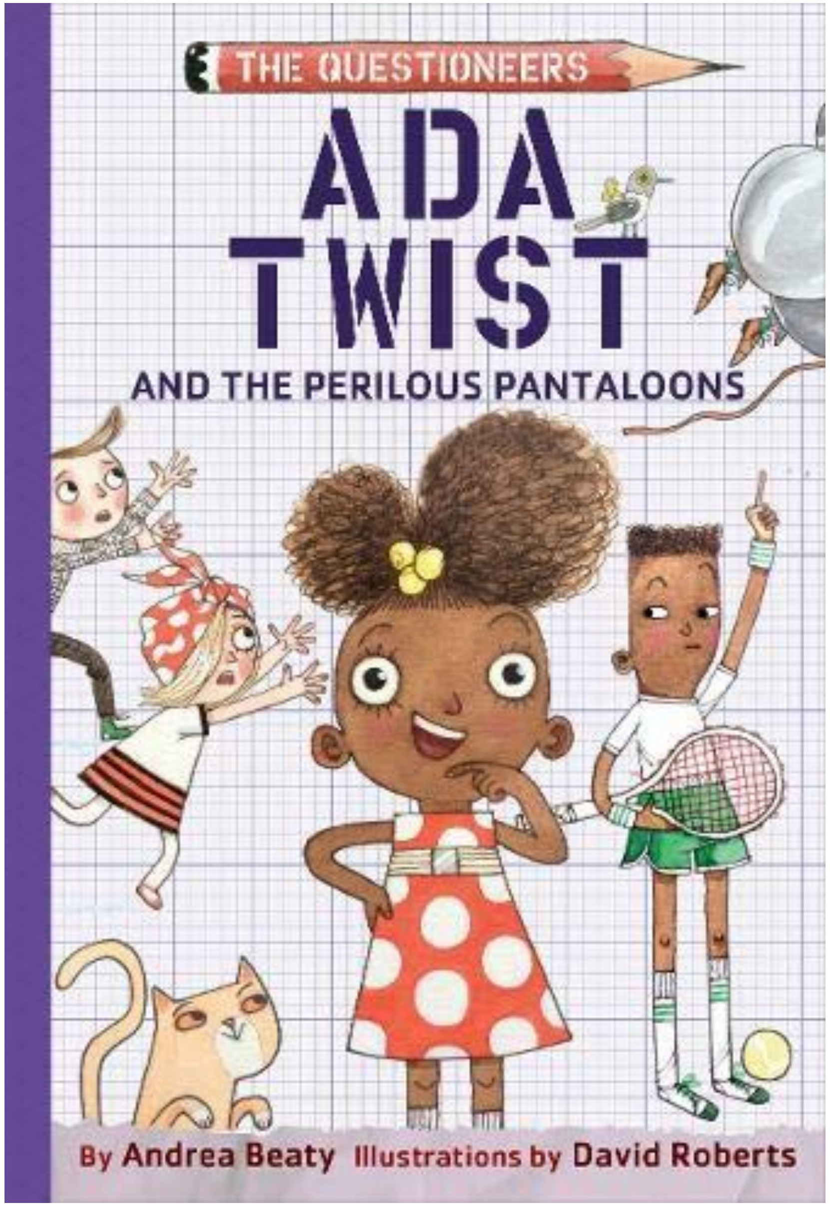

THE QUESTIONEERS
ADA TWIST
AND THE PERILOUS PANTALOONS
By Andrea Beaty Illustrations by David Roberts

This is an ideal book to use to model questioning and scientific thinking. All the steps of the 'Scientific Method' (the way scientists study and learn things) are covered throughout this book from starting with a question, creating a hypothesis/predicting an outcome, experimenting/testing, gathering and recording results of the tests/experiments, drawing conclusions and discussing/evaluating the results.

Science enquiry starts with a question. Science investigations in school can often be focused on the traditional concept of a fair test. There's nothing wrong with fair testing, but it is only one approach to investigating science questions.

Different types of questions and situations require different types of enquiry and different ways to find answers; in order to acquire a breadth of science skills, children need to learn to carry out a variety of investigations.

There are five approaches that children need to learn to recognise and use:

