THE CHURCH SCHOOLS OF CAMBRIDGE

Footprints of Faith

Walk Two: SCIENCE

Key Stage 2 Teacher's Book

Victoria Goodman

Walks for schools through culture, history and belief in Cambridge

Walk Two: Science

AIMS:

- To show that Christians in Cambridge have made a huge contribution to science.
- To show that Christianity both motivated and provided a framework for their scientific work as they say themselves working to unlock the secrets of creation.
- To show how they have been inspired by their faith to appreciate and seek to understand the workings of the created world.
- To show the stepping-stones of learning, development of understanding, and relevance of their discoveries to the world we live in today.

There are five stopping places on the full walk. You will probably not be able to do them all in one day, and are encouraged to choose those which will suit your class best. Each stop is designed to look at the contribution made by a particular individual to the development of science. The children will see something related to the individual, hear their story, and take part in an activity designed to deepen their understanding of the story/issue and/or relate it to our world today.

HOW TO USE:

You will have chosen which stops you intend to visit during your walk.

At the Round Church you should have picked up a set of resources to use on the walk:

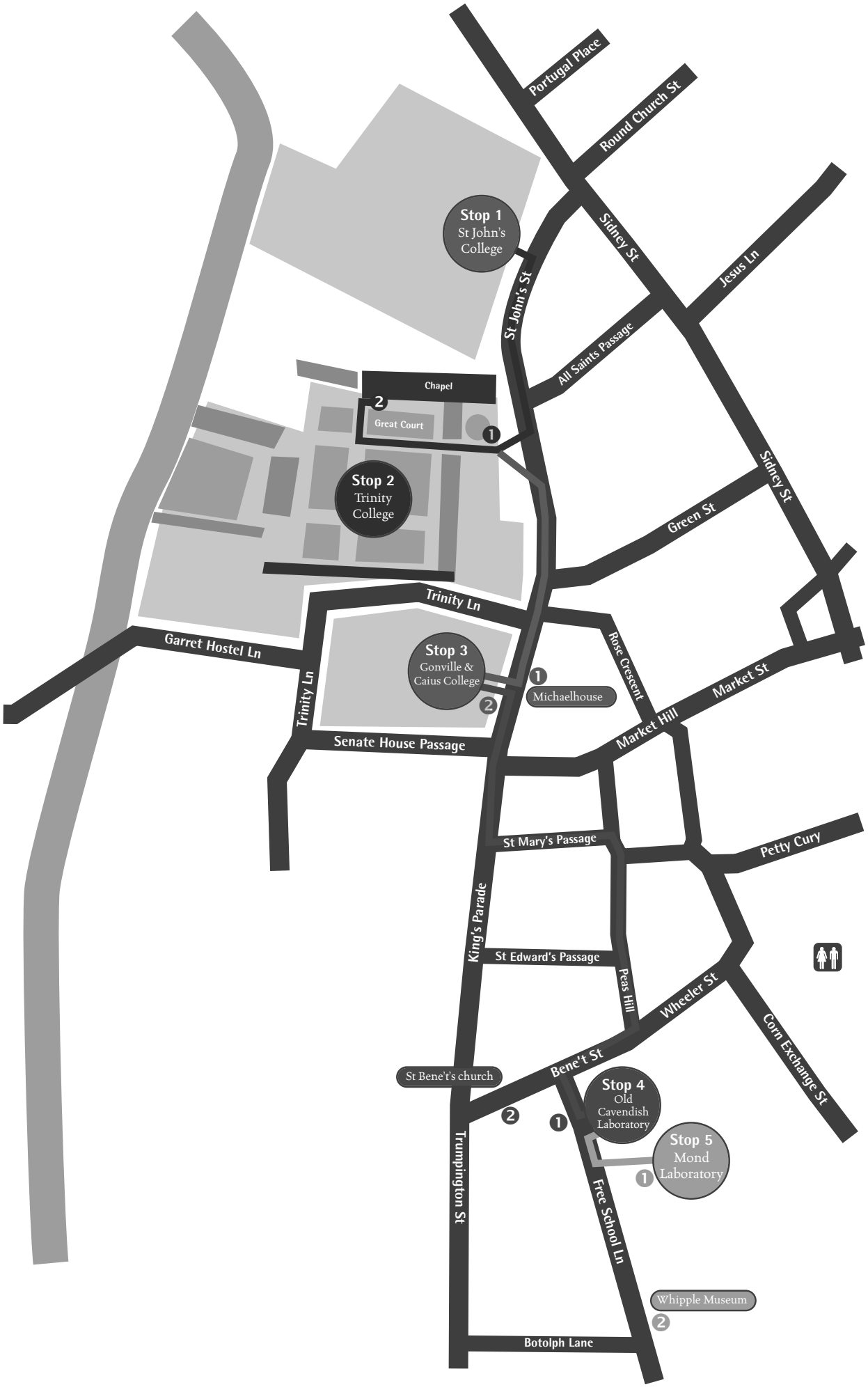
- this **booklet** which includes an itinerary with maps, photographs and directions, plus a story and activity for each stop
- a **bag** for each stop, containing: resource cards, artefacts and activity resources.

You will also need the set of activity sheets that you have printed off for each child, as well as pencils, coloured pens or pencils and clip boards.

Please check for extra equipment needed for specific activities!

Resources must be returned to the Round Church at the end of the walk. The resources will not necessarily be checked before the next school uses them. Please help the next school by returning everything in the correct bags in the order you found them.

There is a list of useful phone numbers at the back of this pack.


Portugal Place
Round Church St
Sidney St
Jesus Ln
Stop 1
St John's College
St John's St
All Saints Passage
Chapel
2
Great Court
1
Stop 2
Trinity College
Sidney St
Green St
Trinity Ln
Garret Hostel Ln
Stop 3
Gonville & Caius College
1
2
Michaelhouse
Rose Crescent
Market St
Market Hill
Trinity Ln
Senate House Passage
St Mary's Passage
Petty Cury
King's Parade
St Edward's Passage
Peas Hill
Wheeler St
Corn Exchange St
St Bene't's church
Bene't St
2
1
Stop 4
Old Cavendish Laboratory
Stop 5
Mond Laboratory
1
Trumpington St
Free School Ln
Whipple Museum
2
Botolph Lane

Story One:

(15 minutes)

William Gilbert (1540–1603)

- **Look at the memorial to William Gilbert on the outside wall of St John's College in Bridge Street (just past the bus stop)**

I wonder if anyone knows what this is?

This is a memorial to remember a man called William Gilbert. He was born over 450 years ago, and lived in the time of Queen Elizabeth I.

- **Go into St John's College through the main entrance. Pause half way across the court and point out the statues on the outside of the chapel. The statue of William Gilbert is third from the right.**
- **Show the portrait of Gilbert –** Resource Card A

This is a portrait of him.

