RISING STARS

SWITCHED ON Science

Second Edition

Teacher's Guide

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Contents

How to use Switched on Science, Second Edition

HOW THE YEAR 5 TOPICS FIT WITH THE NATIONAL CURRICULUM

In England the primary science curriculum has been written to indicate the basic entitlement for children at Key Stages 1 and 2. *Switched on Science, Second Edition* ensures full coverage of the content for this year group and more, so that children are given access to ideas and ways of working scientifically in a range of contexts, thus providing appropriate repetition and reinforcement, to ensure retention.

WHAT IS INCLUDED IN THE PRINTED AND ONLINE RESOURCES?

Teacher's Guide structure

Each Teacher's Guide contains six topics covering the primary science programme of study and more. The first five topics, designed to each last a half-term (although they can be planned flexibly depending on how science is delivered in your school), are linked directly to the programme of study. The sixth topic in each pack is our 'Science in action' topic. This off-curricular topic reinforces key working scientifically skills linked to the curriculum. It is an opportunity for children to apply their science skills in a wider context.

Topic overview pages

At the beginning of each topic, learning outcomes for Working scientifically are listed as well as the Subject knowledge concept statements. These are taken directly from the science programme of study. The topic overview section also offers cross-curricular opportunities, essential scientific vocabulary, health and safety guidance, big questions for research and discussion and, crucially, background subject knowledge for teachers. This enables non-specialist teachers to quickly up-skill themselves with the relevant scientific knowledge and language before beginning the lesson. Also listed here, are possible misconceptions that teachers may come across, as well as a run-down on what children should have learnt up to this point (so, reference to similar topics in lower year groups).

Get started guidance

At regular points, where a new area of the topic is being introduced, there is a 'Get started' activity, which provides a suggestion on how to 'hook' children's interest.

Activities

Each activity begins with the key learning objectives from the subject knowledge element of the curriculum plus working scientifically where appropriate. At the end of each activity, guidance is given for assessment purposes.

Activity resources

Scaffolds, diagrams, tables, timelines, etc. to accompany the activities can be found at the back of the Teacher's Guide. They are photocopiable, and can be downloaded (and edited) as word documents from our online platform (accessed online via *My Rising Stars*). Teachers do not have to create their own resources (unless they wish to) and all are available as editable files.

Teaching PowerPoints

After listening to feedback from teachers who were creating their own PowerPoints to teach the topics in the first edition of *Switched on Science,* the second edition now contains a teaching PowerPoint for each topic. This gives teachers a front-of class resource which compliments the activities.

Pupil videos

Every year group has pupil-facing science videos (accessed online via *My Rising Stars*). There is one pupil video per unit which are clearly referenced throughout the book.

CPD (Continuing Professional Development) videos

Switched on Science, Second Edition has CPD videos (accessed online via *My Rising Stars*). There is one CPD video per unit. They are designed for teachers and additional staff members to 'brush up' on subject knowledge before beginning a topic. Many of them show a practical example of an activity in the unit. The CPD videos are referenced clearly in the 'About this topic' panel at the start of each new topic.

Editable medium term planning

You will find all teaching notes, editable activity resource sheets and six stimulating interactive activities, covering all topics on the *My Rising Stars* website. There are also half-termly editable plans. The suggested plans cover one topic per half-term and two activities per week. The plans are fully editable so that you can change them to suit your class and school schedule. Please see the inside front cover for details of how to log into *My Rising Stars*, where you can access all online resources for *Switched on Science, Second Edition.*

Assessment and progression

Switched on Science, Second Edition, has been written so that the activities in each year group show progression from one year to the next and from topic to topic.

Support for assessment is linked to every activity across all year groups. Each activity begins with an indication of the learning objectives for that activity. Where appropriate there is a learning objective (L.O.) for subject knowledge or working scientifically or both. Each activity is written to help the children meet these learning objectives.

At the end of each activity, there is a section which suggests how the teacher could assess children to find out whether they are at Emerging (Em.), Expected (Exp.), Exceeded (Exc.); some schools might use different terms. These are suggestions for what to look for when carrying out a formative assessment and will also help teachers when considering next steps for children, moving them from Emerging to Expected to Exceeding.

For those schools who want to use end-of-topic tests, these can be found online. They can be downloaded or photocopied and given to the children as required. *Switched on Science, Second Edition* year group packs cover Key Stage 1 and Key Stage 2, with content and working scientifically skills revisited and reinforced throughout.

TOPIC 1

Out of this world

About this topic

Curriculum link: Year 5, Earth and space

SUMMARY:

In this topic, children learn about space. Starting with the Solar System, they look next at how ideas about space have changed over time before they explore what causes us to experience night and day on Earth.

UNITS:

1.1: Our Solar System
1.2: Meet the scientists
1.3: Day and night

ACTIVITY RESOURCES

- 1.1: What's in our Solar System?
- 1.2: Let's make a Solar System
- 1.3: Universe address cards
- 1.4: Solar System data

ONLINE RESOURCES:

Teaching slides (PowerPoint): Out of this world
Interactive activity: Out of this world
CPD video: Out of this world
Pupil video: Out of this world
Word mat: Out of this world
Editable Planning: Out of this world
Topic Test: Out of this world

Learning objectives

This topic covers the following learning objectives:

- Describe the movement of the Earth and other planets relative to the Sun in the Solar System.
- Describe the movement of the Moon relative to the Earth.
- Describe the Sun, Earth and Moon as approximately spherical bodies.
- Use the idea of the Earth's rotation to explain day and night and the apparent movement of the Sun across the sky.

Working scientifically skills

This topic develops the following working scientifically skills:

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

CROSS-CURRICULAR LINKS

This topic offers the following cross-curricular opportunities:

English

- Create mnemonics for the planets in our Solar System.
- Ask questions about space and decide best way to answer them.
- Write instructions on how to make a model of day and night.
- Create fact files on the planets.
- Research, perhaps email, for information about living on the International Space Station (ISS).

- Hot seat key historical figures in space exploration.
- Explain the terms ‘heliocentric’ and ‘geocentric’ and argue a point with evidence.
- Design and write postcards from different planets and galaxies.
- Write a sci-fi story based on research about planets and fiction.
- Produce a glossary, e.g. planet, orbit, moons, rings, probes, meteorites.

Numeracy and mathematics

- Create an excel spreadsheet of planetary data.
- Big numbers: use them to calculate distances between planets, day lengths, etc.
- Use precise measurements when making a card clock, i.e. angles.

Computing/ICT

- Use search engines to find out information about the Solar System and present it to classmates.
- Log onto Astronomy Picture of the Day (see Useful Websites on *My Rising Stars*).
- Access interactive space puzzles.
- Create PowerPoint presentations about, e.g. the ISS Pluto.

History

- Research the history of space exploration and create a timeline of events
- Research how ideas have changed, e.g. prior to Galileo, Newton.
- Research when each of the planets were discovered and find out who discovered them.

Geography

- Locate space centres around the world.
- Create a map of day and night across the world.
- Use a map of the Moon.
- Map the stars – locate stars and constellations.
- Plot the orbit of the ISS around the Earth.

PE

- Exercise and nutrition for astronauts.
- Design a fitness routine for astronauts on the ISS.
- The implication of zero gravity in space on movement.

Music

- Create space music.
- Listen to ‘Nasa Sounds of Saturn’ (see Useful Websites on *My Rising Stars*).
- Listen to a range of space-themed songs.
  - Elton John – ‘Rocket Man’
  - David Bowie – ‘Space Oddity’
  - Gustav Holst – ‘The Planets’

Design technology

- Build a model of the Solar System.
- Design a planet.
- Design and make a rover for Mars or a lunar vehicle.
- Make papier-mâché planets.
- Use different media to paint planets, e.g. oils, pastels, watercolours.
- Create collages of planets using different materials.

PSHE

- Recognise how scientific discoveries affect how people think, create, behave and live.

STEAM (SCIENCE TECHNOLOGY ENGINEERING ART AND MATHS) OPPORTUNITIES

Invite into class

- Someone from the local community who remembers watching the first Moon Landing in 1969 – children can interview the person.
- Astronomer from a local university or amateur astronomy group.
- Arrange for an inflatable planetarium to visit the school.
- ESERO-UK network of space ambassadors.
- Book some Moon Rocks http://www.stfc.ac.uk/public-engagement/activities-for-schools/borrow-the-moon/.
- Artists to create a range of artwork linked to the planets.
- Local Astronomers / STEM ambassador to run a ‘night sky’ family evening.

Visit

- Local planetarium.
- National Space Centre, Leicester.
- Science museums, e.g. London or Manchester.

TEACHER SUBJECT KNOWLEDGE

Our Solar System has a large star, the Sun, at its centre and eight planets and their moons, which orbit the Sun. All planets have almost circular orbits that lie within a nearly flat disc called the ecliptic plane. The vast majority of the Solar System's mass is in the Sun, with most of the remaining mass contained in Jupiter.

The planets in order of their distance away from the Sun are:

> Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune.

The four smaller inner planets, Mercury, Venus, Earth and Mars, are mainly composed of rock. The four outer planets, called the 'gas giants', are substantially more massive. The two largest, Jupiter and Saturn, are composed mainly of hydrogen and helium.

The Solar System also contains many other objects such as the Asteroid Belt. This sits between the orbits of the planets Jupiter and Mars. It is made up of thousands of objects too small to be considered planets. Some are no larger than a grain of dust, while others, like Eros, can be more than 160 km across. A few, like Ida, even have their own moons. Some large objects, like Pluto, are now classified as dwarf planets.

Discovering the Solar System

The model of the Solar System has been refined over many centuries.

Aristotle (384 BC–322 BC) proposed the geocentric model, with Earth at the centre of the Universe. The five known planets (Mercury, Venus, Mars, Jupiter and Saturn), the Moon, the Sun and the stars moved around Earth in perfect spheres.

Ptolemy (*c.* 90–168 AD) refined the geocentric theory. Ptolemy said they did not travel in exact spheres but moved around the spheres on elliptic orbits, turning around on themselves.

Alhazen (965–1038 AD) first used maths to describe the motions of the planets.

Nicolaus Copernicus (1473–1543) made accurate observations of the Moon and the planets. He used maths to show that their movements could be explained much better if he put the Sun at the centre of the Solar System.

Johannes Kepler (1571–1630) used maths to show that the orbit of a planet is an ellipse with the Sun at its focus and that it moves faster when it is closer to the Sun than when further away.

Galileo Galilei (1564–1642) championed the heliocentric model and used telescopes to show that Jupiter had moons. A devout Roman Catholic, Galileo came into conflict with the church by challenging its doctrines. Hence, the biggest argument in history.

In medieval times and before, it was commonly accepted that Earth was flat. Nowadays, we have photographic and other evidence to show that, like other planets and the Moon, Earth is spherical in shape.

Earth and the Moon both move. Earth orbits the Sun once every 365 $\frac{1}{4}$ days and spins on its axis once a day. Although when you look up into the sky the Sun seems to move around the Earth, this is an illusion: in fact the Earth spins and causes night and day. The part of the Earth that faces the Sun is in daylight and the part that is not facing the Sun is in darkness.

Before modern calendars, people used to keep track of the days by watching the phases of the Moon. One full cycle of the Moon's phases is approximately 28 days, which is very close to the amount of time we now know as one month. Its regular movement around Earth, as seen by its phases, gives rise to one 'month of time'.

CHILDREN'S MISCONCEPTIONS

Children might think…

- That there is only one Solar System – there are lots.
- That the Earth is at the centre of our Solar System.
- That there are stars in our Solar System other than the Sun. In fact, the Sun is the only star in our Solar System.
- That all planets have rocky surfaces. Some do, but the outer planets are gas giants.
- That planets can only be seen with a telescope. In fact, you can see Mercury, Venus, Mars, Jupiter and Saturn without a telescope.
- The Sun moves around the Earth and causes day and night (the spinning Earth causes it).
- That night-time is caused because the Sun goes to the back of the Earth. In fact, it is the Earth that moves.

Children already know...

- That Earth and space are not covered in Key Stage 1 or lower Key Stage 2 at all. However, the children will be aware of our Sun and be familiar with the names of some of the planets.
- The study of light and shadows in Year 3 introduces children to the Sun's apparent movement across the sky.

SCIENTIFIC VOCABULARY

You can download a Word mat of essential vocabulary for this topic from *My Rising Stars*.

daytime: the time when part of the Earth is in daylight

geocentric: (Earth-centred) the Earth is at the centre of the Solar System

heliocentric: (Sun-centred) the Sun is at the centre of the Solar System. The belief that the Sun is at the centre of the Solar System is heliocentrism

night-time: the time when part of the Earth is in darkness

orbit: the path of a planet or moon around another celestial object

planet: a celestial body that orbits a star, is round and has cleared smaller objects away from its orbit

solar system: a series of planets that orbit a star

star: an astronomical body that produces its own energy

Sun: the star at the centre of our Solar System

time zone: a geographical region where the same time is set

1.1 Our Solar System

GET STARTED

Introduce the topic using PowerPoint Slides 1–4.

Ask children to write their own address (keep some records with you, some children might need help), then tell them that they have only managed to write part of it and that they need to write their address in the Universe. Let children share ideas about what their address might be and then give them Activity Resource 1.3 to see if they can work out the correct order for the cards. Do let them search for parts of the address they do not know to help them.

You could give children a postcard with a stamp on it and get them to write it to themselves and address it using the universe postal address, post it and see how long it takes to arrive home. Or do this as a class together.

LET'S THINK LIKE SCIENTISTS

Use these questions to develop research skills and speaking and listening:

- How big are the planets?
- How far away from us are they?
- What do they look like?
- How many planets are there?

ACTIVITIES

1 THE SOLAR SYSTEM

L.O. Describe the movement of the Earth and other planets relative to the Sun in the Solar System.
Report and present findings from enquiries, including conclusions, causal relationships and explanations of and degree of trust in results, in oral and written forms such as displays and other presentations.

- Working in groups, ask the children to discuss the planets in our Solar System. See how many of them they know and what they know about them. They could record their ideas on a large sheet of paper, each person adding what they know in a different colour pen and then writing their name in the same colour. This helps assess who has contributed what.
- Then you might choose to show them a video clip of '*The Solar System Song*' (see Useful Websites list on *My Rising Stars*) so they can use it to check their initial ideas.
- Use the fact cards about the Solar System from Activity Resource 1.1. There are 20 in all, so it is useful to double these up for a whole class. Everyone is given at least one or two cards and they have to read and memorise what is on the card. As soon as they have done that, they swap their card with someone else and learn a new fact. After 5–8 minutes each child will have learned a number of facts. Collect the cards in, tell children to go back to their groups to work together and add as many new facts as they can remember to their original sheet of paper. Explain to children they should help each other remember facts and try to write as many new ones down as possible.
- Consolidate this by having a quick-fire question session, asking a range of questions that demand children think about the information they have learned, e.g:
  - Has anyone ever visited the Moon?
  - Which planet has a huge wind storm?

YOU WILL NEED

- PowerPoint Slide 5
- Video clip – 'The Solar System Song'
- Activity Resource 1.1
- Interactive activity
- PowerPoint Slides 5, 6 and 7

ASSESSMENT

Subject Knowledge

- Em. Children can name some of the planets in the Solar System.
- Exp. Children are able to name and describe planets in the Solar System in the correct order from the Sun.
- Exc. Children have extended their research beyond the classroom and are able to talk about similarities and differences between planets in the Solar System.

- What is at the centre of the Solar System?
- Which planet has terrible weather?
- Either as a class or individually, children could access the interactive activity on *My Rising Stars* to consolidate knowledge. Finally, tell the children that they need to learn the names of the planets in order from the Sun. Use PowerPoint Slide 5 to find the correct order, then learn them. An easy way of doing this is to create a mnemonic: use PowerPoint Slide 6. Introduce children to a mnemonic that will help them remember the names of the planets, such as *My Violent Evil Monster Just Scared Us Nuts*. Ask them to produce one of their own then share these as a class. Children can come up with some wacky sentences!
- They could record their mnemonic using the approach on PowerPoint Slide 7, alongside key facts about each planet. They could also carry out extra research or watch a video clip (see Useful Websites on *My Rising Stars*).

Working Scientifically

- Em. With help children can say what they know about the solar system.
- Exp. Children know planet names and their relationship (order) with each other.
- Exc. Children research and communicate additional complex information e.g. distance, when discovered

2 MODELLING THE SOLAR SYSTEM

L.O. Describe the movement of the Earth and other planets relative to the Sun in the Solar System.

Plan different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary.

Take measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings when appropriate.

- Show PowerPoint Slide 8 and ask the children which planet is the odd one out, using visual clues (or personal knowledge) from the photographs.
- In this activity, children model the Solar System. Explain to children that scientist often use models to help people understand an idea, especially one that cannot be seen easily. This model uses fruit to represent the planets: PowerPoint Slide 9 and Activity Resource 1.2 gives guidance on the distance of each planet from the Sun. Tell the children that the distance has been scaled down so the Solar System can fit into the school grounds.
- Children need to work in groups of at least ten so as to include eight planets, the Sun and someone to organise them. Provide a set of labels (Sun, names of planets, group manager…) so that each child in a group has a card. Tell children they are going to make a human model of the Solar System in the playground. The idea is to place themselves – the planets, far away from the Sun so that they are roughly in proportion to the distances in real life. Use Activity Resource 1.2 to do this. The person who is organising could take

YOU WILL NEED

- Fruit to represent the Sun and eight planets
- Activity Resource 1.2
- PowerPoint Slide 8
- Sticky labels with names of planets

ASSESSMENT

Subject Knowledge

- Em. Children participate in the activity and can say what they are trying to show.
- Exp. Children can say what the fruit represents and describe the positions of the planets in the Solar System.
- Exc. Children use the word model with confidence and can make comparisons about size of planets and distances relative to each other and the Sun.

a video clip or photograph of the final fruit Solar System and, back in class, the group could create a voice-over or print out the photograph to put in their book. Ask children to:

- Explain what a scientific model of the Solar System is.
- Describe how using this model helped them to learn about the Solar System.
- Describe what they now know about the positions of the different planets in comparison to each other and the Sun.

Working Scientifically

- Em. Children follow instructions as part of a group.
- Exp. Children measure out the solar system, identifying and positioning each planet correctly.
- Exc. Children know this is a model and can talk about how useful it is.

3 WHAT IS AT THE CENTRE OF THE SOLAR SYSTEM?

L.O. Describe the movement of the Earth, and other planets, relative to the Sun in the Solar System.

Describe the Sun, Earth and Moon as approximately spherical bodies.

- Ask children to write down their mnemonic for remembering the planets and ask them to add the Sun as part of it, then decide where it should be.
- Either use an orrery if you have one, or show children the video clip (see Useful Websites list on *My Rising Stars*), which illustrates how the planets move around the Sun. In this activity, children should learn a number of scientific words such as *orbit* and *heliocentric* (which means the Sun is at the centre). Children watch the video again, this time focusing on the speed that the different planets orbit the Sun. Ask, e.g.:
  - What shape is the Earth and other planets? (Use PowerPoint Slide 10 if children are unsure of the answer.)
  - Do all planets orbit at the same speed?
  - Which planet orbits the fastest / slowest?
  - Which planets look as if they are hardly moving at all?
- Give children the data on Activity Resource 1.4, which has information on the orbit and day length of the planets. To complete this activity, children must use the data to answer questions and also look for patterns in the data.
- Working outside, arrange children into the same groups as in the previous activity (Modelling the Solar System). Ask each child in a group to model being the planet they were before (they could wear their planet name label again). This time, each child rotates and moves around the Sun (another child) while the other planets also move. This is quite complex, so children will need time to organise themselves. They could plan their model on a mini whiteboard or piece of paper first. They could create concentric circles (orbit paths), about 1 m apart to represent the order of the planets.
- The child organising their group could take a video or photograph for the children to use back in the classroom, creating a voice-over or printing out photographs so that each child can identify which planet they were and explain their movement around the Sun, using words such as '*heliocentric*' and '*orbit*'.

YOU WILL NEED

- PowerPoint Slide 10
- Activity Resource 1.4
- Video or camera equipment
- Video clip 'Planets moving around the Sun' (See Useful Websites list)

ASSESSMENT

Subject Knowledge

- Em. Children need support to carry out their part of the model.
- Exp. Children know that the model shows how planets orbit the Sun at different speeds. They can also say that planets are spheres.
- Exc. Children are able to explain similarities and differences between the movement of different planets.

1.2 Meet the scientists

GET STARTED

In a previous activity, children learned how the planets revolved around the Sun. That is what we know today, but people did not always think that. Show children PowerPoint Slide 11 and ask why people thought the Earth was flat; what everyday observations would make them think that?

Ask children to think about ways to persuade someone that the Earth is not flat, e.g. if we kept walking we would fall off if it was flat, but we do not.

LET'S THINK LIKE SCIENTISTS

Use these questions to develop research skills and speaking and listening:

- Whose ideas shaped our understanding of our Solar System?
- Why did Galileo fall out so badly with the Roman Catholic church?
- Why was Galileo in danger because of his views?

ACTIVITIES

1 COPERNICUS AND GALILEO

L.O. Describe the movement of the Earth and other planets relative to the Sun in the Solar System.

Describe the Sun, Earth and Moon as approximately spherical bodies.

Identify scientific evidence that has been used to support or refute ideas or arguments.

- Show children two different video clips; the first about Copernicus and the second about Galileo (see Useful Websites list on *My Rising Stars*).
- Linking with literacy, ask children to take some notes as they watch the video clips. It might help if children watch them first, then take notes on a second viewing when they have some idea of the content. So children can make focussed notes and know how to complete it, draw an example two-column table on the whiteboard (see below). Children could work in pairs, one making notes on Copernicus, the other on Galileo, then collaborate to complete their tables.

Copernicus (1473–1543)	Galileo (1564–1642)

YOU WILL NEED

- Video clips (see Useful Websites list)
- PowerPoint Slides 11–15
- Books and online resources to research Galileo and Copernicus

ASSESSMENT

Subject Knowledge

- Em. Children know that the Sun and planet move and that they are spherical (approximately round).
- Exp. Children can name and describe planets and their movement around the sun.
- Exc. Children can describe the way different planets orbit the sun.

- The aim is for children to develop their understanding that ideas about the world have changed over time, and early ideas about the Solar System were changed by two scientists. Show PowerPoint Slide 12 and ask children to use it to describe what most people thought the Solar System was like in Medieval times and how it was different to what Copernicus thought. How do they think the observations made by Copernicus helped change the idea that the Earth was flat and was at the centre of the Universe?
- What we know about the Solar System today is based on the scientific evidence that they used to refute; in other words, prove wrong, the ideas that were incorrect about the Solar System.
- Using their notes, children discuss in groups the similarities between Copernicus and Galileo and answer a series of questions, such as: 'What did people believe about the Solar System before Copernicus and Galileo?' How were Copernicus's and Galileo's ideas different to what people, and especially the Christian Church, thought? Show children PowerPoint Slides 13–15 for them to discuss their answers to the question on each slide.
  - How did their ideas get them into trouble?
  - What would you have done if you had been Copernicus or Galileo?
  - What is the difference between a heliocentric and geocentric model of the Solar System?
  - Use PowerPoint Slide 15 and ask children to discuss the question on Slide 18.
- **Extension:** Children could carry out some additional research about these two scientists and communicate what they have researched in different ways from hot seating, to children working in small groups, to videoing an interview with Copernicus or Galileo. Encourage children to role-play and dress up in the fashion of the day; they could even role-play a court scene from one of the trials.

Working Scientifically

- Em. Children can talk about Copernicus and Galileo but need support to talk about idea that the planets go around the Sun.
- Exp Children know that Copernicus and Galileo changed people's ideas about how the planets move in the Solar System.
- Exc. Children can take on the roles of these scientists and present arguments and refute the geocentric ideas of the time.

1.3 Day and night

GET STARTED

Ask children to write down what they think happens to the Sun at night when we cannot see it. Where is it? Revisit their responses at the end of this activity and ask children if they think that they need to change what they wrote.

LET'S THINK LIKE SCIENTISTS

Use these questions to develop research skills and speaking and listening:

- Why do some parts of the world have night-time all the time for parts of the year?
- Why do some parts of the world have daytime all the time for parts of the year?
- What do you think would happen to us and to our life if it was night-time all the time?
- What do you think would happen to us and to our life if it was daytime all the time?

ACTIVITIES

1 EXPLAINING DAY AND NIGHT

L.O. Use the idea of the Earth's rotation to explain day and night and the apparent movement of the Sun across the sky.

- There are two ways to teach the concept of day and night; first, a straightforward demonstration or giving children the opportunity to research day and night themselves and then to model day and night with an explanation to the rest of the class. Show children a video clip that illustrates day and night (see Useful Websites list on *My Rising Stars*). Use a globe and a torch to model day and night. As you demonstrate, place a small plastic figure on the UK and ask children to explain, using scientific vocabulary what is happening. When is the figure in daylight and when is it in darkness (night-time)? Give one child the role of scribing the words on the whiteboard. Vocabulary should include:

  Orbit 24 hours Rotation Rotate Day Night Darkness Light
- Then give each group a large ball and torch and challenge them to use both to model day and night and explain why it happens using the vocabulary listed. When each group feels confident, they engage in peer assessment by sharing with another group and commenting on each other's demonstrations and explanations.
- Some children could create a video clip to record their work, others an annotated diagram and written explanation. Use PowerPoint Slides 16 and 17 to challenge children to apply their understanding to explain what is shown in each slide using the appropriate scientific language.
- You could develop this further by asking children to think about changes in day and night through the year.
  - Are night and daytimes always the same length?
  - When are the days longest?
  - How is day and night across a year different in the Arctic countries compared to the UK?
  - How is day and night across a year different in countries on the equator compared to the UK?

YOU WILL NEED

- Video clip about day and night (see Useful Websites list)
- Globe and / or large ball
- Torch
- Small model of person
- PowerPoint Slides 16 and 17

ASSESSMENT

Subject Knowledge

- Em. With support, children can say, when demonstrated, which part of the Earth is in daylight and which part is in darkness and therefore night.
- Exp. Children can model and explain day and night.
- Exc. Children can explain why a model is useful for explaining day and night and give a demonstration.

2 THE APPARENT MOVEMENT OF THE SUN ACROSS THE SKY

L.O. Use the idea of the Earth's rotation to explain day and night and the apparent movement of the Sun across the sky.

- Ask the children to discuss, write and draw any ideas that they have about the pattern of the Sun's path. What do they think happens to the Sun during the day? Show the children the learning outcome for this activity and focus on the word 'apparent'. Ask children to look up this word in a dictionary. What do they think that the Learning Outcome means by 'apparent movement of the Sun across the sky'?
- The apparent movement of the Sun across the sky is a challenging idea, it goes against what children think they see, and that is the Sun moving (or appearing to) from east to west during the day. One way to show the apparent movement of the Sun is to place mini suns on the window, every hour to track where the Sun is. Remind children not to look directly at the Sun. By the end of the day, they will see the pattern of how the Sun appears to move. The challenging element for children to recognise is that it is not the Sun that is moving but the Earth. Remind them of prior learning; that the Sun does not move. The Earth spins on its axis so the pattern is showing the movement of the Earth as it spins. Refer back to Activity 1 Explaining day and night. This builds on that learning.

YOU WILL NEED

- Mini suns to stick on the window

ASSESSMENT

Subject Knowledge

- Em. Children think that the Sun is moving across the sky.
- Exp. Children can say that the Earth is spinning round, which makes it seem like the Sun is moving.
- Exc. Children make links with prior understanding, e.g. the Sun does not move, the Earth orbits the Sun, the Earth takes 24 hours to make one rotation and it is this movement that we see.

3 WHAT IS A TIME ZONE?

L.O. Take measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings when appropriate.

- In groups, children discuss what they think 'time zone' means. Have they heard of it? Have they ever travelled into a different time zone? How do they know? Is it the same time all over the world at this very moment?
- Begin by asking a pupil to sit on a rotating chair, then darken the room. Shine a torch on the pupil on the chair, then rotate the chair slowly. Ask the pupil to explain what they see as they are moved around steadily. Discuss what the chair and the torch might represent and how the model might be used to explain day and night.
- Now explain that telling the time of day according to sunrise, sunset and high noon is not accurate. It is more useful to divide it up equally into smaller units to discuss the idea of an hour, minute and second.
- Tell the children that the time in other countries is not always the same as it is in the UK. They may well be aware of this from their holidays abroad. Show children the CPD video, 'Out of this world' clip so that they know how to make the night and day card clock. Explain that they need to watch carefully because they are going to work in pairs to make their own.

YOU WILL NEED

- Rotating chair
- Torch
- CPD Video, 'Out of this world' (on *My Rising Stars*)

ASSESSMENT

Working Scientifically

- Em. Children can use the template with support.
- Exp. Children use the Night and day card clock to say what time it is in other countries when they are given the time in the UK.
- Exc. Children use their knowledge to work out time differences between the UK and other countries in the world.

- Ask them to make a card clock by drawing two concentric circles on a piece of card and dividing them into 24 equal sections. At this point, make sure that children link their maths to this work; ask them to remind their partner how to use a protractor to draw angles. Give children time to practise first and support those who have difficulties. Children label the divisions anti-clockwise from 1 to 24 to indicate the hours.
- Children place the card clock under a globe so that the time in the UK is 12 o'clock midday. The card should be at right angles to the globe base. Then they can explore the time in other countries by identifying a city and reading the time on the card clock. One person could name a country, the other has to find it on the globe and the other works out the time. The children might have to take turns using the globes or you can demo this.

4 THE MOON

L.O. Take measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings when appropriate.

- Show children the Pupil video, 'Out of this world' to place the next set of activities in context. Revise day and night learning and then introduce key ideas about the Moon.
- Challenge children to work out what takes approximately 27 days, 7 hours, 43 minutes, 11.6 seconds (1 orbit of the Moon around the Earth).
- In the next set of activities children learn about the Moon. Begin by showing a video clip (see Useful Websites list on *My Rising Stars*). As children watch, stop at key points and ask them to summarise or make notes on their individual whiteboards about what they have just learned. They could even draw diagrams, so give them time to complete this. Once finished, the children could check their work, including spellings, and then transfer this into their science book. Use PowerPoint Slide 18 so that children apply what they have learned.
- Ask children to model how the Moon orbits the Earth as it spins, then tell them to add the Sun so, as the Earth spins, the Moon orbits the Earth and the spinning Earth and orbiting Moon, both orbit the Sun.
- Observe children modelling this idea and listen to their explanations as a formative assessment. Children could take part in self-assessment and peer-assessment, reflecting on their learning with classmates, deciding whether they understand the orbit of the Moon and why it seems to change size, shape or both.
- To consolidate this learning, children should carry out a 'Moon watch'; observing the phases of the Moon over a month and recording their findings. Observation over time is a type of scientific enquiry, in this case over one month. Children bring to school each day their record of the Moon and where it is in its phases.