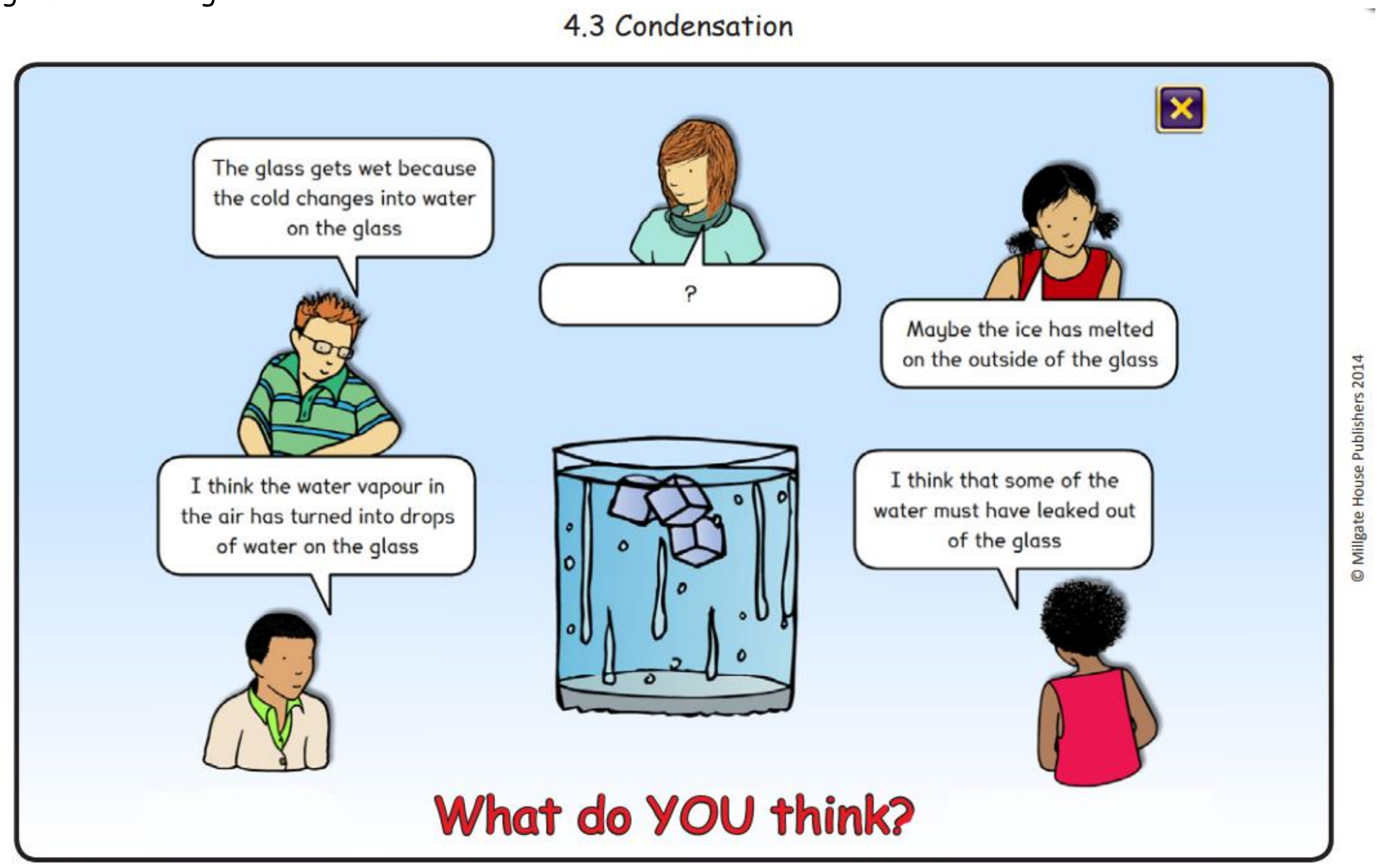
- fair testing
- observation over time
- pattern seeking/finding an association
- identifying and classifying
- researching using secondary sources.

The type of enquiry is identified for each suggested investigation in this resource booklet.

The learning activities are suggestions and by no means prescriptive. Teachers are welcome to use and adapt the plan and resources to suit their needs.

Suggested learning activities	Experiences and Outcomes and relevant benchmarks
Chapter 2: '***Ada looked carefully at the two mugs of coffee. Steam was rising from her Mum's mug and when she placed her hand over the steam, her palm became damp. When she placed her hand over her Dad's mug, her hand stayed dry. When Ada touched her Mum's mug it was hot. When she touched her Dad's mug it was cold and damp on the outside'.*** Ada had lots of questions and these included: What makes steam and why does it go up? Why was Dad's mug damp on the outside? ***What makes Dad's mug cold and damp on the outside?*** The water we see on glasses and other surfaces is called **condensation.** We see condensation in lots of different places, but it isn't obvious where the water comes from. There is normally water vapour in the air, but it is a colourless gas so we can't see it. Where the temperature is lower, the gas turns into droplets of liquid. This is what we see as mist or **condensation.** Condensation forms when moist air hits a cold surface. A glass containing ice is usually cold enough for water vapour in the air to turn into droplets of liquid water on the side of the glass. Concept Cartoons are cartoon-style drawings that put forward a range of viewpoints about a particular situation. They are designed to intrigue, provoke discussion and stimulate thinking.	By investigating how water can change from one form to another, I can relate my findings to everyday experiences. **SCN 1-05a** • Uses more complex vocabulary to describe changes of states of water, for example, 'condensation' and 'evaporation'

This one could be used to promote discussion about Ada's Dad's mug and could be used as a starting point for carrying out an investigation:



[Science concept cartoons: condensation | Resource | RSC Education]()

The children may think that condensation only happens in the sky if they know that clouds form as a result of condensation. However, condensation happens all around us every day.

Here is an investigation that will help them to understand what condensation is, where it comes from, and where it happens in everyday life. Because this is an exploratory activity, ideally keep background information to a minimum.

This type of science enquiry involves **observation over time** and requires the children to observe and record any changes that they notice.

Working in groups and with two identical clear cups/tumblers/jars, get the children to fill one ¾ full of ice and pour enough water over it to cover the ice. Fill the second cup with water to the same level. Ask them to observe the cups carefully for 3 minutes and then to record their observations.

The outside of the cup that doesn't have ice in it will be dry while the one that has ice in it will be moist; the water vapour in the air has been chilled by the surface of the cold cup and turned back into a liquid.

