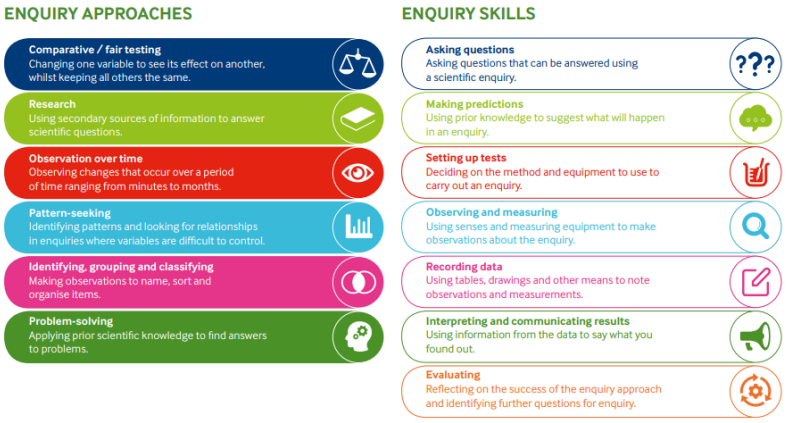
Year Group:	3	Strand: 6	What can magnets do?
Physics			
Key NC Reference and Objectives	• Compare how things move on different surfaces • Notice that some forces need contact between two objects, but magnetic forces can act at a distance • Observe how magnets attract or repel each other and attract some materials and not others • Compare and group together a variety of everyday materials on the basis of whether they are attracted to a magnet, and identify some magnetic materials • Describe magnets as having two poles • Predict whether two magnets will attract or repel each other, depending on which poles are facing.		
Enquiry Approaches and Skills in Science			
Key Investigation	- Compare and group together a variety of everyday materials on the basis of whether they are attracted to a magnet, and identify some magnetic materials **Enquiry Approach: Identifying, Classifying and Grouping** **Enquiry Skills: Making Predictions, Observing and measuring, gathering and recording data to help answer questions, Interpreting and communication results, Evaluating** **Guidance:** 1. In groups, children choose ten different materials/objects, predicting five they think are magnetic and five they think are not. Discuss choices and reasons for them. Allow them to test using a magnet and children can record results in a table. What do they notice? 2. Compare aluminium and steel drink cans – what is the same, what is different? Test with a magnet. What happens? Why? 3. Sort coins with a magnet. What do children notice? Why are some one pence, two pence, five pence and ten pence coins magnetic and some not?		
Other suggestions for investigations and activities	1. Investigating forces that need contact between two objects and how to record these scientifically. **Enquiry Approach: Identifying, Classifying and Grouping** **Enquiry Skills: Observing and recording data in a labelled diagram** **Guidance:** Investigate forces through sports. Ask two children to throw a ball to each other. Discuss as a class what is causing the ball to move. Explain that their muscles are generating a force to move the ball but we cannot see it. **Explain how forces cannot be seen but the effects of them can be and how they can be described**. Ask how children describe the action of throwing and look for the words 'push'. Children practise throwing or kicking a ball. **Explain the forces can make things move**. Move on to a child kicking a ball slowly, running after it and the kicking it harder. **Explain that a force can change the speed of a moving object.** Ask children to pass the ball around a circle now without the ball stopping. **Explain that force can change the direction of a moving object.** Finally asked a children to enter the middle of the circle, receive a ball and stop it each time. Discuss how a force can stop an object moving. Return to the classroom and ask children		

to record diagram of forces in action Explain that forces cannot be seen but that scientist use arrows on a diagram to show the direction of the force.

Extension:

Children can use other classroom objects to experiment with the pushing/pulling forces; for example, putting on a pair of gloves, tear a piece of paper or tissue, opening and closing books, drawers and doors. Investigate throwing a ball up and down, discuss the contact forces to send and object up (it is between the hand and the object). Discuss what makes the object come back down. Gravity is a non-contact force which is also a pull.

