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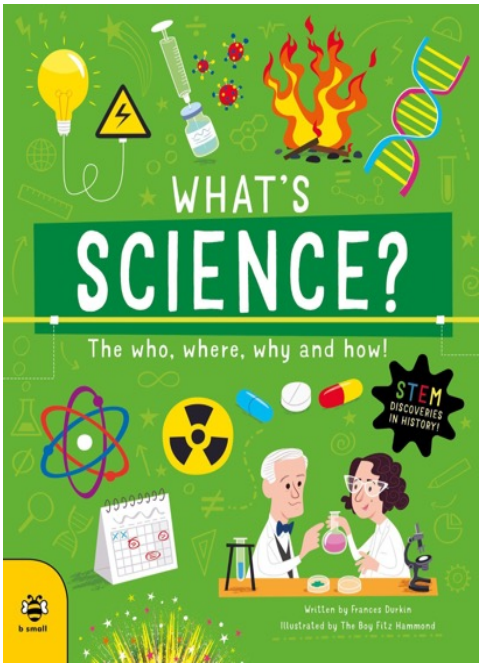
STEM DISCOVERIES IN HISTORY!

Educational Resource Pack

What's Science/Technology?
(STEM Discoveries and Inventions)
by Frances Durkin and The Boy Fitz Hammond



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Key Info

Suitable for: Ages 8+

Explore themes of:
- Exploration of significant scientific discoveries and inventions that shaped the world
- Understanding the circumstances and context in which these discoveries and inventions were made
- The creative processes and innovative thinking that led to these significant advancements in science and technology
- How scientific discoveries and technological inventions have impacted society, both historically and in the present
- The personal stories and human elements behind these scientific and technological advancements
- The problem-solving skills and ingenuity demonstrated by inventors and scientists in overcoming challenges

About the books

What's Science?: The Who, Where, Why and How!
Discover the people and places behind 13 major science discoveries that changed the world. You'll read about what motivated them, why they did what they did, when they did it ... and with whom!
There is a glossary at the back of the book plus a 'take it further' activity on each page.
Discover the human side of STEM!

What's Technology?: The Who, Where, Why and How!
Discover the people and places behind 13 major technological inventions that changed the world. You'll read about what motivated them, why they did what they did, when they did it ... and with whom!
There is a glossary at the back of the book plus a 'take it further' activity on each page.
Discover the human side of STEM!

Fact-filled non-fiction that uncovers the who, where, why and how of historic scientific discoveries.

Who made the books?

Frances Durkin
Dr. Frances Durkin is a historian, writer and mum who grew up in a large, history-loving family. A regular contributor to Aquila magazine on all sorts of historical and STEM subjects for children and co-creator of the Histronauts, Frances runs workshops at museums and bookshops and has written for the Tate. Frances lives in Buckinghamshire, UK, with her young family.

The Boy Fitz Hammond
Born in York when fast trains were yellow and blue, The Boy Fitz Hammond now lives in Edinburgh. He has worked with various clients including Oxfam, Shelter, BBC, Honda, Microsoft and the Barclays Premier League. His illustrations have also been used by many editorial, educational and publishing clients across a diverse range of titles.

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Contents

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Extract 1 (What's Science?): A Burning Discovery (pages 4 to 5)

Discussion questions

1. What is archaeological evidence and how does it help us learn about the past?
2. How did early humans use fire in their daily lives? Can you name a few ways?
3. How did fire provide heat and light for early humans? Can you think of ways we still use fire for heat and light today?
4. Why was fire important for early humans in protecting themselves from predators? How might fire have helped them stay safe?
5. How did fire change the way people ate? Why was cooking food important for early humans?
6. What are some likely scenarios for the initial encounters between early humans and fire?
7. Can you list and explain the three important things needed to create fire? Why are these three things important? What happens if one of these things is missing?
8. Imagine you are an early human discovering fire for the first time. How do you think you would react? Would you have been excited or cautious? What might you do with fire and why?
9. How do firefighters today prevent and put out fires? What tools and equipment do they use and how are they different from what was used in ancient times?
10. How do you think the discovery and use of fire changed the course of human history? How has fire shaped our modern lives and societies?

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Activity 1: Blazing Beginnings

- Begin the lesson by capturing the children's interest and activating their prior knowledge. Ask them what they already know about fire and how it's used in their daily lives. Examples might include staying warm; cooking food; giving light; camping trips and in cultural celebrations like lighting candles on a birthday cake or as part of a religious festival.

• Encourage them to share their thoughts, experiences and observations related to fire. Write down their responses on the board, creating a visual display of their initial understanding of fire.

• After the discussion, introduce the topic of fire in more detail. Share the provided double-page extract with the class, projecting it on a screen or providing printed copies for everyone to follow along.