YOU WILL NEED

- Pupil video, 'Out of this world'
- Video clip about the Moon (see Useful Websites list)
- PowerPoint Slide 18
- Balls or other objects to model Earth, Sun and Moon

ASSESSMENT

Subject Knowledge

- Em. Children record their observations and can say that the Moon changes in the night sky.
- Exp. Children know that the Moon obits the Earth and both orbit the Sun, they can describe the changes in the Moon that they observe.
- Exp. Children can model the orbit of the Earth, Moon around the Sun and name the phases of the Moon.

5 BISCUIT MOONS

L.O. Describe the movement of the Moon relative to the Earth.

- Have fun with this starting point and ask children what biscuits have got to do with the phases of the Moon; see if any of the children can work out what they are going to be doing!
- Children really enjoy this activity, for obvious reasons; they get to eat biscuits! Before beginning this activity, check the information about children with allergies in your class. This should be treated as an additional activity and not take the place of Activity 4, The Moon, which is essential learning.
- This is fun and quite simple. Using biscuits, children create a record of the phases of the Moon. Show children PowerPoint Slides 18 and 19. Whichever biscuit is used, the children work in small groups to plan the phases, checking they are correct by using either the internet, a book or their own observations. If using Jaffa Cakes, the children share the cakes and phases amongst the group so everyone has a phase to create. Once this is done, the children 'eat' the Jaffa Cake into the phase of the Moon they are responsible for. When using Oreos, the children take one biscuit off leaving the other with cream on, then scrape off (or scoop) the cream off to create phases of the Moon. Both approaches to creating the phases can be glued onto sugar paper or card and displayed around the classroom, making sure it is out of direct sunlight though!
- The Jaffa Cake approach is also great for children to make a video clip, munching though the phases of the Moon and providing a voice-over explanation.

YOU WILL NEED

- Round biscuits, e.g. Oreos or Jaffa Cakes
- PowerPoint Slides 18 and 19
- Glue and sugar paper
- Tablet or video camera

ASSESSMENT

Subject Knowledge

- Em. Children know how to make their phase but need support to explain this as part of the idea phases of the Moon.
- Exp. Children create a 'Biscuit Phases of the Moon' display or video clip and are able to describe the movement of the Moon around the Earth.
- Exc. Children use the model to explain how the phases occur in the context of the Moon orbiting the Earth. They can also apply their understanding to other planets that have Moons.

6 MOON CRATERS INVESTIGATION

L.O. Plan different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary.

Take measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings when appropriate.

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

Use test results to make predictions to set up further comparative and fair test.

- Show children a picture of the Moon's surface. Ask them to discuss how they think that the craters on the Moon were formed.
- Prior to this activity, children will have watched video clips about the Moon, seen photographs of the Moon's surface or used binoculars at school or at home to observe the surface of the Moon. Children will know that the Moon has craters; some children might suggest

YOU WILL NEED

- PowerPoint Slide 20
- Cocoa to model the surface of Moon
- Flour
- Object to drop to create craters

they were always there, others might talk about meteorites hitting the surface. The Moon's craters were formed when asteroids or meteorites hit the surface, the rock vaporised and a crater was left behind.

- One way to model this and also to investigate crater formation is for children to carry out the activity shown on PowerPoint Slide 20. They drop (or use a tube to roll) an object, e.g. rock, marble or ball of plasticine from a height into the flour covered with cocoa. The object makes the crater; the bottom of the crater is known as the floor, the edges the rim and the pattern made by the flour on the cocoa is the ejecta.
- Give children the opportunity to explore making craters and then ask them to use this experience to ask questions about crater formation that they can investigate through a fair test. At this stage make sure that most children are working at the appropriate level by challenging them to ask questions that demand measurements, e.g.:
  - How does the height of the drop affect the size (width, depth) of the crater?
  - If I keep the mass (weight) the same but change the shape, e.g. wider, what affect does it have on the size of the crater?
- Encourage children to make their measurements as accurately as possible, given that they are measuring flour, and to consider whether a repeat reading should be used.
- The data is continuous, so children will record:
  numbers + numbers = line graph.
- For children who need support, they could design a fair test to show which object makes the biggest crater and display their results in a bar chart.
- Children should use their results to suggest new questions, e.g.:
  - How does the angle the object hits the Moon affect the size, depth or shape of the crater?
  - What happens if I keep the object the same but change the surface, e.g. wet or dry?
- Ask children to think about an appropriate way to communicate their activity and results, e.g.:
  - Design and write a newspaper article that includes diagrams or photographs as well as a dynamic and interesting heading and subheadings.
  - Produce a video of their science investigation with explanations to go on the school website.
  - Write up their investigation as if writing for a children's science magazine or for a school newsletter.
  - Create a PowerPoint presentation that includes additional information about the Moon.

ASSESSMENT

Working Scientifically

- Em. Children carry out a comparative test, testing two objects and comparing the results using a bar chart.
- Exp. Children carry out their fair test, use data to produce a line graph and use their data to ask new questions.
- Exc. Children are able to reflect on their work and suggest improvements and reasons for them.

7 BECOME AN EXPERT – RESEARCH A PLANET

L.O. Describe the movement of the Earth and other planets relative to the Sun in the Solar System.

Report and present findings from enquiries, including conclusions, causal relationships and explanations of and degree of trust in results, in oral and written forms such as displays and other presentations.

- This is an activity that children can carry out across this topic, gradually building up their understanding of the Solar System. You might choose to use this as a home-learning activity.
- In this activity children engage in research about two different planets so they become an expert and can share what they know with others in their class and in the school. Children research two planets to develop the ability to compare and contrast the similarities and differences between planets and understand their nature in the Solar System. Make sure that across the class all the planets in the Solar System are researched. Make sure that the Earth, Sun and Moon are also researched.
- Give children time to write down the names of the planets in our Solar system using the mnemonic for remembering the names. Ask them to think about which two planets they would like to research and why.
- There are a number of ways that this can be organised, e.g.:
  - An individual research project.
  - Pairs working together.
  - A small group researching the same planet and organising jobs and sharing information. If this is a group activity, the group could vote on which planets to study.
- Linking with and using literacy skills is important to the quality of children's research and this supports the development of their understanding of the Solar System. Children need to retrieve, record and present information from non-fiction sources, e.g. books, Internet, video clips and posters. They should be able to explain and discuss their understanding of what they have read, not copy verbatim. They should decide the best way to communicate to an audience, e.g. booklet, newspaper article, science blog, PowerPoint or video interview, using notes from their research.
- To scaffold children in managing to research without copying verbatim, use the question stem approach where children use the stems to ask a range of questions that then become the focus of their reading. So, if a group of children are researching Venus, using the question stems should result in a wider range of information, e.g.:
  - Which way does Venus rotate?
  - Who discovered Venus?
  - What is the atmosphere of Venus like?
  - How does Venus go round the Sun?
  - Where is Venus in the Solar System?
  - Can Venus be seen at night?
- Children should then use their notes to communicate what they have learned. This could be as part of a whole class working wall, a 'Big Book' on the Solar System, a set of 'Fact File Top Trumps' cards, PowerPoint presentation, a Planet Blog on the school website or perhaps a 'Hot Seating' activity.

YOU WILL NEED

- Books, websites, etc. to research planets
- Materials to record and communicate findings, e.g. fact cards, Big Book

ASSESSMENT

- Em. Children use a model or watch a video and talk about how the planets move around the Sun.
- Exp. Children can describe how the planets move around the Sun.
- Exc. Children describe the orbits of different planets around the sun.

Working Scientifically

- Em. Children research answers to their questions and communicate their information.
- Exp. Children research information and describe similarities and differences between planets.
- Exc. Children present information that explains the similarities and differences between their two planets, applying their knowledge of key features, e.g. day/night, atmosphere, moons, orbit and year.

TOPIC 2 Material world

About this topic

Curriculum link: Year 5, Properties and changes of materials

SUMMARY:

In this topic, the children learn about materials and how they change. First they test properties of materials before looking at how materials dissolve, what a solution is and evaporation. Finally, children compare reversible and irreversible changes.

UNITS:

2.1: Sorting and grouping materials
2.2: Solutions and mixtures

ACTIVITY RESOURCES

- 2.1: Why that material?
- 2.2: Investigation planning board
- 2.3: Graphing materials
- 2.4: Growing salt crystals

ONLINE RESOURCES:

Teaching slides (PowerPoint): Material world
Interactive activity: Material world
CPD video: Material world
Pupil video: Material world
Word mat: Material world
Editable Planning: Material world
Topic Test: Material world

Learning objectives

This topic covers the following learning objectives:

- Compare and group together everyday materials on the basis of their properties, including their hardness, solubility, transparency, conductivity (electrical and thermal) and response to magnets.
- Know that some materials will dissolve in liquid to form a solution, and describe how to recover a substance from a solution.
- Use knowledge of solids, liquids and gases to decide how mixtures might be separated, including through filtering, sieving and evaporating.
- Give reasons, based on evidence from comparative and fair tests, for the particular uses of everyday materials, including metals, wood and plastic.
- Demonstrate that dissolving, mixing and changes of state are reversible changes.

Working scientifically skills

This topic develops the following working scientifically skills:

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

CROSS-CURRICULAR LINKS

This topic offers the following cross-curricular opportunities:

English

- Create a 'Wordle' using scientific language relating to materials.
- Use recipes for cooking.
- Evaluate each other's writing.
- Write poetry using different genre, e.g. a Haiku about materials.
- Ask the children to write an explanation about how they made jelly dissolve quickly or produce a recipe card for one of the separation experiments.
- Write explanation texts using headings and subheadings.

Numeracy and mathematics

- Use appropriate measurements, e.g. volume, weight.
- Improve the accuracy of volume measurements by taking account of the meniscus.
- Take repeat readings, calculate the mean.
- Represent data from tables as a bar or line graph.

Computing / ICT

- Know how to use the Internet safely.
- Research discoveries and inventions, e.g. Play-doh, Post-It notes, microwave ovens.
- Use dataloggers to take measurements of temperature, e.g. when finding the best thermal insulator.
- Use search engines effectively when looking for secondary sources to help plan investigations.

Design technology

- Research smart materials.
- Observe changes in cookery.
- Read Michael Rosen's *Centrally Heated Knickers* – design and evaluate a pair using materials and technology.

History

- Create timelines of discoveries of materials.
- Compare materials that were used in a previous age and new materials that we now have, e.g. what were toys made of in Victorian times?

Art

- Use materials to create sculptures.
- Re-use materials to make new objects.
- Design clothes using, e.g. ring pulls, newspaper, plastic bags.

STEAM (SCIENCE TECHNOLOGY ENGINEERING ART AND MATHS) OPPORTUNITIES

Invite into class

- Artist / sculptor who uses different materials.
- A poet to help develop poems, e.g. Haikus.
- Local recycling firm, or local authority environmental officer.
- Crafts person, e.g. to make stained glass, carpenter.
- Food technician or a chef.
- Someone from a local university to talk about smart materials.
- A science ambassador to set challenges.
- A primary engineer to use materials for construction.
- Local industry to share how they use materials, e.g. from a packaging firm, wind turbines.

Visit

- A local quarry.
- Local industry using different materials.

Teacher subject knowledge

There are many ways to group materials from their colours to their textures, but there are also standard groupings such as metal and plastic. Standard groupings are based on properties and origins, which are not always easy to grasp, e.g. plastics have a huge range of properties.

It is important that children experience how materials behave in their natural state and when changed, e.g. clay or a sheet of newspaper rolled up. This helps them appreciate why things are made from specific materials.

The choice of a material for a particular job is often a compromise. For instance, silver is a better electrical conductor than copper, but it would be too expensive to use in electrical wires.

Material chosen depends on the appearance, comfort, cost or all of these. For instance, wood, steel and plastic are all strong enough to make chairs and can all be manufactured into suitable shapes. Sometimes the properties of materials may be combined to produce a material that ends up with the properties of none of them. For example, copper is a soft metal and zinc is rather brittle, but together they make brass, which is hard and tough.

Solutions and mixtures

A mixture contains more than one substance. These are not chemically joined, which means they are easy to separate using their properties, e.g. size, magnetism and solubility. Mixtures can be:

- Gas in solid (e.g. pumice stone); solid in solid (e.g. muesli).
- Solid in gas (e.g. smoke); gas in gas (e.g. air); liquid in gas (e.g. clouds, mist and aerosol).
- Gas in liquid (e.g. fizzy drinks); liquid in liquid (emulsion, e.g. milk); insoluble solid in liquid

(suspension, e.g. muddy water); soluble solid in liquid (solution, e.g. salt water).

This unit mainly covers soluble solids.

A substance may dissolve in one liquid but not in another. For instance, nail varnish dissolves in acetone but not in water.

A solution is usually transparent, even if it's coloured. Substances like instant coffee do not really dissolve; instead, small solid particles remain in suspension and the liquid is murky. Focus on the 'disappearance' of the solid granules as evidence of dissolving.

When a solid is added to water, the water particles surround the solid edges. If the attraction between the water and solid particles, is greater than that between the solid particles then it will dissolve. This process is affected by things like temperature and the amount of solid. There is always a limit to how much solid can dissolve in a given amount of water.

CHILDREN'S MISCONCEPTIONS

Children might think...

- That 'material' just means 'fabric'. In fact, a 'science material' means any kind of matter in the world around us.
- That 'everyday materials' are single substances. Actually, they can be mixtures or compounds, e.g. brick, glass.
- They are comparing properties when they are comparing objects.

Sometimes children confuse the following properties:

- Tough and hard: a diamond is very hard, but if hit with a hammer it will shatter because it is brittle.
- Tough and strong: polythene does not break when dropped but is not strong because it is easy to tear apart.

- That dissolving means that the substance has disappeared. If the liquid is evaporated the substance is still there but just cannot be seen.

Children already know...

- About everyday materials and their properties and uses (Years 1 and 2).
- About magnetic materials (Year 3).
- About rocks (Year 3).
- About temperature and heating and cooling (Year 4).
- The states of matter and change of state (Year 4).
- About evaporation and condensation in the water cycle and the factors that affect evaporation (Year 4).

SCIENTIFIC VOCABULARY

You can download a Word mat of essential vocabulary from *My Rising Stars*.

dissolve: when a solid mixes with liquid to make a solution

elastic: returns to original shape when force removed

electrical conductor: material that allows electricity to flow through it

evaporate: heat liquid until it turns into gas

filter: use porous material to separate solid and liquid

flexible: easily bends; opposite of rigid and stiff

hard: resistant to scratching or pressure

insoluble: when something can't dissolve

mixture: two or more substances that can be separated

plastic: retains new shape when force removed

rigid: hard and fixed; not flexible

soluble: when something can dissolve

solute: the material that dissolves.

solution: mixture of solid and liquid (you might not be able to see the solid)

solvent: usually (liquid) that does the dissolving

strong: resistant to tearing

thermal conductor: heat travels quickly through thermal conductors, e.g. metals

thermal insulator: does not let heat travel through easily, e.g. wood and plastic

tough: resists cracking; opposite to brittle

2.1 Sorting and grouping materials

GET STARTED

Introduce the topic using PowerPoint Slides 1–4.

Tell children that they are going to create a Wordle; show them PowerPoint Slide 5 so that they have an idea what a Wordle looks like. Give each group a pile of A4 paper that has been cut in half lengthways and make sure that there are plenty on each table along with some sticky putty. The challenge is to write down as many words as they can that have something to do with names of materials, properties of materials and uses, one word per sheet of paper. It does not matter if a word is repeated around the class. The aim is to elicit children's prior knowledge of materials. Give children up to ten minutes for this activity, then ask them to create the Wordle on a wall by placing their words horizontally and vertically. Children could use ICT to create a Wordle by using a website. Children could then share and compare their Wordle with a partner, print it out and display it.

Use the Wordle as a starting point for discussion with children about materials.

LET'S THINK LIKE SCIENTISTS

Use these questions to develop research skills and speaking and listening:

- What is the lightest material there is?
- Which materials do we use that the Tudors (or any other age) did?

ACTIVITIES

1 SORTING MATERIALS

L.O. Compare and group together everyday materials on the basis of their properties, including their hardness, solubility, transparency, conductivity (electrical and thermal) and response to magnets.

- Give children a range of objects made from different materials, these could be from school or home.
- Ask them to carry out quick challenge classifications, encourage them to refer back to their Wordle for ideas. You could leave children to see how many different ways of sorting they come up with, or engage them in a series of quick-fire groupings, e.g. 'You have 60 seconds to sort into…':
  - Types of materials, e.g. wood, metal, ceramic, plastic, fabric, paper, card.
  - Properties of materials, e.g. transparent, opaque, translucent, flexible, hard, strong, elastic, plastic, magnetic, thermal insulator, electrical insulator.
  - Double properties, e.g. transparent and flexible.
  - Triple properties, e.g. elastic, waterproof, opaque.
  - Opposites, e.g. rough / smooth, transparent / opaque, flexible / rigid.
- This activity is a useful formative assessment point to find out those aspects children are confident with and those that they require some further support with.

YOU WILL NEED

- Range of objects made from different materials

ASSESSMENT

Working Scientifically

- Em. Children sort according to a limited range of categories, not always scientific, e.g. colour.
- Exp. Children sort according to most common materials and properties.
- Exc. Children include categories that other children do not know or are unsure of, e.g. electrical and thermal insulators.

2 WHY THAT MATERIAL?

L.O. Give reasons, based on evidence from comparative and fair tests, for the particular uses of everyday materials, including metals, wood and plastic.

- Bring in an item of clothing, e.g. a warm winter coat or a ski suit. Ask children to think about why the different materials have been used to make it. Make the point that objects are usually made from materials that have properties that are needed, e.g. the coat keeps someone dry and warm in winter.
- Use the same set of objects from Activity 1 and tell the children to look at each object and talk about why each material has been used for the purpose. They can record their findings on Activity Resource 2.1. Again, refer them to their Wordle from the previous activity for key words and ideas and, once they have completed their activity, tell children that their partner is going to check their work, not only to make sure that their answers are correct, but also to make sure that they have spelled all the words correctly. Ensure that at the beginning of the activity children understand the expectation that all scientific words must be checked using a dictionary or word mat before they are written down. You might ask the children to identify which are materials and which are properties (perhaps as a mini plenary). They go through the Wordle and write an 'm' on the materials and 'p' on the properties.
- This activity is a useful formative assessment point to find out if children are confident with the idea that materials have been specifically chosen for the object because of their properties.

YOU WILL NEED

- Warm coat or other item of clothing
- Range of objects from Activity 1
- Activity Resource 2.1

ASSESSMENT

Working Scientifically

- Em. Children can name objects and the materials they are made from.
- Exp. Children name the material and can suggest why it has been used according to obvious properties.
- Exc. Children include categories that other children do not know or are unsure of, e.g. electrical and thermal insulators.

3 TESTING MATERIALS – WHICH MATERIAL MAKES THE STRONGEST CARRIER BAG?

L.O. Give reasons, based on evidence from comparative and fair tests, for the particular uses of everyday materials, including metals, wood and plastic.

Take measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings when appropriate.

Record data and results of increasing complexity using scientific diagrams and labels, classification keys, tables, scatter graphs, bar and line graphs.

- Introduce children to the idea that they will be investigating the strength of bags. Discuss as a class how they might do this. Bring in two carrier bags both full of shopping but one has the handles stretched and about to break, the other is still in shape. Ask the class to compare the two and say which one they think is the strongest and why. Ask a couple of children to come and hold the bags and say what it feels like on their hand, e.g. one seems to cut into the hand and is uncomfortable.

HEALTH AND SAFETY

- Wear safety glasses when testing strength.
- Put a container of foam or scrunched up waste paper underneath the bags so that weights drop into it and not onto toes or fingers.

YOU WILL NEED

- Range of different carrier bags
- Objects to fill carrier bags for testing
- Broom handle or similar

- Use the results from the observations made here to make predictions and set up further comparative and fair tests.
- Children carry out these fair tests so that they can use their data to give reasons for the use of specific materials. This is different from children stating that, for example, a plastic bag is used because it is light or waterproof. At the end of this activity, the children should be able to give reasons for the material being used by referring to their test data.
- Children could use either ordinary plastic shopping bags or mini bags, the latter can be better because some of the large plastic bags hold a huge amount of weight, more than you might have available in the classroom.
- Some children could use Activity Resource 2.2, others could create their own plan to answer the question: 'Which material makes the strongest carrier bag?'
- Work with children to help them recognise that the question gives clues as how to carry out their activity, e.g.:

Which **material** is the **strongest for a carrier bag?**

This is what we change – the type of material bag is made from.

This is what we measure – the strength of the bag in kg.

This is a useful teaching point so that children learn to use the question to help plan their activity, then the next question is how will we make it a fair test.

- The most straightforward way to test the bags is to use a broom handle across two chairs with the mini bag handles slid onto the handle. Then weights are placed in the bag until it breaks and children record their results. Encourage children to add an additional column to their table to record their qualitative observations, e.g. how the bag breaks.

Type of material	Weight held in kg	How the bag broke

- When the children have completed their test, they can then transfer the data onto a bar graph, again using the question to help them draw the bar graph and label it.
- The graph title always begins with 'A graph to show…' and then uses the question.

'A graph to show which is the strongest material for a carrier bag?'

Or

'A graph to show the strongest material for a carrier bag'

- Finally, once the children have completed this, you need to return to the curriculum statement, which requires children to give reasons, based on evidence from comparative and fair tests, for the particular uses of plastic for a bag. Some children may require scaffolding to answer this question, e.g. plastic bags are the best because plastic is a strong material, 'Our data shows that plastic bags held X kg more than the paper bags'.

ASSESSMENT

Working Scientifically

- Em. Children are able to describe what they did and say which bag was best but not relate it to the properties of the material.
- Exp. Children carry out the fair test and use their data to give reasons why one type of bag is the strongest.
- Exc. Children complete their test and draw conclusions and then suggest other materials or aspects to test.

4 TESTING MATERIALS – WHAT IS A THERMAL CONDUCTOR?

L.O. Compare and group together everyday materials on the basis of their properties, including their hardness, solubility, transparency, conductivity (electrical and thermal) and response to magnets.

- Bring in a range of thermal insulators, e.g. woolly socks, scarves, gloves, hot drink cups, flask and a hot water bottle with a cover, and ask children to work out what they all have in common. Alternatively, you could add an 'odd one out' such as a T-shirt and ask: 'Which one is the odd one out and why?'
- Begin asking children to think back to Year 4 when they sorted materials into those that conducted electricity and those that did not – insulators. Electrical insulators allowed electricity to pass through easily, and electrical insulators did not allow electricity to pass through easily. Give them a selection of materials to sort, to see how many remember which materials are electrical conductors and which are electrical insulators. They could check their own responses by placing them in an electrical circuit.
- Tell children that they are going to find out about a different kind of conductor and insulator, materials that are thermal conductors and insulators. Ask them to use a dictionary to look up the word 'thermal' and then discuss with their partner or in a group what they think a thermal conductor is and what they think a thermal insulator is.
- As a class create a definition of a thermal conductor, e.g. material that can transfer (move) heat from one object to another or away from your hand to the object. If a material is not a good thermal conductor, it is a thermal insulator (remind children of electrical conductor and electrical insulators). This can be quite challenging for children to understand, so ensure that they do before you move on to the activity.
- Give children lots of different objects made from metal, plastic and wood and ask them to sort them into thermal conductor, thermal insulator. What do they notice? Metal is a thermal conductor, it moves heat from our hands so it feels cold. Wood is a poor conductor, heat is not transferred away so it feels warm.

YOU WILL NEED

- Range of objects / materials to act as thermal conductors and insulators

ASSESSMENT

Subject Knowledge

- Em. Children can say which spoon feels cold to touch and which feels warm but do not link to the idea of thermal conductors.
- Exp. Children say which materials are thermal conductors and thermal insulators.
- Exc. Children begin to apply their understanding to objects in the kitchen, e.g., use of wooden spoons for stirring hot food, oven gloves for protecting hands from hot dishes and wooden saucepan handles so that people do not burn their hands.

Working Scientifically

- Em. Children can compare two spoons and describe what happens.
- Exp. Children use the results from their comparative test to say which materials are thermal conductors and thermal insulators.
- Exc. Children use results to predict results on other materials used when cooking.

5 TESTING MATERIALS – WHICH MATERIALS ARE THERMAL CONDUCTORS AND WHICH ARE THERMAL INSULATORS?

L.O. Compare and group together everyday materials on the basis of their properties, including their hardness, solubility, transparency, conductivity (electrical and thermal) and response to magnets.

Give reasons, based on evidence from comparative and fair tests, for the particular uses of everyday materials, including metals, wood and plastic.

Plan different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary.

- Give each group a range of kitchen items from oven gloves and saucepans to chopping boards and ask them to find as many different ways of classifying them as they can using scientific words.
- Give children a collection of plastic, metal and wooden spoons. Ask them to predict which are thermal conductors and which are thermal insulators and why they think that. Have the children put the spoons into a jug of warm water (or you can do a teacher demonstration). The metal transfers the heat from the water, the heat travels through the metal and so the metal spoon feels warm, while the plastic and wood do not conduct the heat and so the heat does not travel through the wooden spoon to the hand.
- Then ask children how they could test their predictions using the following resources:
  - Hand-hot water
  - Beakers
  - Spoons
  - Digital thermometers
- Working in pairs or small groups of no more than four, ask children to draw an annotated diagram to show how they would carry out their comparative test. Some children will probably suggest placing the spoons into beakers of hand-hot water and feeling each spoon, others might suggest placing a digital thermometer against each spoon to see if there is a difference in temperature between each spoon. If so then they should use a table to record results.
- Once children have their results and used them to decide whether their original predictions were correct, then use PowerPoint Slides 6 and 7 to challenge them to apply what they have learned about materials and thermal conductors and insulators.

YOU WILL NEED

- Range of kitchen equipment for each group, including thermal conductors and insulators
- Digital thermometer
- PowerPoint Slides 6 and 7

ASSESSMENT

Working Scientifically

- Em. Children can say which spoon feels cold to touch and which feels warm but do not link to the idea of thermal conductors.
- Exp. Children use the results from their comparative test to say which materials are thermal conductors and thermal insulators.
- Exc. Children begin to apply their understanding to objects in the kitchen, e.g. use of wooden spoons for stirring hot food, oven gloves for protecting hands from hot dishes and wooden saucepan handles so that people do not burn their hands.

6 TESTING, TESTING

L.O. Give reasons, based on evidence from comparative and fair tests, for the particular uses of everyday materials, including metals, wood and plastic.

Plan different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary.

Take measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings when appropriate.

Record data and results of increasing complexity using scientific diagrams and labels, classification keys, tables, scatter graphs, bar and line graphs.

Use test results to make predictions to set up further comparative and fair tests.

- In this activity children have the opportunity to choose their own question to answer, they could choose from those offered below or decide on their own experiment to test the properties of a specific material, e.g.:
  - Which is the stretchiest fabric?
  - Which is the strongest fabric?
  - Which material is the most absorbent?
  - Which material is the most flexible?
  - Which is the best packaging material for meringues?
- Children could use sticky notes to plan their investigation or use Activity Resource 2.2 to help organise their test. At this level children should be challenged to:
  - Use measurements and collect data.
  - Record their results using a table.
  - Transfer the results in their table into a graph.
- Some children will be able to use their data to make and test new predictions, e.g. having found out ‘Which material is the most absorbent?’ they could then suggest that fabrics would be less absorbent if cooking oil was spilled and test different liquids. They could put their new predictions on sticky notes and attach them on a working wall about materials.

YOU WILL NEED

- Range of materials for children to test
- Activity Resource 2.2
- Sticky notes

ASSESSMENT

Working Scientifically

- Em. Children carry out simple comparative tests with limited use of measurement.
- Exp. Children carry out a fair test and use their results to answer their question.
- Exc. Children use their test results to suggest new predictions and test those.

2.2 Solutions and mixtures

GET STARTED

Leave a plastic bottle on each desk and tell children that it is a mystery liquid, although it looks clear there is something inside the liquid. Tell them that at the end of the lesson they are going to write all over the bottle suggesting what is inside the liquid and how it got there.

LET'S THINK LIKE SCIENTISTS

Use these questions to develop research skills and speaking and listening:

- Does everything dissolve?
- How do you know something has dissolved?

ACTIVITIES

1 SEARCHING FOR A SOLUTION

L.O. Know that some materials will dissolve in liquid to form a solution and describe how to recover a substance from a solution.

Plan different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary.

- This is the first time children will have come across the idea of dissolving in the curriculum, so they will need experience of comparing materials that do and do not dissolve and the development of key language such as:

  Dissolve   Solution   Solute

- Do children know what dissolve means? Give children access to transparent plastic cups of water and some white sugar and some sand. They put sugar in one cup of water and sand in another and talk about their observations with their group or partner. The children may need to stir the water to dissolve the sugar. The children should notice that the sugar has 'disappeared' into the water. Explain to them that the sugar has dissolved.
- Give the children a range of materials. Ask them to find out which ones dissolve in water and which do not, then ask them to think about how they are going to decide whether the material has dissolved or not. Ask the children to think about how they will record their observations, e.g. in a table, a list or a set.
- This is a simple comparative test – do they dissolve or not? Including very obvious things such as centicubes is useful, particularly for those children who find these concepts difficult.
- At the end of the activity, ask children to write a sentence about which materials dissolved and which did not. Introduce the word 'solution', which is when a solid dissolves in a liquid it creates a solution, e.g. when sugar dissolves in water it creates a sugar solution.
- Ask children to use a highlighter and mark the ones that they tested that are solutions.

YOU WILL NEED

- Transparent plastic cups
- Range of materials to dissolve in water, e.g. salt, instant coffee, loose tea, sand, rice, sugar, plastic centicubes
- Teaspoons
- Paper and pens
- Whiteboards and dry-wipe markers

ASSESSMENT

Subject Knowledge

- Em. Children describe what happens to substances in water and, with support, use the word dissolve.
- Exp. Children can identify materials that dissolve and can define the words *solute*, *solution* and *dissolve*.
- Exc. Children suggest why some materials dissolve and others do not and can suggest other solutes, solutions and solvents.

- Give children the task of finding out what a solute and solvent are and to write three definitions on their white boards for ‘solvent’, ‘solute’ and ‘dissolve’, and then once they are confident in their definitions to write them in their books.
- Do not forget to return to the mystery liquid in the bottle on each desk (from the Get Started activity). Using dry-wipe marker pens, children write information about the mystery liquid based on what they have learned in this activity.

Working Scientifically

- Em. Children can carry out a simple comparative test between two materials and say what happens.
- Exp. Children test and identify materials that dissolve.
- Exc. Children use test results to predict and test new materials that will or will not dissolve.

2 DISSOLVING SUGAR

L.O. Know that some materials will dissolve in liquid to form a solution and describe how to recover a substance from a solution.