2. Investigate how things move on different surfaces

Enquiry Approach: Comparative/Fair Testing
Enquiry Skills: Observing and measuring, gathering and recording data to help answer questions

Guidance: Review previous session on contact and non-contact forces. This session is to introduce the force of friction. A way to do that is by: placing a large book on the table and explain how the low side of the book in in contact with the table. Explain that a pushing force can get something to move and push gently on the book (but not hard enough to move the book). Discuss with children why the book did not move and look for an answer about there being a force stopping the movement. Explain that this force is called friction. Explain that if we push harder we can greater a force that is stronger than the friction force. Explain that when we move the book the force of friction is still acting, so that when we stop pushing the book will stop. Give examples of friction in everyday life to help illustrate more.

Using toy cars and a ramp, test different surfaces for friction by placing the material on the ramp and then measuring the distance the car travels draw conclusions of, e.g. greater the friction, the shorter the distance, the rougher the materials surface, the greater the friction. This experiment could be place in the context of runaway/road tracks for lorries and cars that can't slow down.

Extension: Challenge the children to devise an experiment to investigate the effects of water on the grip of a shoe in the context of a slippery floor. Look for answers linked to testing a shoe on a dry ramp and then a wet ramp.

3. Explore and investigate the two poles on a magnet.

Enquiry Approach: Identifying, Classifying and Grouping
Enquiry Skills: Observing and measuring, gathering and recording data to help answer questions

Guidance: Recap and review contact and non-contact forces. Friction is a contact force, gravity and magnetism are non-contact forces. Children explore the magnets identifying including north pole and south pole on a magnet. Children explore that magnets will attract or repel each other depending on which way they are facing and how they will attract some materials but not others.

Extension: Challenge the children to devise an experiment that they could conduct to find out if one pole was stronger than another.

Extension: Making a compass

Children can turn a possible a paper clip into a compass using the instructions on Reach out CPD.

Key Misconceptions for Children

1. The biggest magnet will be the strongest.

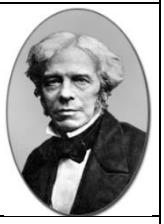
The strength of a magnet is determined by the material it is made of and the strength of the external magnetic field applied when it is magnetised.

Activities to explore this: Ask children to devise a simple test to investigate the strength of a magnet. (There are so many possible tests – how many books will a magnet work through, how many paper clips will a magnet pick up, from how far away will a magnet attract a paper clip?)

2. All metals are magnetic.

Magnetic materials are always made of metal, but not all metals are magnetic. Iron, steel (an alloy of iron and carbon), nickel and cobalt are magnetic. Most other metals, for example aluminium, copper and gold, are not magnetic.