• As you read through it, pause and ask the discussion questions to the children, and invite them to ask questions of their own, to ensure their engagement and that they are understanding the content.

• Emphasise the significance of fire for early humans, discussing its crucial roles in providing heat, light, cooking food and protection against predators. Talk more about how these roles were fundamental to early human survival and development.

• Also, highlight the historical aspects, such as the earliest uses of fire in Israel and the development of fire-making methods over time, particularly the invention of matches and their impact on society.

• Transition into the creative writing activity by explaining to the class that they will step into the shoes of an ancient human who has just discovered fire and write a diary entry expressing their discovery, emotions and how fire changed their life and community.

• To set the mood, dim the lights and show a crackling fire on the board, with accompanying sound. Ask the children to reflect on what they might have seen, heard and felt as an early human upon encountering fire for the first time, creating a word bank to capture their initial reactions.

- Give each child a copy of Activity Sheet 1: Fire Discovery Diary, which includes an example of a diary entry, as a guide. Point out the effective use of descriptive language by modelling how to include words, phrases and engaging sentence starters to help them feel confident and creative with their writing.

- Allow children time to write their diary entries. Remind them to refer to the example and focus on their storytelling. During this time, circulate the classroom and provide assistance where needed. Afterward, ask them to illustrate their diary entries to accompany their written reflections.

• Conclude the lesson by inviting volunteers to share their diary entries with the class.

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Activity sheet 1: Fire Discovery Diary

Imagine you are an early human who has just discovered fire.
Write a diary entry describing your discovery, emotions and how fire changed your life and community. Use the example below to help you get started.

Example:

Dear Diary,

Today was a day like no other. As the sun dipped below the horizon, painting the sky orange and pink, I stumbled upon a mesmerising sight: fire! Flames leaped and crackled, sending sparks spiralling into the night. It was like a tiny piece of the sun had fallen to the earth. Even though it frightened me at first, the warmth and light it offered were comforting.

Our group gathered around this newfound wonder. It provides a source of light and warmth and keeps predators away. We've only just begun to learn how to control it and we hope to use it to cook our food, making it safer and tastier. The elders have also started to share stories and wisdom around the fire, bringing us all closer together.

As the flames flickered and danced, I felt a mix of awe, excitement and responsibility. Fire is a gift from nature and we have to use it wisely, respecting its power. We have to pass down this knowledge to help our community and generations to come. Tonight, as I lie down to sleep, I'm filled with thankfulness for this extraordinary discovery and the adventures that await us with the magic of fire.

Your diary:

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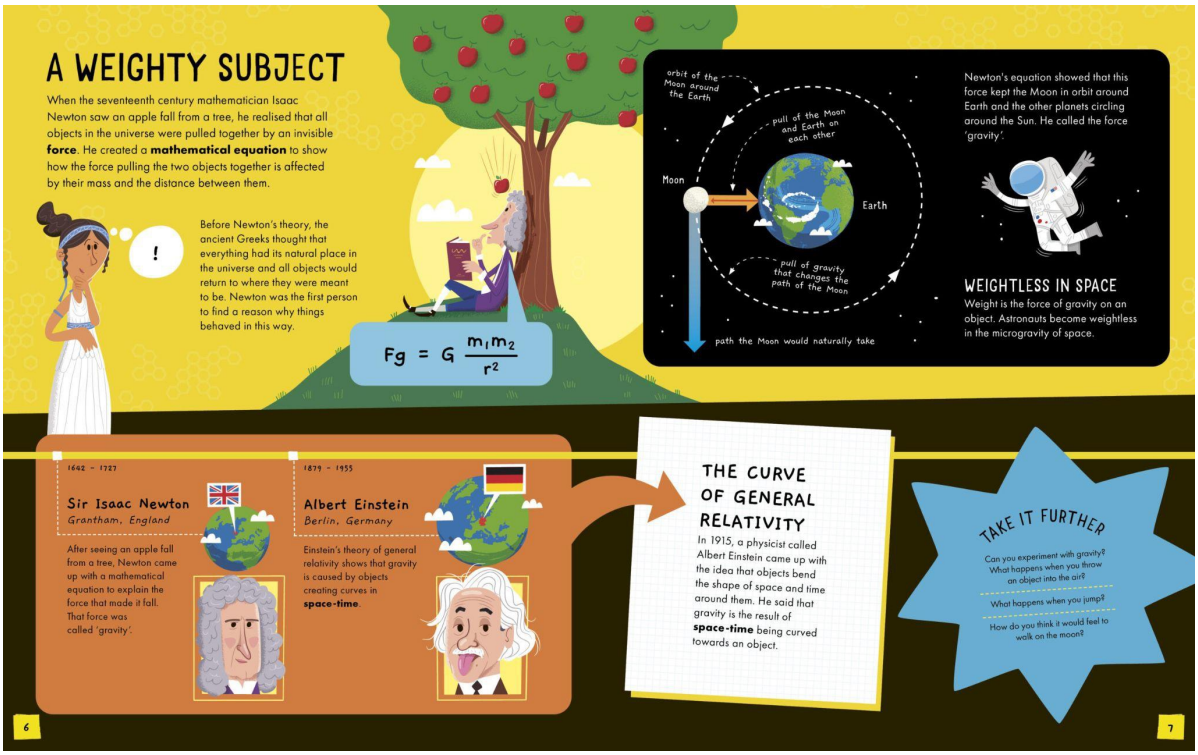
Extract 2 (What's Science?): A Weighty Subject (pages 6 to 7)