Can anyone see what he is wearing in the statue and the portrait that would be a bit unusual today?

In those days even men wore special lacy collars called ruffs.

- **Hold up the ruff –** Artefact 1

Who would like to try one on?

▲ Memorial to William Gilbert on Bridge Street

- **Make your way to the chapel. Gather in the ante-chapel and stand by the memorial plaque describing Gilbert's career (on the wall to the right of the entrance to the main chapel).**

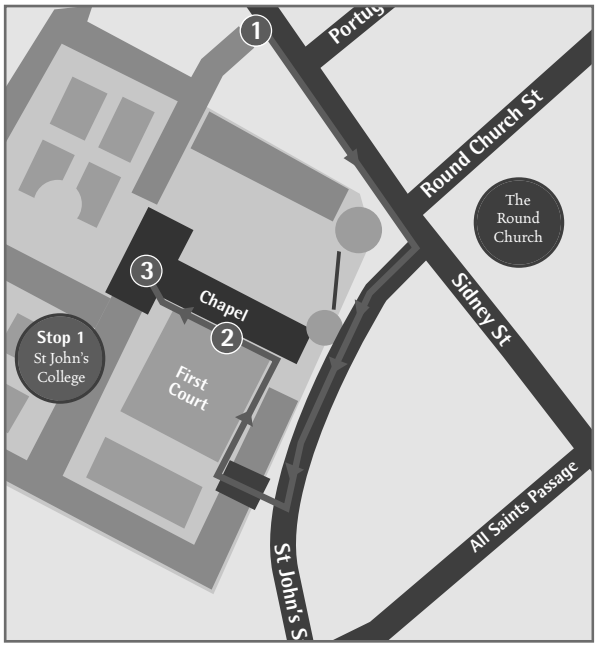
There was a smaller chapel here when William Gilbert was a student at St John's college, and he would have gone to worship God in services there. He loved hard work – he studied for 3 different degrees! The last one qualified him to be a doctor. He went to work in London, and eventually became President of the College of Physicians and personal doctor to Queen Elizabeth I – he was the most important doctor in the country.

But that wasn't all. As well as working as a doctor, he spent his spare time doing scientific research just for fun! He was really interested in magnetism and static electricity, which he called the 'amber effect'. The ancient Greeks had noticed that something strange happened to the gemstone amber (fossilised tree resin) when it was rubbed with silk or wool (like rubbing your hair with a balloon). We now know that the friction of the rubbing causes the amber to become electrically charged, but for over a thousand years people thought that there was something mysterious and magical about it. William Gilbert thought that there must be a way of understanding what was happening. The Greek word for amber was "electron". When he was explaining his ideas, William used a Latin word "electricus" (meaning like amber), and created the name for the scientific study of electricity.

William Gilbert was also really interested in magnets. People had known since the 6th century BC that a special kind of stone was magnetic. In William Gilbert's time they called it lodestone, but we know it as the mineral magnetite. People could see the powerful effects of magnetism, and thought that it was a kind of magic.

essential information

Directions:
The walk starts at the memorial to William Gilbert on the wall of St John's College, (❶ on map just across the street from The Round Church, Bridge Street, Cambridge).



Summary:

- Show the picture William Gilbert and give the introduction on page 1 – *Resource Card A and Artefact 1* (2 minutes)
- Follow the pavement round to the left of the memorial until you reach the main entrance to St John's College; inform the porters of your arranged visit; go across the court to the chapel (5 minutes)
- Pause half way across the court and look at the statue of William Gilbert on the outside wall of the chapel (❷ on map, fifth from the left)
- Go into the chapel (❸ on map) and gather in the ante-chapel to stand by the memorial to Gilbert (on the wall to the right of the entrance to the main chapel)
- Tell the story of William Gilbert on pages 1–3 – *Resource Cards B and C; Artefacts 2 and 3* (8 minutes)
- Activity on page 4 – Testing superstitions (in ante-chapel) – *Activity one cards, activity sheet one* (15 minutes)

- **Show a magnet and demonstrate the magnetic effect on a metal strip – Artefact 2**

Maybe William sat in this chapel when he was a student, thinking about how God had made the world, and how it worked. Then he did something totally new – he started to test every idea that anyone had ever had about magnets and static electricity, to check whether they were correct. In the past people often just believed everything that was written down in books was true. Ideas were passed on for hundreds and even thousands of years, even if they were totally wrong!

- **Show a modern magnetic compass – Artefact 3**

This has got a magnet in.

I wonder what we might use it for?

In Tudor times sailors used magnetic compasses to help them on long voyages – they looked a bit like this:

- **Show the Tudor magnetic compass – Resource Card B**

The word 'lodestone' meant 'leading stone' because it was used in a compass to lead or guide the way. But in those days no sailor was allowed to eat garlic anywhere near the ship's compass, because someone had once written that garlic would stop a compass working.

William Gilbert thought that this sounded a bit silly. He checked out every idea any one had ever had about magnets by doing experiments. He tested them all, and recorded his results in a big book which was called 'De Magnete' or 'On Magnets'

- **Show the picture of Gilbert's book – Resource Card C**

He proved that garlic had no effect on compasses. That must have been a big relief to the sailors! William's book about magnetism was read all over Europe, and it changed the way people did science forever. It made people realise

continued on the next page

that you had to do experiments to check that your ideas and theories were correct. You couldn't just guess anymore, or believe everything you read. The famous scientist Galileo used William Gilbert's book when he was working out how to explain the important discovery that the Earth moved around the Sun.

William Gilbert was a very famous and influential man when he died – all his hard work had paid off. He had got people thinking about how the world really worked, and how amazing it was. Science had taken a huge step forward. From now on people started to test their ideas, to see if they were correct.

Activity One:

(10 minutes)

Testing superstitions

William Gilbert tested lots of different ideas and theories to see which were correct.

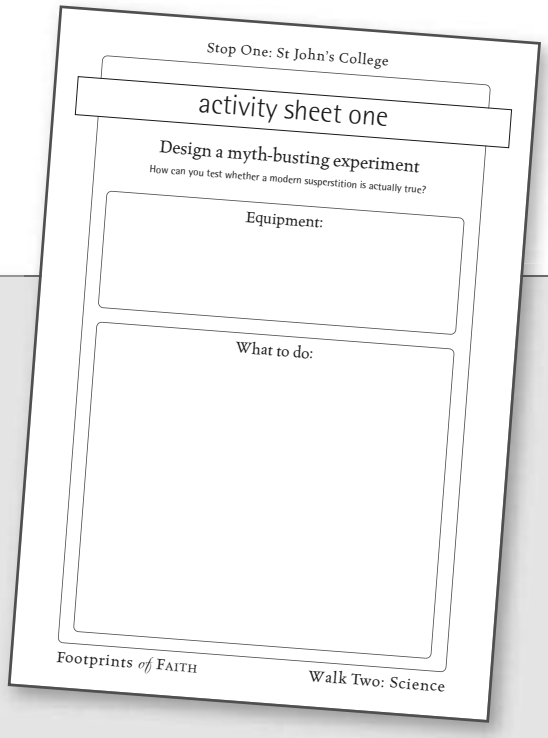
I wonder if anyone can think of any myths or superstitions we still use today?