Activities to explore this: See Key Investigations box

	3. Smooth surfaces produce no friction. Friction occurs between all surfaces and materials including air and water. Rougher surfaces produce more friction, but even very smooth surfaces such as ice produce some friction. Activities to explore this: Measure the friction between an object and a surface by pulling the object across the surface using a force meter. Compare different surfaces, including oiled surfaces and ice. Even with very smooth surfaces there will be visible 'pull back' as the object resists to move due to friction.	
Key scientists to learn about	**Michael Faraday** (1791–1867) – A British scientist whose work was based around magnetic fields. **Isaac Newton** - An English mathematician and physicist who made many discoveries about gravity. **(Year 5 investigate his work further into gravity).** 	
Previously Taught Vocabulary	force, push, pull, twist, turn	
New Key Vocabulary	**Gravity:** The force that pulls objects together and makes objects fall to the ground. **Contact Forces:** forces that act between two objects that are physically touching each other. **Non-contact Forces:** forces that act between two objects that are not physically touching each other. **Compass:** a device for finding directions, usually with a magnetised pointer that automatically swings to magnetic north. **Friction:** a force that exists between two surfaces in contact. **Magnet:** a piece of metal that has the power to draw certain objects towards it and to hold or move them. **Magnetism:** the force of attraction or repulsion between substances made of certain materials, such as iron, nickel, cobalt, and steel. **Magnetic material:** a material that is attracted to a magnet and can be made into a magnet. **Non-magnetic material:** a material that is not attracted to a magnet, e.g. copper, aluminium, wood, pottery, glass, plastic. **Magnetic Poles:** The ends of a magnet, where its magnetic force is strongest. A magnet has a north (N) pole and a south (S) pole. **Magnetic north pole:** a place at the end of the magnet that points towards the planet's North Pole. **Magnetic south pole:** a place at the end of the magnet that points towards the planet's South Pole. **Repel:** to push away from each other. **Repulsion:** a force between materials of the same magnetic polarity that tends to repel or separate them.	**Force:** A push or a pull, or a combination of these, such as a twist. A force can cause an object to speed up, slow down or change shape. Forces cannot be seen, but the effects of forces can be. Examples of forces include gravity, friction and magnetism.
Core Substantive Knowledge/Background Teacher Knowledge	<u>Forces</u> We can't see forces, but they are an important part of our everyday lives. Understanding forces allows us to build houses that don't fall down and chairs that don't collapse. Forces affect us when we drive to school or fly on holiday. Understanding forces enables us to launch satellites into orbit that can beam television signals around the world and map the planet from space!	

Forces can be a complex topic area, so at primary level it is important to keep explanations quite simple to allow the children to gain a clear understanding. At the most basic level, forces are about pushes and pulls.

Newton's first law of motion states that an object will continue at a constant speed and in the same direction unless a force acts upon it. This means that even if an object is travelling at high speed, it will continue at that speed unless another force acts on it. A force is only required for acceleration, deceleration or a change of direction. For example, if you were to throw a rock in space it could keep moving forever. It would keep travelling in a straight line, only stopping or changing direction if it hit another object or got caught in the gravitational pull of a star or planet. This doesn't happen if we throw a rock on Earth. The rock will always eventually come to a stop because of forces including friction, gravity and air resistance. These forces act on moving objects and eventually bring them to a stop.

The word "force" is one that is used in everyday language. For example, "air force", "police force", "gale force winds", and "forces of nature".
When introducing forces, a fun starter activity is to ask the children to brainstorm as many uses of the word "force" as possible. Think about what the word "force" means in each example.
A force is a push or a pull or a combination of these, such as a twist. A force can cause an object to speed up, slow down or change shape. Forces cannot be seen, but the effects of forces can be.
Some forces, such as friction and air resistance, act when objects or fluids are physically touching each other. Other forces act at a distance, such as magnetism and gravity. The planets and the Sun do not touch, yet the planets stay in orbit around the Sun due to the force of gravity. These are called contact and non-contact forces.
Three contact forces are:
Impact forces – when one surface collides with another
Frictional forces – occurring when two surface are already in contact
Strain forces – generated in elastic materials when they are stretched or squished
Non-contact forces exist between objects not in contact like a planet or something drawn to its surface **(gravity)** or a magnet material and a magnet **(magnetism).**

Friction is very useful. We need friction to create a good grip between the soles of our shoes and the ground, or between our car tyres and the road. At times, friction can be something we want to reduce. Oil or lubricants are added to door hinges or the gears of our bicycles to reduce friction and make them move more easily. There are two types of friction that exists between two surfaces in contact with each other. Static friction which exists when two surfaces are in contact that are not moving. It pushes in the opposite direction to the force pushing on the object. Sliding friction exists between two surfaces when one is sliding over the other. It pushes against the force pushing the object. When that force is removed, the sliding friction slows and stops the object.