Discussion questions

1. What is gravity and how did Isaac Newton define it? Can you share a time when you noticed something in your surroundings that helped you understand or discover something new?
2. How did his understanding of gravity differ from what the ancient Greeks believed?
3. What do you think 'Fg', 'G', 'm1', 'm2', and 'r^2' represent in Newton's mathematical equation?
4. What does 'invisible force' mean? Can you think of other invisible forces we experience daily?
5. What are some everyday examples where we can see the effects of gravity in our lives?
6. Why do you think it's important for astronauts to train and prepare for the effects of gravity before going to space? What are some things you think would be challenging to do there because of the absence of gravity?
7. Can you imagine living in a world where gravity worked differently or didn't exist? Describe one way your daily routine might change in a gravity-free world.
8. Do you think there are other forces or concepts in the universe that we haven't discovered yet? What could they be and what kind of effects do you think they might have?
9. What does a 'theory' mean? How did Albert Einstein's ideas add to the discussion? Why is it important for scientists to study how things move and interact in the world?
10. How might our world be different if Isaac Newton had not made his groundbreaking discovery about gravity? Can you think of a modern invention that relies on our understanding of gravity?

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Activity 2: The Pull of Gravity

- Begin the lesson by displaying images or diagrams of Isaac Newton and the falling apple.

- Prompt the class with a question: "What do you think is the connection between these two images?" Encourage them to share their thoughts. Record their range of responses on the board, emphasising that all ideas are valuable and there are no right or wrong answers at this stage.

- Whilst they are doing this, draw attention to how they're creating ideas or hypotheses. Explain that this is called theorising, a skill well-known among scientists and mathematicians, just like Isaac Newton.

- Next, read the provided double-page extract with the class, projecting it on a screen or providing printed copies for everyone to follow along. Pause and ask the discussion questions to the children, and invite them to ask questions of their own, to ensure their engagement and understanding of the content.

- Discuss how both Isaac Newton and Albert Einstein contributed to our understanding of gravity, explaining their laws and theories. Clarify the fundamental principle of gravity: it pulls all objects towards the centre of the Earth, introducing the unit of force used to measure gravity - the Newton (N).

- Conduct a simple classroom gravity demonstration using scrunched-up paper and a flat sheet of paper. Tell the class that you will drop them at the same time from the same height to see what happens and ask them to predict which one will reach the ground first when dropped simultaneously.

- Drop both objects at the same time and watch them fall freely. Encourage the children to observe and note what they see as the objects fall. After the demonstration, discuss the results and point out that the scrunched-up ball reached the ground quicker than the flat sheet.

- Explain that gravity pulls everything towards the centre of the Earth at the same rate (9.8N/kg), regardless of their mass. Initially, this might suggest that all objects should fall to the ground simultaneously. However, other forces, like air resistance, can affect how fast something falls. Describe air resistance as a force that opposes gravity, pushing upwards and attempting to slow down an object. Show how a scrunched-up ball, with less surface area, experiences less air resistance, allowing gravity to pull it down faster. In contrast, the flat sheet faces more air resistance, causing it to fall slower.

- Describe how in a vacuum (where there's no air or resistance to slow things down, such as in outer space or a controlled environment, used in scientific experiments or industrial processes, where air and other gases are removed), everything falls at the exact same speed because of gravity. So, even a feather and a heavy bowling ball would fall together and reach the ground at the exact same time!

- Task children to creatively explore the concept of gravity and its impact on daily life by having them design a comic strip set in a gravity-free world using Activity Sheet 2: Comic Strip Story.

- Ask them to show characters attempting a range of activities including eating, drinking, sleeping, playing, going to school and more. Illustrate how these are different without the influence of gravity and depict the challenges they face without gravity. Let them find creative and humorous solutions to these challenges, either finding ways to cope with the lack of gravity or discovering surprising benefits to their situation. Encourage them to use speech bubbles and captions to convey their story.