The children may think that the moisture came from inside the cup. Instead of explaining to them where it came from, challenge them to think of a way to test this hypothesis. *How can they find out if the water drops came from inside the cup? Can they plan and carry out a simple experiment to test this idea?* They might suggest the following: ***<u>Cover the cup:</u>*** cover the cup with clingfilm and repeat the experiment. Presumably, if the water came from inside the cup, covering the cup should keep the water from getting to the outside. The water will still appear on the outside of the cup. ***<u>The colour test</u> :*** put a drop of red food colouring into the cup with the ice and see if the water that appears on the outside of the cup is red, too. The water on the outside will not turn red. After discussing the results of their investigations and establishing that the water probably did not come from inside the cup, ask the children again where they think the condensation came from and why it only appeared on the cup with ice. If no one gives the correct answer, explain that there's water in the air all around us, but the droplets are so tiny that we can't see them. Ask them to think about other examples of condensation that happen all around us in everyday life and share with the class. A few examples of condensation are forming on a cold glass of lemonade, a cloud of steam forming when you breathe out on a cold day, 'fog' forming on a cool bathroom mirror, spectacles 'misting up' when you go from the warm house to outside in the cold, and dew drops collecting on a spider's web early in the morning. Point out that all of these examples involve warm, moist air coming into contact with a cooler surface. What is evaporation and condensation? - BBC Bitesize	

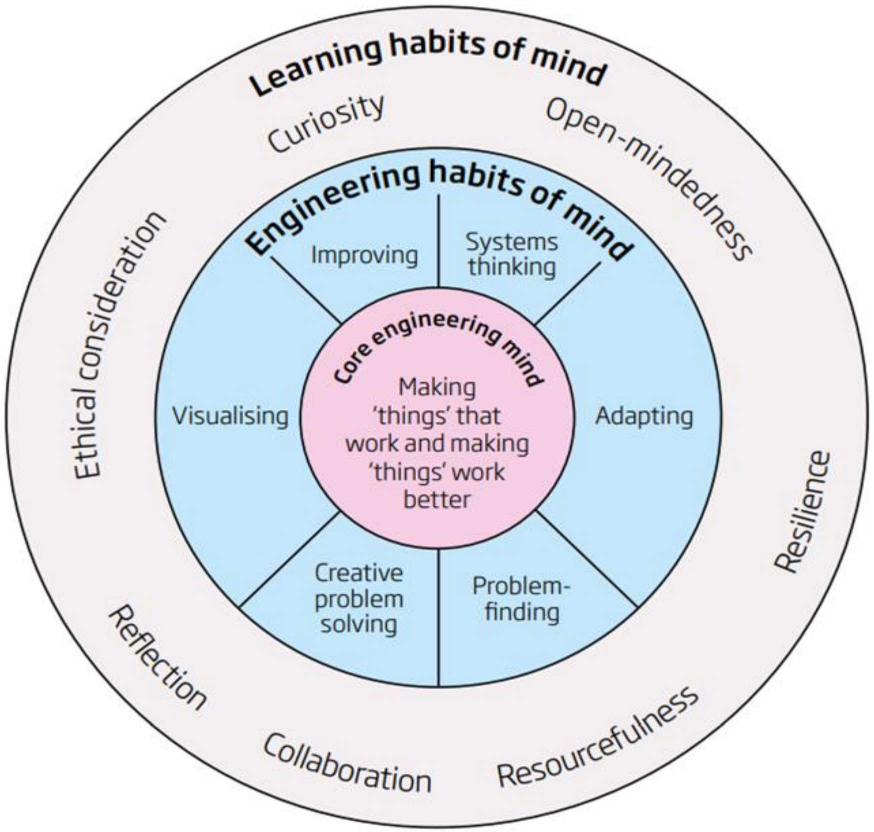
Chapter 6 **Ada grabbed her binoculars and came back to the tree. The Great Backyard Bird Count was only a few weeks away.** The children could learn to identify and name a variety of common birds that they see in their local area. This could then be expanded to include concepts such as: • Carnivores, herbivores, insectivores and omnivores as they find out what different birds eat • The life cycle of birds • The basic needs of birds for survival and how our outdoor environments can be changed or modified to make them more nature/ bird friendly • Birds are part of complex ecosystems and this can be explored by looking at food chains and webs that different birds are part of – identifying which ones are predators and which are prey and which may be both! • Biodiversity: differences and similarities within and between species as well as across different ecosystems. These types of science enquiry (above) might involve **researching using secondary sources.**	I can distinguish between living and non-living things. I can sort living things into groups and explain my decisions. **SCN 1-01a** • Creates criteria for sorting living things and justifies decisions. • Sorts living things into plant, animal and other groups using a variety of features. I can explore examples of food chains and show an appreciation of how animals and plants depend

[Birds in the Garden (maths.org)](https://nrich.maths.org) Do some bird watching in the garden at home or at school. https://www.bbc.co.uk/bitesize/articles/zpdcydm Once a few birds have been recorded, discuss the information recorded and ask some questions about it. For example: *How many birds of a particular type did you record on e.g. each day (or each hour etc.)?* *Did you see the same type of birds at specific times of the day?* *How many different types of birds did you see each day (or each hour)?* The children will be able to think of many other questions too! *Are you able to see any patterns in the information you collected or do the sightings of birds appear to be quite random?* *If you do find any patterns, can you try to explain why, or at least have an idea why?* *(Science enquiry by **pattern seeking/finding an association**)* It is a great opportunity for Maths (data handling) which could include tallying and creating graphs (**MNU 1-20b**)	on each other for food. **SCN 1-02a** • Interprets and constructs a simple food chain, using vocabulary such as 'producer', 'consumer', 'predator' and 'prey'. I have used a range of ways to collect information and can sort it in a logical, organised and imaginative way using my own and others' criteria. **MNU 1-20b** • Selects and uses the most appropriate way to gather