You are going to be split into small groups and given a card with some modern superstitions written on it. Choose one of the superstitions. Like William Gilbert, you are going to design an experiment to prove whether the statement is true, or just a myth that people have passed on without thinking about.

You will have about five minutes to discuss what you are going to do, and then ten minutes to write or draw a plan of your experiment on the activity sheet you have on your clipboard.

How can you make sure that your experiment is fair?

- **How many times will you have to do the experiment to prove or disprove the statement?**
- **How many different people will you need to do the experiment on?**



activity sheet one

Design a myth-busting experiment

How can you test whether a modern superstition is actually true?

(20 minutes)

Story Two:

(15 minutes)

Isaac Newton (1642–1727)

- **Stand just outside the main gate of Trinity College, and point out the apple tree (in the grass on the right, as you are looking at the gate).**

This tree is very famous! It doesn't look very big, but it is actually grown from a much older tree – a tree that changed the course of history! It's an apple tree.

I wonder if anyone knows its story?

The original tree is the one that Isaac Newton was sitting underneath when an apple fell on his head and he had an amazing idea about how gravity worked – or so the story goes.

The original apple tree wasn't in Cambridge, but this one has been planted here because Isaac was a student and then a professor in this college. We are going into the college to learn a bit more about him.

- **Go through the main entrance to Trinity College and across the court to the chapel to finish off the story (it is on the right of the court, but you have stay within the cordoned area to get there, so follow the path straight ahead to the middle of the court, turn right and follow the path to the edge of the court, and then right again to get to the chapel entrance). Go inside stand beside the statue of Isaac Newton (on your left as you go in).**

This is Isaac Newton. Doesn't he look an imposing figure? Newton's new theory wasn't that apples fall to earth because of gravity – Galileo had already worked that one out. Newton could connect what he saw happening on earth to what is happening to the planets in outer space. He suggested that planets are always moving towards the sun for the same reason that objects fall to the earth – gravity. "Newton's Law of Universal Gravitation" was used by scientists for hundreds of years. It was the basis of Einstein's "Theory of Relativity".

- **Show the portrait of Newton – Resource Card D**

In those days it was fashionable for men to shave off their hair and wear a wig.

- **Show the long grey wig – Artefact 4**

I wonder if anyone would like to try it on? You don't need to shave your hair off!

Isaac Newton wrote a very famous book called the *Principia Mathematica*.

- **Show the Latin edition of the 'Principia' – Artefact 5**

I wonder if any one would like to read a bit of it for us?

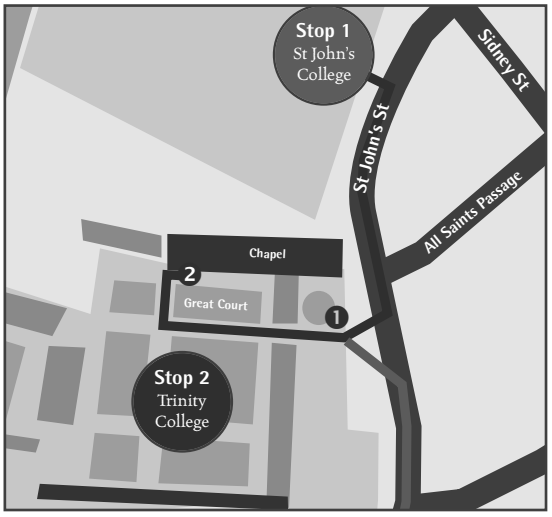
I wonder what language he wrote it in?

This book is full of mathematical explanations, including his three laws of motion. These laws can be used to explain the movement of everything from spiralling of galaxies to subatomic particles! But Isaac didn't just think about maths and how the universe worked, and he wasn't just a scientist. He had ideas about all kinds of things, like religion (how God created the world in harmony), and music (how the seven notes in

essential information

Directions:
Leave St John's College through the main gate; turn right and proceed down Trinity street to Trinity College; stand outside the main entrance, near the apple tree.

(5 minutes)



Summary:

- Point out the apple tree (in the grass on the right as you are looking at the gate) (❶ on the map) and tell the first part of the story on page 6 (2 minutes)
- Go into the college through the main gate and let the porter know about your arranged visit. Cross the court to the chapel (on the right of the court, but you have to stay within the cordoned area to get there) (❷ on the map) and stand beside the statue of Isaac Newton (straight ahead just as you go in) (3 minutes)
- Tell the rest of the story on pages 6–8 – *Resource Cards D, E and F; Artefacts 4, 5 and 6 and 6b* (10 minutes)
- Activity on page 9 – Making a colour wheel - (in chapel) *Activity two cards, Artefact 7, activity sheet two* (15 minutes)

music matched the seven colours in the rainbow). He even wrote books about the Bible. He also had a shed behind this chapel where he often stayed up all night doing lots of experiments. He was an alchemist – someone who wanted to work out how to turn ordinary metal into gold. Alchemists were very secretive about what they did. Newton designed his scientific apparatus himself, and wrote more than a million words about alchemy in his notebooks, but his work was not discovered until the twentieth century. Now people recognize how important it was. Alchemy was actually how the science that we call chemistry started.

Newton also made a big contribution to another branch of science called optics. When he was a young man, Isaac went for a walk along the river out of Cambridge to visit the Fair on Stourbridge Common. It was the biggest fair in Europe, and there was a lot to see.

- **Show the prism –** Artefact 6

On one stall Isaac bought a piece of glass a bit like this.

Can anyone tell me what it is called?

A prism.

Can you see what the statue of Isaac Newton is holding?

He's holding a prism because it helped him make an important discovery.

When you hold a prism up to the light it sparkles, and you can sometimes see lots of different colours in it. It was being sold at the fair because it was so pretty; it was an ornament. But Isaac was interested in how it worked. He studied it, and had one of his great ideas that changed science. Isaac worked out that light looks white, but is made up from lots of different colours. He hung the prism up in the window of his room in the sunshine, and made a huge rainbow on the wall.

continued on the next page

- **Reconstruct the prism experiment by shining a torch (artefact 6b) onto the prism to create a rainbow effect**

People said that the prism had made the colours, so Isaac hung a second prism upside down in front of the first, and the rainbow became white light again. He realised he could use the prism to take light apart and put it back together again! Before this people thought colours were a mixture of light and dark. Now Isaac Newton had proved that light itself was made of all the different colours. There is even a picture in one of his notebooks where he has drawn a diagram to help him work it out.