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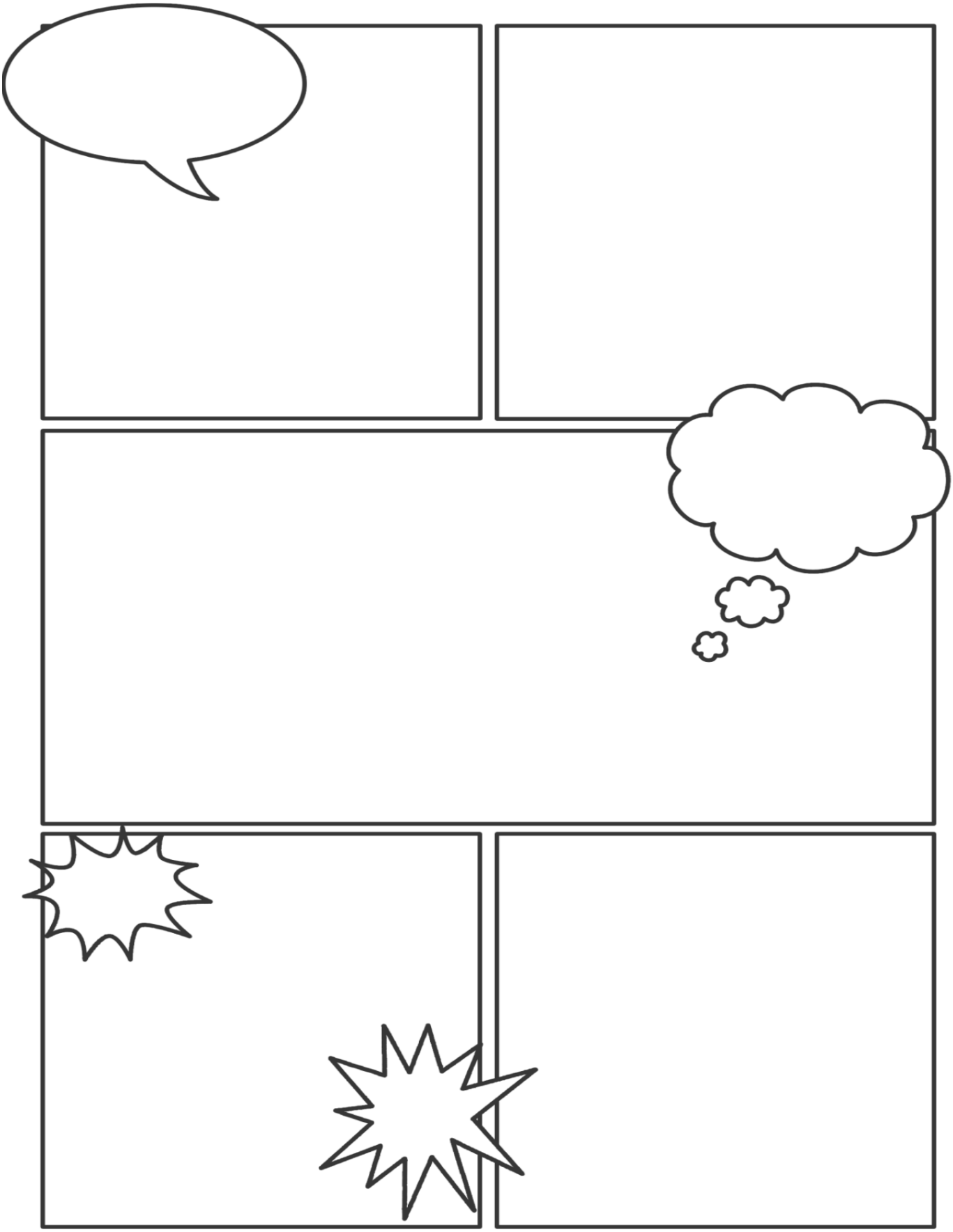
Activity sheet 2: Comic Strip Story



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Extract 3 (What's Technology?): Tools that Rock (pages 4 to 5)

TOOLS THAT ROCK

The Stone Age is the name for the period of history from around 3.3 million years ago to 3,300 BC, when early humans and other **hominids** used rocks and stones as tools. The first stone tools were those that could be picked up and immediately used to crush, grind or be thrown as weapons.

The earliest examples of manufactured stone tools are known as Oldowan tools. These were simple broken stones that could be used for chopping, crushing, grinding and preparing animal skins. It is thought that these were created by *Homo habilis* and *Australopithecus*. The tools became more advanced over time. Aechulean tools were flaked on both sides to create sharper edges. These included hand-axes, arrowheads, knives, spearheads and **adzes**. They were made by *Homo erectus* and *Homo heidelbergensis* and could be used for hunting, preparing food, and making things.