Big Schools' Birdwatch: https://rspb.org.uk/helping-nature/what-you-can-do/activities/big-schools-birdwatch	and sort data for a given purpose, for example, a survey, questionnaire or group tallies.
Chapter 7 **Poor Uncle Ned. His pantaloons are just like a balloon and he is floating away!** ***'I could make a gadget to help him steer the helium pantaloons,' said Rosie, who was an engineer.*** What is an engineer? What do they do? (*An engineer is someone who uses science and maths to develop solutions to problems. Engineers do not just build machines. They also design systems to make things function better).* https://www.youtube.com/watch?v=owHF9iLyxic&t=2s Engineers use something called the 'Engineering Design Process.' Find out about the Engineering Design Process by watching this video: [Engineering Design Process - YouTube]() By using this approach with the children, the learning activity becomes a skill focussed, STEM (engineering) learning activity.	I can describe some of the kinds of work that people do, and I am finding out about the wider world of work. **HWB 0-20a / HWB 1-20a** • Talks about the world of work, for example, from visits, visitors and interdisciplinary learning I can design and construct models

 ➢ **ASK:** Students identify the problem, requirements that must be met, and constraints that must be considered. ➢ **IMAGINE:** Students think about solutions and research ideas. They also identify what others have done. ➢ **PLAN:** Students choose two to three of the best ideas from their list and sketch possible designs, ultimately choosing a single design to prototype.	and explain my solutions. TCH 1-09a • Creates and justifies a solution to a given design challenge considering who is it for, where and how will it be used I can recognise a variety of materials and suggest an appropriate material for a specific use TCH 1-10a • Selects materials to use in a specific task I can explore and experiment with sketching,

➢ **CREATE:** Students build a working model, or prototype, which aligns with design requirements and that is within design constraints. ➢ **TEST:** Students evaluate the solution through testing; they collect and analyse data; they summarise strengths and weaknesses of their design that were revealed during testing. ➢ **IMPROVE:** Based on the results of their tests, students make improvements on their design. They also identify changes they will make and justify their revisions. ***<u>NB: THIS PROCESS IS A CYCLE – NOT LINEAR</u>*** *Note: Different sources have slight variations in the steps/number of steps identified in the design cycle, but they are broadly the same/very similar.* The Royal Academy of Engineering have identified common attributes and the skills engineers have regardless of their engineering discipline; they call these the **Engineering Habits of Mind**. There are six Engineering Habits of Mind, and these have now been broken down into more specific skills which are transferable across all curricular areas: **Systems Thinking** – Smaller parts coming together to make a whole. **Problem Finding** – Finding problems, deciding how to fix them and checking existing solutions. **Visualising** – Thinking about how the final product will look. **Creative Problem Solving** – Working together to create solutions to problems. **Improving** – Making things better. **Adapting** – Applying things in a new context.	manually or digitally, to represent ideas in different learning contexts. TCH 1-11a • Creates manual and/or digital sketches to represent ideas. I explore and discover engineering disciplines and can create solutions. TCH 1-12a • Builds a solution to a specific task, which has moving parts. By investigating forces on toys and other objects, I can predict

 More information can be found here: **Bill Lucas Webinar: Engineering Habits of Mind** https://www.youtube.com/watch?v=1Ty3MIDPZ3s	the effect on the shape or motion of objects. **SCN 1-07a** • Predicts and then investigates how a force can make an object change speed, direction or shape, and uses vocabulary such as pushing, pulling, stretching, squashing and twisting to describe forces.

These have been broken down:

Systems thinking

- Using ideas from one subject in another subject
- Working out the possible consequences of something, before they happen
- Putting things together to make something new
- Spotting similarities and difference between things
- Spotting patterns and working out what comes next

Problem-finding

- Asking lots of questions to make sure I understand
- Finding out why something doesn't work
- Checking and checking again until I'm happy
- Finding mistakes in mine and other people's work
- Thinking about the world around me, and how it could be better

Visualising

- Thinking out loud when I am being imaginative
- Making a plan before I start work
- Practising something in my head before doing it for real
- Making models to show my ideas
- Explaining my ideas to other people so that they understand

Creative problem solving

- Coming up with lots of good and new ideas
- Making really detailed mind-maps
- Thinking before doing something
- Working succesfully in a group
- Taking on board other people's ideas and using them