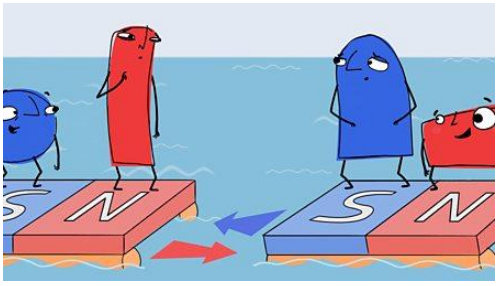
<u>Magnets</u>
A magnet is an object that is made of materials that create a **magnetic field.** Magnets have at least one **north pole** and one **south pole**. A magnetic field is the region in space where a magnetic force can be detected.
Magnetism is the force of **attraction** or **repulsion** between substances made of certain materials. Magnets come in different strengths, but they are all made from a very small group of metals. This is because not all metals are magnetic. Iron (and steel, an iron alloy) and cobalt are the metals usually used in magnets. The force of magnetism, simply put, is due to the **motion of electric charges.**

Magnets are present in most **electronic devices.** In fact, anything that has a motor uses a magnet. Televisions, computers and microwave ovens all operate with magnets. Magnets are used to keep refrigerator doors closed and are even mounted on trucks that clean roads. You'll also find magnets in medical devices to create a magnetic picture, in trains, and in the systems used to slow down roller coasters. More uses for magnets are found every day.

Magnets **attract, or pull, objects made with iron**. Paper clips, scissors, screws, nuts, and bolts are just a few common everyday objects that are magnetic. A magnet will not attract paper, rubber, wood, or plastic. It is not true that a magnet will attract any kind of metal. For example, aluminium cans are metal, but do not contain iron, therefore they are not magnetic. Steel is a metal that is made with iron, so steel objects like tools and silverware are usually magnetic.

	Magnets have two poles, a **north pole** and a **south pole.** The north pole of one magnet will repel and push away the north pole of another magnet. The south pole will repel another south pole. North and south poles are attracted to each other. A magnetic field flows from North to South and these fields are not visible, but if you place a piece of paper on top of a magnet and sprinkle fine iron powder on top, the shape of the invisible magnetic fields become visible as the fine iron powder clings to them. There are many shapes of magnet and each has a different magnetic field shape. Magnets can **pull through gases, like air, but they can also pull through solids and even liquids**, depending on the strength of the magnet. A **magnetic field** is the area around the magnet where it can attract or repel things. A magnet will affect a magnetic object only when it enters its magnetic field. This is why a small magnet on one side of the room will not attract things on another side. The strength of a magnet is stronger as you get closer to it, and likewise its strength is weaker as you are farther away. A compass needle is a small magnet. The Earth acts like a giant magnet. Its magnetic field is like a bar magnet at its centre. The North Pole of the Earth attracts the north-seeking pole of the compass needle. It is possible to turn a paperclip into a magnet by following the Reach Out steps outlined on how to make a compass in the suggested activities box. Magnetic materials are made of thousands of tiny magnets called magnetic domains. Before the material is magnetised, all the little magnets point in different directions, so their effects cancel each other out. But a magnetic field can line them up so that they all point in the same direction. This turns the material into a magnet. When describing this to young children, you shouldn't mention the term "domains", but you can ask them to imagine lots of tiny mini-magnets inside the material that need to be lined up in order for it to work properly. Scientists measure magnetic fields with an instrument called a **magnetometer**. The instrument can also be used to measure the magnetism in ancient rocks. As the rocks formed, they were magnetised by the Earth's field. Rocks of different ages may be magnetised in opposite directions, because the Earth's magnetic field has often reversed. By piecing together records from different places, scientists can work out how rocks have moved in the billions of years since the Earth was formed. Magnets have been used by humans since ancient Greece. It is believed that naturally occurring minerals called magnetite were first **discovered by the Ancient Greeks** in the area of Turkey. Magnets used to be known as "**lodestones**". The **Vikings** were known as the first people to use this magnetic material to create compasses that allowed them to navigate across water through poor weather conditions to discover and conquer new land. It is thought that the Vikings kept the **magnetic compass** a secret for many years. Magnetic compasses can now be found in every ship across the world to navigate the open seas. Today almost all magnets are manufactured using various **natural materials** from around the world. Every magnet is surrounded by an **invisible, three-dimensional magnetic field**. A field is a region in which something varies from point to point. In Earth's atmosphere, for example, wind speed and direction vary from place to place. In a magnetic field, the strength and direction of the magnetic effect varies in a similar way. The field is at its strongest near the magnet. The idea of a magnetic field is based on the work of British scientist **Michael Faraday** (1791–1867) in the early 19th century. He sprinkled particles of iron around magnets to reveal what he called "lines of force" stretching from one pole to another. These helped him to explain many magnetic effects. We now see lines of force as indicating the direction of the field, with their spacing indicating its strength.
Prior Knowledge	1.6 Year 1 Pushes and pulls – pushes and pulls around us, how things move in our world, how forces can be dangerous, e.g. moving cars.
Assessment	Thorough assessment of outcomes in books and folders, quizzes and written scientific investigations, also supported by observations and questioning in lessons, assessing the following: Substantive Knowledge: - Pupils understand that some forces need contact (friction) and that some forces work at a distance (gravity, magnetism). - Pupils understand how friction can affect how an object moves over a surface.