Early stone age woman cleaning an animal skin with stone tools

Homo sapien wielding a knapped axe

c. 3.3 million – 300,000 years ago

Early Stone Age
Lower Palaeolithic

Early hominids, including *Homo habilis* and *Homo erectus*.

Oldowan tools were made by breaking stones into useable tools. These were followed by more advanced Aechulean tools that had sharper edges.

300,000 – 40,000 years ago

Middle Stone Age
Middle Palaeolithic

Homo sapiens and Neanderthals developed the technology to knap longer, sharper blades.

3,300 BC

The Stone Age ends and the Bronze Age begins.

4

These tools are evidence of human evolution. They show how our ancient ancestors lived, hunted and interacted with their environment.

From around 250,000 years ago *Homo sapiens* and *Neanderthals* knapped longer blades for cutting and made tiny blades called microliths that were inserted into handles. It is during this period that early cave paintings were made.

WHAT IS KNAPPING?

Knapping is the process of creating stone tools by striking a large stone, the core, with a hammerstone in order to chip off flakes. These flakes could then be knapped further to create the specific shape that was required. This method was used during the Stone Age to make all kinds of sharp-edged tools, often from a kind of stone called flint.

MODERN STONE TOOLS

Obsidian is a type of igneous rock that is formed when the lava from a volcano cools very quickly. It was used in the Stone Age to produce very sharp blades. Today, obsidian blades are sharper than steel but they are very brittle and can break easily. Obsidian scalpel blades are sometimes used in surgery but they are too fragile for common use.

obsidian

TAKE IT FURTHER

The Iron Age ended when the Bronze Age began. We call it the Bronze Age because there is evidence of the creation and use of bronze in the archaeology from that time.

What difference do you think this new material made to the lives of the people who lived then?

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Discussion questions

1. What time period does 'The Stone Age' refer to and what did early humans and hominids use as tools during this time?
2. Can you think of tools or technologies we use today that serve similar purposes to the stone tools used in the Stone Age?
3. How can we learn about human evolution and the lives of ancient ancestors by studying these stone tools from the Stone Age?
4. How are cave paintings connected to the Stone Age and what do they reveal about the experiences of early humans during that era?
5. How did the stone tools change and become more advanced over time during the Stone Age?
6. What is the specific technique of making stone tools by hitting one rock with another called?
7. Can you describe what obsidian is, how it looks and how it was formed?
8. If you were an early human living during the Stone Age, how do you think you would have used stone tools in your daily life?
9. How do you think life changed for people as they transitioned from the Stone Age to the Bronze Age? What new things could they create or do?
10. If you were to design a new tool inspired by Stone Age technology, what would it be and how do you think it would help people in their daily lives today?

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Activity 3: Stone Age Sculpting

- Begin by reading the double-page extract that explains that the Stone Age is a prehistoric period in human history that lasted for a very long time, from around 3.3 million years ago to 3,300 BC.

- Use it to introduce the three main periods within the Stone Age: the Early Stone Age (or Lower Palaeolithic), the Middle Stone Age (or Middle Palaeolithic) and the Late Stone Age (or Upper Palaeolithic); and to provide a brief overview of some key hominids, such as Homo habilis, Homo erectus, Homo sapiens and Neanderthals, discussing their roles and contributions to tool-making.

- Emphasise that during the Stone Age, early humans and hominids primarily used rocks and stones as tools for various purposes, such as hunting, preparing food, creating art and making shelters. These tools were crucial for their survival and adaptation to their environments. Explain how they developed increasingly sophisticated tools, reflecting their evolving cognitive abilities and problem-solving skills.

- Show some images of Oldowan and Acheulean tools, highlighting their distinct features and purposes. Explain that Oldowan tools were simple broken stones used for various tasks like chopping, crushing, grinding and preparing animal skins, created by Homo habilis and Australopithecus. Describe Acheulean tools as more advanced, flaked on both sides to create sharper edges, including hand-axes, arrowheads, knives, spearheads and adzes, made by Homo erectus and Homo heidelbergensis.

- Next, explore the knapping process. Define knapping as the process of creating stone tools by striking a larger stone (the core) with a hammerstone to chip off flakes, which could then be further shaped to create specific tool shapes. Emphasise that knapping was a fundamental technique during the Stone Age, allowing early humans to craft sharp-edged tools essential for their daily activities.

- Explain to the children that while we can't replicate the exact knapping process with stones in the classroom, we can recreate the concept and craft our own 'stone tools' using clay.