Plan different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary.

Take measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings when appropriate.

Use test results to make predictions to set up further comparative and fair tests.

Reporting and presenting findings from enquiries, including conclusions, causal relationships and explanations of and degree of trust in results, in oral and written forms such as displays and other presentations.

- Show children a can of cola (not diet). Then, on a small plate spoon 12 spoonfuls of sugar into a pile. Explain that this is approximately how much sugar is dissolved in one can of cola. Discuss their reactions.
- For this activity use PowerPoint Slide 8, which shows four different ideas about dissolving. All are valid ideas: 1, 2 and 4 result in more complex patterns in the data whilst idea 3 would work as a comparative / simple fair test.
  - Idea 1: I think that the amount of sugar affects how quickly it will dissolve.
  - Children measure volume of water, weight of sugar, time to dissolve (line graph).
  - Idea 2: I think that the temperature of the water affects how quickly the sugar will dissolve.
  - Measure temperature using spirit or digital thermometer, volume of water, weight of sugar and time to dissolve (line graph).
  - Idea 3: I think that if we stir the sugar and water it will dissolve more quickly.
  - Children measure volume of water, weight of sugar and time to dissolve (table).

YOU WILL NEED

- Clear plastic cups or containers
- Can of cola
- Sugar Plate and spoon
- PowerPoint Slide 8
- Digital scales
- Activity Resource 2.3

ASSESSMENT

Subject Knowledge

- Em Children can talk about materials dissolving.
- Exp. Children describe that some materials will dissolve in liquid to form a solution.
- Exc. Children explain what can affect how a material (substance) dissolves in a liquid.

Working Scientifically

- Em. Children carry out Idea 3 and can say what happened.
- Exp. Children carry out a fair test and report their results to the rest of the class and explain cause and effect, e.g. the higher the temperature, the faster the sugar dissolves.
- Exc. Children use the full range of scientific vocabulary in reporting to the class, e.g. *dissolve*, *solution* and *solute*, and use the data to suggest new tests.

- Idea 4: I think that the amount of water affects how quickly the sugar dissolves.
- Children measure volume of water and time to dissolve (line graph).

- Where appropriate, children should apply their developing graphing skills to represent the data in their tables into graphs. Those children who need support could use Activity Resource 2.3.
- Finally, children communicate their tests and results to either the rest of the class or another group. Take this opportunity to engage children in peer-assessed feedback on how they carried out tests and their conclusions.

3 SIEVING

L.O. Use knowledge of solids, liquids and gases to decide how mixtures might be separated, including through filtering, sieving and evaporating.

- Begin by showing children the video clip that shows different everyday uses of sieves from fishing nets to dishwashers.
- Sieving to separate mixtures is a straightforward concept, so start by challenging children to separate dry mixtures in the least number of steps using different household sieves. Use Slide 10.
- Then turn this one around and ask children to use their experience of separating using sieves to make a dry mixture for other children to find ways of separating the different materials. Increase the number of items the children can use in their sieve, e.g. sand, pebbles, magnetic objects, raisins etc.
- If you really want to excite the children, then add some very small fake gold grains, e.g. either sprayed gold or bits of fake gold pebbles used by florists and tell the children that they are going ‘Panning for Gold’.

YOU WILL NEED

- PowerPoint Slide 10
- Video clip (see Useful Websites list)
- Items for dry mixtures, e.g. dried peas, lentils, flour, magnetic metal (paper clips, nuts and bolts), sand, pebbles, raisins etc.
- Household sieves, e.g. colanders, flour sieves, tea strainers, net curtains
- Magnets
- Fake gold grains

ASSESSMENT

Working Scientifically

- Em. Children are able to use a sieve to separate a limited number of items in a mixture.
- Exp. Children use different sieves with different sized holes to separate a mixture.
- Exc. Children make their own choices for a mixture and broaden items to be used as a sieve, e.g. using different fabrics.

4 FILTERING

L.O. Use knowledge of solids, liquids and gases to decide how mixtures might be separated, including through filtering, sieving and evaporating.

Plan different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary.

Use test results to make predictions to set up further comparative and fair tests.

- Show children the video clip showing how a Life Saver Bottle was invented to clean filthy water so that it is clear and drinkable. You don't need to show the whole video, just about the first six minutes. Tell children that they are going to learn the science behind how the Life Saver Bottle works.
- Filtering is different to sieving because the solids are mixed into a liquid, e.g. water. However, the solids have not dissolved into the water so can be separated using a physical barrier that lets the water through and leaves the small particles behind. Explain to children that in our own and other countries water is filtered (cleaned) so we can drink it.
- Challenge children to compare three or four different materials to find out which material is best to clean the dirty water.
- If you offer children a wide range of materials, when children feed back their results they will learn about how successful other materials are.
- Allow children to make their own dirty water using soil from a safe source and then carry out a comparative test to find out which materials make the best filter. Ask children to think about:
  - How will they know which is best?
  - How will they keep it fair?
  - What will they measure?
- Having carried out their test, ask children to think about how they could improve on their filtering system, e.g. by combining filters. Perhaps they could use the results from another child who used a different filter.
- Ask children to write a set of instructions on how to filter dirty water with annotated diagrams and explain the difference between sieving and filtering.
- Then ask children to draw what they think is inside the Life Saver Bottle that cleans the water.

YOU WILL NEED

- Video clip – 'Life Saver Bottle' (see Useful Websites list)
- Clear containers
- Water mixed with soil or sand
- Range of materials to act as filters, e.g. cotton balls, muslin, curtain netting, paper towels, coffee filters, gravel (e.g. aquarium gravel), sand

ASSESSMENT

Subject Knowledge

- Em. Children can talk about what they did and what happened but they are unable to link it to the idea of filtration.
- Exp. Children can describe what they did and can explain how filtration works.
- Exc. Children use the language of solutions, solute and solvent and filtration to explain how dirty water is cleaned.

Working Scientifically

- Em. Children follow instructions on filtering water.
- Exp. Children carry out a fair test, record their results, draw conclusions.
- Exc. Children apply their test results to, for example, recognise the limitations of their approach and suggest how to set up further tests to improve their filters.

5 EVAPORATING

L.O. Use knowledge of solids, liquids and gases to decide how mixtures might be separated, including through filtering, sieving and evaporating.

Plan different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary.

Report and present findings from enquiries, including conclusions, causal relationships and explanations of and degree of trust in results, in oral and written forms such as displays and other presentations.

- Using a dictionary, children define the words *evaporate, evaporated* and *evaporating* and then use them in three different sentences.
- Evaporation is useful for separating a soluble solid from a liquid. One of the key ideas for children is that it is the liquid that evaporates and the solid is left behind. There are lots of ways for children to explore this, but the most straightforward is to make a solution of salt and water in a shallow container and leave it somewhere warm in the classroom for the water to evaporate, leaving the salt behind. The problem with this is that you end up with lots of containers around the classroom and it can take several days for a result.
- A quick alternative is to pour a small amount of salt solution (it is better if it is a saturated solution, where the water cannot hold any more salt) into a small aluminium cupcake case and place over a night light until the water has evaporated.
- When children have completed either activity ask them pair up and explain to their partners what has happened to the water and why the salt is left behind. Challenge them to use key scientific words, e.g. *solution, evaporation* and *separated*. It is also a good idea to leave a couple of containers on the side to observe over a longer period of time. This helps to avoid the misconception of needing to heat the water to a high temperature for evaporation to occur.
- It is important children understand that processes such as evaporating salt from water are really useful and used by people every day. For example, exactly the same process is used to get salt that we put in or on food. See the Useful Website links for video clips to explain this process.
- Although distillation is not necessary at this level, if children understand how they can evaporate water from a solid then to understand distillation children apply their knowledge of evaporation. Begin by showing children the video clip (see Useful Websites list) that shows a ‘fictitious Robinson Crusoe’ using simple distillation to get clean water to drink. Challenge children to create a similar scenario using the same materials but in the classroom using resources available to them, e.g. trays, beakers, cut down plastic bottles, stones, plastic bags or cling film.

YOU WILL NEED

- Salt and water solution
- Small containers for evaporating
- Heat source, e.g. small lamp
- Video clips – salt from evaporation (see Useful Websites list)

ASSESSMENT

Subject Knowledge

- Em. Children can describe that water disappears but are unable to link what happens to the process of evaporation.
- Exp. Children describe the process of evaporation and say it can be used to separate mixtures.
- Exc. Children apply their knowledge of evaporation in different contexts e.g. if shown a video clip of salt being harvested from salt pans.

Working Scientifically

- Em. Children describe what they did and what happened.
- Exp. Children carry out the activity and can explain how water evaporates and leaves the salt behind.
- Exc. Children use the language of solutions, solute and solvent to describe the cause and effect (causal relationship) between evaporation and separating salt from a solution.

6 SORT THIS OUT!

L.O. Use knowledge of solids, liquids and gases to decide how mixtures might be separated, including through filtering, sieving and evaporating.

Plan different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary.

Report and present findings from enquiries, including conclusions, causal relationships and explanations of and degree of trust in results, in oral and written forms such as displays and other presentation.

- Take into class two bottles of water one from the tap and another that is filthy that you have made. Give someone in the class an empty glass of water and ask them to choose which water they would like to drink. Usually the child chooses the clear water, so ask the class to share their ideas of how they could get the filthy water to look like the clean water. It's an important point that water that 'looks clean' may not also be safe for drinking.
- This is an activity where the children apply their knowledge and experience of different ways to separate mixtures and provides a useful assessment point. If children can successfully apply their knowledge then you can be confident that children understand the key ideas.

  There are three ways this activity can be offered to the children:

  1. The children are given water with a mix of solids in it which includes insoluble solids, magnetic materials and solids dissolved in water to separate and record how they did it.
  2. Children create their own mixture to separate out and choose how to record what they did.
  3. Children create their own mixture and swap theirs with another group to separate out and tell the other group how they did it and what was in their mixture.
- The aim is for children to work independently and use the different ways of sorting mixtures and record how they separated each one, e.g. video clips, photographs, diagrams.

YOU WILL NEED

- Bottles of clean and dirty water
- Materials for mixing and dissolving with water
- Filters and equipment for separating clean water as in the previous two activities

ASSESSMENT

Subject Knowledge

- Em. Children can separate a mixture having chosen from a limited selection of materials and approaches.
- Exp. Children apply their knowledge of how to separate a mixture.
- Exc. Children apply their knowledge of filtering and know their process has limits.

Working Scientifically

- Em. Children require help to separate simple mixtures.
- Exp. Children communicate how they decided to separate the solids in the mixture, record their results and how they can trust their result (that their water is clean).
- Exc. Children can explain how they separated visible solids from the water and know that the end result (water) still might have materials (and, perhaps, e.g. bacteria) in it so that it is not totally clean.

7 GROWING CRYSTALS

L.O. Plan different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary.

Report and present findings from enquiries, including conclusions, causal relationships and explanations of and degree of trust in results, in oral and written forms such as displays and other presentations

- This activity allows children to apply knowledge practically, extend and assess working scientifically skills. This activity should not take the place of others in this topic, as it is additional learning.
- Using microscopes, digital microscopes and hand lenses, give children the opportunity to observe a range of household substances that are crystals, e.g. salt, sugar and rock salt, and collect descriptions from the children of what they see.
- Make sure that the children are supervised by an adult when handling hot water. If you use boiling water, only the teacher should demonstrate it. Children should not handle boiling water. Ensure that children know what it meant by 'supersaturated solution', e.g. a solution that is so full of salt that it can no longer dissolve any more and any more salt falls to the bottom of the container.
- Use Activity Resource 2.4. This is an activity where children make observations over several days, as they observe the crystals growing. Ask children to explain what has happened to the water and why the salt is left behind. Based on what the children have already learned, they could be asked to predict what they think might happen. This would also be useful assessment information. Can children apply their learning? If they work in pairs, they could take a series of photographs when setting the crystals and then, over the next few days, as the crystals grow. These could be used in a PowerPoint presentation or as a set of photographic instructions to go on the school website for parents to try with their children with an explanation about solutions, solvents, solutes, evaporation and supersaturated solutions.
- Finally, to conclude the topic and review learning, ask children to look at the Wordle they originally created (see page 24) and ask them to add new words that they have learned during this topic. Children then write a sentence to say what they think was the most important thing that they have learned.

YOU WILL NEED

- Activity Resource 2.4
- Supersaturated salt and water solution. We suggest that the teacher uses the boiling water (as children should use no hotter than 60°). Ensure it's in a proper container if you do use it (not a plastic cup).
- Range of household crystals, e.g. salt, sugar
- Hand lenses and / or microscope
- Camera to record results over time

ASSESSMENT

Working Scientifically

- Em. With support, children follow the instructions and can talk about the changes that take place over several days.
- Exp. Children follow the instructions and can explain why the salt is left behind.
- Exc. Children repeat the activity but ask questions, e.g. what if we change the solute (liquid), amount of salt or what the crystals form around?

TOPIC 3

Circle of life

About this topic

Curriculum link: Year 5, All living things and their habitats

SUMMARY:

In this topic children look at the life cycles of various species including mammals, amphibians, fish and birds. They also look at and describe the life process of reproduction in plants and animals.

UNITS:

3.1: Making new plants
3.2: Animal life cycles
3.3: Making babies

ACTIVITY RESOURCES

- 3.1: Plant fertilisation
- 3.2: Different babies
- 3.3: Endangered animals
- 3.4: Planning your presentation

ONLINE RESOURCES:

Teaching slides (PowerPoint): Circle of life
Interactive activity: Circle of life
CPD video: Circle of life
Pupil video: Circle of life
Word mat: Circle of life
Editable Planning: Circle of life
Topic Test: Circle of life

Learning objectives

This topic covers the following learning objectives:

- Describe the differences in the life cycles of a mammal, an amphibian, an insect and a bird.
- Describe the life process of reproduction in some plants and animals.

Working scientifically skills

This topic develops the following working scientifically skills:

- Plan different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary.
- Take measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings when appropriate.
- Use test results to make predictions to set up further comparative and fair tests.
- Report and present findings from enquiries, including conclusions, causal relationships and explanations of and degree of trust in results, in oral and written forms such as displays and other presentations.
- Identify scientific evidence that has been used to support or refute ideas or arguments.

CROSS-CURRICULAR LINKS

This topic offers the following cross-curricular opportunities:

English

- Write instructional texts for the growing of plants (which could then be filmed).
- Persuasive writing and / or debate on the subject of zoos and conservation.
- Write a non-chronological report about how different types of animals reproduce.
- Create an information leaflet based on plant or animal reproduction.
- Make a glossary of topic words and use dictionary to check definitions and spellings.
- Write a biography of a famous conservationist.
- Re-write *Tadpole's Promise* by Jeanne Willis and Tony Ross.

Numeracy and mathematics

- Collect data.
- Set maths challenges using animal reproduction and population growth, e.g. a pair of rabbits could have 11 litters a year, with an average of six babies each litter. If the parents live for seven years how many babies could they produce?
- Read *The Rabbit Problem* by Emily Gravett, which illustrates population growth in the context of rabbits.

Computing / ICT

- Record a 'Gardeners World' instructional video to show each other how to grow seed potatoes or take stem cuttings.
- Create a blog about an endangered species, or an animal or plant found in the school grounds.
- Digital photographs (or a time lapse camera) to record the changes that take place as the plants grow.
- Use PowerPoint.
- Make a 'Common craft' style video animation, e.g. 'The life cycle of a plant'.
- Create a booklet or poster.
- Use sites such as the RSPB at home.

Drama

- Role-play the life cycle stages of different animals and plants.
- Role-play the life of a famous conservationist (or an interview with him / her).

Art

- Create models that illustrate an animal life cycle.
- Create still-life drawings or paintings of plants, seeds and / or animals.
- Find out about the work of artist and conservationist David Shepherd and create drawings or paintings of endangered species.

Design technology

- Research where our food comes from and how plants are grown.
- Plan and cook recipes using the fruit and vegetables that the class grows.

PSHE

- This unit has links to sex education. Check school policy on what can be covered and how it should be handled.
- Discuss whether animals should be kept in zoos.

STEAM (SCIENCE TECHNOLOGY ENGINEERING ART AND MATHS) OPPORTUNITIES

Invite into class

- A botanist from a local university or secondary school.
- An artist to develop children's ability to do botanical drawings.
- A local gardener to give a masterclass on planting seeds and growing plants.
- A zoologist from a local university to support work on life cycles
- Someone who can bring in hens' eggs for the children to incubate and explain how to care for them.
- A local writer to write poems and descriptive prose or non-fiction explanation texts.

Visit

- Local botanical gardens.
- A garden centre to find out about plants from experts.
- A farm to find out about animal reproduction and husbandry.

Teacher subject knowledge

Plant reproduction

Flowers are the reproductive organs of a plant. They produce pollen and eggs, which then produce seeds.

In sexual reproduction the male parts of the flower produce pollen and the female parts produce ova, or eggs. Both pollen and eggs contain half the genetic information necessary to make a new plant, in the same way that sperm and eggs do in animals. Plants cannot pollinate their own flowers: they need to get their pollen to the flowers of another plant. Often the pollen is carried by insects, but it can also be dispersed into the wind. When pollen lands on the stigma of another flower, it joins with the egg and their DNA combines. The egg is now fertilised. This will happen many times with all the eggs in the ovary.

Asexual reproduction needs only one parent, unlike sexual reproduction, which needs two parents. This means that the offspring (new plant) is a clone (because there has not been a joining of genetic information). Asexual reproduction in plants can differ. Many plants develop underground food storage organs that later develop into the following year's plants. Potato plants and daffodil plants do this (tubers and bulbs). Others, such as the spider plant, *Chlorophytum*, produce side branches with plantlets on them. Strawberries produce runners with plantlets on them.

Animal reproduction

All animals grow from an egg. In insects, fish and amphibians, this egg is a ball of jelly and reptiles' eggs have leathery shells. The baby develops inside and then hatches when it is ready to come out.

Mammals do start off as a tiny egg, but this egg stays inside the mother in a special area called the womb. The baby is known as an embryo. The baby is joined to the mother by a placenta, and it gets food and oxygen that way. Once the baby is developed enough, it is ready to be born.

Many animals, including amphibians and insects, have a distinct juvenile form that looks very different from their adult form. This larval stage then undergoes a process of metamorphosis where it loses some features and gains new ones, e.g. a tadpole will lose its gills and tail and grow legs. Larvae may live in different environments, such as underground or in water, and may eat different foods. Some animals will spend most of their lives in a larval stage, becoming adults only to breed and produce eggs, after which they die.

Fertilisation occurs when a single sperm fuses with a single egg. The genetic information of the two cells combines to produce an embryo that then develops further, usually within an egg or, in the case of mammals, inside the mother's womb.

Many animals release thousands of eggs and millions of sperm (especially into the water) at a time. The large numbers increase the chances of a sperm meeting an egg, especially in animals where the male and the female may not spend much time in physical proximity. The eggs are abandoned by the parents and the young left to fend for themselves. Many of the offspring will get eaten or die, so many babies are needed to make sure just a few make it to adulthood to produce more offspring.

In mammals and birds the eggs are kept inside the female and fertilised with sperm from the male. Fewer eggs are needed since the chances of fertilisation are higher. There is also a higher level of parental care after the offspring are born and therefore a higher chance of survival, so the numbers of offspring are lower.

CHILDREN'S MISCONCEPTIONS

Children might think...

- That sex is not something plants do, or that it takes two plants to produce seeds to make a new plant.
- That the life cycle begins at the baby / larval stage when in fact it begins at the egg stage (or embryo in mammals).
- That a sperm or egg contains a tiny baby inside it, and that fertilisation causes it to start growing. In fact, sperm and eggs each contain half the genetic information needed to make a whole new animal.
- They may also not know that it is possible to make new plants by growing runners or through taking cuttings.

Children already know...

- The structure of flowers and how they relate to reproduction (Year 3).
- The process of pollination (Year 3).
- That animals have offspring that grow into adults (Year 2).
- The process of fertilisation in plants (Year 3).
- Depending on when the 'Growing Up and Growing Old' unit is taught relative to this unit, they may already know about the life cycle of a human (Year 5).

SCIENTIFIC VOCABULARY

You can download a Word mat of essential vocabulary from *My Rising Stars*.

asexual reproduction: to reproduce without a mate

bulb: a part of a plant that stores food underground, can grow a new shoot

external fertilisation: when sperm and eggs join outside the body

fertilisation: when an egg and pollen (or sperm) join together

gestation: when a baby animal develops inside its mother

internal fertilisation: when sperm and egg join inside the body

larva: the young form of some animals, which looks very different from its parents. It undergoes a dramatic change to become an adult and loses its young features or gains new ones

metamorphosis: a dramatic change in the life cycle of an animal in which it ends up looking totally different

pollination: when pollen from one plant is transferred to the ovary of another

sexual reproduction: reproduce with both a male and female

sperm: male animals make this

Runners

Some plants, like strawberry plants or spider plants, grow runners which have new plants on the end.


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Bulbs

A bulb is underground storage formed from the plant stem and leaves. In the centre of the bulb is the bud for the next year's flower.

Tubers

Potato sprouting – this is not rights free but exactly what is needed here


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3.1 Making new plants

GET STARTED

Introduce the topic using PowerPoint Slides 1–4.

Take the children out into the school grounds to find plants with flowers. Children work in small groups and take a flower, draw it large on the school playground using chalk and annotate it with any previous learning that they remember about flowers and plants. They could write about how they survive, how they pollinate and their parts. Groups visit one another's drawings to make suggestions or gain information for their own diagram. Leave their work if possible so that they can return to it later in the lesson and add information. Take photographs.

LET'S THINK LIKE SCIENTISTS

Use these questions to develop research skills and speaking and listening:

- Why is pollination so important to gardeners and farmers?
- If some grapes are seedless, how do you grow new grape plants?

ACTIVITIES

1 PLANT REPRODUCTION

L.O. Describe the life process of reproduction in some plants and animals.
Report and present findings from enquiries, including conclusions, causal relationships and explanations of and degree of trust in results, in oral and written forms such as displays and other presentations.

- Introduce children to plant reproduction by reminding them that they learned about plant parts and their functions in Year 3. Encourage children to remind themselves of learning by using books, the Internet, etc. They should self-check to make sure that they are correct.
- Give children a flower to dissect, they could work in pairs to share knowledge. They could stick the different parts of their dissected flower on a piece of card and annotate it to identify parts of the flower head and function of each part. Show children PowerPoint Slide 6 and check if their annotations are correct and then use this to discuss pollination.
- Explain the role of pollen and eggs. Pollen are the male cells. Eggs are female cells. When the pollen meets an egg, it fertilises it. This is called sexual reproduction. The fertilised egg then turns into a seed. Get the children to look at their dissected flower in more detail and identify where the pollen is made, where the pollen lands, and how it travels to the egg. There are a number of video clips that show this process, and children should access these or use books to watch and read about pollination and plant fertilisation (see Useful Websites list).
- One key point that moves their learning on from Year 3 is the need for male and female cells so a male cell fertilises the female cell, which becomes a seed. The seed is dispersed, grows into another plant and the process begins over again – hence the 'life cycle'. In plants this is called sexual reproduction because it requires the male cell to fertilise a female cell.

YOU WILL NEED

- Flowers to be dissected
- Activity Resource 3.1
- PowerPoint Slides 6–12
- Video clips (see Useful Websites list)

ASSESSMENT

Subject Knowledge

- Em. Children can identify parts of a plant but not link to the process of reproduction.
- Exp. Children can describe how a plant is pollinated.
- Exc. Children can apply their knowledge to a different plant.

Working Scientifically

- Em. Children need support to explain the process of pollination and fertilisation, with the help of, for instance, a puppet or plant model.
- Exp. Children create a video of the process of plant reproduction using the process of pollination.

- Give children a set of cards from Activity Resource 3.1 to order and complete the plant fertilisation sequence. Use PowerPoint Slides 7–12 to support them in their knowledge of the process.
- Children learn and understand the process by making a 'Common Craft' style video animation called 'The life cycle of a plant' using simple pictures drawn on paper and cut outs (see Useful Websites list for an example). As an alternative, children could create a plasticine model, draw the life cycle as a comic strip, create an information page or even act out a role-play.
- Whichever method children use to explain the process, use a framework to support their communication of plant pollination and fertilisation. Begin by getting the children to storyboard the process, e.g.:
  - List the key scientific vocabulary you will need; e.g. *stamen, pistel, ovary, pollinator, pollen, male, female* and *fertilisation*. Use PowerPoint Slide 12 to remind children that fertilisation results in the production of seeds, which are the next plant.
  - Make a storyboard frame for each step in the process, check your steps are in the right order and correct.
  - Add a sentence of two for each step – this is your narration or text.
  - Now apply your 'story of pollination' to the genre you are going to use to communicate to someone else.
- Once children have completed this activity, they should share their 'story' with a different group, or children from a parallel class. Use this as an opportunity to peer assess where a different group provide positive critical feedback, checking the language used and accuracy of the knowledge of the process.

- Exc. Children are able to include in their video more than one plant example, or different pollinators, and know the role that animals including insects play in pollination and plant reproduction.

2 NEW PLANTS FROM OLD

L.O. Describe the life process of reproduction in some plants and animals.

- Revise and reinforce learning about plants that reproduce sexually as a starter. To do this, give groups the name of a part of a flower, e.g. *petal, anther, stamen, filament, stigma, ovary, ovule, nectary* and *sepal,* and each group must write a glossary definition, drafting and re-drafting using their mini whiteboards. If they are unsure, they can check in a book or use the Internet. You talk through the 'story' of plant reproduction and the group must put their hand up when their part is mentioned in order to tell the rest of the class what it does.
- The aim of the following activity is for children to know that not all plants reproduce sexually and some plants can reproduce without flowers or fertilisation. This is called asexual reproduction.
- Give each group:
  - A spider plant and / or a strawberry plant, both of which need to show the runner.
  - Some bulbs, e.g. onions, daffodil that have new bulbs (plants) growing on them.
  - Tubers, e.g. potatoes that have sprouting eyes.

YOU WILL NEED

- Plants for each group, e.g. spider and / or strawberry plants, bulbs, potatoes that are sprouting from their eyes
- PowerPoint Slide 13
- Pens and paper
- Camera to record results

ASSESSMENT

Subject Knowledge

- Em. Children can say where the new plant is on a bulb, tuber and runner.
- Exp. Children describe how the different plants create new plants.
- Ext. Children are able to compare the different ways of plant reproduction and give advantages and disadvantages for each one.

- Tell children that in each case new plants are being made and ask them to work out how this happens. Encourage them to observe the plants and to discuss their ideas with the rest of the group. Ask the children to look carefully and see if they can explain why the strawberry or spider plant has runners, the potato has eyes and small onion or daffodil bulbs have mini bulbs attached. Ask them to compare this way of producing new plants and sexual reproduction from the previous activity: what are the similarities and differences and what are the advantages and disadvantages of both? You could show children PowerPoint Slide 13 that shows examples of each.
- Give children access to the Internet, books or leaflets so that they can check and add to their ideas. When the children are ready, tell them that their next task is to write a sentence next to each one explaining how the plant reproduces. They could do this by making a fact card for each one, annotating around the plant or use a dry-wipe pen on their table. Use this as an opportunity for children to visit another group to peer assess and give feedback, e.g. one good thing and another to think about either an improvement or additional information.
- Now tell each group that they are going to plant and grow some of the new plants from the old and video the process with a commentary that uses these words: *asexual reproduction, runners, spider plant, strawberry plant, same* and *parent*.

3 PLANTS FROM CUTTINGS

L.O. Describe the life process of reproduction in some plants and animals.

- Demonstrate to children how to take a cutting from a plant, so that children know what to do when they take theirs. The CPD video ‘Circle of life’ shows how to take cuttings from a plant. People can grow plants by taking cuttings, which means that new plants can be grown from an existing plant.
- Explain that some plant stems can grow roots if they are planted in the correct conditions. Gardeners do this to create lots of copies of the same plant without having to grow them from seeds. Show children the video clip ‘Circle of life’ (see Useful Websites list on *My Rising Stars*) that explains how to take cuttings from geranium plants.
- Give each group a geranium plant to take cuttings from and plant in small pots. Ask them to take a series of photographs with a digital camera to record the process and how they grow and develop into new plants. What do they think is the advantage of this approach? How is it different to sexual reproduction? Why is this an efficient and cheap way to grow new plants?
- Remember to allow time to check on the progress of the plants every week for the rest of the term and water the pots regularly. The geranium cuttings could form part of an outdoor pot display.

YOU WILL NEED

- Cuttings from plants (see video, `Circle of life’ on *My Rising Stars*)
- Geranium plants for each group
- Camera to record results
- Video clip (see Useful Websites list)

ASSESSMENT

Working Scientifically

- Em. With support, such as photographs or watching and stopping a video at set points, children take cuttings and grow them.
- Exp. Children are able to carry out and explain how to take plant cuttings and why this is useful.
- Exc. Children independently use scientific language to explain how to take a plant cutting and the advantages and disadvantages compared with sexual reproduction of plants.

3.2 Animal life cycles

GET STARTED

Show children the video, 'Circle of life' again and ask them to think about how many different kinds of life cycle were shown, to name them and think about which one is the closest to the human life cycle. Then ask children; what do they all have in common? They are all cycles – life cycles.

LET'S THINK LIKE SCIENTISTS

Use these questions to develop research skills and speaking and listening:

- Which came first, the chicken or the egg?
- Why do most eggs you buy in the shops not turn into chickens?
- What does 'metamorphosis' mean?

ACTIVITIES

1 BIRD LIFE CYCLES

L.O. Describe the differences in the life cycles of a mammal, an amphibian, an insect and a bird.

- Ask children what they think is inside a chicken's egg. You may be surprised what children think, and so this is a good way of finding out children's initial ideas.
- Once they have completed this short starter, give children the time to share their ideas. Next, show children a video clip of the life cycle of a chicken (see Useful Websites list on *My Rising Stars*). The suggested video is short, so show it twice to the children so that they can take notes. The children share what they have learned within their group and think of any questions they still many have about a hen's life cycle. Using their notes and additional information they have researched from, e.g. photographs, books and Internet sites, ask them to create a group poster of an annotated life cycle diagram. Encourage children to draft out their poster first and also consider how they could make parts of it interactive or 3D. Depending on the time of year, children could also look at some of the bird nest webcams provided by organisations such as the RSPB.

YOU WILL NEED

- Video clip: 'Life of chicken' (see Useful Websites list)
- Books and websites giving information about the life cycle of chicken
- Materials to make a poster

ASSESSMENT

Subject Knowledge

- Em. Children can say that a hen lays an egg and a chick hatches.
- Exp. Children describe the life cycle of a hen.
- Exc. Children can explain how the embryo changes and hatches and then continue explaining that this cycle is repeated.

2 BUTTERFLY LIFE CYCLE

L.O. Describe the differences in the life cycles of a mammal, an amphibian, an insect and a bird.