Improving

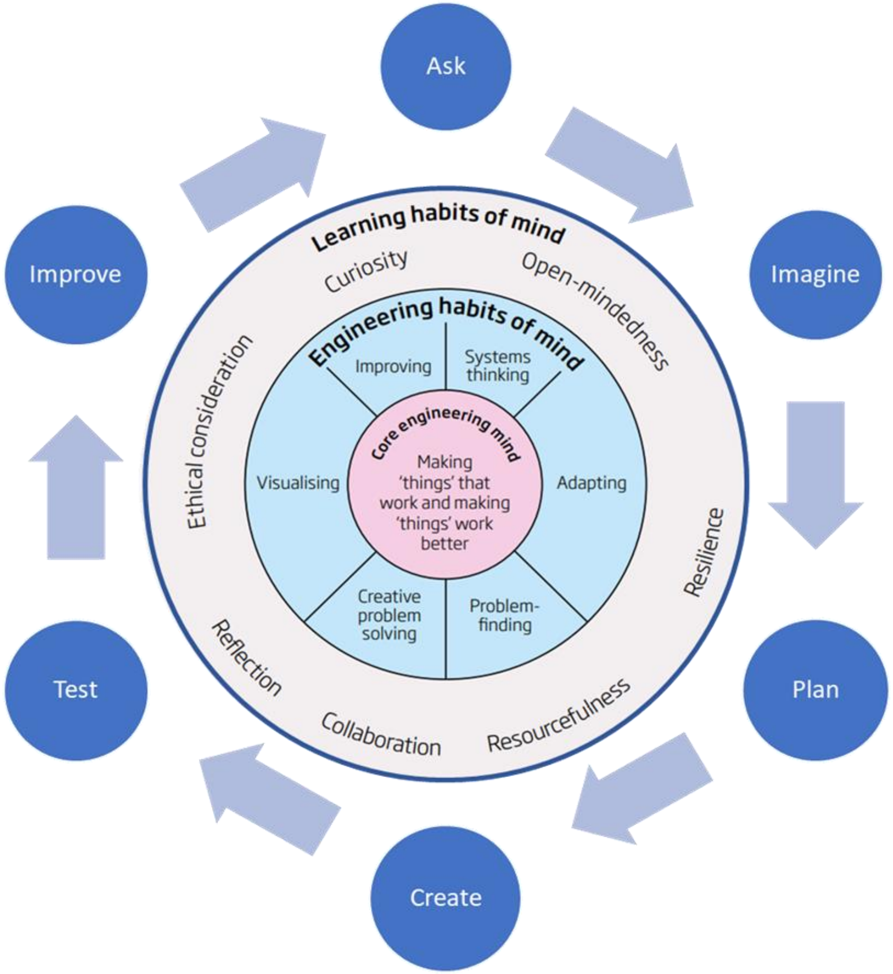
- Working hard and practising to get better, even when it's tricky
- Working out what I need to do to improve
- Making what I've done better
- Experimenting with things, just to see what happens
- Sticking at doing something until it's the best it can be

Adapting

- Explaining how well I am doing to my teacher or friends
- Evaluating how good something is
- Sticking up for what I think when talking with other people
- Deciding how something could be done differently
- Behaving appropriately in different settings

Royal Academy of Engineering | Education Resources Hub

We can help the children to develop these skills, and to 'think like an engineer' by using these alongside the Engineering Design Process:

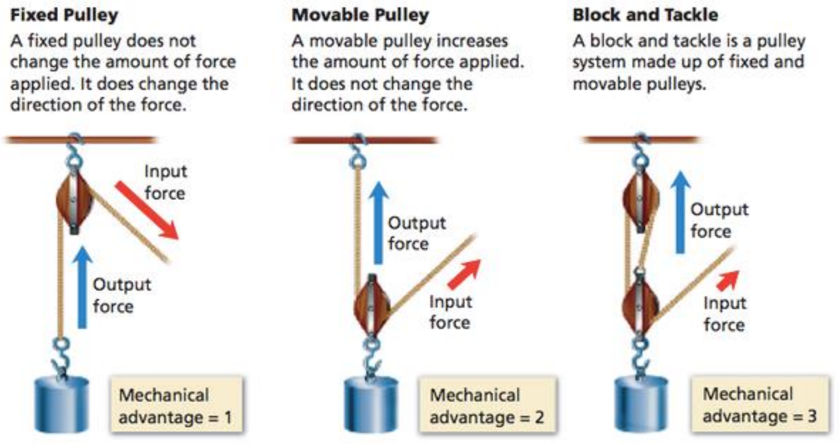


The rope attached to Uncle Ned got tangled in a tree which stopped him from floating away but he needs Rosie's steering device so he can get down!!

ASK: Can you use the Engineering Design Process to solve a problem:

- **design and build a lifting machine to get Rosie's steering device up to Uncle Ned.**

Need a Lift? Try a Pulley! (youtube.com)



A pulley system is a simple machine that uses a wheel with a groove and a rope or chain. It is designed to help make lifting or moving heavy objects easier by reducing the amount of force required. The basic principle behind a pulley system is that it changes the direction of the force applied to lift an object. Instead of pulling the object directly upward, a pulley allows you to pull the rope downward, which in turn raises the object.