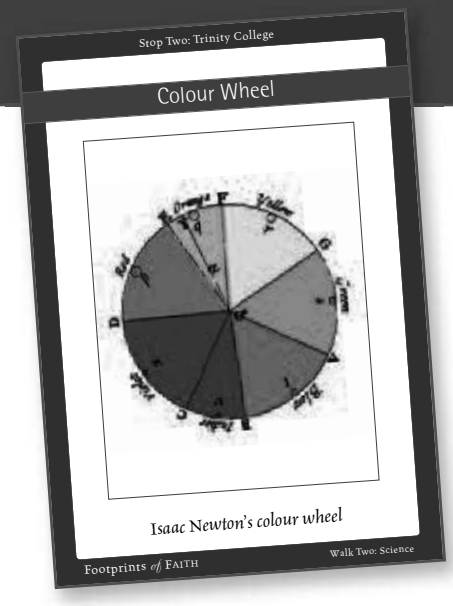
- **Show Resource Card E – illustration from Newton's notebook**

The prism experiments got Newton thinking about how we see things. He used his ideas to design and build the first reflecting telescope, which used mirrors to reflect light and form an image.

- **Show the picture of Newton's telescope – Resource Card F**

Modern telescopes such as the Hubble space telescope use the same idea!

Isaac Newton used his telescope to look at the world, and look out into space. He couldn't see as much as we can, but he could see the wonderful universe, which he believed God has created. He really enjoyed seeing how everything fits together and in harmony.



Activity Two:

(20 minutes)

Make a colour wheel

Isaac Newton designed the colour wheel based on the light spectrum. He linked the seven colours of the rainbow to the seven notes of the musical scale.

- **Show the activity card with a picture of Newton's colour wheel.**

Newton was trying to create a way of linking light and colour to an idea about harmony spreading through all of God's creation.

The way the colours are set out around the wheel started artists thinking about how colours work together. Sometimes colours on opposite sides of the wheel are called complementary colours, because they look good together.

- **Look at the diagram on the worksheet for this activity.**

On the inside wheel use your coloured pencils to colour in the seven colours of the rainbow – see if you can remember the correct order!

Can anyone remember a rhyme to remind you what the colours are?

(e.g. Richard Of York Gave Battle In Vain)

On the next wheel, write or draw something you have seen in nature that matches each of the colours.

On the outside wheel try and write a word or phrase that describes each colour.

- **Show a picture painted by Pablo Picasso during his blue period – artefact 7**

I wonder why Picasso used so much blue? What was it helping him to say through his painting?

If you have time:

Think about a colour you really like. How does seeing it make you feel? Can using colour help you to express yourself?

Use the back of your sheet to write a description or draw a picture to show how colours can say something important about how you see the world.

activity sheet two

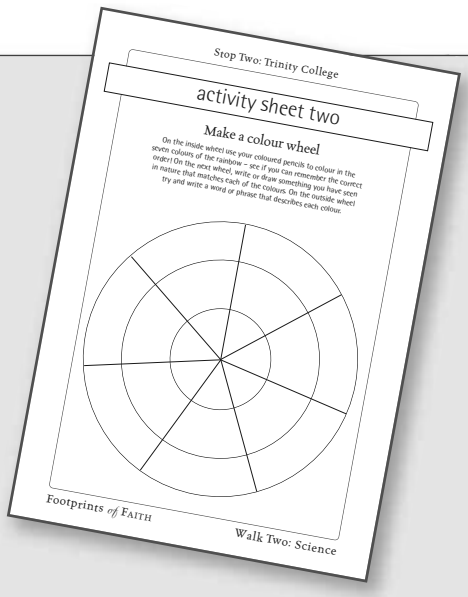
Make a colour wheel

On the inside wheel use your coloured pencils to colour in the seven colours of the rainbow – see if you can remember the correct order!

On the next wheel, write or draw something you have seen in nature that matches each of the colours

On the outside wheel try and write a word or phrase that describes each colour

(20 minutes)



Story Three:

(15 minutes)

William Harvey (1578–17)

- **Stand on the pavement opposite Cauis College, just beside Michaelhouse**

This is Stephen Hawking's college.

- **Show the picture of Stephen Hawking –** Resource card G

Has anyone heard of him or even seen him?

He spends a lot of time thinking about huge things, like how the universe works. He showed the world some of his ideas in the Paralympic Games opening ceremony!

We are going to hear about someone who was very interested in little details, but who was just as important for science. They have both seen how important it is to try to understand how things work.

- **Point out the statue of William Harvey (on the corner of the shop to the left of Michaelhouse)**

This is a man called William Harvey.

What do you think his job is?
What is he holding?

(a heart!)

- **Point out the bust of Harvey above and to the left of the entrance to the college**

I wonder why there are two statues of William Harvey? Was he such an important man that he needed more than one?

- **Go into the Michaelhouse chapel (through the café) or Great St Mary's church to tell the story of William Harvey**

William was another Cambridge student who became a royal doctor [like William Gilbert – Stop 1]. This is what he looked like:

- **Show the portrait of Harvey –** Resource Card H

He wasn't afraid to get his hands dirty, so he would have spent a lot of time wearing one of these:

- **Hold up the blood-stained apron –** Artefact 8

Who would like to model it for us?

As well as being a student at Cambridge, William went to Padua in Italy to study anatomy – how the body works.. Whilst he was there he learnt that the most important thing was to look carefully at the human body to see how it worked. He helped in operations and saw people being cut up, so he could actually see what went on inside their bodies. He made very detailed drawings of what he saw, so he could remember and try to work out what was going on.

- **Show anatomical drawing –** Resource card I

When he came back to England he got a job as doctor to King James I and then King Charles I. But in his spare time he liked to do scientific experiments. He was really interested in blood!

The old medical textbooks said that the two kinds of blood vessels, the veins and the arteries, were completely different. People believed that the blood in the arteries was made by the heart and the blood in the veins was made by the liver.