- Begin reminding children of literacy work related to prefixes and ask them to use their dictionaries to find out what the prefix 'meta' means and the word 'morph', then work out what the word 'metamorphosis' might mean. Share ideas and come to an agreed definition.
- Show the children photographs or a video clip to teach them the life cycle of a butterfly and illustrate the idea of changes as metamorphosis.
- Prepare a set of lolly sticks onto which is written the names of common British butterflies such as the Red Admiral, Cabbage White, Brimstone, Peacock, Speckled Wood and Comma. Each group takes a lolly stick and researches the life and life cycle of that butterfly, which should include:
  - Description
  - Body parts
  - Habitat
  - Diet
  - Life cycle; egg, caterpillar (larva), chrysalis
- Using this information, children create a fact card in the shape of the butterfly or a model of a life cycle that, when completed, they share with another group. They then discuss the similarities and differences between the different species of butterflies. Ask children to compare their work on the life cycle of a chicken (bird) with the life cycle of a butterfly and list the similarities and differences.
- Depending on the time of year and the habitats available around your school, children could go on a life cycle hunt looking for evidence of the different phases of a butterfly's life cycle or join the annual Big Butterfly Hunt (which usually take place July to August).
- Engage children to analyse the results on a national count looking for trends in butterfly numbers (see Useful Websites list), which could result in them researching how to attract butterflies into the school grounds and planting appropriate plants. Bee and butterfly seed mixes can also be purchased and sown.

YOU WILL NEED

- Information sources about butterflies, including photographs showing the stages of a butterfly's life cycle and video clips, national butterfly count (see Useful Websites list)
- Lolly sticks labelled with butterfly names
- Cards and pens

ASSESSMENT

Subject Knowledge

- Em. Children can place pictures of a butterfly life cycle in order.
- Exc. Children describe the life cycle of a butterfly.
- Exp. Children explain how the life cycle of a butterfly is an example of metamorphosis.

3 LIFE CYCLE OF A FROG

L.O. Describe the differences in the life cycles of a mammal, an amphibian, an insect and a bird.

Report and present findings from enquiries, including conclusions, causal relationships and explanations of and degree of trust in results, in oral and written forms such as displays and other presentations.

- Use the poem *Changes* by Jill Brasell as an introduction to life cycles. It is fun and you could suggest to children that they write their own as a home or school activity.
- In this activity children choose how to communicate the life cycle of a frog in an interesting way, e.g.:
  - Mini-book
  - Life cycle wheel
  - PowerPoint
  - Model using dough or recycled materials
  - Animation
- Use PowerPoint Slide 15 to show examples of ways of communicating the life cycle of a frog.
- To do this they will need to research the life cycle of a frog, make notes and use those notes for their project. Give children access to books, specific websites (see Useful Websites list on *My Rising Stars*) and to video clips they can watch and take notes about.
- Make sure that, prior to the activity, you discuss with the children what they think should be the success criteria for their work, e.g.:
  - It communicates the correct scientific knowledge of the frog life cycle.
  - Correct scientific language is used.
  - Metamorphosis is shown.
  - The life cycle of a frog is compared with another animal, e.g. chicken or butterfly.
  - It is well presented in an interesting way.
- Show the class the video about frogs that was made by a young person (see Useful Websites list). The children use their agreed criteria to assess of her presentation: What was good about it? Was there anything that she could have improved?
- You could use the Interactive Activity with children who require support. It asks them to drag and drop to complete life cycles of a frog, butterfly and a chicken.
- Read to the class *Tadpole's Promise* by Jeanne Willis and Tony Ross and ask children to write their own story but in the context of a different life cycle.

YOU WILL NEED

- Resources about life cycle of frog, including video clips
- Interactive activity 'Circle of life' (from *My Rising Stars*)
- Poem: Changes by Jill Brasell
- *Tadpole's Promise* by Jeanne Willis and Tony Ross
- PowerPoint Slide 15

ASSESSMENT

Subject Knowledge

- Em. Children can place pictures of a frog life cycle in order.
- Exc. Children use their research to describe the life cycle of a frog and can talk about key similarities and differences between the life cycle of a frog and another animal.
- Exp. Children explain how the life cycle of a frog is an example of metamorphosis and compare it with, for example a butterfly.

Working Scientifically

- Em. Children can tell the story of a life cycle e.g. orally, using dough models, drag and drop.
- Exp. Children can present their research, communicating scientific knowledge and using scientific language.
- Exc. Children choose a specific genre linked to audience to communicate their research

3.3 Making babies

GET STARTED

Watch the video clip: 'Bird of Paradise' (see the Useful Websites link on *My Rising Stars*) and ask why children think the male makes such an effort to attract a mate. What do they think would happen to an animal species if mating and reproduction did not happen?

LET'S THINK LIKE SCIENTISTS

Use these questions to develop research skills and speaking and listening:

- If rabbits have so many babies, why isn't the world covered in rabbits?
- Why does a frog need to produce so many tadpoles?
- Why do zoos sometimes send their male animals to other zoos?

ACTIVITIES

1 WHY DO SOME ANIMALS LAY SO MANY EGGS?

L.O. Plan different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary. Take measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings when appropriate.

Use test results to make predictions to set up further comparative and fair tests.

- Remind children about pollen and eggs in plants. Explain that male animals make sperm, females make eggs. When sperm meets an egg, it fertilises it. In many animals this happens outside the body.
- Use PowerPoint Slides 16–20 to help children develop their understanding of animal reproduction. As a class: Show the video about coral (see Useful Websites list on *My Rising Stars*). Ask the children to think about why the coral needs to release a lot of sperm / eggs. Then show children the 'Springwatch' video and ask the question, why do you think that frogs lays so many eggs? Follow this by showing them how newts feed on frogspawn (see Useful Websites list for both). Animals, like frogs and coral, release large amounts of sperm to increase the chances of all the eggs being fertilised.
- In this activity, children investigate why some animals release lots of sperm and eggs. Here they model sperm and eggs by this using birdseed and plastic cups.
- Working outside, place the plastic cups a few centimetres apart in a group. Explain to the children that you are going to imagine that you are frogs. The birdseed is the 'sperm' and the plastic cups are the 'eggs'. If the seed gets into the cup, it has been fertilised.
- Choose a volunteer and hand them five seeds. Stand 2 m away and try to throw the birdseed, one seed at a time, into the plastic cups.

YOU WILL NEED

- Paper or plastic cups
- Birdseed
- PowerPoint Slides 16–20
- Video clips (see Useful Websites list)
- Activity Resource 3.2
- Information sources about animal life cycles and reproduction

ASSESSMENT

Working Scientifically

- Em. Children describe the activity and need support to link it to the concept of reproduction.
- Exp. Children use the data to describe what happens when lots or small amounts of sperm is produced.
- Exc. Children use the data to explain the advantages of producing lots of eggs and sperm and link this to reproduction of different animals.

- Count how many 'eggs' were fertilised. Now hand another volunteer a large handful of birdseed. Ask them to throw the whole handful in one go at the plastic cups. Count how many eggs were fertilised this time. Are more fertilised than last time? Why? What does this show? In external fertilisation, large numbers of sperm and eggs are released. The reason so much sperm is released is that it increases the chances of eggs being fertilised.
- Next give the children a list of several different animals, such as frog, horse, duck, salmon, and for each animal, children carry out research to find out whether fertilisation happens inside or outside of the body and roughly how many offspring are produced at a time. Bring the class together to discuss why frogs have so many babies and horses have so few? How would this affect how the parents care for their offspring? On a large sheet of paper, list the advantages and disadvantages of having one baby, then do the same for having hundreds. Discuss as a group and collate the ideas on the board. Children should then be able to complete Activity Resource 3.2.

HEALTH AND SAFETY

Be aware of children who may have seed / nut allergies.

2 UNUSUAL LIFE CYCLES

L.O. Describe the differences in the life cycles of a mammal, an amphibian, an insect and a bird.

Describe the life process of reproduction in some plants and animals.

- Show children the video clip of the life cycle of the cicada (see Useful Websites list on *My Rising Stars*) and ask children to discuss in groups what they think is unusual about it.
- In this activity, children research the life cycle and reproduction of other plants and animals from around the world (in the rainforest, in the oceans, in desert areas and in prehistoric times). They do this by asking pertinent questions, and researching answers that enable them to think about why their life cycles are different, e.g.:
  - Seahorse: the males give birth.
  - Duck billed platypus and echidna: are mammals but lay eggs.
  - Mayfly: remains a nymph for several years yet may only live for 24 hours as an adult.
  - Dung beetle: lay each egg in a dung ball.
  - Kangaroo: the baby lives in a pouch.
  - Dinosaur: laid eggs (reptiles) – how do we know?
  - Coco-de-mer palm: has the largest seed.
  - Cacti: wait for rain before flowering.

YOU WILL NEED

- Video clip of the cicada (see Useful Websites list)
- Information sources on animal and plant life cycles and reproduction
- Lolly sticks labelled with different animals and plants

ASSESSMENT

Subject Knowledge

- Em. With support, e.g. using cards, children can arrange and talk about a simple life cycle.
- Exp. Children research and represent the life cycle.
- Exc. Children research and represent the life cycle and explain why it is unusual.

- Children often find it hard to choose an animal or plant to research, so use the lollipop stick approach used previously; write the name of an animal or plant on each stick and then someone from each group picks a stick to research what is written on it.
- After completing the research, ask children to create a life cycle poster to display in the school hall or corridor so that children from other classes can learn about life cycles.

3 ENDANGERED ANIMALS

L.O. Identify scientific evidence that has been used to support or refute ideas or arguments.

- Set a timer for two minutes and challenge groups to list as many animals as they can that they think are endangered, i.e. at risk of dying out and becoming extinct. At the end of the time, show the children PowerPoint Slide 21 that shows how many plants and animals become extinct every day.
- Why are some animals in danger of becoming extinct? Ask children to create a definition of the word 'extinct' and listen to each other's meaning then create a definition with the whole class. Ask the children to name animals that they know about that have become extinct such as the dodo, Tyrannosaurus Rex, etc. Show children PowerPoint Slide 22, which shows photographs of endangered species.
- Show the photo slideshow of endangered animals (see Useful Websites list). Discuss the different animals shown. Give each group time to create a spider diagram of some of the reasons why animals may become extinct. Discuss with the class and introduce any reasons they hadn't thought of.
- Give children the following list of animals and ask each group to research the reasons their animal is endangered: what is threatening each animal?

  Tigers Parrots Macaws Gorilla

  Sumatran rhinoceros amur leopard ring-tailed lemur orangutan
- Give them Activity Resource 3.3 to collect information about their animal and use it to prepare a two-minute presentation.
- After each group has given their presentation to the class on behalf of their animal, the class can then vote on the most effective one and say why. After children have listened (and asked questions) to each group, ask them to think about what is common in each case, that is, humans are responsible for animals becoming endangered, e.g. war, cutting down habitats, poaching, selling animals for their fur, ivory and as pets.

YOU WILL NEED

- Activity Resource 3.3
- Information sources about endangered animals
- PowerPoint Slides 21 and 22
- BBC slideshow of endangered animals (see Useful Websites list)

ASSESSMENT

Subject Knowledge

- Em. Children can name some animals that might become extinct like dinosaurs.
- Exp. Children are able to talk about why different animals might become extinct.
- Exc. Children make links between endangered species and the effect of human activity.

4 FOR AND AGAINST ZOOS

L.O. Identify scientific evidence that has been used to support or refute ideas or arguments.

- Begin by asking children whether they think zoos are a good thing and ask them to vote for or against zoos. Count the votes and keep a record so that towards the end of this activity children can return to the outcome and vote again to see if anyone has changed their ideas as a result of finding out about zoos. You could use PowerPoint Slide 23 as a starting point for this discussion.
- Set this activity in the context of children asking other people what they think and collecting arguments for and against zoos. Children could interview other children and adults around the school and of course at home.
- Children should also at school or at home (or both) research the arguments for and against zoos, as well as access zoo websites to find out what zoos do for endangered species.
- A simple way to collect the for and against arguments is to create a working wall titled 'For / Against' where children can place sticky notes or write their arguments, as well as, being a place where they can place data for the number of people for and against zoos.
- Split the class into three groups: 'for', 'against' and an 'undecided' group. The 'for' and 'against' groups report their arguments and evidence to support their ideas and the 'undecided' group is allowed to ask questions. At the end the 'undecided' group has to decide which group provided the most persuasive evidence.
- At the end of the work return children to the original survey that asked children whether they were for or against zoos. Rather than simply ask them to vote again, ask them to think about what they have learned and ask them to write down which argument would persuade them to vote the opposite to the way they first voted.

YOU WILL NEED

- PowerPoint Slide 23
- Sticky notes

ASSESSMENT

Working Scientifically

- Em. Children decide whether they like zoos or not but are unable to give scientific reasons.
- Exp. Children use their research to make decisions about zoos.
- Exc. Children recognise both sides to the argument and use evidence to support or refute their decision.

5 MEET THE SCIENTISTS

L.O. Identify scientific evidence that has been used to support or refute ideas or arguments.

- Show the video about Jane Goodall, which describes her work and legacy. Ask the children to think about and discuss in their groups what kind of person she was, e.g. was she brave, foolish, determined, patient? How did she work to save chimpanzees?
- Ask children to think about how we know so much about different animals? What do people do to find out about animals? Collect their ideas and list them.

YOU WILL NEED

- Video clip – Jane Goodall (see Useful Websites list)
- Information sources about environmentalists etc. to be researched
- Activity Resource 3.4
- PowerPoint Slides 24 and 25

- Give children the following words and ask them to find out what they mean using their dictionaries and what they have in common:

Naturalist	Conservationist
Environmentalist	Ecologist

- Do children know the names of anyone other than Jane Goodall who is passionate about plants and animals, who is naturalist, a conservationist or presents television programmes?
- Create a class mind map accepting in the first instance all ideas.
- Give each group the name of one of the following people:

Jane Goodall	Sir David Attenborough	Jacques Cousteau
Peter Scott	Rachel Carson	Gerald Durrell

- Explain that they are going to produce a biographical report or a presentation about that person's life and work. Children might want to use the 'Planning your presentation' sheet (Activity Resource 3.4). Before they begin you could use the literacy support shown on PowerPoint Slides 24 and 25 to remind children about biographies and how to create one. It would also be useful to discuss the following with children, which is aimed to support them in accessing and taking notes from books, video clips or the Internet.
  - Assessing the information – Do I think it is reliable?
  - Cross check – Use two sources and see if they say the same thing, e.g. dates
  - Skim and scan – to pick out important information
  - Take notes – do not copy, just take key words and ideas
- As children gather information remind them that they may need to explain evidence of how their scientist researched animals, and how they used their work to say, for instance, that humans are affecting how animals live. They should use this information to help support their argument for the ideas the scientist has about animals and, for eaxmple, why some are becoming extinct.
- When they have collected all of their information then ask children to think about the best way to present the biography, such as a newspaper article, magazine article, book, TV programme or PowerPoint presentation.
- Over a week, each group could present their biography to the rest of the class who can ask questions as well as engage in peer assessment by commenting on good points and making suggestions for improvements.
- When children have heard all the presentations the class could then vote on which scientist they think has made the most impact, giving reasons why.

ASSESSMENT

Working Scientifically

- Em. Children are given information, e.g. sentences and pictures to support their research.
- Exp. Children are able to explain the ideas of their scientists and what they did to find out about animals.
- Exc. Children are able to create a biography that focusses on how the person researched, their ideas and impact on how people think and what they do today.

6 WE ARE CONSERVATIONISTS

L.O. Plan different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary.

Record data and results of increasing complexity using scientific diagrams and labels, classification keys, tables, scatter graphs, bar and line graphs.

Identify scientific evidence that has been used to support or refute ideas or arguments.

- Ask children to draw a picture of themselves as a conservationist and what qualities they think that they have that would make them good at this role.
- Having learned about life cycles of plants and animals and famous conservationists, this activity aims to give children the opportunity to apply what they have learned to finding out about living things in their local environment and plan how they could have a positive impact.
- Ask children to think about what they have learned during this topic especially how people have studied animals, what did they do and what evidence did they collect, e.g.:
  - Jane Goodall observed and took notes, photographed and videoed. She identified individual animals and kept a record of how they behaved.
  - Sir David Attenborough filmed animal behaviour, some of it never seen before.
  - Rachel Carson recorded a number of animals and made links between animal populations declining and the use of pesticides.
- Ask the class to think of ways that they could find out about their local environment using some of the approaches the scientists used, e.g. photographs, sketches, notes and counting populations.
- Take children out into the school grounds and local environment so they can explore plants and animals (e.g. invertebrates) and choose one plant or animal, or an area (e.g. tree or hedge) to study, gather information and become an expert in what they have chosen.
- They could begin by asking a range of questions using question stems and then decide how to answer them using different scientific enquiries such as: research, observation over time, pattern seeking (tally charts, counting populations). They could even carry out a comparative test such as what happens if they plant a wildlife area. Does the number of insects increase? Can they provide evidence to support their idea?
- This project could be given a dedicated day or week, or spaced out over, e.g. a month or several terms as a special project.

YOU WILL NEED

- Camera and other materials for gathering and recording information

ASSESSMENT

Working Scientifically

- Em. Children require support to find out about animals in a given habitat.
- Exp. Children collect useful research information and data from their local environment to inform conclusions and decisions.
- Exc. Children use how famous scientists work to plan data collection and inform their plan to make a positive effect on the local environment.

TOPIC 4

Let's get moving

About this topic

Curriculum link: Year 5, Forces

SUMMARY:

In this topic children learn about forces and machines. They start with the force of gravity then study friction forces, including air and water resistance, before investigating how simple machines work.

UNITS:

4.1: Forces of nature
4.2: Friction
4.3: What are simple machines?

ACTIVITY RESOURCES

- 4.1: How does gravity act?
- 4.2: Read all about it!
- 4.3: My investigation plan
- 4.4: Levers, table and graph
- 4.5: Pulleys
- 4.6: Working out maths in gears
- 4.7: My Rube Goldberg design

ONLINE RESOURCES:

Teaching slides (PowerPoint): Let's get moving
Interactive activity: Let's get moving
CPD video: Let's get moving
Pupil video: Let's get moving
Word mat: Let's get moving
Editable Planning: Let's get moving
Topic Test: Let's get moving

Learning objectives

This topic covers the following learning objectives:

- 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.

Working scientifically skills

This topic develops the following working scientifically skills:

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

CROSS-CURRICULAR LINKS

This topic offers the following cross-curricular opportunities:

English

- Ask questions about forces, e.g. how air and water resistance are used in sport.
- Retrieve, record and present information from non-fiction about famous scientists, e.g. Galileo, Newton.
- Provide reasoned justifications for their views using data and subject knowledge, write conclusions.
- Use of science dictionaries.
- Use a thesaurus to improve explanations in science.
- Identify the audience for and purpose of communication in science, select the appropriate form, e.g. PowerPoint, newspaper article, Blog, leaflet.
- Produce instructions for another group on how to undertake a fair test investigation.
- Structure text using, for instance, headings, bullet points, underlining, check grammar.

- Assess the effectiveness of their own and others’ writing in science.
- Read *Egg Drop* by Mini Grey.

Numeracy and mathematics

- Decide on the levels of accuracy required, e.g. parachute drop time.
- Calculate the area of, e.g. a parachute canopy.
- Use appropriate equipment, e.g. Newton meters.
- Decide when to use and calculate averages, e.g. repeat readings.
- Measure angles, e.g. resistance, rockets.
- Use appropriate graphs, e.g. bar or line according to the data.
- Compare data and solve difference problems in line graphs.
- Solve comparison, sum and difference problems using information presented in a line graph
- Complete, read and interpret information in tables, including timetables.

Computing / ICT

- Use graphing packages, e.g. tables and graphs for recording, presenting and analysing data.
- Use slow-motion video, e.g. parachute falling to help explain science concept of air resistance.
- Use Internet safely to research how air and water resistance is used, famous scientists.
- Use computer for communicating science, e.g. Word and Publisher.
- Select appropriate software / Apps for the task, e.g. slow motion, stopwatch.
- Question trustworthiness of Internet information by verifying it with another independent source.
- Take photographs of cars and use them to make a slideshow explaining streamlining.
- Use the computer to share outcomes from, e.g. fair testing with another class or school.

History

- Create a timeline of different travel, e.g. air, sea, road.
- Research scientists, e.g. Isaac Newton, Galileo.

PE

- Using PE equipment to learn about gravity and explore how some equipment is designed to reduce friction / be aerodynamic.
- Watch Olympic video clips, talk to athletes about being aerodynamic and reducing air and water resistance.

Geography

Locate local, national and international places where key events related to travel took place, e.g. Stephenson’ Rocket, Campbell’s Bluebird, NASA space launches.

STEAM (SCIENCE TECHNOLOGY ENGINEERING ART AND MATHS) OPPORTUNITIES

Invite into class

- Someone from the local community who skis, mountain climbs or any other sport that requires understanding of forces.
- Sports ambassadors to illustrate how forces are used.
- Outreach from the physics department of a local university to engage children in activities related to forces including levers, pulleys and gears.
- Someone who role-plays Isaac Newton or Galileo.
- RAF or someone from a local airfield involved in parachute jumps.
- A cyclist who can discuss and demonstrate forces and friction in cycling.
- STEM Ambassador, e.g. an engineer.

Visit

- Local museum, particularly machinery.
- Local motor garage to find out about how pulleys, levers and gears are used.
- Visit local cycle shop to find out about gears.
- Visit a local climbing wall to experience how forces are used.

HEALTH AND SAFETY

If using metal masses, make sure that children know how to use them to avoid dropping on feet, fingers or surfaces that can be damaged.

TEACHER SUBJECT KNOWLEDGE

Gravity

Gravity is an attractive, non-contact force. It is measured in Newtons (N).

Any two objects have a force of gravity between them. This only becomes obvious when the objects have a very large mass, such as the Earth, Moon or Sun. Gravity gives weight to objects with mass and causes them to fall towards the centre of the Earth when dropped. The force of gravity on the Moon is less than that on the Earth.

Galileo discovered that everything falls at the same speed. In 1658 he dropped two balls of different masses from the leaning tower of Pisa. He discovered they hit the ground at the same time. This contradicted the ideas of Archimedes and the accepted view that heavy objects fall faster than light objects.

Sir Isaac Newton first set out the laws of gravity. His universal law of gravitation states that every mass in the universe attracts every other mass with a force that is directly proportional to their combined masses and inversely proportional to the square of the distance between them. Albert Einstein further developed the theory of gravity. He didn’t believe it was a force at all. Instead, he said gravity was a distortion in the shape of space–time, otherwise known as ‘the fourth dimension’. According to him, moving objects move in space–time, which fits with Newton’s theory.

Friction

Friction is a force. It occurs when any two things rub against each other. These can be solid things, like your two hands rubbing together or a hammer hitting a nail. They can be gases, like the air slowing down your car. In this case, we call the friction air resistance. And finally, friction can occur in liquids, such as when water slows down a boat.

The size of the friction force can be very big; two rough surfaces will generate more friction than two smooth surfaces.

Air and water resistance are what’s known as drag forces. These depend on the shape, size and speed of the object that is moving through the air or water. Streamlining jet planes or submarines reduces the air or water resistance, allowing the objects to move through air or water much better.

Taking measurements

Forces can be measured using a force meter / Newton meter. Force meters contain a spring connected to a hook. If the hook is fixed onto an object and pulled until the object starts to move, the spring stretches, the bigger the force applied (pull) the longer the spring stretches and the bigger the reading. Newton meters measure in Newtons (N), the higher the number the bigger the force.

CHILDREN’S MISCONCEPTIONS

Children might think...

- That heavy objects fall faster than lighter objects. In fact, they both fall at the same speed.
- That objects come to a stop when there is no friction. In fact, they’ll keep on moving forever if they’re left alone.
- That friction only occurs between solids and surfaces. Water and air resistance are examples of friction that involves a liquid and a gas.

Children already know...

- A little about forces covered in the magnets topic in Year 3, so they should know what a force is and that some forces do not have to be in contact to act.

SCIENTIFIC VOCABULARY

You can download a Word mat of essential vocabulary from *My Rising Stars*.

air resistance: the resistance of air to forward movement

force meter: an instrument for measuring forces

friction: the force made when two objects rub against each other

gravity: the force that attracts a body towards the centre of the Earth

Newton: the unit of force

non-contact force: a force that does not need to touch an object to work, e.g. magnetic force

reliable: something that can be depended on

water resistance: the resistance of water to forward movement

weight: the force with which something is attracted to the Earth

Did you know?

- Albert Einstein didn't believe that gravity was a force at all. He believed that gravity was a distortion of space and time.
- Modern submarines have a teardrop-shaped hull, which is the best shape to help them reduce water resistance.
- The ancient Greeks, Egyptians, Indians and Chinese all used simple machines to build marvellous structures like the pyramids and the Great Wall of China.
- Some racing bikes can have as many as 27 or 33 speed gears.
- Rube Goldberg's cartoons are actually mocking modern society's dependence on complex technology.

4.1 Forces of nature

GET STARTED

Show photos of the effects of gravity and other forces such as air resistance and discuss the Let's think like Scientists questions on the right.

LET'S THINK LIKE SCIENTISTS

Use these questions to develop research skills and speaking and listening:

- What is gravity?
- What would happen if there was no gravity?
- What would happen if the force of gravity on Earth was bigger or smaller?

ACTIVITIES – GRAVITY

1 INVESTIGATING GRAVITY

L.O. Explain that unsupported objects fall towards the Earth because of the force of gravity acting between the Earth and the falling object.

Plan different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary.

Use test results to make predictions to set up further comparative and fair tests.

- Prior to this lesson give children a home or school activity challenge to research Isaac Newton and Galileo and to bring what they have found out to share with classmates. Ask children to share with a partner what they have found out, and then with someone else from another group, using if they want to any new ideas, facts, etc. they have learned from someone else. Bring children together and ask them a set of key things that they found out about Newton and Galileo; in particular, their scientific thinking.
- Take children out into the playground or onto the field with a range of PE equipment, e.g. foam javelins, a range of balls, soft athletics hammer, soft discus and any other piece of equipment that can be safely thrown. Tell the children that they are going to carry out a science activity and they have to work out the connection between the activity and Newton. They are going to explore throwing the different pieces of equipment as high and as far as they can (making sure that they work safely) and to find the links every time they use the PE equipment.

YOU WILL NEED

- Range of PE equipment that can be safely thrown
- Chalk or pens and paper

ASSESSMENT

Working Scientifically

- Em. Children describe what they have done and require support to link the scientific ideas of gravity and how things fall to the activity using PE equipment.
- Exp. Children make links with using the PE equipment with ideas about gravity and how things fall.
- Exc. Children make links with their research and explicitly test Newton's and Galileo's ideas about gravity and how things fall, e.g. How can we keep it up in the air longer? Do all balls hit the ground at the same time?

Subject Knowledge

- Em. Children can say that objects will fall to the ground.

- Bring the class together outdoors and ask them to draw or write their ideas in chalk on the playground, or back in class on a large sheet of paper. Get them to share ideas and make links between what they know about Newton and Galileo and their experiences with the PE equipment. Draw out ideas about gravity, force, non-contact force, invisibility and how things fall to the ground, as a starting point for the next set of activities. Ask children to think about how they could use the PE equipment to demonstrate the ideas that Newton had about gravity and Galileo about how things fall. Allow them to go back and use the equipment to rehearse and refine their ideas.

- Exp. Children will say that object fall to the ground because of the force of gravity.
- Exc. Children explain that objects fall towards the Earth because of the force of gravity acting between the Earth and the falling object. (non-contact force).

2 GALILEO AND NEWTON

L.O. Plan different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary.

Use test results to make predictions to set up further comparative and fair tests.

- Put a timer on for about three minutes. Working in groups of three, give each group a set of sticky notes (each group should have a different colour) and ask them to write one fact about Galileo and Newton and see which group can put the most facts on the board.
- Take this activity outside or into the hall and give each group the set of differently sized balls. Ask them what would happen if you dropped them from the same height at the same time. Gather their answers, do not worry if they vary, it might be because children find it hard to keep an eye on all of the balls at the same time or that they were not dropped exactly at the same time. What they should notice is that all of the balls hit the floor at the same time. The children could use a tablet and video and play back using slow motion to check what happened, they might need some support in thinking what the camera should be focusing on; it might be close to the floor where the balls will hit.
- Use PowerPoint Slides 5 and 6 to further children's knowledge of gravity. You could reinforce this by showing a video clip and discuss gravity in more detail. Explain that something is pulling the balls down towards the centre of the Earth and this is a force called gravity. Remind the children about their research on Galileo and his experiment at Pisa; they have just done something similar and got the same results. Imagine if they were Galileo, what other questions about objects falling might he have asked? In groups, children share their questions and where appropriate use the appropriate scientific enquiry to answer them.

YOU WILL NEED

- Different-coloured sticky notes for each group
- Three different-sized balls for each group
- Camera or tablet to record results
- PowerPoint Slides 5 and 6
- Video clip on gravity (see Useful Wesbsites list)

ASSESSMENT

Subject Knowledge

- Em. Children describe what happens to the balls. With support, they make links with a force pulling the balls down to the ground.
- Exp. Children explain how the balls fall using the idea of gravity as a force and try out other ideas, e.g. if the balls were of different weight.
- Exc. Children recognise gravity as a non-contact force and use observations to ask and answer new questions of their own.

3 WHY IS GRAVITY IMPORTANT?

L.O. Explain that unsupported objects fall towards the Earth because of the force of gravity acting between the Earth and the falling object.

Identify scientific evidence that has been used to support or refute ideas or arguments.

- Give children the opportunity to discuss the question ’Why is gravity important? and collect their ideas to return to later in the activity.
- The aim of this activity is to help children understand that gravity attracts all objects towards the Earth (and each other). Gravity works all over our Earth and also everywhere in the Universe. Without Earth›s gravity, we would fly off its surface.
- Use the whiteboard to show children a globe and place a matchstick person at the top. Ask them to draw the same on their own whiteboard. Now ask them to annotate it to describe what gravity does to the person. Now ask children to draw a person at the South Pole and near to the equator, then annotate each one to describe the effect of gravity on the person.
- Children should always draw the person being pulled towards the centre of the Earth. Next, using Activity Resource 4.1 which shows the Earth surrounded by clouds, ask them to show the direction the rain falls in and why.
- Now revisit the whiteboard work. First, ask the children to draw a picture of the Moon and the Earth on their whiteboards. Tell them the Moon orbits the Earth, ask them what they think keeps the Moon orbiting the Earth (gravity). Explain that the Moon has less gravity (downward pull) than the Earth, then show them a video clip of Neil Armstrong walking on the Moon. Ask them to apply what they know about gravity and the Moon to explain why walking is harder on the Moon than Earth.
- Finally, revisit their original answers to ‘Why is gravity important?’ and ask them to think about whether any of the statements need changing. Use Activity Resource 4.2 as a round-up and free-writing activity for gravity.