- Show a simple demonstration of how to mould the clay to resemble a stone tool (e.g. a hand-axe, arrowhead, or knife), using plastic knives and sculpting tools. Explain the various techniques, such as pinching, carving and smoothing, that they can use to achieve the desired shapes and edges.

- Before giving out the clay, Encourage children to refer to the provided Activity Sheet where they can sketch out and plan their clay tool design. Advise them to think about the shape, size and features they want to incorporate into their tool and to use the sheet to jot down these initial ideas.

- Distribute clay to each child and encourage them to choose a specific stone tool design (e.g. hand-axe, arrowhead, etc.) based on the provided examples to imitate.

- Guide the children through the process of moulding the clay into their chosen tool shape. Encourage them to start with a rough outline and then refine the shape gradually. Encourage them to personalise their tools, adding unique details or patterns that make their creations distinct. Remind them that each Stone Age tool was crafted uniquely based on the needs and creativity of its maker.

- After the allotted time for crafting, invite children to reflect on their creations and the process they followed. Encourage them to share what inspired their designs and any challenges they faced.

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Activity sheet 3: My Clay Creation

Plan and sketch out your clay tool design in the space provided.

Tool name: _____

Key features

Shape: Describe the overall shape of your tool (e.g. arrowhead, hand-axe, knife).

Functionality: Explain what your tool will be used for (e.g. hunting, cutting, etc.).

Materials: Mention the materials the tool might be made of in the Stone Age.

Reflection: After completing your tool, reflect on the crafting process by answering these questions:

What did you enjoy most about this activity?

What was the most challenging part of designing your tool?

How does your tool design represent the Stone Age?

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Extract 4 (What's Technology?): Hot off the Press (pages 6 to 7)

Discussion questions

1. Approximately how many years ago did Johannes Gutenberg invent the printing press?
2. What materials did Johannes Gutenberg use to create his printing press, and how did they contribute to making the press efficient and effective?
3. Who inspired Johannes Gutenberg when he was making his printing press?
4. Why do you think he worked so hard to make his printing press the best it could be?
5. Gutenberg's press made making books easier, but every page had to be printed one by one. How is this different from how we make books now?
6. When people first saw a book made by Gutenberg's press, how do you think they felt? How might they have imagined sharing information in the future?
7. Gutenberg worked on his printing press in secret. Why do you think he chose to keep his work hidden from others? What might have been some of his reasons for doing so?
8. Do you think Gutenberg knew just how much his printing press would change the world? Why?
9. If Johannes Gutenberg were alive today, what do you think would amaze him about our modern technology, considering what he knew from the printing press?
10. How might life be different for you today if Gutenberg hadn't invented the printing press?

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Activity 4: Printing past and Present

●●Begin the lesson by asking the class about their favourite books and why they enjoy them. Encourage a lively discussion where they can share their thoughts and preferences.

- Highlight the idea that books are like windows to different worlds, allowing us to explore new ideas, cultures and experiences. Emphasise how books are a fundamental tool for learning and education.

- Transition into discussing how books have been an essential part of human history and learning for a very long time. Show a few pictures of ancient scrolls and manuscripts and ask them if they know how books are made today and how texts were created before the use of modern machines.

- Share an image of Johannes Gutenberg and ask the class if they recognise him or know anything about him. Allow for a brief discussion and gather any existing knowledge they may have.

- Introduce him as a German inventor who played a significant role in changing how books were made. Discuss that he lived about 600 years ago and was responsible for a groundbreaking invention related to books and printing called the printing press.

- Next, read the double-page extract to find out more about him and how he created the printing press, taking inspiration from different cultures and working secretly to finish it. As you read through it, encourage children to ask questions and discuss what they've learned.

- Contrast Gutenberg's era of printing with modern-day printing methods. Explain that Gutenberg's press used movable metal type, ink and paper, and each page had to be set by hand. Compare this with today's printing technology, which involves computers, digital typesetting and automated printing processes. Show a simplified demonstration on a video of how these two methods work.

- Distribute Activity Sheet 4: Book Making: Then And Now, which features a Venn diagram. Tell the children to compare and contrast the processes of book making using the historic printing press and modern-day methods.

- Guide the children to categorise the distinctive differences between the two methods by placing them within the respective circles representing each method. Then, instruct them to identify the similarities between them and place them in the overlapping section at the centre of the Venn diagram.
- **Similarities could include**: Both have the same objective of creating books; arrange text in a specific order for printing; the end goal is to produce a book that can be read by a wider audience.
- **Differences could be**: In Gutenberg's time, letters were arranged by hand and they used metal letters for printing. Today, we use computers and digital fonts, allowing faster book production with precise machine printing. Gutenberg's method was significantly slower and more expensive, which restricted book access to a privileged few, whereas modern bookmaking allows for mass production.