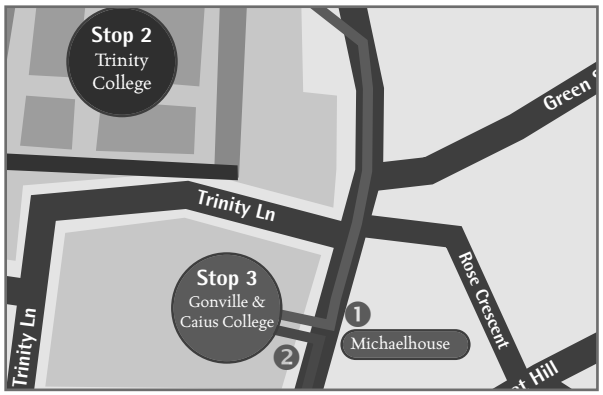
essential information

Directions:
Leave Trinity College and continue along Trinity Street to Gonville and Caius College. Stand on the pavement on the opposite side of the road to Gonville and Caius College – outside Michaelhouse (see page 12) and beside the statue of William Harvey (on the corner of the gift shop) ❶ on map. (2 minutes) Tell the first part of the story outside Gonville and Caius College, then continue along the road to either Michaelhouse (turn right as you go in and walk through the café to the chapel) or Great St Mary's Church (enter the church through the main west door if it is open, or the side door on south side. Go to the visitors' desk at the rear of the church and let them know that you have arrived).

(8 minutes)

Summary:

- Outside Gonville and Caius College: Show the Picture of Stephen Hawking and point out the statue (❶ on map) and bust (❷ on map) of William Harvey – using the information on page 10 – *Resource Card G* (5 minutes)
- In Michaelhouse or Great St Mary's Church: tell the story of William Harvey on pages 10 to 12 – *Resource Cards H and I; Artefacts 8 and 9* (10 minutes)
- Activity on page 13 – Observational drawing – *activity sheet three* (15 minutes)



William Harvey didn't think this was right. He had looked carefully, and he thought that the veins and arteries were connected. He knew that he needed to test his ideas, so he did experiments on animals, and even on people. He worked out that the heart pumps the blood, and it moves round the whole body in a circuit. He realised that the blood moves through the arteries away from the heart and then travels through the veins back into the heart. He looked closely and saw that the veins have little valves to stop the blood going backwards. William didn't have a microscope strong enough, but he guessed that there were lots of little blood vessels he couldn't see. He was right, and now we can see them we call them capillaries.

- **Show the paperback copy of Harvey's book –** Artefact 9

William wrote a book about his ideas and experiments, called "On the movement of the heart and blood". You can see one of his diagrams on the front cover. The original book contained careful and detailed drawings to explain his ideas.

It took a little while, but eventually William's theories spread all over the world, and changed the way people thought about medicine and how the body works. Nothing would be the same again – accurate observation and experimentation were the way forward! Harvey originally wrote in Latin, but this copy is in English because people are still interested in reading it.

All through his life William took time to watch carefully and think about what he saw. Even in his spare time when he wasn't working, he loved to sit quietly outside and watch birds. He saw the blood moving round the body, and thought about God moving through the world. When he looked at all the different species of birds, and how perfectly the bodies of animals worked, he praised God for the wonderful world He had made.

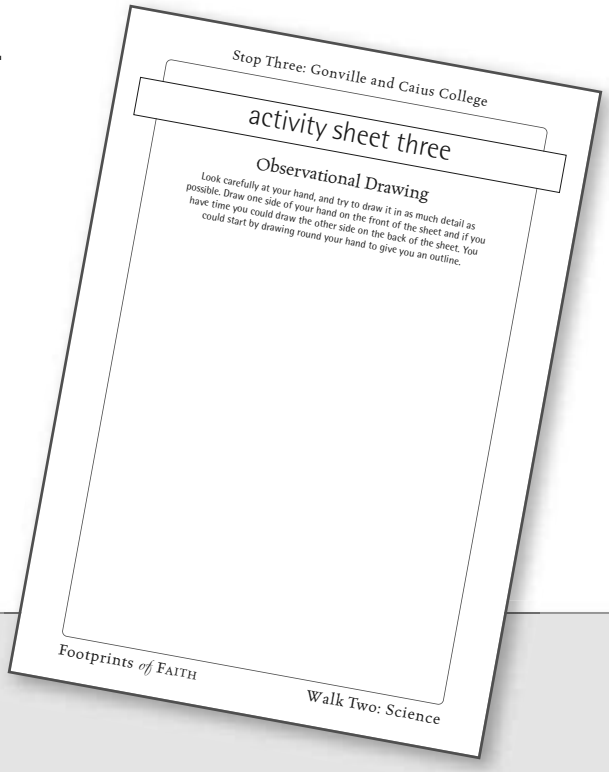
Activity Three:

(20 minutes)

Observational Drawing

Sit quietly and look at your wrist and hand. Wiggle your fingers to see how they move. There are 27 bones in your hand, and 15 joints! Turn your hand over and look at the other side. How many little lines can you see? Can you see any blood vessels?

Draw what you can see in as much detail as possible. Put in all the little lines, and see how many blood vessels you can draw in. Do a drawing for each side of your hand – one on each side of the activity sheet. Try to make your drawings as accurate as possible. Take time to really look!


Stop Three: Gonville and Caius College

activity sheet three

Observational Drawing

Look carefully at your hand, and try to draw it in as much detail as possible. Draw one side of your hand on the front of the sheet and if you have time you could draw the other side on the back of the sheet. You could start by drawing round your hand to give you an outline.

Footprints of Faith

Walk Two: Science

activity sheet three

Observational Drawing

Look carefully at your hand, and try to draw it in as much detail as possible. Draw one side of your hand on the front of the sheet and if you have time you could draw the other side on the back of the sheet. You could start by drawing round your hand to give you an outline.

(20 minutes)

Story Four:

(15 minutes)

James Clerk Maxwell

(1832–1879)

- **Stand outside the gates to the Old Cavendish Laboratory on Free School Lane**

This is a photograph of a statue which was made to remember James Clerk Maxwell.

- **Show the photograph – Resource Card J**

Can you see what is just beside his feet?

It's his dog Toby. He really loved animals, and especially dogs.

Hasn't he got a great beard?

- **Hold up false beard - Artefact 10**

Would anyone like to try it on?

He was alive at the same time as Queen Victoria.

- **Show the pocket watch – Artefact 11**

In those days men usually wore a pocket watch a bit like this one. Time was important to James. He was always in a hurry. He died when he was quite young, but he fitted so much into his short life that he helped science to take a big leap forward.

He was interested in science even as a young boy. He was taught at home by his mother when he was young. She really got him interested in the beauty of the world, and the harmony in nature. His mother died when he was nine, but she had got him started on a great voyage of discovery. He wanted to know how everything worked. He also had an amazing memory. When he was 8 years old he could recite Psalm 119 – all 176 verses! He was really inspired by verse 18:

- **Hold up a copy of the Psalms p. 195 – Artefact 12**

Who would like to read it for us?

"Open my eyes, so I may see the wonders of your law". (Grail Translation)

[A more modern translation reads: "Open my eyes, to see the wonderful truths in your instructions." (New Living Translation)]

James Clerk Maxwell loved seeing how God's creation and science worked together in harmony.