	- Pupils can identify some materials that are magnetic and group everyday objects based on this property. - Pupils understanding that a magnet has two poles, which will attract or repel different each other and different materials depending on which way the poles are facing. Disciplinary Knowledge: - Pupils have made predictions linked to movement over a surface and if a material is magnetic or not. - Pupils have asked questions linked to forces based on their scientific knowledge. - Pupils have grouped materials together based on whether they are magnetic or not. - Pupils have investigated the concept of a fair test and comparative tests through friction. - Pupils have made observations and recorded results in diagrams, drawings and charts. - Pupils have interpreted results and drawn simple conclusions from these. - Pupils have evaluated investigations, suggesting changes that could be made and generated questions about what to investigate next or further.
Useful Planning Resources Useful Links	Making a compass: https://www.reachoutcpd.com/courses/upper-primary/forces-and-magnets/forces-and-magnets-practical-ideas/objectives/ Background information on magnets: https://www.theschoolrun.com/homework-help/magnets Reach Out CPD Unit on magnets: https://www.reachoutcpd.com/courses/upper-primary/forces-and-magnets/ Explore, Engage and Extend Book, Page 51 and 52. Teaching Primary Science Book, Page 82-87. Explorify, Magnets: https://explorify.wellcome.ac.uk/en/activities/whats-going-on/magnets Explorify, Magnets: https://explorify.wellcome.ac.uk/en/activities/odd-one-out/pull-together Magnets Video: https://youtu.be/yXCeuSiTOug Magnet Poles Video: https://youtu.be/5C-RM4fh5Xg BBC Bite Size: https://www.bbc.co.uk/bitesize/topics/zyttyrd



Appendix:

Instructions for making a compass:

Resources (per group):

- A reasonably strong bar magnet
- A selection of steel paperclips
- Thin piece of cork or a disc cut from the bottom of a polystyrene cup
- Shallow dish of water

1. Straighten out a paper clip.
2. Stroke the paperclip with one end of the bar magnet, in one direction only.
3. Repeat this 10 to 20 times, using the same end of the magnet and stroking in the same direction. Do not rub back and forth.
4. Hold the magnetised paperclip and see if you can pick up another paperclip. If it doesn't work, repeat steps 1 to 3 to make it stronger.
5. Float the paperclip in the middle of a dish of water on the cork or polystyrene disc. The paperclip should slowly point towards north.

Note: Make sure that no strong magnets are near the dish of water or the paperclip will point towards them instead! This experiment can also be carried out using a needle instead of a paperclip, but the children would need to take extra care when using these.

Key Concepts for Sticky knowledge for Knowledge Organiser:

1. Push and pull forces can make things start and stop moving.
2. Different surfaces affect how easily things move over them.
3. Some forces need contact between two objects, but magnetic forces can act at a distance.
4. Magnets attract some materials and not others.
5. Magnets have two poles.
6. Magnets attract or repel each other.