DIY Cardboard Pulley System (youtube.com)

https://littlebinsforlittlehands.com/pulley-simple-machine/

https://www.youtube.com/watch?v=5DLFH8QRNsI&t=13s

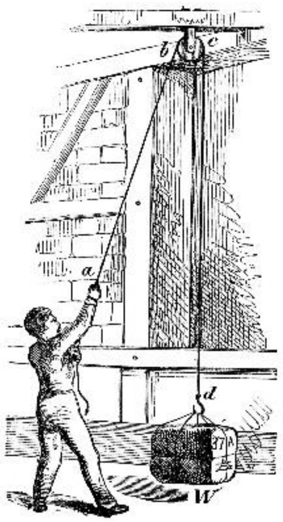
https://www.youtube.com/watch?v=_8fP0YF8D9g

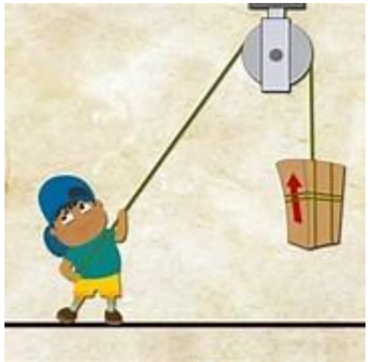
Materials: e.g. elastic bands, string, wool, lollipop sticks, paper cups, pipe cleaners, wooden skewers, empty cotton reels, A4 paper, milk bottle lids (with a hole in the centre), cardboard, paperclips, newspaper, circular objects to draw round to create pulley etc. Small weights/coins/marbles for testing. Sellotape and glue. **Tools:** scissors. Build a strong beam between two tables or two chairs that is least 30 cm long (this represents the tree branch that Uncle Ned is attached to) . Now engineer a lifting machine using a pulley which can transport items up and down. **IMAGINE:** Think about the pulleys you may have seen and how they work e.g. a flagpole, blinds, water well, moving the sails on a boat, fishing rod etc, *What materials will you need to create your pulley system? What kind of container will you need to move the steering device up to Uncle Ned?* *The children need to explore the materials and tinker with them to see how they might move things from one place to another without picking them up and carrying them* **PLAN:** Choose two to three ideas and sketch possible designs, and then choose one of them to build a prototype of. *How much string will you need? How will you make it strong enough to carry an object? What will you use to create a pulley?* **CREATE:** Build your model	

TEST: Add weights/coins/marbles to your container to see how much you can move

IMPROVE: How did it work? What can you change so you can make it better? What changes could you make so you can carry more weight? Make the improvements and test again!

Extra challenge: Could you use two pulleys in the design? If you raised the beam higher, what would you need to change about your pulley system?





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Chapter 9

'We will find Uncle Ned where the *<u>forces balance</u>*' (page 59)

[Forces for Kids | Balanced and Unbalanced | Science Lesson for Grades 3-5 | Mini-Clip (youtube.com)]

A force is a push or a pull or a twist. Forces can make objects move or stop, speed them up or slow them down. If you push a toy car it moves, if you push it harder it moves faster. Forces can also make objects change direction or shape.

The children work with a partner and gather 3 small items and lay them on the table. Using the first item, they apply equal and opposite forces (the same amount in opposite directions) and describe what happens to the object. They repeat with the other 2 items.
When forces are balanced, objects do not move.

The children use one of the items on the table. They apply force from one side of the object but not from the other and describe what happens.
When more force is applied to one side of a stationary object, it moves in the direction that the greater force was moving.

Now the children apply less force from one side of the object than the other and describe what happens.
When equal but not opposite forces are applied, the object rotates
Unbalanced forces make objects move.

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By investigating forces on toys and other objects, I can predict the effect on the shape or motion of objects.
SCN 1-07a

- Predicts and then investigates how a force can make an object change speed, direction or shape, and uses vocabulary such as pushing, pulling, stretching, squashing and twisting to describe forces.
- Investigates balanced

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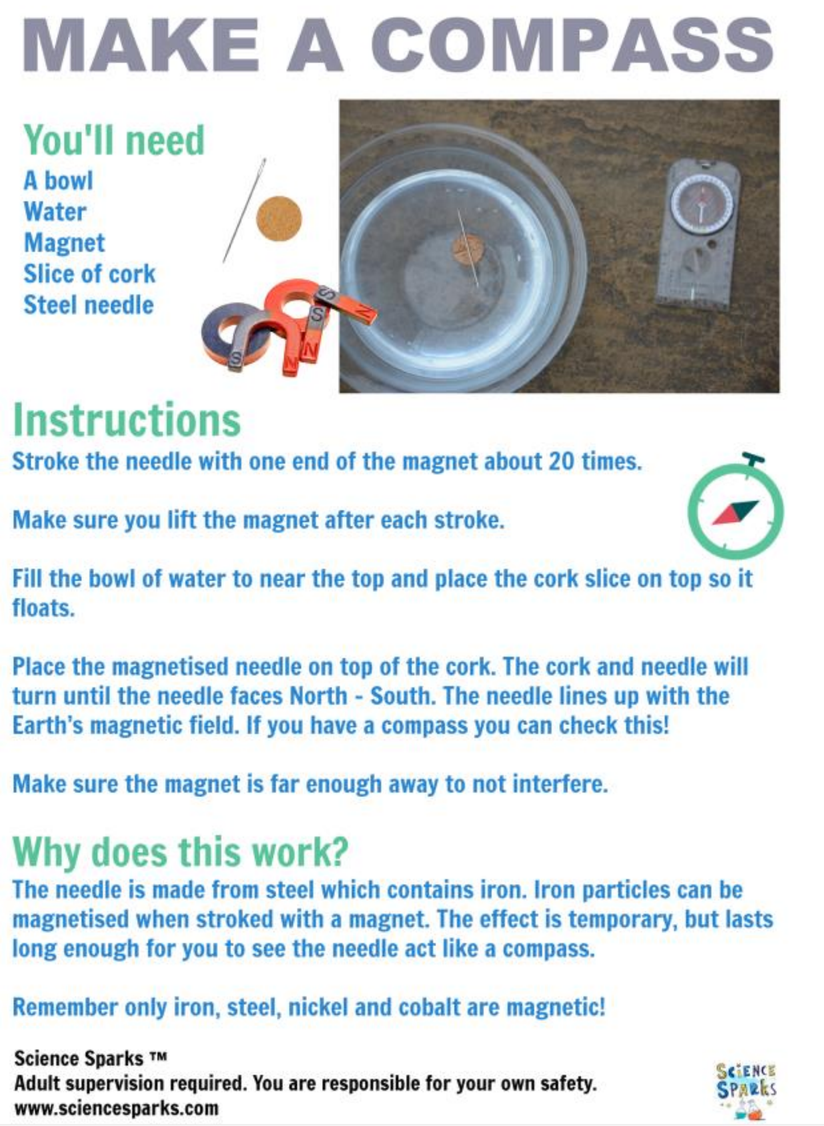
A tug of war contest in the playground can be used to demonstrate balanced forces (as far as possible there should be even sides for pulling). A flag or a piece of cloth tied to the midpoint of the rope is useful as it adds a visual element to the task. Add or remove children to create unbalanced forces and get children to notice the effect of the forces. Pushing can also be used with children in pairs, using one hand to gently push. Children can then talk about the effects that a push or pull can have on the direction of an object/themselves. Straws and a ping pong balls can be used to investigate how to keep the ball stationary /move the ball by blowing through the straws. Newton Balances can be joined together by the hooks and pulled with the same/different forces to observe direction of movement due to balanced / unbalanced forces. This type of science enquiry involves **pattern seeking/finding an association** and requires the children to gather information and notice the patterns involved leading to them forming a conclusion about why there is an association.	forces and explains that if a push and pull are equal in strength and opposite in direction then there is no change in movement.
Chapter 10 **'Ada took her compass from her pocket'.** Ada always carries a compass in her pocket. Have a go at making a compass!	By exploring the forces exerted by magnets on other magnets and magnetic materials, I can contribute to the