He grew up and became such an important scientist that the great Albert Einstein even had a picture of him on his study wall, and said he was the best physicist since Isaac Newton!

James was the first Cavendish professor of physics here in Cambridge, and was in charge of getting this new Cavendish laboratory built. It was the most advanced scientific laboratory in the world when it was built! It was kitted out with all the latest equipment. But when it came to decorating the gateway, James turned back to the Psalms.

I wonder what language the carving on the gate it is written in?

The carving is in Latin, this is the English version of Psalm 111, verse 2:

- **Show the copy of the Psalms again, this time p. 184 – Artefact 12**

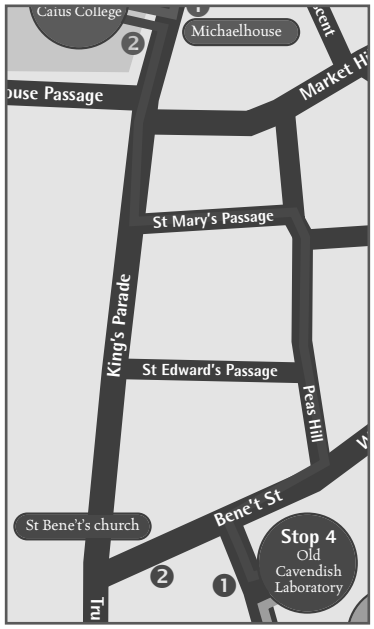
Would anyone like to read it for us?

"Great are the works of the Lord, to be pondered by all who love them." (Grail Translation)

essential information

Directions:
Leave Great St Mary's church or Michaelhouse (continuing past Great St Mary's); and turn left into St Mary's Passage. Go along the passage until you reach the market place. Turn right onto Peas Hill and walk along to the end of the street. Turn right on the corner just past the Arts Theatre into Benet Street. Cross the road, and turn left into Free School Lane, just before you get to St Bene't's church.

(8 minutes)



Summary:

- Stand on the pavement beside the gates to the old Cavendish Laboratory (❶ on map)
- Introduce James Clerk Maxwell – *Story Card, Resource Card J, Artefacts 10, 11 and 12* (3 minutes)
- Go to St Bene't's church (❷ on map) (go back along Free School Lane to the junction with Benet Street, turn left, and the church is almost immediately to the left) to tell the rest of the story – pages 15–16, *Resource Cards K and L, Artefact 13* (12 minutes)
- Activity on page 17 – Match the pairs (in St Bene't's Church) – *activity sheet four* (15 minutes)

[A more modern translation reads: "The Lord's deeds are spectacular! They should be studied by all who enjoy them." (God's Word Translation)]

- **Go to St Bene't's church to tell the rest of the story**

James Clerk Maxwell spent his whole life discovering how wonderful the world was. He loved doing experiments, and continued William Gilbert's work on magnets.

- **If you did not do stop 1 explain that William Gilbert lived in the time of Elizabeth I, and wrote a book on magnetism which had ideas that were still being used in Clerk Maxwell's time.**

He wrote some equations, which explain electromagnetism. These equations are famous for being very beautiful to look at. He explains something very complicated in a very simple and clear way. He gathered all the ideas, experiments and equations from other scientists about electricity, magnetism and light. To show that they could work together, he created set of equations. This area of science is now called quantum electrodynamics – how electric and magnetic fields travel through space in the form of waves and at the speed of light. Maxwell's Equations are so famous, they have even been made into a T-shirt.

- **Show the T-shirt – Artefact 13**

Would anyone like to try it on?

Maxwell also continued the work of Isaac Newton.

- **If you didn't do stop 2, explain about Newton using a prism to identify colours in white light**

He was interested in light and colour. He discovered that white light has three primary colours of red, green and blue, and that all colours could be made from these 3 colours. He also took the first permanent colour photograph

- **Show the copy of Clerk Maxwell's photograph – Resource Card K**

What do you think it is of?

A piece of tartan ribbon!

It doesn't look much, but it was a big advance in photography. Now we can take photos which capture the beauty of the world.

- **Show a beautiful nature photograph – Resource card L**

What do you think it is of?

Now we can even capture the Northern Lights in a photograph!

James Clerk Maxwell's delight in what he saw as a wonderful world created by a loving God has

helped us to enjoy it too.

It has been said that James Clerk Maxwell was the second person, after Isaac Newton, to look at what was happening in the world and see how it related to what was happening throughout the universe.

James Clerk Maxwell used every minute of his life to share his experience of God's love with others. As well as working hard to explain the wonders of creation, James used to spend time visiting the sick, to read to them and pray with them. He also cared for his sick wife. He even found time to write funny poems about other scientists. He died of cancer when he was 48 years old. His doctor said that despite being in great pain he was cheerful to the end. James died at exactly the same age and of the same kind of cancer as his mother.

In 1953, 74 years after Clerk Maxwell died, another important discovery was made in this laboratory that he had designed so carefully. James Watson and Francis Crick made a model to show the structure of DNA – the genetic code. Now scientists can decode the genome, and identify the genes which are passed on from parent to child and can cause cancers. One day they may be able to design therapies which cure the cancers, or even change the genes so that people never get ill.

Activity Four:

(15 minutes)

Match the Pairs

James Clerk Maxwell took great joy in looking at the world around him, and delighting in the beauty of creation. When he took the first permanent colour photograph, he opened up the opportunity for people to see things as they really were in places they would never be able to visit.

Among the many fields of science that Clerk Maxwell worked in, he made great contributions to optics and electromagnetism. Scientists used his discoveries to develop the electron microscope. Now we can use electron microscopes to see things in minute detail, and take colour photographs of them.

Here is a set of pictures. The pictures on the right hand side of the page show some objects as we see them. The pictures on the left hand side show them magnified through a special lens or microscope.

Your task is to work out which magnified picture matches which object.

Take your time to think about it, then draw lines on your worksheet matching up the pairs.

Solution:

1 = D – water droplet/fountain

2 = F – skin/elephant

3 = E – stone/cliff

4 = A – fur/cat

5 = B – grain of sand/desert

6 = G – plant cell wall/leaf

7 = C – compound eye/insect

When you have done that, you might have time to write a poem about one of the pictures.

You could write an acrostic poem – using a letter from the name of the object to start each line of the poem, e.g. KITTEN, ELEPHANT, FOUNTAIN.

activity sheet four

Can you match the pairs?

Put the correct number beside each letter. On your activity sheet draw lines to join the matching pairs. Then write a poem about one of these images on the back of your sheet.