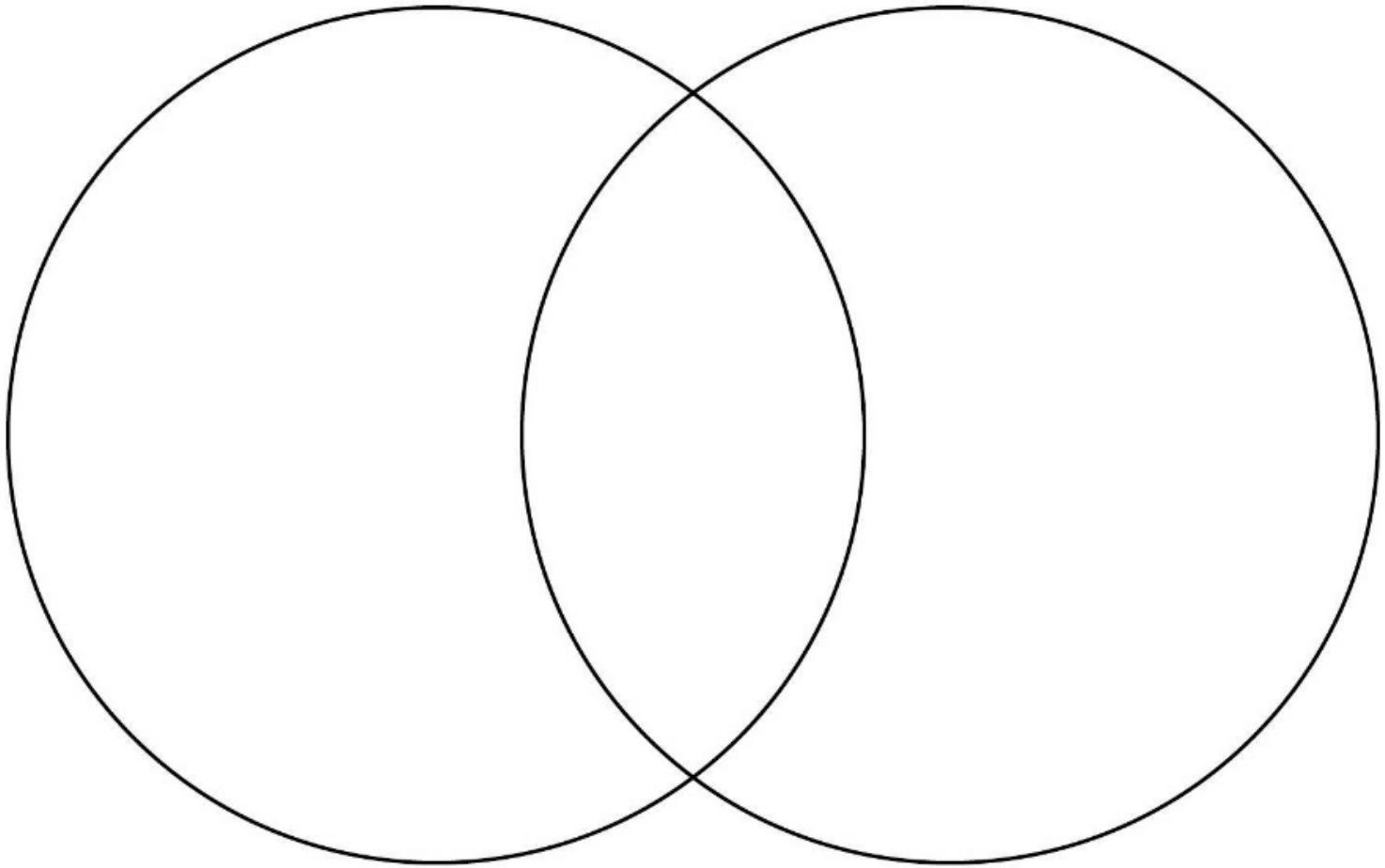
- To deepen the learning experience, allow the children to engage in a hands-on activity to simulate the process of creating both a book in Gutenberg's era and one using modern-day methods. Provide materials such as paper and printing blocks. Show them the process of printing words, then assemble the pages into a mini-book and bind it together using simple binding techniques. Alternatively, introduce the children to the contemporary world of book creation using digital tools. Show them how to compose their stories or illustrations on a computer or tablet and assist them to print their content.

Activity sheet 4: Book Making: Then and Now

<u>Gutenberg's Era</u>
Write or draw key features of book making using Gutenberg's printing press in the left circle of the Venn diagram.