Magnetism can be seen in action whenever you have two magnets close together. Magnets have a positive and a negative side. This causes them to either push against one another or be pulled together. Two positive sides will repeal each other causing the magnets to push apart. But turn one magnet over so you have a positive and a negative near each other and they will attract each other.

The Earth is a giant magnet with its own unique magnetic field. The magnetised needle is attracted to it and points to the “magnetic north pole” of the Earth’s giant magnet.

The compass you will make works just like the compass on a ship or in a car. These compasses also use a magnet held by something that allows the needle to float very evenly. Often it will be a liquid that does not freeze like oil.

Create a second compass and add it to the same bowl of water. What happens? What happens if you bring your magnet near the water? What happens if you spin the compass? (This type of science enquiry involves **observation over time** and requires the children to observe and record any changes that they notice).

design of a game.

SCN 1-08a

- Demonstrates through practical activities that like poles repel and opposite poles attract.
- Gives at least two examples for how magnets are used in everyday life

Chapter 11 **'Uncle Ned was trapped in an air current that slowly whirled around inside the U-shaped area. The whirlwind picked up bits of dust and small leaves and lazily whirled them around and around, high in the air, with Uncle Ned'.** Simulate what a tornado /whirlwind is like using a jar. https://www.youtube.com/watch?v=RtjXgAsDjII **NB** both tornadoes and whirlwinds are types of atmospheric vortices, which are rotating columns of air. However, there are differences between the two. Tornadoes are typically larger and more powerful than whirlwinds and are associated with severe thunderstorms and other severe weather events. Whirlwinds, on the other hand, are generally smaller and less powerful than tornadoes, and are often associated with minor weather events. **Materials:** A jar/bottle Water Washing Up Liquid Teaspoon Blue food colouring/blue glitter or small beads Vinegar (Optional) **Method:** • Fill the jar or bottle up with water until it's ¾ full. • Add 3-5 drops of blue food colouring or a tiny amount of blue glitter or about 15 small beads and lightly stir. (The bigger the jar/bottle, the more food colouring you might need to add!)	The **science concept** involved in this investigation is **gravity** which is acting against the water when the jar is swirled. Gravity is a concept that is considered at Second Level and not First. However, this investigation* can provide an opportunity for science enquiry by fair testing, and therefore an opportunity for the children to develop their 'Inquiry and investigative skills' *(page 14, Ed. Scot. CfE Sciences Es and*

• Mix in a teaspoon of washing up liquid (and vinegar if you wish – this helps if the mixture is too 'bubbly')) and tightly close the lid on the jar/bottle. • Rotate the jar/bottle around in a circle, holding it by its lid. You should see a tornado /whirlwind start to appear in the water. • After you've stopped swirling, the tornado/whirlwind will eventually start to fade. **The Science:** As the water in the jar is swirled around, it is forced to the outer side of the jar/bottle and because of that, the air inside is left to rotate in the middle, creating the shape of a tornado/whirlwind. The spiralling shape is formed because of the gravity acting against the water. *Suggestions for further investigations: (This type of science enquiry involves **fair testing**; children are encouraged to see that one thing has an effect on another, to identify the differences they have noticed and to explore all the variables (any phenomena subject to change) that may have an effect). • Try different liquids - can you form a whirlwind in thicker liquids? • Does it matter if there is no detergent? • What happens if you use different shaped containers?	*Os and Benchmarks document)*
Chapters 14 -16 **'I'm going to hit balls to Uncle Ned, and when he catches them, their mass will be added to his mass, and gravity will pull him toward Earth...'** **'Uncle Ned is like a boat floating on a sea of air. You're going to weigh him down with tennis balls until his 'boat' sinks and Beau can grab him!'** **'You'll overcome the buoyancy force!' said Iggy (p92-93)**	By investigating floating and sinking of objects in water, I can apply my understanding of buoyancy to solve a practical