(20 minutes)

Story Five:

(15 minutes)

Ernest Rutherford
(1871–1937)

- **Stand beside the Mond building; look at the picture of the crocodile carved on the wall**

This picture of a crocodile was put here to remember Ernest Rutherford, one of the scientists who worked in the Cavendish laboratory.

I wonder what the picture tells us about his character?

Rutherford could be snappy, but the crocodile is also thought of being a good father, and Rutherford looked after his students. The crocodile is also said to be unable to look round and see its tail, and Rutherford was always looking forward to the next scientific discovery.

This is what he actually looked like:

- **Show the photograph of Rutherford –** Resource Card M

Didn't he have a wonderful moustache?

- **Who would like to try one on? –** Artefact 14

Ernest Rutherford could be very fierce and crocodile-like, but there was a way of telling what kind of mood he was in, and whether it was a good idea to go into his laboratory. When his research was going well he would stride around singing hymns!

- **Go to the Whipple Museum, or back to St Bene't's church to hear the story**

Ernest was born on a farm in New Zealand around 140 years ago [just before James Clerk Maxwell died], and he died in England just before the Second World War. He was interested in science even when he was a child. He used to use some of the things lying around on the farm to do experiments. He once made a cannon out of a brass tube from a hat stand, with a marble for a cannon ball and real gunpowder as the charge. The cannon ball didn't hit the target, but the explosion destroyed the cannon!

When he was a university student in New Zealand, Ernest's first experiments were with magnets [just like William Gilbert] and then he got interested in electromagnetism [like James Clerk Maxwell]. Eventually he realised that he needed to share ideas with other scientists, so he left New Zealand and travelled the world – he became a professor of physics at McGill University in Canada, then at Manchester University, and finally here in Cambridge.

Throughout his life Rutherford built his own equipment for his experiments out of things he found lying around the laboratory. He could do something that most people can't – he could look at something really complicated and see simplicity. He saw how beautiful the world was, and how everything worked together in harmony. He never forgot the experiments he did as a boy on the farm, and saw himself as a simple man. Someone said he had simple ideas, simple apparatus (or equipment), but powerful results.

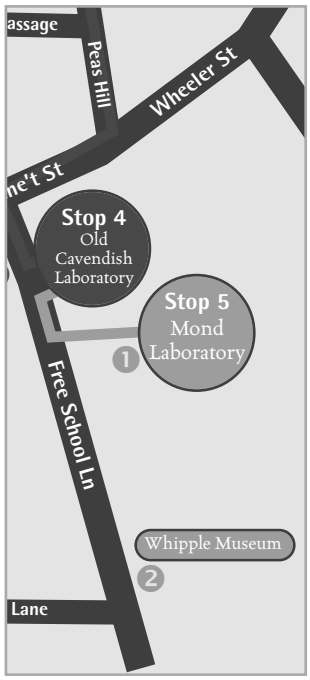
Rutherford was very interested in atoms. Atoms are the building blocks of everything in the universe. They are incredibly small, and can't even bee seen with the most powerful electron microscope.

Rutherford helped the world of science by working out what an atom looked like – which is very tricky for something so tiny!

essential information

Directions:
Leave St Bene't's church and turn left towards the Guildhall and Corn Exchange. Turn first right into Free School Lane. Go through the carved wooden gates of the Old Cavendish Laboratory stop 4 on the map. The Mond building is straight ahead and a little to the left (1 on the map)

(5 minutes)



Summary:

- Stand outside the Mond building beside the crocodile (1 on map)
- Introduce Ernest Rutherford – page 18, *Resource Card M, Artefacts 14* (3 minutes)
- Go to the Whipple Museum (2 on map and see page 20) (go back through the carved gates, turn left and continue up Free School Lane until you arrive at the museum which is on the left, just before the junction with Botolph Lane) or St Bene't's church (go back through the carved gates, turn right, continue to the junction with Benet Street, turn left, and the church is almost immediately to the left) to tell the rest of the story – pages 18–20; *Resource Cards N and O, artifact 15* (10 minutes)
- Activity on page 21 – Atom Experiment – (in the Whipple Museum or St Bene't's Church) – *activity sheet four and activity cards* (15 minutes)

If you made a little dot with the tip of a sharpened pencil, and that dot was just made up of carbon atoms, then there would be about four billion billion carbon atoms in it. And what is more amazing, is that most of the atom is made up of empty space!

Optional explanation for older children:

People had worked out that there were both positive and negative charges in an atom (a bit like in magnets). But they used to think that an atom looked a bit like a plum pudding – mainly positive charge, with the negative charge scattered around like the plums in the pudding.

Rutherford designed a model of an atom using the results from an experiment where alpha particles were blasted through a piece of really thin gold foil.

- **Show the diagram of the atomic models** – Resource Card N

Rutherford worked out that the positive charge was concentrated in the middle of the atom, and the negative charges were all moving round the edge, with empty space between. To give you an idea of size, you could say that if the nucleus of positive charge in the centre of the atom was scaled up to be the size of a small pea, then the whole atom would be around the size of the British Isles. That's a lot of empty space!

Once he had worked out what an atom looked like, Rutherford and two of his students worked here, in this laboratory, to split an atom – using some equipment that they had designed themselves called a particle accelerator.

Rutherford saw that a huge amount of energy was released when an atom was split, but saw that it might be possible to use the energy to do something like power a light-bulb, but he thought that it would be difficult to make enough or do it cheaply enough to be useful in everyday life.

Rutherford saw the world as something beautiful, which worked in harmony. He didn't imagine that just over ten years later his ideas would be used to an incredibly powerful weapon – the atomic bomb – which was used to bomb Japan in the Second World War.

I wonder what Rutherford would have thought of that?

Would he have enjoyed the explosion and the huge mushroom cloud?

What would he have thought of all the destruction?

One of his friends said that he was glad Rutherford didn't live to see it!

- **Show the picture of a mushroom cloud –** Resource Card 0

But there have been some good uses for nuclear energy and radiation! Nuclear power stations are increasingly important for providing the world's electricity, now that oil and gas supplies are running out. Radioactivity is also used in medicine (to cure cancer, diagnose diseases and sterilize medical equipment), in agriculture (to stop food being spoiled by insects and bacteria), and in industry (in navigation beacons and satellites, in smoke detectors, and to power space vehicles). Radioisotopes have even been used to get rid of pollution from oil and sewage spills.

Optional information for older children:

Rutherford was called the Father of Nuclear Physics, and won a Nobel prize for chemistry. When he died he was buried in Westminster Abbey near Isaac Newton – the farm boy from New Zealand had travelled the world and made a huge contribution to science. This was honoured in 1997. In chemistry the elements are arranged in groups of similar types in a chart called the periodic table. The recently created element 104 was named rutherfordium.