YOU WILL NEED

- Activity Resources 4.1 and 4.2
- Mini whiteboards and dry-wipe markers
- Video clip of Neil Armstrong on the Moon

ASSESSMENT

Subject Knowledge

- Em. Children can say that objects will fall to the ground but do not use the word ‘gravity.’
- Exp. Children will say that objects fall to the ground because of the force of gravity.
- Exc. Children explain that objects fall towards the Earth because of the force of gravity acting between the Earth and the falling object. (non-contact force).

ACTIVITIES – AIR RESISTANCE

1 FALLING CUPCAKE CASES

L.O. 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.

Plan different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary.

Report and present findings from enquiries, including conclusions, causal relationships and explanations of and degree of trust in results, in oral and written forms such as displays and other presentations.

- Take the children outdoors, ask them to run to the other side of the playground and back.
- Put children in pairs and give one child in each pair a large sheet of card to hold in front of them, tell them to run across the playground and back and then talk to their partner about what forces they felt. Then take feedback from everyone and ask them what they have learned from this activity. Some children might talk about air resistance, which will provide an opportunity to develop this idea.
- Carry out a quick activity where children drop two pieces of paper the same size, one scrunched up and one not so that children can compare their descent. Collect their ideas on why the same type and size of paper falls differently. Encourage discussion about air resistance, and ask children to create their own definition and place it in their book (later children can return to this and decide whether they think they want to improve upon it).
- Air resistance is the force that air exerts against a moving object, in this case the paper. When the scrunched up paper is dropped it falls more quickly to the ground than the other piece of paper. This is because the surface area of the scrunched up piece of paper is smaller and so there is less air resistance.
- As children discuss this, place words, such as *friction, air resistance*, *gravity* and *fall*, on the board or a working wall display.
- Follow this with an activity where children explore 'Falling cupcakes cases'. Begin by giving each group a range of cupcake cases of different sizes, from those used for chocolates to large muffin cases. Give children 5–10 minutes to explore what happens when they drop them. As children observe, challenge them to think about air resistance and gravity. Show the CPD video, 'Let's get moving' from *My Rising Stars*. to support children's understanding.
- Collect children's experiences and ideas, e.g. children might say that:
  - Cupcake cases usually turn when falling.
  - Bigger cupcake cases fall more slowly than smaller ones.
  - If you flatten a cupcake case it falls more slowly.

YOU WILL NEED

- Cupcakes cases of different sizes
- PowerPoint Slide 7
- CPD Video, 'Let's get moving'
- Activity Resource 4.3
- Ruler
- Stopwatch
- Mini whiteboards or paper and pens

ASSESSMENT

Subject Knowledge

- Em. Children can say that objects will fall to the ground.
- Exp. Children will say that object fall to the ground because of the force of gravity.
- Exc. Children explain that objects fall towards the Earth because of the force of gravity acting between the Earth and the falling object. (non-contact force)

Working Scientifically

- Em. Children are able to carry out a fair test without repeat readings and use their data to draw a conclusion, e.g. the bigger cupcakes fall more slowly.
- Exp. Children carry out a fair test including repeat readings, then use their data to draw conclusions and can say why they can trust their results (e.g. use of repeat readings).
- Exc. Children apply their subject knowledge to explain the relationship between their results and subject knowledge and say how they change their test to improve the degree of trust in their results.

- Next, ask children to suggest a question or idea that they could test, e.g. Do bigger cupcake cases fall faster than smaller ones? Does the size of the case affect the time they take to fall? Use PowerPoint Slide 7 as a stimulus for asking questions.
- Once children have a testable question, ask them to create a plan on a whiteboard or piece of large paper – they could concept map their plan or draw what they think they will do. Share the Working scientifically learning objectives with them that focus on measurement and reliability, challenge children to make sure that they use these in their planning and explain why they might need to repeat readings. Some children might benefit from using all or parts of the planning framework in Activity Resource 4.3.
- Move children on from non-standard measures such as little cupcake case, middle sized, etc. to measure, for instance, the diameter of each cupcake case and record their results in a table. Stopwatches should be used or a timer on a tablet. Check children understand that they need to repeat readings because there can be a delay in their response between seeing the cupcake case land and stopping the timer.
- Once data has been collected, separate out the final working scientifically statement so that you can scaffold children into developing their ability in using data at the end of a fair-test investigation.
- **Report and present findings from enquiries** – e.g. using an annotated diagram, table and graph.
- **Include conclusions** – make sure that children use numbers (their data), apply knowledge and scientific language such as air resistance, gravity.
- **Causal relationships** – between the data, i.e. the size of the cupcake case and time it takes to fall linked to the idea of air resistance, air pushing the cupcake case up.
- **Explanations of and degree of trust in results** – they can trust results because they carried out a fair test and repeated readings so that they did not rely on one reading that might have been an ‘oddity’.

2 PARACHUTES

L.O. Identify the effects of air resistance, water resistance and friction, that act between moving surfaces.

Plan different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary.

Take measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings when appropriate .

Record data and results of increasing complexity using scientific diagrams and labels, classification keys, tables, scatter graphs, bar and line graphs.

Use test results to make predictions to set up further comparative and fair tests.

- A natural follow-on activity to ‘Falling cupakes cases’ is work on parachutes. If you have a large ‘parachute canopy’ as often used for PSHE activities it would provide a great starting point for children to feel how, when the canopy is raised, it fills with air and how air resistance

YOU WILL NEED

- Parachute canopy
- *Egg Drop* by Mini Grey
- Materials for pupils to make parachutes, e.g. cloths, string, toy figures
- PowerPoint Slides 8–10 Ruler / tape measure
- Stopwatch
- Pens and paper

can be felt as the children let the canopy lower. Use PowerPoint Slide 8 to support children discussing and describing their experience.

- If available to you, read the *Egg Drop* by Mini Grey to the class, a story about an egg that wants to fly. It offers a great context for children to investigate parachutes for the egg so that it has a soft landing. Otherwise, you can simply challenge children to design, make and test parachutes that will ensure a hard-boiled egg lands without breaking. This is a popular activity and one that can really challenge children in terms of working scientifically and the application of their knowledge about air resistance.
- Begin by getting children to make and explore a parachute from either paper or a J-Cloth and using a Lego toy or a weighted pipe cleaner person. This initial exploration is important because it is from this that children are going to ask questions. You could use PowerPoint Slide 9, which shows different kinds of parachutes and can help to prompt discussion about questions. At this stage children should be asking questions that demand the use of number. For some children the simpler 'Which…?' question stem will be appropriate but for the majority, beginning with 'How does…?' is more likely to extend those children who should be working at expected and beyond. Using 'How does…?' is also likely to provide data that would lead to children needing to present the data as a line graph.
- Which…? questions could include:
  - Which material makes the best parachute (or the slowest parachute)?
  - Which shape is the best for a parachute (or makes it fall slowest)?
  - Which is better, a parachute with a hole or not?
- How does…? questions could be:
  - How does the area of the canopy affect the time to fall (or descend)?
  - How does the mass of the toy person affect the time to fall (or descend)?
- Show children slide 10. Ask them to create a similar plan on a large piece of paper, with their parachute design in the centre and phrases or bullets in each box for how they will complete their experiment, leaving enough room to collect their results.The aim is to scaffold planning but to ensure the majority of time is spent on carrying out their test and on data presentation and analysis.
- As a useful rule of thumb, share the following with the children to help them decide which graph to use:
  - Where children have data such as Material / Time (object and number) to descend, then the graph will be a bar graph.
  - Where children have data that are numerical measurement values, e.g. a number (area) and number (time to descend), then they draw a line graph.
- When children have carried out their tests, they should be given time to analyse their data, draw conclusions and use test results to make predictions to set up new tests, e.g. if children decide that lighter material is better than heavier, they might choose an even lighter material and test this, or if their data shows a pattern where the greater the area the longer the parachute takes to descend, the children might test several more data points. Children should be challenged to apply their understanding of air resistance in their conclusions.

ASSESSMENT

Subject Knowledge

- Em. Children describe how parachutes fall to the ground.
- Exp. Children describe how air resistance slows a parachute down.
- Exc. Children explain how air resistance is the force of the air on the parachute.

Working Scientifically

- Em. Children carry out a comparative test, e.g. different materials, and need support to use a timer and record results.
- Exp. Children confidently test parachutes using repeat readings and make sense of their data, using it to suggest new tests.
- Exc. Children apply their knowledge of air resistance to suggest new questions, testing their idea rather than only the data.

4.2 Friction

GET STARTED

Many children will have some knowledge of the word 'friction', so you could begin by getting the children to discuss in groups what they think friction is and examples of friction. They could create a group concept map on a large piece of paper or put their ideas on sticky notes and place on a working wall. Ask children to apply what they already know by asking questions such as: What would happen if there was no friction in the world? What things would be harder to do and what things would be easier?

LET'S THINK LIKE SCIENTISTS

Use these questions to develop research skills and speaking and listening:

- What should you think about when planning a fair test?
- How might you make the test as accurate as possible?
- What will you do if some of the results don't look sensible?

ACTIVITIES

1 WHAT IS FRICTION?

L.O. Identify the effects of air resistance, water resistance and friction, that act between moving surfaces.

Plan different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary.

- There are many ways to help children understand friction – the best are those that are practical, so here are some short activities that help children understand this concept. They could be a series that the whole class do at the same time or a carousel of activities and then bring children together to discuss their findings and how their ideas about friction have developed.
- **A: Jelly cubes, cooking oil and chop sticks** – children explore friction by transferring jelly cubes from one bowl to another with chopsticks. Now add a little sunflower oil to the jelly cubes and move more of them to another bowl. Compare the difference. Then ask the children to explain what is going on.
- **B: Sliding off a book** – children compare different fabrics, rough and silky, and sort them according to which ones do and don't slide off their reading book. Children should discuss why.
- **C: Sliding surfaces** – children have and / or make a collection of materials that have different surfaces, e.g. sandpaper, smooth tile, pencil erasers, plastic ruler and a wooden ruler. Children observe how easy or hard it is to move the different surfaces over each other and suggest reasons why.
- **D: Brush up** – children move brushes over each other (different directions), these could be hair brushes, nail brushes, scrubbing brushes. What do they notice as the bristles move over each other? What if they moved a brush over, e.g., their table surface or some sand paper? What is happening and why?

YOU WILL NEED

- Activity A: 2 bowls, Jelly cubes, cooking oil and chopsticks
- Activity B: Selection of fabric samples, books
- Activity C: Collection of materials with different surfaces
- Activity D: Selection of different brushes

ASSESSMENT

Subject Knowledge

- Em. Children can describe how some objects move on different surfaces but do not use the word 'friction'.
- Exp. Children can say that friction is a force between two objects.
- Exc. Children can explain friction in relation to different surfaces.

Working Scientifically

- Em. Children carry out activities, describe what happened, but they do not make links with the idea of friction.
- Exp. Children can describe what happens and talk about friction as a force.
- Exc. Children apply their ideas about friction to try out ideas of their own.

2 THE BIG TRAINER TEST

L.O. Identify the effects of air resistance, water resistance and friction, that act between moving surfaces.

Plan different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary.

Take measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings when appropriate.

- Recap on what children think friction is, focus on ideas such as:
  - Friction is the force between one object rubbing against or over another object.
  - Friction makes thing slow down / harder to move over.
  - We can increase or decrease friction.
  - Without friction things would keep moving.
- Divide the class into groups and give each one a selection of shoes and ask them to think about the soles of the shoes and what they know about friction. Ask children whether they have ever slipped on a surface and get them to think about why.
- Pose the first question – 'Which shoe do you think has the most friction?' Ask children to put the shoes in order of most to least friction and write their reason/s on a sticky note next to the shoes. Each group should swap with another and discuss whether they agree with the other groups order and reason/s.
- Now ask children to plan a fair test to find out 'Which shoe has the most friction?' and ask them what they would measure. If children have not experienced Newton meters then prior to this activity give them some to explore and find out what they do and how they work. Give them time to push objects in the room and measure the force it took to start the object moving, e.g. books, drawers, bags and chairs. Make sure that children experience different Newton meters so that they know different ones measure different amounts of force.
- Mathematics is key to this activity and features heavily, so you might need to remind children of calculations (averages), how to use equipment and how to draw a graph. This activity is ideal for ensuring that children understand why repeat readings are taken. Model how to measure the force it takes to start a shoe moving and do this, three times, each time recording the measurement. Most will notice that each measurement is different, which one will they trust? This is why repeat readings are taken, so an average can be calculated and the children can get closer to the real result. Children should use repeat readings for this activity and be able to explain why they are using them.

YOU WILL NEED

- Selection of shoes with different grips
- Sticky notes and pens
- Newton meters

ASSESSMENT

Subject Knowledge

- Em. Children can describe how some objects move on different surfaces but do not use the word 'friction'.
- Exp. Children can say that friction is a force between two objects.
- Exc. Children can explain friction in relation to different surfaces.

Working Scientifically

- Em. Children carry out a comparative test without using standard measures (Newton Meters)
- Exp. Children measure accurately, use repeat reading to improve trust in their data, and use data to draw a conclusion.
- Exc. Children use their results and knowledge of friction to suggest new questions, e.g. *How does weight affect friction? How does the angle of the slope affect friction?*

- Children should carry out their own tests on their shoes and when the activity is completed children should use their data (averages) to create a bar graph (remembering a category / object and number requires a bar graph). If children are unsure how to draw the graph and what scale to use, tell them to sketch it on their whiteboard first before committing it to paper.
- If they find the scale hard, remind them to begin at 0 and then find the biggest number in their results, e.g. 100 N, and use it to decide how much they should go up in (intervals), e.g. 1, 5, 10, 20, 50. They place the 0 and their highest number on the graph at each end of the axis, then add the middle value at half way, etc.
- Children should use their graph to answer the original question, writing their conclusion using numbers to substantiate or prove their conclusion and use their knowledge of friction to explain their result.

3 FRICTION SEARCH ON MY BIKE

L.O. Identify the effects of air resistance, water resistance and friction, that act between moving surfaces.

- Tell the children that you are going to pose a question that has something to do with friction to 'Why do Olympic cyclists shave their legs?' and give the children one week to find the answer. The answer is it make the cyclist more aerodynamic and reduce friction, but it also allows wounds to heal faster and makes them easier to treat.
- Hold a 'bring your bicycle to school' day, and include your own or borrow one. The aim of this activity is for children to explore their bicycle to find out which parts reduce and increase friction and why this is important.
- This activity is best held outdoors where, under supervision, children can use their bikes, put brakes on, look at tyres, chains etc. to find out how friction as a force is applied. Children could work in pairs looking at one bike and then their partner's. When they have completed their friction search they should lay their bicycle on the playground surface and then use chalk to label and annotate their bike to show where friction is increased and reduced, e.g. oil is used to reduce friction on the chain area, friction is increased on tyre treads so that the bike can grip the road surface.
- When they have completed this activity, children could participate in peer assessing each other's work and also take a photograph. Back in class, use PowerPoint Slide 11 to ask children to identify on the bike where friction is increased and decreased and why.
- Finish the activity by showing them PowerPoint Slides 12 and 13 that show different examples of friction and ask them to apply what they know about friction to answer the questions. As a home / school activity, challenge children to create their own slide showing how friction is applied in life to use in a quiz session over the coming week.

YOU WILL NEED

- Bicycles
- Chalk
- Camera to record evidence
- PowerPoint Slides 11–13

ASSESSMENT

Subject Knowledge

- Em. Children talk about how they ride their bike and make some connections, e.g. how the brakes stop the wheels.
- Exp. Children recognise where friction is reduced and increased on their bicycle and can explain why.
- Exc. Children apply their knowledge of friction to their bicycle and make suggestions about other kinds of bikes or vehicles.

WATER RESISTANCE

1 FORCE OF WATER

L.O. Identify the effects of air resistance, water resistance and friction, that act between moving surfaces.

Take measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings when appropriate.

Use test results to make predictions to set up further comparative and fair tests.

Report and present findings from enquiries, including conclusions, causal relationships and explanations of and degree of trust in results, in oral and written forms such as displays and other presentations.

- Show the children the clip the force of water (see Useful Websites list): discuss the concept of water resistance and what the children are testing. Tell them that they are going to be doing something similar so they need to watch and learn.
- This can be a messy activity so do it outside or tell children to work with a set of rules about safety and spillages. In groups, give children a tall cylinder full of water and some plasticine.
  - Children make a set of different shapes using plasticine, making sure that the mass is the same.
  - They then time how long it takes for each shape to reach the bottom.
  - Children record the times and repeat the readings to ensure that they can trust their results.
- Remind them of the video they watched and ask them to work out what question they think the children were trying to answer. The children might suggest:
  - Which shape is the most streamlined?
  - Which shape moves through water the fastest?
  - How does the shape affect how fast it moves in water?
- Give children time to plan what they are going to do and encourage them to focus on four aspects of mathematics:
  - Which measurements are they going to make? For example, weigh the plasticine, measure time to fall?
  - How will they calculate averages when taking repeat readings?
  - How will they use their knowledge of solid shapes, e.g. spheres, cubes, triangular prisms, cones?
  - Which graph should they draw? Remember the rule of thumb: word and a number in a table = bar graph.

YOU WILL NEED

- Video clip (see Useful Websites list)
- Large cylinder of water
- Plasticine or similar material to make different shapes
- PowerPoint Slides 14 and 15

ASSESSMENT

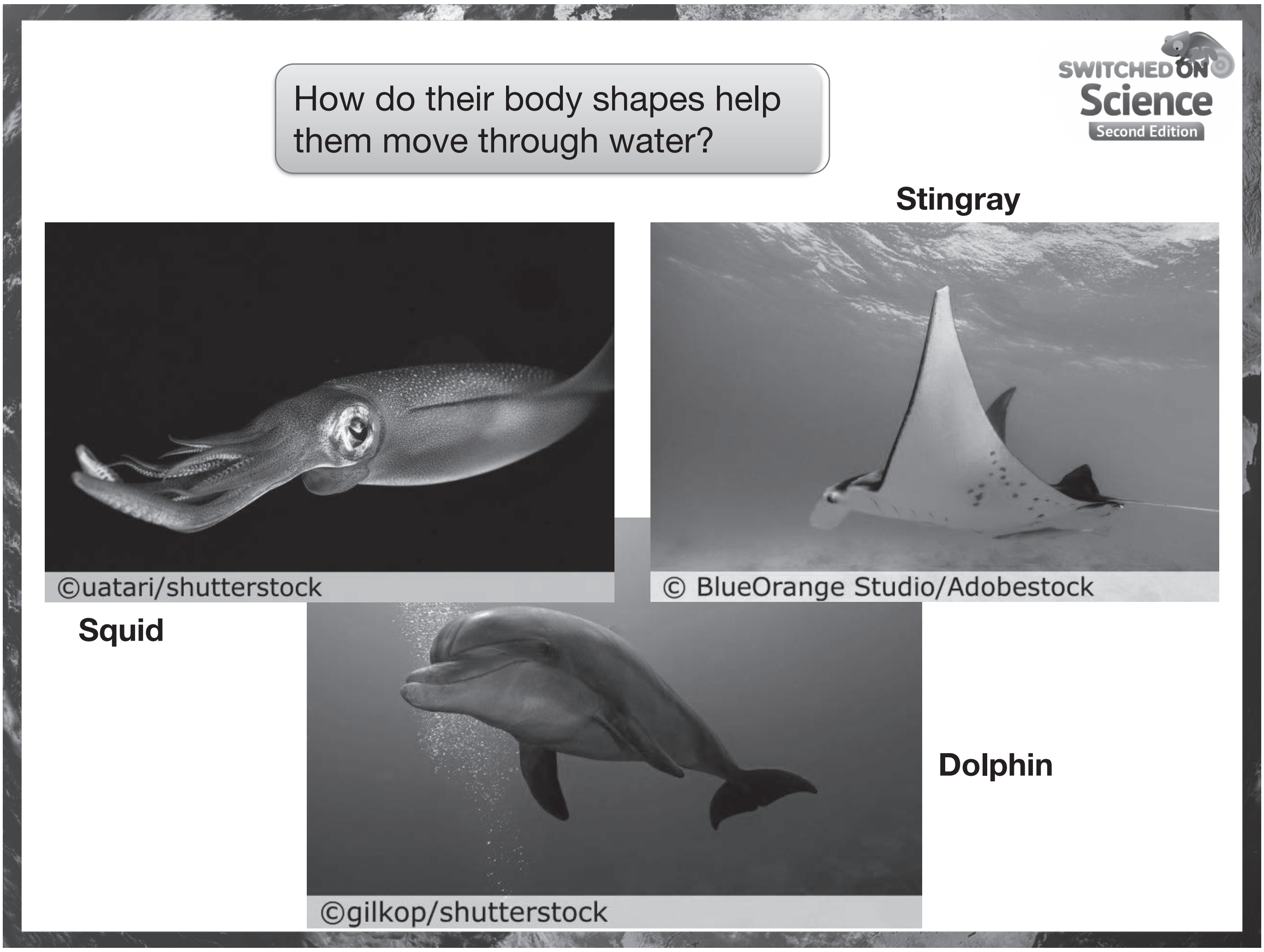
Subject Knowledge

- Em. Children describe how different objects move through water differently, but do not link it to water resistance.
- Exp. Children know that water resistance is a force that can slow objects down.
- Exc. Children can apply their knowledge of water resistance in different contexts e.g. submarines, boat shapes, birds diving.

Working Scientifically

- Em. Children carry out the fair test and say which shape travelled through the water the fastest.
- Exp. Children carry out a fair test and use their data to draw conclusions and can explain why some shapes move faster through the water.
- Exc. Children use their test results and explain why they can be trusted and use the concept of water resistance to explain how different shapes move through water.

- Once they have completed their fair test and presented their data as a bar graph, ask children to use the data to draw conclusions about how different shapes travel in water. You could show the video again so that children are prompted to use subject knowledge about friction, water resistance and how some shapes are more streamlined so they 'cut' through the water and so travel faster.
- Show children PowerPoint Slides 14 and 15 and challenge them to apply what they have learned from this activity to make sense of the shapes of boats and animals in water.
- Finally, ask the children to look at their results again and think about predicting, e.g. what would happen if the shapes were dropped in a different liquid such as cooking oil (e.g. thicker, more viscous), then set up and carry out a new test.



4.3 What are simple machines?

GET STARTED

Set a timer. Children work in groups and have 60 seconds to list as many machines as they can. Return to this list at the end of the activity and ask children if their idea of what is a machine has changed and why.

LET'S THINK LIKE SCIENTISTS

Use these questions to develop research skills and speaking and listening:

- How do you think the wheel was invented?
- What do you think the world would be like if there was no gravity on Earth?
- What in your life would you miss the most if the wheel had not been invented?

ACTIVITIES

1 WHAT IS A MACHINE?

L.O. Report and present findings from enquiries, including conclusions, causal relationships and explanations of and degree of trust in results, in oral and written forms such as displays and other presentations.

- Children may think that machines are always huge and require electricity. In this activity children learn that they use machines every day, some are very simple. They also learn to sort these into those that use gears, pulleys, levers and springs and explore how a small force can have a big effect.
- Show the class PowerPoint Slide 16 and discuss the examples of machines with a lever, wedge, inclined plane (slope) wheel, axle and screw pulley, spring or gear. Ask children to work with their talk partners to discuss which machines they use and how they work.
- Give the children a collection of everyday machines that use springs, levers, pulley or gears.
- Explain to children that these are simple machines and they can help to change the size of the force, e.g. a small force on a hand whisk is changed into a bigger force to whisk food (through the gears). Use PowerPoint Slide 17 and ask the children to explain how forces are used to make the stapler work.
- A simple machine can also change the direction of a force, e.g. pushing down on one end of a see-saw moves the other end up.
- Ask the children to sort the objects and to discuss how each one helps the object to work so that the machine can change the size of a force and direction of a force.
- Help children make links (causal relationships) between what they do and what happens, e.g. they apply a small force and the bottle opener takes the bottle top off.
- Use the interactive activity (*My Rising Stars*) to group machines into various types.

YOU WILL NEED

- Everyday objects and tools using simple machines, e.g. stapler, nutcracker, hammer, hand whisk with gears, pliers, plastic bottle with screw top, pair of scissors, nail clippers, door wedge, ice cream scoop, tin opener, slinky, bottle opener, wind-up toy, geared toy, spring-loaded ball pen, pair of scales (with springs)
- Interactive activity:
- PowerPoint Slides 16 and 17

ASSESSMENT

Subject Knowledge

- Em. Children require support to sort the objects they are unable to link the idea of a small force having a big effect.
- Exp. Children sort the objects and can describe how each one allows them to use a small force but have a bigger effect (force).
- Exc. Children recognise these are simple machines that help us do a job more easily.

2 MAKE A SIMPLE SEE-SAW – A LEVER

L.O. Recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect.

Use test results to make predictions to set up further comparative and fair tests.

- Show children the video clip of a see-saw in action (see Useful Websites list) and discuss how it works or even better visit a local park to explore how a see-saw works.
- Show the children PowerPoint Slide 18 and explain that a see-saw is a simple lever, a smaller force is used one end to move the other end. Explain to children that the fulcrum is where the see-saw balances in the middle, the place that allows the plank of wood to move up and down. Show PowerPoint Slide 19 to reinforce how levers work.
- Give children a cardboard or plastic tube, sticky tape and a piece of strong card or a tin can and ruler or Lego pieces and ask them to make a simple see-saw. Using masses (weights) they are going to explore how much effort (weight) it takes to move the person (or weight) at the other end. Give children time to explore and carry out comparative tests where they change the masses used, where the tube or can is placed and if this makes any difference, each time predicting what they think will happen and then testing again.
- Challenge children to answer the question, 'What distance from the fulcrum will different weights balance a 1 kg load?
- Children work systematically by changing the distance of different masses (e.g. 100 g, 200 g, 300 g) at one end, they measure and record these different values using a table and then transfer their data to a line graph (number + number = line graph). For those children that require some support they could use the table and graph on Activity Resource 4.4.
- Children should use the data and pattern shown in the line graph to write their conclusion. Ask children to say which key words they will need to use, e.g. force, *fulcrum, lever, move, small, lift, heavy, weight*.

YOU WILL NEED

- Video clip of a see-saw (see Useful Websites list)
- Cardboard or plastic tube
- Sticky tape
- Strong card or a tin can and ruler or Lego pieces
- PowerPoint Slides 18 and 19
- Activity Resource 4.4
- Weights

ASSESSMENT

Subject Knowledge

- Em. Children describe how the see-saw moves but do not link to a lever.
- Exp. Children know that a see-saw is an example of a lever and that a small force can move something.
- Exc. Children know how changing the length of a lever can make something easier to move.

Working Scientifically

- Em. Children observe that when they place a weight on the other side of the see-saw they have to move close to the end to balance the 1 kg weight.
- Exp. Children record results, transfer them to a line graph and write an appropriate conclusion.
- Exc. Children are able to sketch their prediction of the line graph prior to completing the data collection.

3 COAT HANGER CATAPULT

L.O. Recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect.

Take measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings when appropriate.

Report and present findings from enquiries, including conclusions, causal relationships and explanations of and degree of trust in results, in oral and written forms such as displays and other presentations.

- Show the children the video of how to make a coat hanger catapult (see Useful Websites list on *My Rising Stars)*. The children are going to be working in pairs to create this catapult, so challenge them to watch the video and, using literacy skills, take notes on how it is made and the explanation given for how this simple machine works.
- Set out a range of materials for making the coat hanger catapult, including small and larger marshmallows, different size and thickness of elastic bands. Once they have made their catapult and tried it out, then ask children to ask questions about what would happen if they changed certain variables such as:
  - Number of elastic bands.
  - Thickness of elastic bands.
  - Number of twists of the elastic bands.
  - Angle of firing.
- Challenge children to test the changes and record their results, then using numerical data, draw conclusions focusing on causal relationships, e.g. If I change the elastic band, then the marshmallow travels further. If we move the fulcrum, it makes the marshmallow go further.
- Focus on the mathematics and remind children to measure length and angles accurately, take repeat readings, calculate averages and choose between a bar and line graph, e.g. number of twists of elastic band is a single digit (not continuous, e.g. 1.6 turns) and number so it needs a bar graph whereas angle and distance is number + number = line graph.
- Children choose how best to communicate their activity; giving children a specific audience challenges them to use their literacy skills to make sure the level, scientific language, grammar, tenses, use of headings, etc. is of a high standard along with choice of medium, e.g. PowerPoint, a video demonstration or non-fiction explanatory text. Ensure that children report the scientific method and results as well explain the scientific concept of a simple machine.

YOU WILL NEED

- Video of a coat hanger catapult (see Useful Websites list)
- Coat hangers
- Elastic bands of different thicknesses
- Marshmallows of different sizes

ASSESSMENT

Subject Knowledge

- Em. Children describe what the catapult does but do not link to a lever.
- Exp. Children know that the catapult is a machine using a lever and that a small force can move something.
- Exc. Children can explain how to change the machine (catapult) to have a different effect.

Working Scientifically

- Em. Children make the catapult and describe what it does.
- Exp. Children make and test their catapult, record results and use them to explain how it works using appropriate language.
- Exc. Children apply their knowledge to explain how the catapult works, e.g. using fulcrum and force to explain the relationship between changing variables and effects on the results.

4 USING PULLEYS

L.O. Recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect.

Take measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings when appropriate.

- Show children a video clip where a strong man pulls a lorry and then children use pulleys to pull the same lorry (see Useful Websites list on *My Rising Stars*). Discuss with children how the pulleys work.
- Show children the animation that shows what a pulley is, how it works and what happens when you increase the numbers of pulleys. This reinforces the ideas shown in the first clip. Ask children what they have learned about pulleys from the two video clips and use these to create a set of key facts, e.g.:
  - What does a pulley look like?
  - What does a pulley do?
  - Why are pulleys used?
- Tell children that they are going to make and use some simple pulleys to experience how they work. The video clip linked to this activity shows several methods of how to make simple pulleys. Show children the video sequence (see Useful Websites list), stop it at each point so that the children can then copy the activity setting up the pulley system between two classroom chairs.
- **Wooden skewer and cotton reel pulley**: As children work make sure that they compare what it feels like to lift an object with and without the pulley system so that they experience the difference in the amount of force that is required. Tell children to observe carefully how the system works and use Activity Resource 4.5 to to draw this pulley system and annotate it to explain how it works. and explain how it works.
- **Broomstick and string pulley system**: Show children PowerPoint Slide 20 to illustrate what this system looks like and how it works. The children should begin with one rope loop pulley, then two, three, four etc. and each time children compare the changes in the force they need to use to lift. Once again, children observe carefully how the system works and use Activity Resource 4.5 to draw and annotate how the pulley lifts the container of water using appropriate scientific language, e.g. pulley, system, force, lift, load and effort. Children could explore whether there is a mathematical pattern in the amount of force (effort) needed to lift the container using a force meter (Newton meter) as each new pulley loop is added.
- If the school has a set of pulleys children could then use these and repeat the activity.