There isn't an outcome at First Level about floating and sinking but children will have already been naturally investigating floating and sinking through play etc. . They may have also explored floating and sinking as part of an investigation into materials and their properties (Through exploring properties and sources of materials, I can choose appropriate materials to solve practical challenges. SCN 1-15a ***Benchmark****: Identifies properties of different materials, for example, rigidity, flexibility, rough, smooth and waterproof, (e.g. classify/group items on the basis of does it float or does it sink) and their uses linked to their properties)*

This activity, like all the other activities, is a suggestion and by no means prescriptive. Teachers are welcome to use and adapt the plan and resources to suit their needs and that of the children .

A buoyant force acts on all objects that are either partially or fully submerged in either a gas or a liquid. There are two forces involved working in opposite directions:

- the weight of the object being pulled down by gravity
- the upthrust from the liquid or air underneath the object pushing up

If the object is less dense than the liquid or gas, the upthrust is greater than the weight and the object will float. (Density is how tightly packed the material inside something is).

If the object is denser than the liquid or gas, the upthrust is less than the weight and the object will sink.

If an object floats we say that it is buoyant.

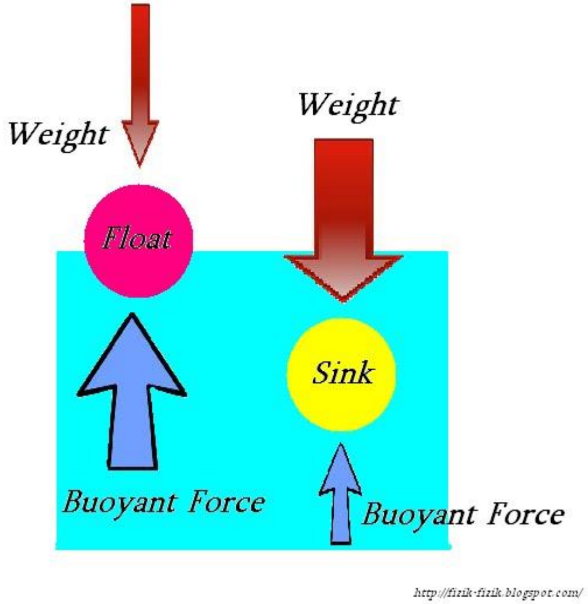


Diagram taken from: PHYSICS Form 4 Form5: Buoyant Force (fizik-fizik.blogspot.com)

challenge.
SCN 2-08b

- Explores the factors which affect floating, for example, the object's shape and the density of the material that the object is made of, and collates, organises and summarises findings with assistance.

It isn't possible to replicate the situation in the story where mass is added to Uncle Neds pantaloons filled with helium gas that were floating in the air, but it is possible to investigate what happens when you add mass to something that is floating in water. An object floats equally well in shallow water as in deep water. Adding more weight to a floating object changes the balance of forces so if you add enough mass to a floating object, it eventually sinks. You will need a small container, a basin of water and some coins or marbles. What happens when the empty container is placed in the water? What happens when you add weight (by adding coins or marbles) to the container? What happens if you take out coins or marbles? What happens if you add more coins or marbles? For this second buoyancy activity, you will need: Aluminium foil Paper towels Pennies Bucket or bowl or sink, Water Cut a square of aluminium foil and shape it into a boat e.g. with two pointed ends (like canoes) or make it square or rectangular etc. and carefully float it in the container of water. Gently add one penny at a time. To prevent the boat tipping, carefully balance the load as you add the weight.	

Keep adding pennies until the boat finally sinks. Carefully take out the sunken boat and place it and the pennies on paper towels. Pour any excess water back into the container. Count how many pennies the boat could support before sinking (i.e., the penny that sank the boat does not count). This could be done on a tally sheet and then a graph created. Repeat the investigation, but this time use different sized foil boats or the same size boat but a different shape. *Do smaller boats sink with less coins? Do you get the same results with boats of different shapes? Do you see a pattern in your results?* *When you first put the boat on the water, it floated because it was less dense than the density of the water. As the pennies were added, its mass increased and the boat floated lower in the water. Eventually, when enough pennies were added, the boat's density roughly equalled the density of water. The boat sinks because its density has become greater than the density of water.* Repeat the investigation but this time use liquids other than water, such as cooking oil, liquid detergent etc. To avoid using a lot of the liquid, you can use a small container (just wide enough to fit your boat in) and fill it so it is just a little deeper than the height of the boat so that the boat can sink. Think about the densities of the liquids compared to that of water and how this affects the results. This type of science enquiry involves **fair testing**; children are encouraged to see that one thing has an effect on another, to identify the differences they have noticed and to explore all the variables (any phenomena subject to change) that may have an effect.	I have used a range of ways to collect information and can sort it in a logical, organised and imaginative way using my own and others' criteria. **MNU 1-20b** • Selects and uses the most appropriate way to gather and sort data for a given purpose, for example, a survey, questionnaire or group tallies.