<u>Similarities</u>
Write or draw features that are common to both Gutenberg's era and modern-day methods in the overlapping section in the centre of the Venn diagram.

<u>Modern-Day Methods</u>
Write or draw key features of book making using modern-day methods in the right circle of the Venn diagram.



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National Curriculum Objectives - Key Stage 2

- Science

Pupils should be taught to:

- - Ask relevant questions and use different types of scientific enquiries to answer them
- - Identify differences, similarities or changes related to simple scientific ideas and processes
- - Use straightforward scientific evidence to answer questions or to support their findings.

-Design and Technology

Pupils should be taught to:

- - Generate, develop, model and communicate their ideas through discussion, annotated sketches, cross-sectional and exploded diagrams, prototypes, pattern pieces and computer-aided design
- - Select from and use a wider range of tools and equipment to perform practical tasks [for example, cutting, shaping, joining and finishing]

- Accurately understand how key events and individuals in design and technology have helped shape the world

- Art and Design

Pupils should be taught to:

- - Improve their mastery of art and design techniques, including drawing, painting and sculpture with a range of materials [for example, pencil, charcoal, paint, clay]

- History

Pupils should be taught about:

- -The lives of significant individuals in the past who have contributed to national and international achievements

- English

Spoken language

Pupils should be taught to:

- - Ask relevant questions to extend their understanding and knowledge
- - Consider and evaluate different viewpoints, attending to and building on the contributions of others

Reading – comprehension

Pupils should be taught to:

- - Develop pleasure in reading, motivation to read, vocabulary and understanding by:
- - Listening to and discussing a wide range of fiction, poetry, plays, non-fiction and reference books or textbooks
- - Reading books that are structured in different ways and reading for a range of purposes
- - Understand both the books they can already read accurately and fluently and those they listen to by:
- - Checking that the book makes sense to them, discussing their understanding and exploring the meaning of words in context
- - Distinguish between statements of fact and opinion
- - Retrieve, record and present information from non-fiction

Writing – composition

Pupils should be taught to:

- - Plan their writing by:
- - Noting and developing initial ideas, drawing on reading and research where necessary
- - Draft and write by:
- - Using further organisational and presentational devices to structure text and to guide the reader [for example, headings, bullet points, underlining]
- -Make simple additions, revisions and corrections to their own writing by:
- -Evaluating their writing with the teacher and other pupils

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Additional Activities and Innovative Ideas

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- Guest Speaker Series: Invite STEM professionals into the school to give talks or presentations. They can discuss their career paths, the projects they work on, and the impact of their work on society. This provides children with valuable insights into the diverse opportunities available to them within STEM.

- Author Q&A Session: Reach out to the author, Frances Durkin, and/or illustrator, The Boy Fitz Hammond, to see if they'd be willing to participate in a Q&A session with the class. Children can prepare questions about the book's content and any other aspect they find intriguing.

- STEM Community Fair: Collaborate with local community organisations and businesses to host a STEM fair where children can interact with professionals, conduct experiments, and learn about the applications of STEM in the community.

- STEM Book Club: Start a schoolwide STEM book club where children and staff read and discuss books related to scientific discoveries and technological advancements, fostering a culture of continuous learning.

- Future Science and Tech Predictions: Divide the class into small groups and ask each group to predict how a specific area of science and technology (e.g. transportation, communication, healthcare) will evolve in the future. They can create a presentation or poster to illustrate their predictions.

- Science and Technology Museum Visit: Take children on an educational trip to a science museum or technological centre where they can engage with interactive exhibits, participate in demonstrations and explore various scientific and technological concepts in a hands-on manner.

- STEM Inventors' Showcase: Organise a class or school-wide event where children can research and present on the inventors featured in the books. They can dress up as the inventors, create posters and share interesting facts about their lives and contributions to science and technology.

- Interactive Timeline Wall: Collaboratively create a large classroom timeline showcasing the major scientific and technological discoveries throughout history that are mentioned in the books. Have children research and contribute to it by adding dates, descriptions and illustrations of each discovery.

- STEM Role Models Display: Design a display featuring influential STEM role models, including both historical and contemporary figures. Highlight their contributions and encourage children to learn more about these role models and their work.

- Time Travel Diary: Task children to write a diary entry as if they were a scientist from the past, describing their daily life, motivations and challenges they faced while working on their discovery.

- Scientific Storytelling: Ask children to choose a discovery from the books and write a short fictional story based on the inventor's journey to making the discovery. Encourage creativity and imagination while incorporating accurate historical details.

- Science and Technology Debate: Arrange a debate where children can choose to argue for or against the importance of a particular scientific or technological discovery discussed in the books. This activity encourages critical thinking, research and public speaking skills.