YOU WILL NEED

- Activity Resource 4.5
- Video clips (see Useful Websites list)
- PowerPoint Slide 20
- Wooden skewers
- Cotton reels
- Broom handle
- Pulleys
- String or rope
- Weight to lift, e.g. milk carton with handle filled with water
- Force meter

ASSESSMENT

Subject Knowledge

- Em. Children need support to carry out the activity and can describe what it feels like to pull the container with and without the pulley.
- Exp. Children can describe how a pulley system works: they know a smaller force has a greater effect.
- Exc. Children explain how pulleys in daily life work e.g. window blinds, flagpole, well, crane.
- Em. Children need support to carry out the activity and can describe what it feels like to pull the container with and without the pulley.
- Exp. Children use their data to describe how adding more pulleys affects the amount of force need to lift an object.
- Exc. Children ask their own questions, such as: *What happens if we keep adding pulley loops? If we increase the weight lifted? Can we measure the force used to pull the container?*

5 USE A PULLEY TO DO A JOB

L.O. Recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect

- Show children PowerPoint Slide 22 that provides a range of examples where pulleys are used to do a job.
- Show children PowerPoint Slide 20 to remind them how a pulley works. When children understand how a pulley system works they can then use this knowledge to make pulley systems to do a job. Children could use everyday materials and re-use them for a new purpose or use construction kits such as Lego. Some children will have their own ideas about what they could make, others might need some support, e.g. suggest that they could choose to make a:
  - A pulley system to raise a flag.
  - A well with a pulley system to raise a cup of water.
  - A pulley system to raise a figure or container of, e.g. stones or sand.
  - A pulley system to find out what the greatest weight is it can lift 10 cm off the ground.
- When children have made their model, use the opportunity for peer assessment by asking children to visit other models and leave a positive comment and a suggestion for improvement. Children could create a diagram, take a photograph or create a video clip about their design along with annotations or verbal explanations using appropriate scientific language, e.g. *pulley, system, force, lift, load, effort*.

YOU WILL NEED

- PowerPoint Slides 20–22
- Everyday materials for making pulleys, axles etc. (e.g. cotton reels, wooden skewers or pencils, string)
- Lego or other toys with pulleys

ASSESSMENT

Working Scientifically

- Em. With support, children carry out the activity and can describe how it works.
- Exp. Children can explain how their pulley system works.
- Exc. Children continually revise their design to solve problems to improve their pulley system to lift a maximum weight.

6 GEARS

L.O. Recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect.

- Children bring their bicycles into school. In the playground, children turn their bikes upside down so they balance on the handlebars and seat. Then children observe the chain and gears and try to work out how, by moving the pedals, the wheels go round.
- Show children PowerPoint Slides 23 and 24 and use them to discuss what gears do and how they work. Use your own bike or a child's to provide some basic words such as *gears, move, teeth, cogs, turn*. You could draw (or have available) a simple diagram using chalk on the playground or use a gear set to reinforce how the teeth fit together, how one cog pushes the other and so on and the bike wheels move.
- Explain that a gear is just a wheel with teeth, ask children to find a gear on their bicycle, it is also called a cog. To make something move, at least two cogs must be put together so that their teeth fit into each other. The teeth fit together, so when you turn one gear (cog), it makes the other cog turn as well. Small cogs can turn large cogs, they turn more often than the big wheel, it means that a small force can make something large move, or in other words, you can use less effort to make a big thing move.

YOU WILL NEED

- PowerPoint Slides 23–25
- Video clip (see Useful Websites list)

- In a bicycle, a small movement as the pedals turn results in larger movement, the wheels turn around.
- Ask children to explore how the pedal turns the chain that turns the gears (cogs) that turn the wheel, focusing on how a small movement makes the bigger bicycle wheels move round.
- They could photograph or video parts of the gear system and annotate or provide a commentary to explain how gears make the wheels go round.
- Show PowerPoint Slide 25 and ask children to explain how the gears on the bike work.
- Back in the class you could show children a video clip (see Useful Websites list) to help explain how gears on a bike work and to introduce the idea of ratio in gears.

ASSESSMENT

Subject Knowledge

- Em. Children know that they have to turn the pedal to make the chain go round to make the wheels move.
- Exp. Children can describe how a small movement at the pedal is transferred to a large movement in the wheel.
- Exc. Children explain the causal relationship between pedalling and the cycle wheels moving and can say what happens when the gears are changed.

7 MATHS IN GEARS

L.O. Recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect.

Report and present findings from enquiries, including conclusions, causal relationships and explanations of and degree of trust in results, in oral and written forms such as displays and other presentations.

- Bring in objects that have gears such as a bicycle, hand rotary whisk and children's toys so that children can explore the relationship between the cogs and how they move.
- Children need to have access to gear kits such as Lego technic, or gears from nursery or foundation stage construction sets. The aim is for them to recognise there is a mathematical relationship between how two cogs move together. Tell children to move cogs that are the same size and count the revolutions (turns) for each wheel, then write their results down using the table on Activity Resource 4.6, which is also shown on PowerPoint Slide 26.
- Ratio is not a Year 5 maths topic, but children should be able to spot a pattern emerging as they move cogs on the cog board. The table in Activity Resource 4.6 and slide 26 shows how to record the movement of cogs and supports children in recognising a pattern in the data.

YOU WILL NEED

- Objects with gears, e.g. bicycle, children's toys
- Gears from Lego or other construction sets
- Activity Resource 4.6
- PowerPoint Slide 26

ASSESSMENT

Subject Knowledge

- Em. Children show that moving one cog results in moving another.
- Exp. Children are able to talk about the pattern in their results.
- Exc. Children use their results to suggest different mathematical patterns using different pairs of cogs.

8 DESIGN A RUBE GOLDBERG MACHINE

L.O. Recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect.

- Show children the Honda advertisement (see Useful Websites list on *My Rising Stars*), which shows how cogs, levers and pulleys can be used to make something move. Show children the advert a second time and tell children to shout out *lever, pulley* or *cog* whenever they see them doing some work.
- The aim of this activity is for children to use their imagination to apply what they know about pulleys, levers and gears to design a fantastic machine that will make something happen. The Honda advertisement provides a great starting point, followed by giving children a drawing of a Rube Goldberg machine and asking them to go through it step by step, explaining how it works. Then ask them to identify the simple machines it contains – many are available on the Internet.
- Ask children to look at video clips that show some Rube Goldberg machines that have been built by primary school children (see Useful Websites list on *My Rising Stars*). Ask the class to consider the designs and to explain what is happening in each machine step by step.
- Once children understand the idea of Rube Goldberg machines, they could set up a competition to find out the best and most imaginative one. The children could come up with their own criteria and select the best.
- Challenge children to make their own Rube Goldberg machine that contains levers, springs, pulleys, gears and other simple machines. This is likely to take several lessons and you will need to gather the materials for this in advance. Tell them to:
  - Choose the task and select the machines they will incorporate into the design.
  - Design the device (they could use Activity Resource 4.7).
  - Select the materials to build the device.
  - Test it until it works.

YOU WILL NEED

- Video clip (see Useful Websites list)
- Activity Resource 4.7
- Everyday materials to build a Rube Goldberg machine

ASSESSMENT

Subject Knowledge

- Em. Children design a machine with limited application of knowledge.
- Exp. Children design a machine applying their knowledge of different mechanisms.
- Exc. Children apply their knowledge to create a series of systems that interact to make their machine work.

TOPIC 5 Growing up and growing old

About this topic

Curriculum link: Year 5, Animals, including humans

SUMMARY:

In this topic, children look at and describe the changes as humans develop to old age. Pupils draw a timeline to indicate stages in the growth and development of humans and learn about the changes experienced in puberty.

UNITS:

5.1: From baby to old age

5.2: Growing up

5.3: Growing old

ACTIVITY RESOURCES

- 5.1: Gestation periods
- 5.2: Milestones
- 5.3: Getting older
- 5.4: Living to 100
- 5.5: How has life expectancy changed?

ONLINE RESOURCES:

Teaching slides (PowerPoint): Growing up and growing old

Interactive activity: Growing up and growing old

CPD video: Growing up and growing old

Pupil video: Growing up and growing old

Word mat: Growing up and growing old

Editable Planning: Growing up and growing old

Topic Test: Growing up and growing old

Learning objectives

This topic covers the following learning objectives:

- Describe the changes as humans develop to old age.

Working scientifically skills

This topic develops the following working scientifically skills:

- Reporting and presenting findings from enquiries, including conclusions, causal relationships and explanations of and degree of trust in results, in oral and written forms such as displays and other presentations.
- Record data and results of increasing complexity using scientific diagrams and labels, classification keys, tables, scatter graphs, bar and line graphs.
- Planning different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary.

CROSS-CURRICULAR LINKS

This topic offers the following cross-curricular opportunities:

English

- Summarise main ideas from non-fiction text.
- Distinguish between statements of fact and opinion.
- Retrieve, record and present information from non-fiction.
- Engage in debates, maintaining a focus on the topic and using notes where necessary.
- Provide reasoned justifications for their views on, e.g. teenagers, elderly people.
- Use a dictionary and thesaurus.
- Use punctuation effectively.
- Think aloud to generate ideas, drafting, and rereading to check that the meaning is clear.
- Learn a poem by heart and perform it showing understanding through intonation, tone and volume so that the meaning is clear to an audience.
- Read books about life changes, e.g. *The Graveyard Book* by Neil Gaiman.
- Write a story or a poem about what it would be like to live past 100.

Numeracy and mathematics

- Collect, present and analyse gestation period data.
- Choose appropriate graphs.
- Collect and record data, e.g. Excel spreadsheets.
- Analyse secondary data.

Design technology

- Investigate and analyse a range of existing products for the elderly.
- Use research and develop design criteria for an aid that is fit for purpose for an elderly person.
- Evaluate their aid against their own design criteria and consider the views of others to improve their work.

PSHE

- Meet and talk with a range of people, listening to their view and opinions.
- Recognise the worth of individuals of different ages by identifying positive things, e.g. their achievements.
- Understand the range of jobs carried out by people they know, and how they can develop skills to make their own contribution in the future.
- Recognise the role of voluntary, community and groups, visit and engage with elderly people.
- Recognise and challenge stereotypes, e.g. teenagers, the elderly.
- As a class or with the whole school, raise some vital funds for a local age awareness charity.

Computing / ICT

- Create interactive timelines using websites such as: www.timetoast.com or www.tiki-toki.com
- Upload a photo to change their face to that of an older person (http://growmeup.com/#)
- Design and make items that could make everyday life easier for old people.
- Use ICT tools such as Sketchup to create a virtual model in 3D.
- Create a human timeline.
- Record the children's poems about growing up and find suitable images online to create a photo slideshow.

History

- Timeline of the life of children through the ages. How has life changed?
- The diary of a Victorian child.

RE

- Find out about 'coming of age' ceremonies, such as confirmation and the bar mitzvah/bat mitzvah.

STEAM (SCIENCE TECHNOLOGY ENGINEERING ART AND MATHS) OPPORTUNITIES

Invite into class

- People of different ages from the local community.
- A school nurse to discuss changes from childhood to adolescence.
- Writer / poet to work with children to explore age in creative writing.
- Someone who works with different age groups, e.g. toddlers, teenagers, elderly people to talk about their work.

Visit

- Visit a group of elderly people to participate in activities, interview them etc.

TEACHER SUBJECT KNOWLEDGE

Humans, like all mammals, give birth to live young. The fertilised egg stays inside the female and develops in the womb. The baby is linked to the mother via a placenta, which gives the baby nutrients and oxygen and takes away waste products.

The amount of time it takes for a baby to develop is called the gestation period. In humans this is roughly nine months (266 days). Smaller animals normally have a shorter gestation period than larger animals. For example, a mouse's gestation period is around 20 days and an African elephant's is 645 days.

Human babies are highly dependent on their parents for a long time after birth. They start to walk at around one year old and learn to talk at about 18 months old. They grow rapidly. By the age of five a child can walk, talk and feed itself, but is still very dependent on its parents.

The human life span can be split into a number of stages: infancy, childhood, adolescence, young adulthood, adulthood and old age. The actual length of these stages varies across different cultures and time periods.

Puberty

This is the time when the body matures from that of a child to that of an adult.

The body prepares itself for being able to produce children of its own. Puberty starts at different times, but usually around 10–14 in girls and 12–16 in boys.

Puberty is triggered by hormones in the body – chemical messengers that travel around it. In boys, the testes develop and begin to produce sperm as well as the hormone testosterone. Testosterone causes boys to grow and become more muscular, their voices to ‘break’ and hair to start growing on their chest and face. In girls, the ovaries develop and begin to release the hormone oestrogen. As well as triggering the maturation and release of an egg once a month as part of the menstrual cycle, oestrogen causes girls to develop breasts and their hips to widen. In both boys and girls other hormones cause pubic and underarm hair to begin to grow.

Spots are common for most teenagers; acne is caused by glands in the skin that produce a natural oil called sebum. Puberty hormones make these glands produce extra sebum, which can clog the pores and cause spots.

Remember to take care when discussing the changes that happen during puberty. Check with your school’s PSHE/SMSC/SEAL coordinator for additional guidance.

Ageing

Ageing is the accumulation of changes in a person over time.

Our bodies become less able to deal with stresses and disease, and our cells gradually become less able to replicate. Commonly, our hair will become grey or white and our skin will lose its elasticity and become wrinkled. Older people’s bodies become more susceptible to diseases such as osteoporosis (weak bones) or arthritis (stiff / swollen joints). Eyesight and hearing often deteriorate too. The upper range of the sound frequencies that we can hear gradually decreases from the age of 18 onwards. This means that children will be able to hear higher sounds than even young adults and the older you get, the lower the upper limit will become.

Due to improved healthcare more people are reaching old age. In Roman times, people who survived childhood could expect to live to about 50, but now we can expect to live much longer than that.

CHILDREN’S MISCONCEPTIONS

Children might think…

- That they know about pregnancy, especially if they have baby brothers or sisters, but they may not know exactly what happens.
- Have general misconceptions about puberty based on playground rumours.
- General misconceptions about what it’s like to be old, based on limited observations of their elderly relatives or from the media.
- Everyone over about 21 is classed as ‘old’.

Children already know…

- That animals have offspring which grow into adults (Year 2).
- That we grow and get bigger as we get older (Year 2).
- About our skeletons and joints (from Year 3).
- The life cycles of different animals, including mammals (Year 5).
- That our bodies change as we get older (from Unit 1).

SCIENTIFIC VOCABULARY

You can download a Word mat of essential vocabulary from *My Rising Stars*.

adolescence: the time in a young person's life when physical and emotional changes leading to adulthood are happening

adolescent: a young person in the process of developing from a child into an adult (teenager)

adult: a person who is fully grown

arthritis: a disease that causes joints to become swollen and painful

gestation period: the amount of time that a baby spends inside its mother's womb before it is born

life expectancy: how many years humans are expected to live. This changes and has lengthened over time

menstruation: a monthly cycle in women. Each month an egg is released and if it is not fertilised by a sperm, the female has her period

pregnant: the condition of a female animal when there is a baby growing inside her womb

puberty: the first part of adolescence, when physical changes begin to happen to the body

teenager: a person aged between 13 and 19 years old

SWITCHED ON Science Second Edition

Babies

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What are the similarities and differences between you and a baby?

5.1 From baby to old age

GET STARTED

Read the 'Riddle of the Sphinx';

'What is the creature that walks on four legs in the morning, two legs at noon and three in the evening?'. Then ask the children to discuss the riddle in pairs and see if they can come up with the answer. The correct answer is a human, - crawling as a baby and walking with a stick in old age. Discuss why a baby horse needs to be able to walk within a few minutes, but a human baby might not be able to stand until about nine months.

LET'S THINK LIKE SCIENTISTS

Use these questions to develop research skills and speaking and listening:

- How does the gestation period of a human compare to that of other animals?
- How does the life cycle of a human compare to that of other animals?

ACTIVITIES

1 GROWING UP

L.O. Describe the changes as humans develop to old age.

- Ask the children to bring in copies of baby photos of themselves. If possible, also make copies of other teachers at the school as babies and give them to each group. Challenge the children to work out who they are and discuss their reasons.
- Children discuss some of the changes that have happened to them as they have got older. How have the children changed since they were babies? How have they changed since they started school? Children could write down their ideas on flipchart paper and share them with the class.
- Now ask the groups to think about the changes that might happen to them as they get older say at 11, 17, 25, 40, 70 and even older. Again they could write down their ideas on flipchart paper and share them with the class.
- On a long, narrow, sheet of paper, e.g. wallpaper lining paper, children create a timeline. They should use their ideas and research to draw their timeline to show how humans change from babies to old age. Make available magazines, access to Google images or photographs from their own families. Show the children examples of timelines, where additional information can be added, and tell them that they will be adding to their timeline over the next few weeks. Between lessons the timelines could be rolled up for storage if there is no room to display them all. As children create their timeline they should use the correct language, e.g. toddler, child, teenager and adult, and list how humans change and indicate what humans can and cannot do at each stage.

YOU WILL NEED

- Baby photos of children and teachers
- Old magazines and other photo sources
- Long, narrow sheets of paper

ASSESSMENT

Subject Knowledge

- Em. Children can look at pictures and describe the person and say whether it is a baby, toddler, etc.
- Exp. Children can describe the changes from a baby to old age.
- Exc. Children can explain the advantages and disadvantages of being different ages.

2 HOW DOES A BABY DEVELOP?

L.O. Describe the changes as humans develop to old age.

- What does 'being pregnant' mean? What do the children think happens during pregnancy?
- Watch the fascinating video of a horse giving birth (see Useful Websites list) on *My Rising Stars*. Give children time to discuss and ask questions and share ideas about pregnancy, in humans and other animals (some may have watched puppies or kittens being born). What do they think happens? What do they know already?
- Use PowerPoint Slides 7 and 8 to discuss how a baby changes as it develops inside the mother. Introduce the children to the term 'gestation period'; they could use literacy skills in using a dictionary to look the phrase up and then explain to each other what it means.
- You could follow this by showing videos and images from websites of the development of a baby in the womb and discuss some of the changes that take place. If a child in the class has a mother who is pregnant she might be willing to come into class and talk about her scans and how the baby is growing inside her womb. By asking questions the children conduct research by using a person as their source of information. Perhaps she might return with the baby after birth to discuss care, etc. The children prepare for that visit by preparing questions.
- If possible, print out a set of scans and display them in a 'Baby Book' along with children's observations of how the baby changes over time. This provides an opportunity for children to report and present findings from research, which is a form of scientific enquiry.
- Key ideas to develop are; length of pregnancy, how a baby develops and grows during pregnancy and the idea that other mammals have similar pregnancies,

YOU WILL NEED

- Video clip (see Useful Websites list)
- PowerPoint Slides 7 and 8

ASSESSMENT

Subject Knowledge

- Em. Children describe what they see on scans.
- Exp. Children can compare scans and describe changes over time.
- Exc. Children recognise parts of the body and ask a range of questions.

3 GESTATION PERIODS OF DIFFERENT ANIMALS

L.O. Describe the changes as humans develop to old age.

- The word 'gestation' was used in the previous activity and here the idea of a gestation period can be reinforced and extended to other animals. Have children read the gestation table for different animals in Activity Resource 5.1 and draw a bar chart. Remind children that when drawing a bar chart they need to remember that what they change goes on the *x*-axis (type of animal) and what they measure (length of gestation period) on the *y*-axis. Some children might need squared paper to successfully construct their bar chart.

YOU WILL NEED

- Activity Resource 5.1
- PowerPoint Slides 8–9

- When children have completed this page, ask them to write a sentence that describes what the pattern in the data shows and use appropriate language, e.g. *pattern, data, conclusion, larger, smaller, shorter* and *longer*.

ASSESSMENT

Working Scientifically

- Em. Children require support to make links between size of animal and gestation period.
- Exp. Children complete Activity Resource 5.1 and conclude that the bigger the animal the longer the gestation period.
- Exc. Children describe the pattern in the data and suggest why larger animals have longer gestation periods.

Gestation periods

- The amount of time for a baby to develop inside the mother is called the **gestation period.**
- A small animal like a mouse might be pregnant for only 21 days.
- A human is pregnant for 9 months.
- An elephant is pregnant for around 645 days!

5.2 Growing up

GET STARTED

Show the YouTube clip 'Birth to twelve years in 2 minutes 45 seconds' (see Useful Websites list on *My Rising Stars*). and then ask children to discuss what they learned from the video, what they found interesting and which changes they recognise they have gone through.

LET'S THINK LIKE SCIENTISTS

Use these questions to develop research skills and speaking and listening:

- Are girls taller than boys? When does this change?
- What changes happen when we become an adult?

ACTIVITIES

1 HOW DO WE CHANGE?

L.O. Describe the changes as humans develop to old age.

- Show the clip 'Birth to twelve years in 2 minutes 45 seconds' again. Alternatively, ask children to describe the changes they have experienced already since birth (they could use photographs of themselves) and what changes they think will happen between now and when they are 12. Encourage children to include other changes, not just physical, e.g. confidence, skills, interests, interacting with people. Ask the children to write down the different changes, each one on a different sticky note, which is then stuck onto a working wall.
- Ask children to read what others have put and think about the main changes that people spotted. Which ones were the most obvious? Are there any changes that have not been included?
- Children compare themselves to each other, whether they are a boy or girl. What changes are similar or different to themselves?

YOU WILL NEED

- Video clip (see Useful Websites list)
- Sticky notes

ASSESSMENT

Working Scientifically

- Em. Children describe changes such as hair and size.
- Exp. Children describe visually how the child has changed and can compare to how they have changed.
- Exc. Children explain changes that are not shown, e.g. what children can do and independence.

2 WHEN CAN YOU DO THESE THINGS?

L.O. Describe the changes as humans develop to old age.

- There are many physical and emotional changes as humans grow, and there are lots of milestones. From birth to death, some things happen around certain ages. Give children the cards from Activity Resource 5.2 and ask them to say the age at which they can do these things.

YOU WILL NEED

- Activity Resource 5.2
- PowerPoint Slide 14
- Poems about growing up (examples in activity notes)

Start school – 4–5 years old	Buy alcohol – 18 years old
Start secondary school – 11 years old	Get a senior citizen's rail card – 60 years old
Vote in a general election – 18 years old	Ride a moped – 16 years old
Get married – 16 with parents' consent	Open a bank account in your own name – 18 years old
Get a paper round – 13 years old	Stand for election as a member of parliament – 18 years old
Drive a car – 17 years old	Get a pilot's licence – 17 years old
Become a blood donor – 17 years old	Be an ambulance driver – over 18 years old

- The answers to these are on PowerPoint Slide 10 so that you can discuss the answers with the class and they can check their answers. Discuss with children what age they think they will be adults, what evidence can they use from the information.
- Ask children to think about what were the important milestones in their own lives so far, e.g. when parents allowed them to ride their bike on their own, were given pocket money. There are a number of poems such as *Goodbye Six*, *Hello Seven* or *Teddy Bear Poem*, both by Judith Viorst, or a poem from Michael Rosen's book *You Wait Till I'm Older than You*. These could be used as part of work in literacy where children apply what they know about growing up and write their own poems noting and developing initial ideas, drawing on reading and research where necessary.

ASSESSMENT

Subject Knowledge

- Em. Children use developmental stages and talk about each one, and are able to compare some.
- Exp. Children are able to describe the key milestones from birth onwards.
- Exc. Children are able to offer reasons why the milestones are linked to specific ages.

3 BEING A TEENAGER

L.O. Describe the changes as humans develop to old age.

- Many schools have separate lessons that deal with changes due to puberty. The science curriculum indicates that children should learn about the changes experienced in puberty. How this is dealt with will depend on your school policy and planned in collaboration with your SEAL / PSHE lead.
- When discussing puberty, do set some ground rules, such as being sensible, respecting each other's ideas and questions and listening to each other. In small groups. Ask children what they know about being a teenager and puberty, suggest that they might have brothers or sisters, friends or other relatives that are teenagers.
- What are teenagers like? Do they have more or less freedom than Year 5 children? What kind of changes happen when someone is a teenager?

YOU WILL NEED

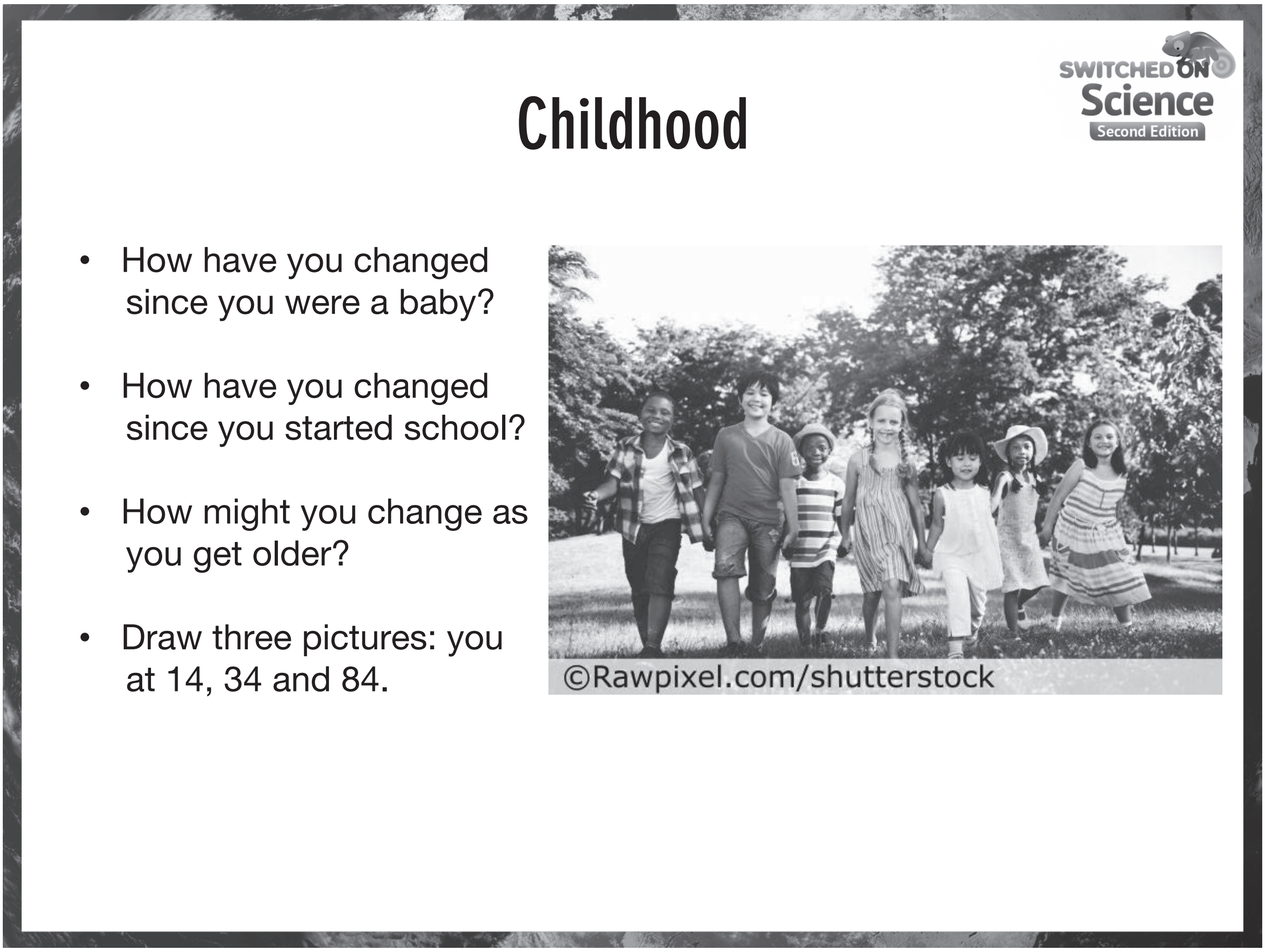
- PowerPoint Slide 12
- Materials to make a Venn diagram
- Timeline from 'Growing up' Activity, page 81

- Use PowerPoint Slide 12, which explains some of the changes that take place during puberty in boys and girls. Which ones do they already know about?
- Give children a list of changes that occur during puberty; you might find it useful to discuss each one first with the class and then ask children to place them in a Venn diagram, sorting them into those that happen only to girls and those that only happen to boys and in the middle those that happen to both. Give children time to share their ideas and to move the changes around if appropriate.
- Revisit the timeline they produced as part of 'Growing up'; Activity 1 in Unit 5.1, page 79. Add any extra information they have found out.
- Finally, give children the opportunity to ask questions that they felt uncomfortable in asking during the activity. Give time for children to write down their questions on a piece of paper and 'Post' them into a question box so that you can read them and make decisions on how best to deal with them. Tell children that they will be confidential; no one except yourself will know who wrote the question.

ASSESSMENT

Subject Knowledge

- Em. With support, e.g. pictures, children can compare themselves with a teenager.
- Exp. Children are able to talk about how being a teenager is different to children of their age.
- Exc. Children use experience from their own lives (e.g. siblings) and research to describe some of the changes that take place during puberty in boys and girls.



5.3 Growing old

GET STARTED

As a class, discuss the various problems that old people might face.

Take care not to give a negative impression of getting old. Stress that many older people do live healthy lives. The idea is to give the children some understanding of what it might be like to get older. You should also explain why some changes happen to our bodies as we get older.

Find out about the world's and / or the UK's oldest man and woman. How old are they? Find out about some of the other 'oldest' world records, such as the oldest astronaut, oldest sky diver or the oldest person to complete a marathon. How old were they?

LET'S THINK LIKE SCIENTISTS

Use these questions to develop research skills and speaking and listening:

- Are people living longer than they did 100 years ago?
- What is helping us live longer? How can we make life easier for senior citizens?
- What can you do to help yourself live longer?
- What would happen if no-one ever died?

ACTIVITIES

1 HOW OLD IS OLD?

L.O. Describe the changes as humans develop to old age.

Record data and results of increasing complexity using scientific diagrams and labels, classification keys, tables, scatter graphs, bar and line graphs.

Report and present findings from enquiries, including conclusions, causal relationships and explanations of and degree of trust in results, in oral and written forms such as displays and other presentations.