- **Show a copy of the periodic table –** Artefact 15

Activity Five:

(15 minutes)

Atom Experiment

You will need:

- Strip of paper 28 cm long
- Activity sheet 5
- Scissors
- Glue stick or sticky tape

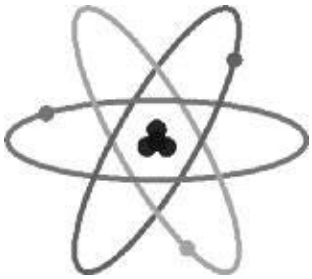
You are going to try to make a model of an atom. Everyone should have a strip of paper. In theory, if you cut your strip of paper exactly in half 31 times, you will end up with a piece the size of an atom!

I wonder if this is really possible?

I wonder how small you can make your paper?

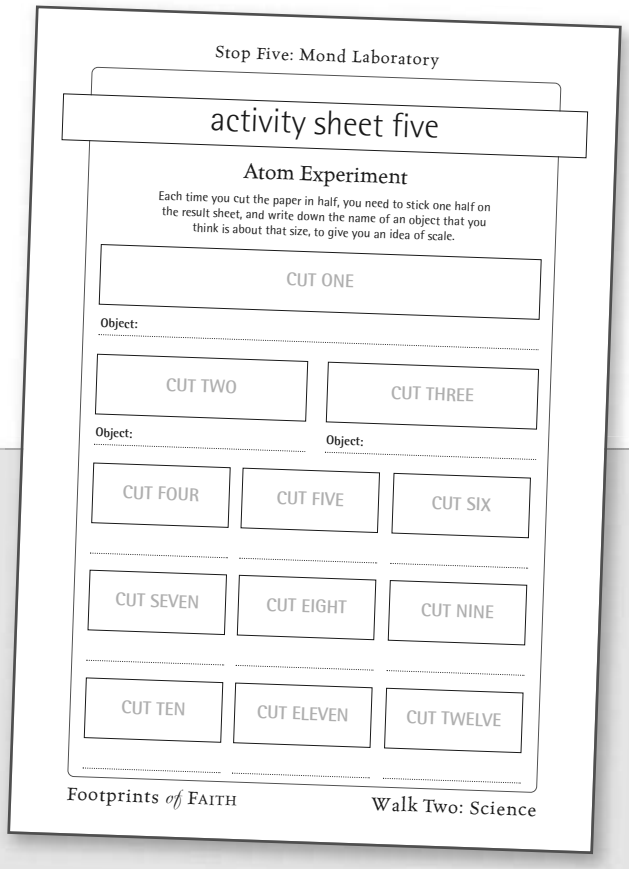
Each time you cut the paper in half, you need to stick one half on the result sheet, and write down the name of an object that you think is about that size, to give you an idea of scale. Then you need to cut the remaining half exactly in half, and record the results again.

Each cut needs to be parallel to the first cut.



Can you do more than 10 cuts?

- If you manage 12 cuts, you will have a piece of paper the width of a human hair.
- If you manage 14 cuts, it will be the width of a microchip.
- If you manage 19 cuts, it will be the same width as visible light waves.
- If you manage 24 cuts, the paper will be the width of a membrane, and you would need an electron microscope to see it.
- You would still have 7 more cuts to go before you got to the size of an atom!


Stop Five: Mond Laboratory

activity sheet five

Atom Experiment

Each time you cut the paper in half, you need to stick one half on the result sheet, and write down the name of an object that you think is about that size, to give you an idea of scale.

CUT ONE

Object:

CUT TWO

CUT THREE

Object:

Object:

CUT FOUR

CUT FIVE

CUT SIX

CUT SEVEN

CUT EIGHT

CUT NINE

CUT TEN

CUT ELEVEN

CUT TWELVE

Footprints of Faith

Walk Two: Science

activity sheet five

Atom Experiment

Each time you cut the paper in half, you need to stick one half on the result sheet, and write down the name of an object that you think is about that size, to give you an idea of scale.

(20 minutes)

Contacts

www.footprintsoffaith.co.uk

To book the bag of resources contact:
The Christian Heritage Administrator at
The Round Church
Tel: 01223 311602
e-mail: admin@christianheritage.org.uk

To arrange a story-teller to lead your walk please contact:

Victoria Goodman –
admin@oldschools.org.uk

The stopping places are usually open during school hours. To check about any last-minute arrangements for visits please contact:

Stop 1 – St John's College

Ask to visit the forecourt and chapel to see the Gilbert statue and memorial.

Tel: 01223 338676 – Chapel Clerk
01223 337726 – Colin Shepherd, Head Custodian
01223 338606 – Front Porters' Lodge

Stop 2 – Trinity College

Ask to visit the chapel to see the Newton statue.

Tel: 01223 338400 – Porters' Lodge
01223 338476 – Chapel Secretary

Stop 3 – Caius College/Great St Mary's or Michaelhouse

Ask to visit to do activity 3; about eating lunch/snacks in garden/church or chapel if raining; and using the loos.

Great St Mary's

Tel: 01223 741716 – Stewart Hall, Head Verger

Michaelhouse

Tel: 01223 309167 – Sue Binns, Centre Manager

Not Tuesday morning, Thursday lunch time and Friday afternoon.

Stop 4 – Cavendish Laboratory, Free School Lane/St Bene't's Church

St Bene't's – No need to make arrangements for a visit, but avoid Tuesday between 10.30 am and 11.15am, when there is a service.

Stop 5 – Mond Laboratory/ Whipple Science Museum (or St Bene't's Church if the museum is closed)

Whipple Museum

Tel: 01223 334554

Ask to book a room to do the activity

St Bene't's – No need to make arrangements for a visit, but avoid Tuesday between 10.30 am and 11.15am, when there is a service.

Toilet Facilities:

- Round Church – ask at the welcome desk
- Great St Mary's – ask the verger or at the welcome desk
- Michaelhouse – ask at the café
- Lion Yard (near St Bene't's Church – see map).

It is also possible to ask to use college toilets if necessary:

- St John's College – ask the porter
- Trinity College – ask the porter

Picnic point:

- Great St Mary's – on the grass outside the South Door – ask the verger for permission to eat inside if it is raining or cold.
- The Round Church – by arrangement
- Michaelhouse – by arrangement

Snack points:

- Michaelhouse – by arrangement
- Great St Mary's – on the grass outside the South Door – ask the verger for permission to eat inside if it is raining or cold.
- St Bene't's – in the churchyard or inside (in the empty space on the left as you come in).
- The Round Church – by arrangement

Don't forget to return the resources to the Round Church at the end of your walk! Please make sure that the resources are in the correct bags.

With many thanks to Christian Heritage, Cambridgeshire Culture, and the staff and children of St Alban's Catholic Primary School.

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