- Begin this session by asking children to secretly write in their book what age they think someone is old; tell them that they will use this later on. Explain to the class that they are going to carry out a survey, in school and they could include at home, to find out what age children and adults think someone is old. Ask children to think about how they could carry out this survey, whether they would separate out responses from children and adults, or ask the age of people to find out if the data shows patterns relating to the age of people. They should also think about how to collect their data and what kind of graph they need to use to communicate their results.
- Ask children to think about their findings; what conclusions can they draw from their data? Ask each group to discuss and then write down their conclusion in large writing to place somewhere in the classroom, e.g. a wall, but not all in the same place. Groups then go around and read the different conclusions. What do they notice? Are all the conclusions the same? Do they agree or disagree with the conclusions? Do they think that the data supports each conclusion? How do the results fit in with what they wrote down before the survey as their personal idea of what age someone is old?

YOU WILL NEED

- Pens and large sheets of paper

ASSESSMENT

Working Scientifically

- Em. With support, children collect data from a small group and talk about what they have found out.
- Exp. Children use their data to draw conclusions and compare the results with their own idea of what age someone becomes old.
- Exc. Children are able to explain whether their data is trustworthy or not and suggest improvements.

- Take advantage of this opportunity to collect data to ask children how much trust they have in their data? Why do they think that? What could they do to make the data even more ‘trustworthy?’ For example, ask more people, make sure that everyone asked exactly the same question or give people a choice of certain ages.

2 HOW DOES IT FEEL TO GET OLD?

L.O. Describe the changes as humans develop to old age.

- Ask children to discuss in their groups what they know about old age, get them to write their ideas down using a concept map approach, where anything is accepted, even if some of the group do not agree. Prompt children by asking them to think about elderly people that they know, e.g. family members, neighbours, people they see in their local community. Broaden this out to ask children to think of the challenges and the positives of getting older. You could show the class the introduction of the CPD video, ‘Growing up and growing old’, which shows children carrying out this activity.
- When children have completed their discussion move onto the next section of the video and stop where the children have put on the different items. At this stage give each group similar items for them all to put on and try to carry out everyday tasks, e.g. buttoning a cardigan, peeling an orange, listening to their partner or trying to bend their knee and wrists. What does it feel like? What emotions do they feel? If this happened to them tomorrow what would they think? Be frightened of?
- The aim of this activity is to help children realise that for some older people this is what happens. Children could complete the table on Activity Resource 5.3. Alternatively, they could photograph each other and place each one in their science book with an explanation using appropriate scientific and also emotional descriptive language. This should be balanced with more positive perspectives, such as those in Activity Resource 5.4.
- Use PowerPoint Slides 13–14 to discuss the topic more.

YOU WILL NEED

- CPD video ‘Growing up and growing old’
- Activity Resources 5.3 and 5.4
- Objects that simulate problems as result of ageing, e.g. glasses, ear plugs, bandages to wrap around knees and wrists to restrict movement, gloves
- PowerPoint Slides 13–14

ASSESSMENT

Working Scientifically

- Em. Children describe a family relative and relate the activity to themselves rather than an elderly person.
- Exp. Children share their ideas and experience of elderly people and show empathy with how an elderly person might feel as they carry out the practical activity.
- Exc. Children apply their experience beyond just the elderly but also younger people with physical challenges.

3 WHAT DO OLDER PEOPLE THINK ABOUT GETTING OLD?

L.O. Describe the changes as humans develop to old age.

Planning different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary.

- Give children the opportunity to ask their own questions about getting older. Then ask the children to think about the different ways that they can be answered. It is unlikely that children will ask questions that result in a fair or comparative test; most questions will fall under the category of survey or

YOU WILL NEED

- Poster making materials, access to computers and PowerPoint

ASSESSMENT

Subject Knowledge

- Em Children can say what it is like to be old.
- Exp. Children can describe the changes as people age.

research. For example, children might put together a set of survey questions to ask elderly people, e.g. at a local community centre or older relatives. They could research specific conditions, e.g. arthritis, or find out who are the longest living men and women in England, the UK and the world. Then create a historical timeline of inventions and discoveries in their lifetime to appreciate the changes that they have witnessed.

- Finally, ask children to create a display, poster or PowerPoint to celebrate old age, which might include events such as the oldest person to abseil, parachute jump, drive a car, fly a plane, or run a marathon.

- Exc. Children can reflect on and change their own perceptions of getting old.

Working Scientifically

- Em. Children require support to consider questions about someone else and to carry out a survey.
- Exp. Children ask pertinent questions, carry out a survey and use the results to draw some conclusions about being older.
- Exc. Children decide what they want to find out and then develop their questions and survey, and use their results, alongside research in communicating their findings.

4 LIVE FOREVER

L.O. Describe the changes as humans develop to old age.

Identify scientific evidence that has been used to support or refute ideas or arguments.

- Ask children to think about and discuss whether they think that people today are living longer than those in the past. Why do they think this might be? They might need some prompting to use other subject knowledge to support their ideas, e.g. think about how modern medicine is different now than in Tudor times or Victorian times.
- Give children access to Activity Resource 5.5, which shows information from the English Life Tables that are published by the Government every 10 years. Ask them to look carefully at the data and what the data shows. It shows how many years after 65 males and females lived. It shows that, over the past 150 years, people have been living longer.
- Support the children in using the data on the table to create a graph. Ask children what kind of graph they should use: because the table has two lots of number data in it, this should be a line graph (both are continuous data). Before they begin, tell children to use their individual whiteboards to work out the axis and scale, and when they and their partner think that it is right (and, of course, the teacher) they can then begin to draw the axis, scale and plot data in their books.
  - What do they notice about the data?
  - Is it the same for males and females?
  - Why do you think it is different?
  - Now ask them to think about and plot what will happen to the line graph over the next 50 years. Scaffold children to look at the current trend – the direction the line graph is going.
  - Then engage children in thinking about PMIs (Positives, Minuses and what is Interesting) in people living longer, perhaps so that one day most people will live over 100 years. Use the data online for children to complete Activity Resource 5.5 then use this as a starting point for writing a short story about a day in their life 200 years from now.

YOU WILL NEED

- Activity Resource 5.5
- Access to the Internet

ASSESSMENT

Subject Knowledge

- Em. Children talk about what it is like to get old.
- Exp. Children can describe the changes as people age.
- Exc. Children can reflect the advantages and disadvantages of living longer.

Working Scientifically

- Em. Children need support to talk about the data.
- Exp. Children create a graph and draw conclusions using the data presented.
- Exc. Children use the data in their graph to predict future trends and are able to suggest whether their predictions could happen.

TOPIC 6

Amazing changes

About this topic

Curriculum Link: Year 5, Properties and changes of materials

SUMMARY:

In this topic, the children learn about materials, how they change and which changes are reversible and irreversible. The topic concludes by looking at how these properties are applied in the real world.

UNITS:

6.1: Getting a reaction
6.2: Real-world reactions

ACTIVITY RESOURCES:

- 6.1: Inflating a balloon
- 6.2: Burning fabrics

ONLINE RESOURCES:

Teaching slides (PowerPoint): Amazing changes
Interactive activity: Amazing changes
CPD video: Amazing changes
Pupil video: Amazing changes
Word mat: Amazing changes
Editable Planning: Amazing changes
Topic Test: Amazing changes

Learning objectives

This topic covers the following learning objectives:

- Demonstrate that dissolving, mixing and changes of state are reversible changes.
- Explain that some changes result in the formation of new materials, and that this kind of change is not usually reversible, including changes associated with burning and the action of acid on bicarbonate of soda.

Working scientifically skills

This topic develops the following working scientifically skills:

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

CROSS-CURRICULAR LINKS

This topic offers the following cross-curricular opportunities:

English

- Use irreversible changes as starting points for poems.
- Evaluate the quality of each other's presentations of findings.
- Produce a piece of creative writing about 'gooey materials'.
- Create a poster to teach others about burning.
- Write a fire safety leaflet.
- Research Antoine Lavoisier who researched burning.
- Creating patterns, e.g. fire flames.
- Research new materials and smart materials using the Internet.

Numeracy and mathematics

- Use data properly to produce an accurate bar or a line graph.
- Handle data from activities.

- Use a timer, e.g. stopwatch or the timer on an iPad.
- Understand ratio.
- Take accurate measurements.

History

- Investigate fireworks used on Bonfire Night and New Year's Eve.
- Look at the effects of burning in The Great Fire of London.
- Research Humphrey Davy's safety lamp.

Design technology

- Producing new materials: applications of use.
- Research flame retardant materials and the uses of the materials.
- Cookery: producing new materials and irreversible changes.

RE

- Light festivals.

PSHE

- Safety in the home.

STEAM (SCIENCE TECHNOLOGY ENGINEERING ART AND MATHS) OPPORTUNITIES

Invite into class

- Someone from the local fire service to talk about their work and safety in the home.
- A chemist from a university to talk about and show activities on burning and combustion.
- A local manufacturer that makes materials to discuss the properties of materials.
- Artists to create a range of artwork using different materials, e.g. sculptures, painting and collage.
- A parent to whom children can demonstrate / share their activities and explain what they know about reversible changes.

Visit

- Local industry, e.g. furniture makers, chemical businesses.
- Local secondary school to use Bunsen burners and fume cupboards to test materials.

HEALTH AND SAFETY

When using hydrogen peroxide, make sure adults and children wear goggles as well as a 'science lab coat' because spills can leave bleached areas. Always wash hands afterwards.

Adult supervision is required if heating hot milk.

See ASE Be Safe! Or the CLEAPSS website for further advice on burning samples of materials in the classroom.

See individual activities for specific health and safety guidance.

TEACHER SUBJECT KNOWLEDGE

Reversible (physical) changes do not produce a new substance or change the amount of a substance. Reversible changes include liquid water to ice to liquid water.

Irreversible (chemical) changes do produce new substances. Although no matter is lost or destroyed, some may become gas and float away. This sort of change is usually permanent and very difficult to reverse. Burning, rusting and chemical reactions (e.g. bicarbonate of soda and vinegar) are all examples of this. Here, the particles are combined into different substances. Clues that a chemical reaction has taken place might be:

- A colour change (this can happen with physical changes too).
- The production of gas.
- The production of light or heat, or a change of temperature.

A common misconception held by children is that when a chemical reaction takes place, especially one in which invisible gases are produced, the chemicals are 'used up' and the matter no longer exists. It is important to remind children that matter does not disappear in a reaction; it just changes form. Even if it is no longer visible, the matter is still present somewhere.

Bicarbonate of soda and vinegar

The baking soda (sodium bicarbonate) is a base while the vinegar (acetic acid) is an acid. When they are mixed together they react together and form a gas carbon dioxide, this is a new material, so it is a chemical change and it is irreversible. It is the gas that fizzes as it escapes the solution. Changing the amount of baking soda and vinegar changes this reaction, either increasing or decreasing the reaction and amount of gas produced.

Milk and vinegar

When vinegar is mixed with hot milk a protein called casein is extracted from the milk due to a reaction between the milk and vinegar. The casein sticks together and forms clumps or curds similar to plastic, and can be moulded and changed in shape.

Rust

Rust is produced in a chemical reaction between iron, oxygen (dissolved in water) and is an example of oxidation, here it leads to corrosion. If rust is left it eats into the iron causing holes and gradually weakening the iron. Iron is often painted over not just for cosmetic purposes but to protect it, however, if the paintwork is scratched water can get to the metal surface causing a chemical reaction between the iron, water and oxygen resulting in rust. Rust is an irreversible change.

Burning

Burning is a chemical reaction, a chemical change, a new material is formed and burning is not reversible. For burning to take place there must be three things: fuel, oxygen and a high enough temperature. This is called the ‘fire triangle’.

CHILDREN’S MISCONCEPTIONS

Children might think…

- That burning and melting are similar.
- That burning and heating are the same.
- That smoke and steam are the same thing.
- When something burns it disappears for ever, it no longer exists.
- That rusting is a physical change; in fact it is a chemical reaction of iron with air and water: rust does not conduct electricity.

Children already know…

- That some materials change state (Year 4).
- That some materials can be dissolved (Year 5).

SCIENTIFIC VOCABULARY

You can download a Word mat of essential vocabulary from *My Rising Stars*.

burning: a specific type of chemical change, particularly in fuels

irreversible / chemical change: one that cannot be undone

reversible / physical change: one that can be undone

rust: a reddish- or yellowish-brown flaking coating that forms on the surface of iron when exposed to air and moisture

6.1 Getting a reaction

GET STARTED

Show children the resources that you will use to carry out this demonstration (see Activity 1 below: 'What you need'). Ask the children to work in pairs and think about the title of this activity, and what they think might happen when all of the materials are combined. They could write their ideas on their mini whiteboards.

LET'S THINK LIKE SCIENTISTS

Use these questions to develop research skills and speaking and listening:

- Are changes in materials helpful?
- Are all chemical / irreversible changes fast?

ACTIVITIES

1 ELEPHANTS' TOOTHPASTE

L.O. Explain that some changes result in the formation of new materials, and that this kind of change is not usually reversible, including changes associated with burning and the action of acid on bicarbonate of soda.

Report and present findings from enquiries, including conclusions, causal relationships and explanations of and degree of trust in results, in oral and written forms such as displays and other presentations.

- This activity is a teacher demonstration. For health and safety purposes make sure that you and the children wear goggles and a science shirt (a white shirt from an older brother or sister that can be used as a science lab coat) since a mild acid is being used. Cover surfaces with newspaper and place the plastic bottle in a tray.
- Always ensure you and the children wash hands after this activity. Hydrogen peroxide is relatively safe to use, and can be purchased from a local chemist; 3, 6 or 9% hydrogen peroxide solutions are sold for use as hair dye or as a first aid treatment for cuts and grazes.
- As you carry out this demonstration, explain to the children what each ingredient is and does. Give a tablet or video camera to some of the children so that they can video this and then it can be played back in slow motion.

YOU WILL NEED

- Video clip (see Useful Websites list)
- PowerPoint Slide 5
- 500 ml plastic bottle
- Small beaker
- 5 g dried yeast
- Washing-up liquid
- 60 ml hydrogen peroxide solution (3, 6 or 9%)
- 60 ml warm water
- Teaspoon
- Food colouring

- Pour the hydrogen peroxide into the plastic bottle – this is a mild acid, e.g. vinegar and lemon juice are acid.
- Squirt some washing up liquid into the hydrogen peroxide and swirl the bottle to mix and some food colouring.
- Place the yeast and warm water together in a beaker and mix using a teaspoon. Yeast is used in baking to make bread rise, so ask the children what they think will happen when this is placed into the plastic bottle.
- Tip the yeast solution into the bottle and stand back, the mixture will foam out of the bottle, rather like toothpaste being squeezed from a tube, hence 'elephants' toothpaste'. Here a new material is made, evidence of a chemical reaction.
- Touch the bottle, it should feel warm, this is evidence that a chemical reaction is happening.

- When the different materials are mixed, oxygen is released and, with the washing up liquid (soap), makes foam bubbles, the gas escapes out of the bottle and the 'foam toothpaste' is forced out like toothpaste from a tube and is called 'elephants' toothpaste' because there is enough to clean an elephant's teeth.
- If you have taken a video of this, do play it back or show the children a video clip (see Useful Websites list on *My Rising Stars*) or use PowerPoint Slide 5 so that children can revisit the activity and discuss what happened and which material was added to the hydrogen peroxide to create the reaction.
- Ask children to think about whether this is a reversible change, that is, can they get each of the materials back, like they did with salt and water solutions? This is an irreversible change, a new material was made, two substances acted together and made the foam, a new substance.
- Ask children to discuss in pairs what they could change if this test was repeated, how could they increase the amount of foam? What would they change (variable) what would they keep the same and predict what will happen?
- Listen to their ideas and, as a demonstration, repeat the test using their suggestions. Video the effect again and ask children whether their prediction was correct. Finally, ask children to write a description of what happened, which substances they think acted together, what was the new material that was made and then whether it is a reversible or irreversible change.

ASSESSMENT

Subject Knowledge

- Em. Children describe what happened using everyday words.
- Exp. Children describe what happened using scientific vocabulary and can say it is an irreversible change.
- Exc. Children explain what caused the change and why it is irreversible.

Working Scientifically

- Em. Children suggest what to do next e.g. put more in.
- Exp. Children suggest what to change and predict results.
- Exc. Children use knowledge about what caused the irreversible change to suggest new tests.

2 INFLATING A BALLOON

L.O. Explain that some changes result in the formation of new materials, and that this kind of change is not usually reversible, including changes associated with burning and the action of acid on bicarbonate of soda.

Plan different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary.

Take measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings when appropriate.

YOU WILL NEED

- Activity Resource 6.1
- Video clip (see Useful Websites list)
- Plastic bottle
- Vinegar
- Bicarbonate of soda (baking soda)
- Balloon
- Scales

Use test results to make predictions to set up further comparative and fair tests.

- Show children the video clip from the Useful Websites link on *My Rising Stars* for this activity and ask them to make notes to help them repeat the activity shown.
- The aim of this activity is for children to inflate the balloon by following their notes but do so using a more scientific approach, using standard measurements.
- The video shows the following:
  - Pour about 2.5 cm (1 inch) of vinegar in the bottle.
  - Using a paper funnel if necessary, put a tablespoon of baking soda into the balloon.
  - Put the mouth of the balloon over the top of the bottle, without pouring the baking soda into the bottle.
  - Pour the baking soda into the bottle from the balloon and see what happens.
- Remind children of the previous activity and what happened when substances were mixed together. Tell them to use what they know to help them think about what happened in the video clip when the two substances were mixed together. They should be able to explain that a gas was produced (carbon dioxide, which filled the balloon and inflated it) and say what the new substance was that was made.
- You might need to show the video more than once to ensure that the children have made notes on how much of each substance was used. Ask the children to convert the non-standard measurements into standard measurements and use those to carry the activity out.
- The next step is to use their test results to make predictions about what would happen if they changed one or both substances (the variables). For example, double or halve the amounts and what do they need to measure to prove whether changing the amount of each substance affects how much the balloon inflated? They then use their predictions to set up, carry out a new test and collect data, then use it to draw new conclusions and check their predictions.
- The challenge for some children might be what to measure for their results; one way would be to measure the circumference of the balloon to see if there is a relationship between the amount of each substance and the circumference of the balloon.
- Obviously, this can be potentially messy and smelly, so consider taking tables outside the classroom if that is possible. Also, make sure that children have access to digital scales for standard measures.
- Show children PowerPoint Slide 6 and revisit what the children did and found out. Then ask children to think of new questions they could ask that demand taking two sets of measurements, e.g. ‘How does the amount of bicarbonate of soda / vinegar affect how much gas is produced?’ ‘By increasing the amounts of bicarbonate of soda or vinegar by regular amounts, e.g. 1 g, 2 g, 3 g and 4 g and measure the circumference of the balloon’. This would result in a table with two ‘number’ variables that would require a line graph.

- Measuring jug
- PowerPoint Slide 6

ASSESSMENT

Subject Knowledge

- Em. Children can describe what happens when bicarb and vinegar are mixed but do not link to irreversible change.
- Exp. Children know that mixing bicarb and vinegar is an irreversible change.
- Exc. Children explain that a new substance has been made so this is an irreversible change.

Working Scientifically

- Em. Children follow a set of instructions to carry out their test and describe what happens.
- Exp. Children carry out a test using standard measures, draw conclusions and suggest new tests.
- Exc. Children use line graph data to predict new values to test this idea, and analyse data to draw conclusions

3 VOLCANIC ERUPTION

L.O. Explain that some changes result in the formation of new materials, and that this kind of change is not usually reversible, including changes associated with burning and the action of acid on bicarbonate of soda.

- Prior to this activity, working in small groups children make papier-mâché volcanoes using a tube for the centre or a hole (crater) into which a funnel can be placed and a wire frame covered with the papier-mâché .
- Show children PowerPoint Slide 7 and ask them to use their knowledge and experience of the previous activity to suggest how they could create a volcanic eruption using vinegar (use white vinegar) and bicarbonate of soda. This time, add red paint or food colouring to create the colour of lava and some washing up liquid to increase volume and bubble. Once again, this activity is best done outdoors because of the potential for mess and unpleasant smell.
- Challenge children to make a one-minute video clip that shows the reaction between the bicarbonate of soda and acid (vinegar). They should draft and redraft their narration to explain the reaction and the new material that is made, as well as the fact it is an irreversible change.

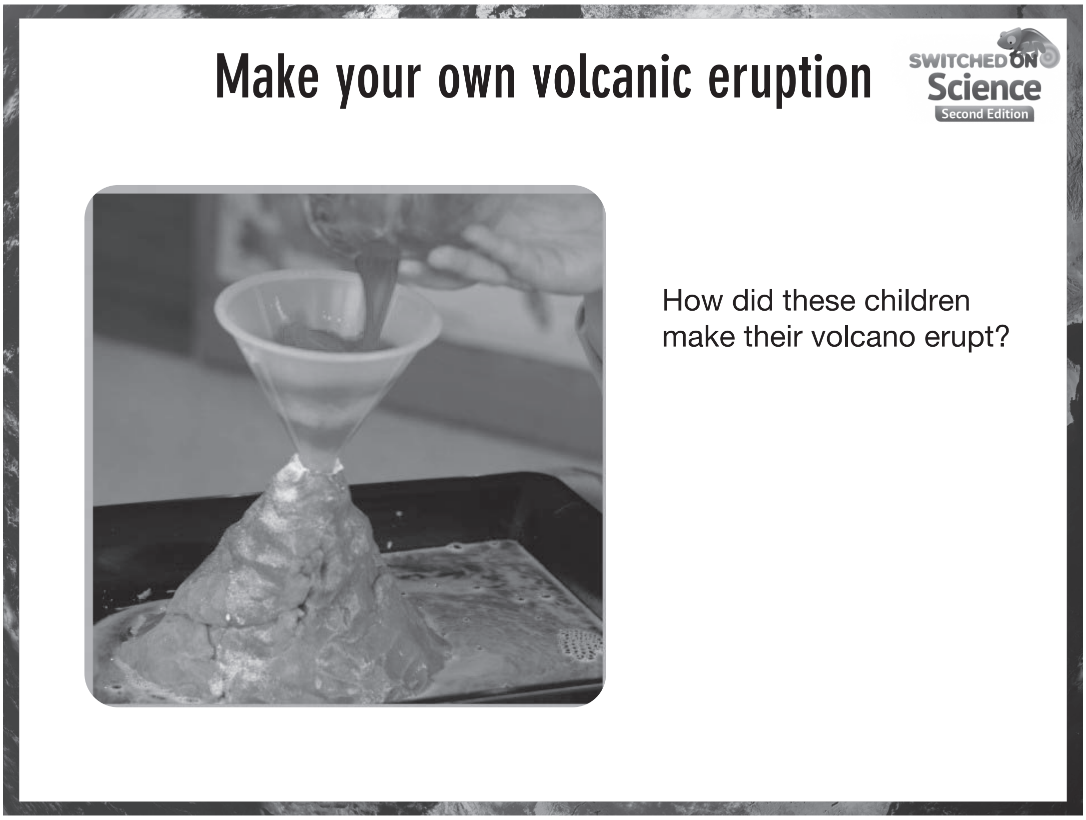
YOU WILL NEED

- PowerPoint Slide 7
- Plastic tube, beaker, wire frame, funnel and papier-mâché to make model volcano
- Vinegar
- Bicarbonate of soda (baking soda)
- Red food colouring
- Washing-up liquid
- Tablet or camera to create video a clip

ASSESSMENT

Working Scientifically

- Em. Children carry out this activity and can describe what they did and what happened.
- Exp. Children explain in their narration how they have made their lava, what the new material is and that this is an irreversible change.
- Exc. Children use scientific language to explain how a new material is made, that the volcanic eruption is an irreversible change and how changing the amount of bicarbonate of soda and vinegar can affect the eruption.



4 MAKING PLASTIC

L.O. Explain that some changes result in the formation of new materials, and that this kind of change is not usually reversible, including changes associated with burning and the action of acid on bicarbonate of soda.

Report and present findings from enquiries, including conclusions, causal relationships and explanations of and degree of trust in results, in oral and written forms such as displays and other presentations.

- Explain to children that they are going to make their own plastic, which they can mould and change shape. Ask them to think about what it would be like if they could make any material they wanted in their home. In groups they think about things that are Positives (advantages), Minuses (disadvantages) and that might be Interesting. Give children time to share their ideas with the rest of the class.
- Give each group access to a camera so that they can take photographs at each stage to record the changes that take place.
- This activity requires hot milk to be used and therefore requires adult supervision when heating the milk (unless a flask of hot milk is used).
- When warm whole milk and white vinegar are combined, this causes the milk to curdle and a solid material is formed. This material can then be moulded into shapes, e.g. for fridge magnets, beads for a bracelet or a sculpture, and left to dry hard, then painted and varnished.
- Key to this activity is the idea that children explain the changes that resulted from the mixing of vinegar and warm milk to form a new material. Children should also be able to explain that this kind of change is not usually reversible, they cannot get back the vinegar and milk.
- Show children PowerPoint Slide 8 and ask them a variety of questions relating to the different changes: what caused them, how the materials changed, what new material was made and whether it is a reversible or irreversible change.
- Using the photographs from the activity, children could use, e.g. ‘Pic – collage’ to show and explain the changes: that took place. Prior to doing this make sure that the children have listed and spelled key vocabulary linked to the changes correctly, e.g. *chemical change*, *irreversible, liquid, solid*, acid and *new material*.
- Ask children to think about new questions that they could ask and test, e.g. using:
  - Different kinds of milk.
  - Different liquids.
  - Different kinds of liquids that are acidic, e.g. lemon or lime juice.

YOU WILL NEED

- Camera
- Hot milk (heated for experiment or in flask)
- Vinegar
- PowerPoint Slide 8
- Different liquids to vary the test, e.g. lemon juice

ASSESSMENT

Subject Knowledge

- Em. Children describe the sequence of events; they know that a change has occurred but do not use the word ‘irreversible’.
- Exp. Children know that, a new material is made and that the process is irreversible.
- Exc. Children link mixing warm milk and vinegar as an acid that produces a new material and is an irreversible change.

Working Scientifically

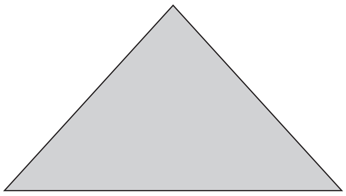
- Em. Children use their photographs to prompt descriptive sentences, oral or written, of the sequence of events.
- Exp. Children use scientific language and subject knowledge about irreversible change to communicate the activity.
- Exc. Children communicate the activity explaining the relationship between cause and effect to explain the results.

5 INVESTIGATING RUST

L.O. Explain that some changes result in the formation of new materials, and that this kind of change is not usually reversible, including changes associated with burning and the action of acid on bicarbonate of soda.

Use test results to make predictions to set up further comparative and fair tests.

- Before beginning this investigation, ask children what they think rust is, where it comes from, where it is found and what it does. They could create a mind map of ideas, saving it to add to their work later.
- Show children the video clips that explain how rust is formed and show examples of rust found on a ship (see Useful Websites list on *My Rising Stars*).
- The key to this activity is the rusting triangle:



- Show children PowerPoint Slide 9 and ask them to think about the rusting triangle then use this to ask questions about how they could carry out tests to find out the answers, e.g.:
  - Is it only iron that rusts? Children place iron (nails, steel wool, nuts and bolts) alongside other materials, e.g. plastic, aluminium and plastic in water, and observe it over time.
  - What happens if there is no water? Leave an iron nail out, dry with no water, cover it in cling film, smear petroleum jelly over a nail.
  - What happens if there is no oxygen? This is a challenge because oxygen is dissolved in water so both water and oxygen (air) would need to be removed / kept away from the nail.
  - Does iron rust faster in salt water?
  - How can we protect the iron used as the feet / legs in North Sea oil platforms to stop them rusting? Children use evidence from previous tests, e.g. painting it, smearing it with a grease.
- Alternatively, show PowerPoint Slide 10 and tell children that they are going to test each question to find out whether these ideas are correct.
- For each test children should take measurements (e.g. of water), make regular observations, use test results to ask further questions and set up tests then decide whether they are carrying out a comparative or fair test.
- Tell children to return to the mind map that they began at the beginning of this activity and to add new knowledge, their learning from tests and vocabulary, using a different coloured pen. Check that children have included language such as chemical reaction, irreversible change, new material, rust and iron.

YOU WILL NEED

- Video clip (see Useful Websites list)
- Pens and paper
- PowerPoint Slides 9 and 10
- Iron materials, e.g. nails, steel wool, nuts and bolts
- Other material including metals and non-metals
- Containers containing salt water, fresh water, no water
- Paint or grease to cover iron materials

ASSESSMENT

Subject Knowledge

- Em. Children know that rust has formed but do not use the word ‘irreversible’.
- Em. Children know that rust is an irreversible change.
- Exc. Children know that rust is a new material and is an irreversible change.

Working Scientifically

- Em. Children carry out a test and can say whether rust has formed.
- Exp. Children ask and test their own questions about rust.
- Exc. Children compare results from different tests and explain the differences.

6 BURNING

L.O. Explain that some changes result in the formation of new materials, and that this kind of change is not usually reversible, including changes associated with burning and the action of acid on bicarbonate of soda.

Report and present findings from enquiries, including conclusions, causal relationships and explanations of and degree of trust in results, in oral and written forms such as displays and other presentations.

- Show children a video clip (see Useful Websites list) that illustrates burning in a Hindu Festival and explains what is required for burning. Alternatively, invite a member of the local fire brigade to discuss fire, what it requires and its dangers.
- Burning is a chemical reaction that needs three things to make it happen (similar to rusting that requires three things): a material to burn, called the **fuel**; a supply of **oxygen** and a source of **heat** to set fire to (ignite) the fuel. Like rusting, these three things can be illustrated by a fire triangle. Show children PowerPoint Slide 11 and discuss with them what would happen if they took away any one of the elements from the triangle.
- Show children PowerPoint Slide 12, which illustrates how to set up a burning activity so they work safely. Ask children to think about a set of rules that they should follow to ensure they work safely and write them on a safety card, e.g.:
  - Tie hair back.
  - Be sensible.
  - Make sure no clothes are loose.
  - They can only strike a match when an adult is present.
  - Do not touch the flame.
- Give each group a candle, light it and ask them to observe what happens, they could sketch the candle burning and annotate what they see. Make sure that they focus on the flame, smoke, wax melting, and the candle wick. Ask the children to think about what the source of fuel is (the candle wick and wax being drawn up the wick), where the oxygen is (the air) and what the heat source was (burning match).
- In groups, ask children to decide whether this is a reversible or irreversible change and what evidence they have to justify their answer. How do they know a chemical change has taken place? What new materials have been made? The chemical change produces carbon dioxide, smoke and water (as steam, which the children will not see).
- Challenge children to show how each of the elements of the fire triangle are needed for burning to take place. Children could suggest to blow the heat source out (flame), remove the fuel (wax), cover the candle with a container so that no oxygen can get in.
- Ask children to apply what they have found out to the work of fire fighters; how do they use their knowledge of the fire triangle to put out fires? Use PowerPoint Slides 13 and 14 to develop children's understanding.

YOU WILL NEED

- Video clip (see Useful Websites list)
- PowerPoint Slides 11–14
- Candles and source of fire
- Container to revent oxygen reaching candles
- Foil tray and sand

ASSESSMENT

Subject Knowledge

- Em. Children know if something is burned they cannot get the original back but do not use the word 'irreversible'.
- Exp. Children know that burning is an irreversible change.
- Exc. Children know the conditions for burning and that this is an irreversible change.

Working Scientifically

- Em. Children describe what happens when a candle is burned.
- Exp. Children makes links between the fire triangle and burning.
- Exc. Children recognise causal relationships, e.g. if the fire is burning, oxygen must be present.

6.2 Real-world reactions

GET STARTED

Tell children that they are going to start their own personal glossary of terms for this topic, beginning with words from the previous activity. Ask them to think about which words they would include e.g. *material, change, reversible, irreversible* and *substance*. They could make their own glossary book or write a special page in their science book and add to their glossary as they work through the topic. They could also use mini whiteboards and draft and re-draft their glossary definitions then give them to another student to peer assess.

LET'S THINK LIKE SCIENTISTS

Use these questions to develop research skills and speaking and listening:

- What are smart materials?
- Which new material do you think has had the most impact?

ACTIVITIES

1 BURNING FABRICS

L.O. Explain that some changes result in the formation of new materials, and that this kind of change is not usually reversible, including changes associated with burning and the action of acid on bicarbonate of soda.

Use test results to make predictions to set up further comparative and fair tests.

Report and present findings from enquiries, including conclusions, causal relationships and explanations of and degree of trust in results, in oral and written forms such as displays and other presentations.

- Show children the video clip (see Useful Websites list) that explains how fabrics are tested and how flame retardant materials help to slow down burning in a home.
- In this activity children will burn a selection of fabrics to find out what happens. Make sure that the class is well ventilated and doors are open. Remind children how to set up this activity, this is shown on PowerPoint Slide 12.
- Children use tongs to hold and burn 1 cm^2 pieces of fabric, observe how they burn and measure how long it takes. The first time children do this they will be so excited that they may miss some observations, so do let them have a practise run. Then they carry out the activity and record their observations using Activity Resource 6.2.
- Fabrics burn differently, some smoulder, others melt, children will notice a smell, smoke and that some fabrics flare up so quickly it almost cannot be timed. Burning is a chemical change, new materials are made, e.g. ash and gases, and it is an irreversible change. Knowing how

YOU WILL NEED

- Video clip (see Useful Websites list)
- PowerPoint Slide 12
- Activity Resource 6.2
- Small samples of different fabrics for burning
- Source of fire
- Tongs
- Foil tray and sand

ASSESSMENT

Subject Knowledge

- Em. Children know if something is burned they cannot get the original back but do not use the word 'irreversible'.
- Exp. Children know that burning is an irreversible change.
- Exc. Children know the conditions for burning and that this is an irreversible change.

Working Scientifically

- Em. Children describe observations of how each fabric burned.
- Exp. Children are able to safely carry out the activity and use their observations and results to explain that burning is an irreversible change.
- Exc. Children apply their knowledge of burning; they ask and test new questions.

materials burn is very important to manufacturers and the fire service. In the home, fabrics that burn and give off toxic fumes or burn quickly are very dangerous, so ask children which fabrics they would choose / not choose to make furnishing such as settees, chairs, curtains and so on. Invite the fire service to discuss burning with children and share their test results: this could generate interesting discussion.

- Children find this activity both motivating and fascinating and recognise the dangers. As a way of presenting their findings children could create a safety poster or leaflet that explains the process of burning and how they tested their fabrics and report on the ways the different fabrics burned.

2 NEW MATERIALS

L.O. Identify scientific evidence that has been used to support or refute ideas or arguments.

- Many scientists research ways to make new materials that can help people to solve problems and make life easier. Without these new materials, we would not have many of the things we use today, from computers to trainers. Ask children to think about the many different things they wear and use every day, and which material they think is the most important and why. You could list their idea and then have a class vote.
- Introduce these new materials to children:
  - Very strong sticky tape (which will hold the weight of an adult), which was inspired by the way different insects stick to surfaces.
  - Self-cleaning materials – materials that clean themselves.
  - Hand-sized pads that allow humans to climb without falling off, e.g. a building.
  - Materials that can heal themselves, like wounds heal on humans, so that when shoes begin to wear out they heal and become like new again.
- Ask children to discuss in their groups PMIs (Positives, Minuses and Interesting things) about each of these materials. Share their ideas and then ask children to think about which of these new materials could be the most useful to people across the world and why. If they could only manufacture and use one of these materials, which would they choose and why?
- Challenge children in their groups to think about all they have learned about materials in this unit, then to be creative and design their own new material. What could it be used for? How would it help people across the world? What would it be made from? How 'green' (environmentally friendly) is their material?
- This activity could result in groups engaging in a 'Dragon's Den' activity where they have to explain and 'sell' their new material. Invite a scientist or someone from local industry to listen to each group's pitch and give feedback on their idea and the way it was presented.

ASSESSMENT

Working Scientifically

- Em. Children work as part of a group, supported by other children.
- Exp. Children are able to design a new material and explain how it can be used and its importance.
- Exc. Children apply their understanding of the properties of materials and are able explain what its impact could be on the lives of people.

1.1 What's in our Solar System?

Fact Card 1

The Sun is at the centre of the Solar System.

Fact Card 2

There is only one star in the Solar System: the Sun.

Fact Card 3

The Sun is 93 million miles away from the Earth. That is equal to 146 million kilometres.

Fact Card 4

Astronauts have walked on the Earth and the Moon but no other planet.

Fact Card 5

Jupiter is the largest planet. It has a 'Great Red Spot' which is a huge wind storm.

Fact Card 6

Bright rings surround the planet Saturn. Jupiter, Uranus and Neptune also have rings.

1.1 What's in our Solar System?

Fact Card 7

Uranus is the coldest planet in the Solar System.

Fact Card 8

Mercury is the hottest planet in the Solar System: it is nearest the Sun.

Fact Card 9

Jupiter, Saturn, Uranus and Neptune are called the 'gas giants' because they are made mostly of gas.

Fact Card 10

Mercury, Venus, Earth and Mars are called the 'rocky planets' because they are mostly made from rocks.

Fact Card 11

Neptune is the stormiest planet: wind storms blow three times as fast as hurricanes on Earth.

Fact Card 12

There are five known dwarf planets in the solar system. Their names are Pluto, Ceres, Haumea, Makemake and Eris.

1.1 What's in our Solar System?

Fact Card 13

Twelve astronauts have walked on the Earth's Moon. Neil Armstrong and Buzz Aldrin of the USA first walked on the moon in 1969: the last astronaut walked on the Moon in 1972.

Fact Card 14

Saturn is between Jupiter and Uranus.

Fact Card 15

Venus lies between Mercury and the Earth.

Fact Card 16

Mars lies between Jupiter and the Earth.

Fact Card 17

Saturn is further away from us than Jupiter but not as far away as Neptune and Uranus.

Fact Card 18

Pluto is the furthest planet from the Sun.

Fact Card 19

The Earth has one 'Moon' but you only see one side of it.

Fact Card 20

Pluto used to be considered a planet but scientists decided it was too small to be one.

1.2 Let´s make a Solar System

Planet	Distance from Sun (km)	Squares of toilet paper out to planet's orbit (short version)	Squares of toilet paper out to planet's orbit (long version)
Mercury	57,910,000 km	1.0	2.0
Venus	108,200,000 km	1.8	3.7
Earth	149,600,000 km	2.5	5.1
Mars	227,940,000 km	3.8	7.7
Jupiter	778,330,000 km	13.2	26.4
Saturn	1,429,400,000 km	24.2	48.4
Uranus	2,870,990,000 km	48.6	97.3
Neptune	4,504,000,000 km	76.3	152.5

1.3 Universe address cards

Virgo Supercluster	**Country**
Name of Planet	**Continent**
House number and street	**Solar System**
Milky Way Galaxy	**Name**
Observable Universe	**Village or town**

1.4 Solar System data

Name of Planet	Average Distance from Sun	Diameter	Time to Spin on Axis (a day)	Time to Orbit Sun (a year)
Mercury	57,900,000 km (36,000,000 miles)	4,878 km (3,031 miles)	59 days	88 days
Venus	108,160,000 km (67,000,000 miles)	12,104 km (7,521 miles)	243 days	224 days
Earth	149,600,000 km (92,960,000 miles)	12,756 km (7,926 miles)	23 hours, 56 mins	365.25 days
Mars	227,936,640 km (141,700,000 miles)	6,794 km (4,222 miles)	24 hours, 37 mins	687 days
Jupiter	778,369,000 km (483,500,000 miles)	142,984 km (88,846 miles)	9 hours, 55 mins	11.86 years
Saturn	1,427,034,000 km (888,750,000 miles)	120,536 km (74,900 miles)	10 hours, 39 mins	29 years
Uranus	2,870,658,186 km (1,783,744,300 miles)	51,118 km (31,763 miles)	17 hours, 14 mins	84 years
Neptune	4,496,976,000 km (2,797,770,000 miles)	49,532 km (30,779 miles)	16 hours, 7 mins	164.8 years

1. Which planet takes the shortest time to orbit the Sun? How do you know?

   ____

2. Which planet takes the longest time to orbit the Sun? How do you know?

   ____

3. Which planet has the shortest day? How do you know?

   ____

4. Which planet has the longest day? How do you know?

   ____

5. Which planet has a daylength that is similar to the Earth's?

   ____

6. What is the difference between the planet with the longest time to spin on its axis and the planet with the shortest time to spin on it axis? Write your calculation down.

   ____

7. What is the pattern in the data between the distance of planets from the Sun and the time they take to orbit the Sun? ____

8. What shape are planets? ____

2.1 Why that material?

Look carefully at the objects you have been given. Complete the table below – the first row has been filled in as an example.

Wood? Metal? Ceramic? Paper? Plastic? Rock? Wool? Fabric?

Name of object	What is object used for?	What material has been used to make it?	Why has this material been picked?
Frying pan	Cooking food	Metal	Hard and strong. It lets heat through quickly.

2.2 Investigation planning board

When you are planning your investigation, work in a group and let everyone write down their ideas for each part on sticky notes. Discuss all the ideas and pick the ones that will make the best plan and stick them in the table below. Keep all the other ideas, because you may want to change your plan once you get started!

I will ask my teacher to make this bigger and laminate it so we can use it for lots of investigations.

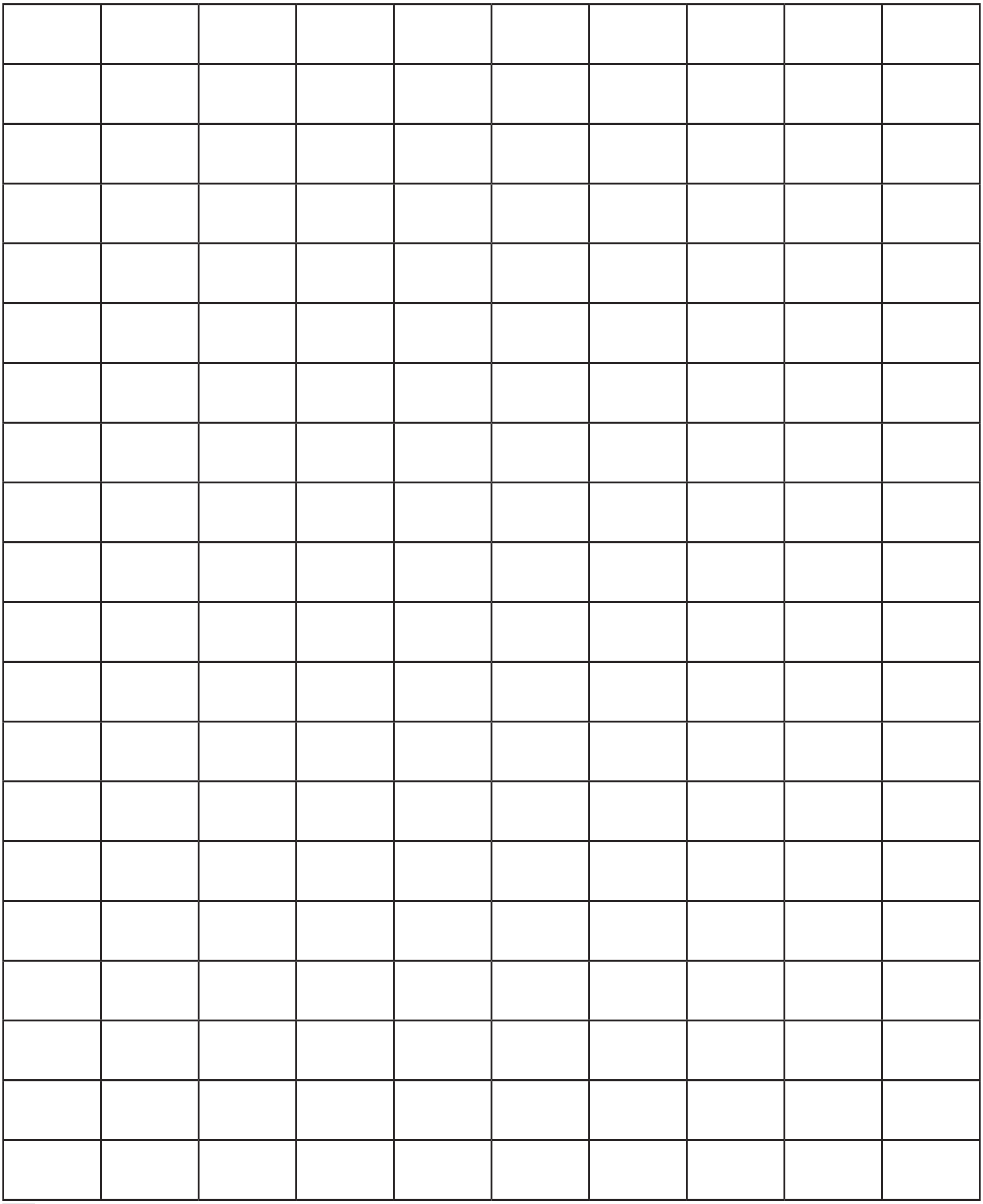
Decide these before you think about the rest.

What is your question?

	Place sticky notes here
What will you change?	
What will you measure to show a change?	
	Place sticky notes here
We will make it fair by…	
We will use…	
This is the table for our results.	
This is a sketch of our graph.	

2.3 Graphing materials

A graph to show what I measured



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What I changed

2.4 Growing salt crystals

You will need

- Table salt – sodium chloride
- Distilled water
- Large jug or container
- A clean, clear glass container e.g. jam jar
- String
- Pencil

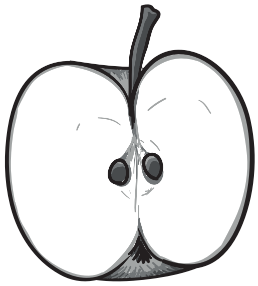
What to do

1. With the help of an adult, pour some nearly boiling water into a container or large jug.
2. Stir salt into the hot water until no more salt will dissolve, i.e. it is a supersaturated solution.
3. With the help of an adult, pour the solution into your jar.
4. Tie a length of string to the pencil, just long enough that the string sits in the solution.
5. Place the pencil across the jar so that the string hangs down into the solution.
6. Leave the jar somewhere it will not be disturbed.
7. Be patient and wait for your crystal to grow!

3.1 Plant fertilisation

Add any missing information to these cards.
Number them in the correct order or cut them out and place them in the correct order.

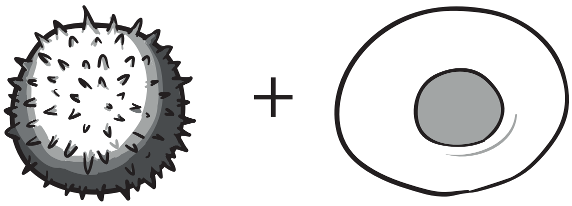
Pollen travels from the stamen of one flower to the stigma of another. **OR** Pollen can be carried by animals such as ____________ , or it can float on the ____________ .



The fertilised egg will develop into a seed.

The wall of the ovary will swell up and become a f ____________ .

The stamen are the male parts of the flower. They make pollen.
Pollen contains half the information for making a new plant.

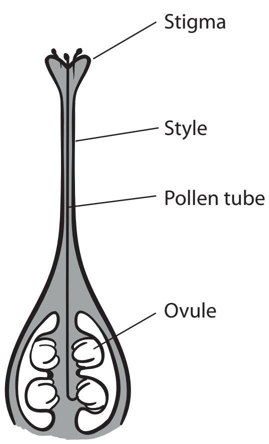


After pollination, the pollen grain and the egg join together.

This is called f ____________ .

The carpel is the female part of the flower. It contains eggs.

Eggs contain half the information for making a new plant.

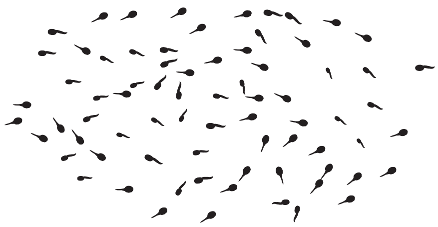


How plants are fertilsed

3.2 Different babies

Add any missing information to these cards.

Frog



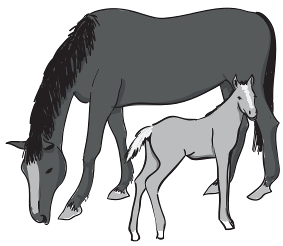
Fertilisation: internal / external

Number of eggs released: ______________

Number of offspring: ______________

Parental care: ______________

Horse



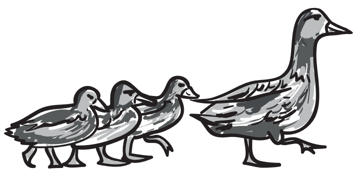
Fertilisation: internal / external

Number of eggs released: ______________

Number of offspring: ______________

Parental care: ______________

Duck



Fertilisation: internal / external

Number of eggs released: ______________

Number of offspring: ______________

Parental care: ______________

Human

Fertilisation: internal / external

Number of eggs released: ______________

Number of offspring: ______________

Parental care: ______________

Why do you think frogs make so many babies?

____

Why might some animals only produce one or two babies at a time?

____

3.3 Endangered animals

Native habitat				
Why is it endangered?				
How are we trying to save it?				
Any other information.				

3.4 Planning your presentation

Use this sheet to plan your presentation about a famous scientist.

Introduction

Explain in one sentence why they are famous.

When were they born?

Are they still alive? If not, when did they die?

Childhood

Where did they live?

What was their family like?

Did any interesting things happen to them?

Discoveries / Work

What did they discover? Or what did they do?

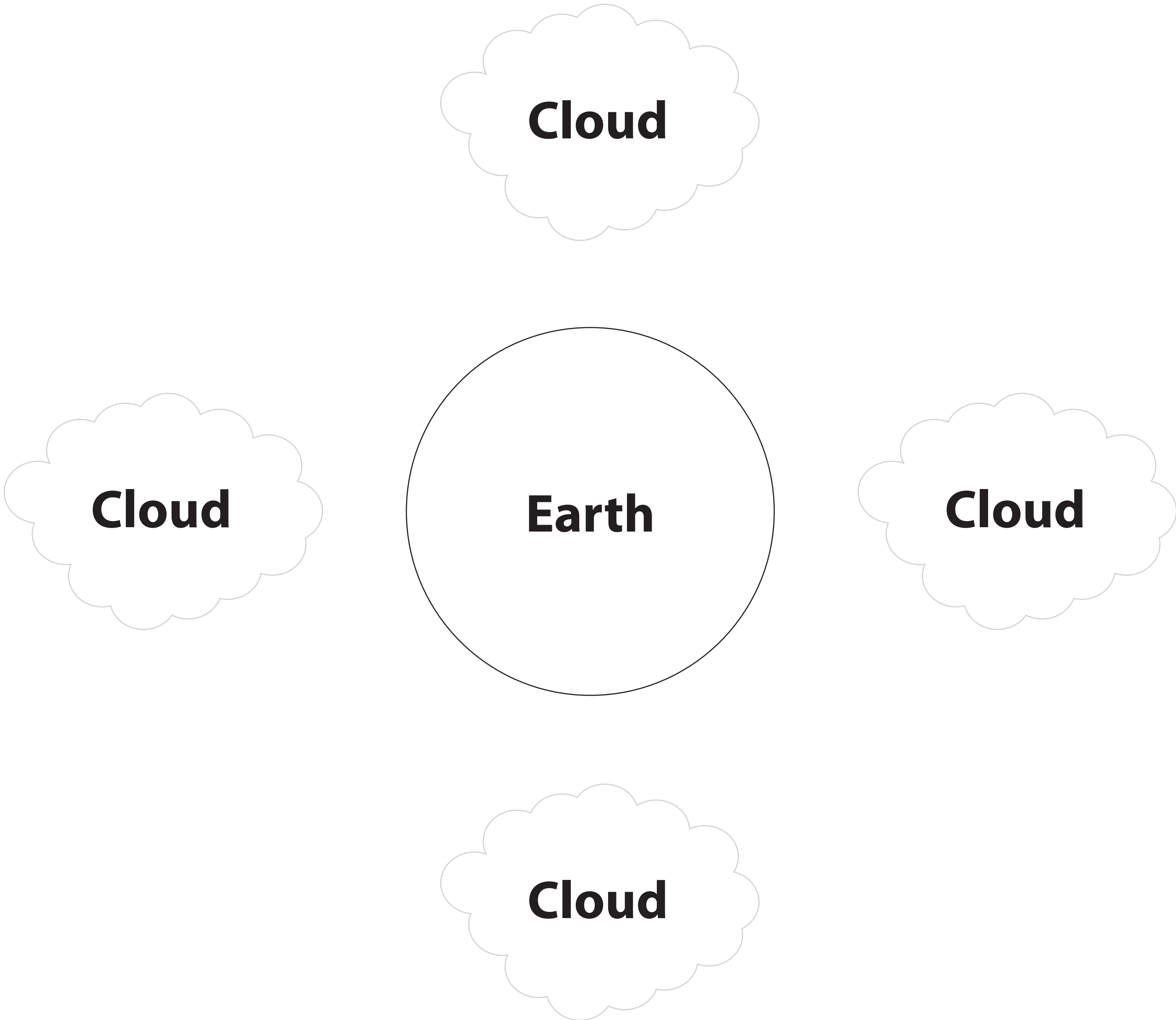
Why was it so special?

Other information

Is there anything else about them that is important to tell your audience?

4.1 How does gravity act?

Draw arrows on the diagram to show the direction in which rain falls at different places on Earth.



4.2 Read all about it!

Galileo and Sir Isaac Newton both made discoveries about gravity. Write a headline and short, eye-catching paragraphs about their theories.

4.3 My investigation plan

I want to find out:

The equipment I will need is:

Variables – What could we change?

We could change…

We are only going to change:

Fair test – What will we keep the same?

We will keep…

Method – What did we do?

Firstly we…

Then we…

4.3 My investigation plan

Measure – How are we going to record our results?

We could record our results by using...

diagrams bar charts drawings tables tally sheets writing lists pictograms

Prediction – What do you predict will happen?

I predict that…

My results

Conclusion – I think this has happened because…

4.4 Levers table and graph

What is the distance from the fulcrum that different weights will balance a 1kg load?

Mass gm	Distance from fulcrum cm
100	
200	

4.5 Pulleys

Draw annotated diagrams of the pulley systems that you make and write an explanation about how each one works.

Wooden skewer and cotton reel pulley

The wooden skewer and cotton reel pulley works ______________________

____

____

____

Broomstick and string pulley system

The broomstick and string pulley works ______________________

____

____

____

4.6 Working out maths in gears

Complete this table.

Cog 1: number of teeth (this is the cog you move – put effort into)	Cog 2: number of teeth	How many turns does cog 1 make?	How many turns does cog 2 make?	Ratio
12	12	1	1	1:1
12	24	2	1	2:1

What do you notice about the pattern in the data?

4.7 My Rube Goldberg design

Here is how it works:

5.1 Gestation periods

This table shows how long different animals are pregnant:

Animal	Length of Pregnancy (days)
Mouse	21
Squirrel	30
Cat	64
Lion	108
Human	266
Camel	370
Rhinoceros	450
Elephant	645

1. Make a bar graph of the table above.

2. a) Which of these is the biggest animal? ______________________________

b) Which of these is the smallest animal? ______________________________

3. Look at the graph you have drawn:

a) Which animal has the longest pregnancy? ______________________________

b) Which animal has the shortest pregnancy? ______________________________

4. Bigger animals take longer to develop. Do you agree? Use the information from the table to explain your answer.

____

____

5.2 Milestones

Start school	Buy alcohol
Start secondary school	Get a senior citizen rail card
Vote in a general election	Ride a moped
Get married with parental consent	Open a bank account in your own name
Get a paper round	Stand for election as a member of parliament
Drive a car	Get a pilot's licence
Become a blood donor	Be an ambulance driver

5.3 Getting older

Try out some of the different demonstrations that show what it might feel like to be old. Write down what you did and how you felt in the boxes below.

What we did	How it made me feel

5.4 Living to 100

More people are living beyond 100, say Office of National Statistics.

More people are living to beyond 100 in England and Wales, according to an Office for National Statistics report.

The number of people reaching 100 rose from 2,280 in 1980 to 11,610 in 2010, it said. It also noted a rise in people living to 110. Most people are also living for longer, it said, surviving for six years beyond life expectancy projections.

The trend towards an ageing population has prompted concern around health care, pensions and retirement ages. It found that a boy born in 2010 could be expected to live until the age of 79, while a girl should live to 83. That compared with a life expectancy of 71 for a boy and 77 for a girl born in 1980.

However, in analysing the age at which death is most common, the ONS has found that most men are living until they are 85, and women to 89. And over the past 50 years, between 1960 and 2010, the average life span increased by about 10 years for a man and eight years for a woman.

Just over 1% of the population – an estimated 524,200 people in England and Wales – were aged 85 or over in 1980, but that had doubled by 2010.

The ONS concluded that 'an upper limit to life span has not yet been reached' in England and Wales, adding: 'We will almost certainly see further increases in the average age at death.'

Source: www.bbc.co.uk/news/uk-20768649

Questions:

Read the above news article and use it to answer these questions:

1. How many more people reached 100 in 2010 than in 1980? _______________

2. a) How much longer can a boy born in 2010 expect to live compared to 1980?

____

b) How much longer can a girl born in 2010 expect to live compared to one born in 1980?

____

3. How many people were aged 85 or over in 2010? __________________

4. Why might it be a problem if people live longer? __________________

Think About:

5. Why do you think people are tending to live longer? _______________

6. Some people think that it will be possible to live for longer and longer. Why might this lead to problems?

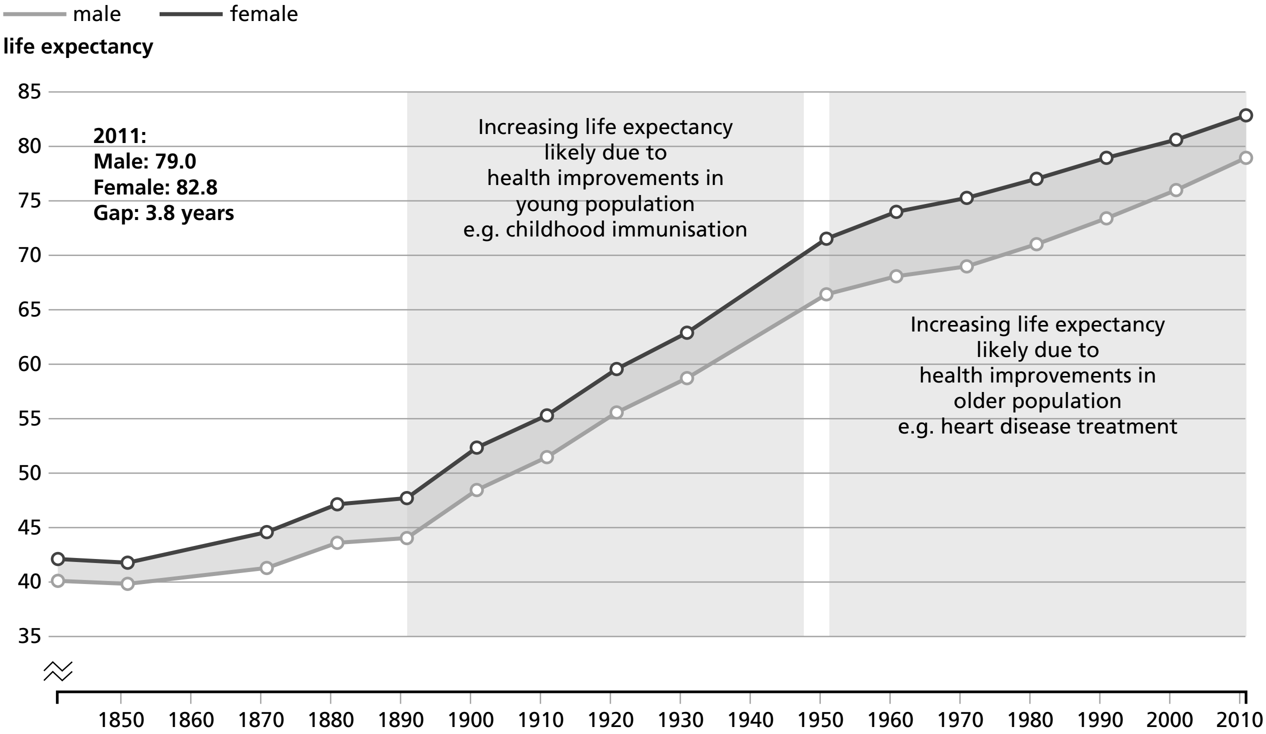
____

7. What would it be like if you could live to be 200 or more? How might the world have changed by then? Write a short story about a day in your life 200 years from now.

____

5.5 How has life expectancy changed?

Life expectancy at birth, England and Wales, 1841 to 2011



Write down three conclusions from the data on the graph. Make sure you include the data in your statements.

6.1 Inflating a balloon

When you are planning your investigation, work in a group and let everyone write down their ideas for each part on a sticky note. Discuss all of the ideas and pick the ones that will make the best plan and stick them in the table below. Keep all the other ideas, because you may want to change your plan once you get started.

Setting up your new fair test	Stick your sticky notes here
What is your new question? It should begin with 'How does the ………. affect……..?'	
What will you change?	
What will you keep the same?	
What will you measure to show that there has been a change?	
What do you predict will happen and why?	

Using your data

Was your prediction correct? How do you know? ______________________________

What is the relationship between what you changed and your results? ______________________________

____

Explain what happened. ______________________________

6.2 Burning fabrics

Swatch of fabric and name	What is the smoke like?	How does it burn?	Does it leave a residue? E.g. ash	How long does it take to burn?	Any other comments