	Science	Year 5
	Term 1 and 2	Topic Title: Forces

Key Question: How are forces used to create or control motion?

National Curriculum Objectives:

- Explain that unsupported objects fall towards the Earth because of the force of gravity acting between the Earth and the falling object.
- Identify the effects of air resistance, water resistance and friction that act between moving surfaces.
- Recognise that some mechanisms, including levers, pulleys and gears, allow a smaller force to have a greater effect.

Vocabulary: Force, gravity, Earth, air resistance, water resistance, friction, mechanisms, simple machines, levers, pulleys, gears

National Curriculum requirement: Pupils should read and spell scientific vocabulary correctly and with confidence, using their growing word reading and spelling knowledge.

Prior Learning:

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. (Y3 - Forces and magnets)

Common misconceptions:

- the heavier the object the faster it falls, because it has more gravity acting on it
- forces always act in pairs which are equal and opposite
- smooth surfaces have no friction
- objects always travel better on smooth surfaces
- a moving object has a force which is pushing it forwards and it stops when the pushing force wears out
- a non-moving object has no forces acting on it
- heavy objects sink and light objects float.

Knowledge: force causes an object to start moving, stop moving, speed up, slow down or change direction. Gravity is a force that acts at a distance. Everything is pulled to the Earth by gravity. This causes unsupported objects to fall.
Air resistance, water resistance and friction are contact forces that act between moving surfaces. The object may be moving through the air or water, or the air and water may be moving over a stationary object.
A mechanism is a device that allows a small force to be increased to a larger force. The pay back is that it requires a greater movement. The small force moves a long distance and the resulting large force moves a small distance, e.g. a crowbar or bottle top remover. Pulleys, levers and gears are all mechanisms, also known as simple machines.

Investigative skills

Fair/comparative testing	Identifying and classifying	Observations	Pattern seeking	Research
How can different materials affect a force? *Which material is most suitable for a zip wire?* *How does the surface area of an object affect the time it takes to sink?* Chn decide for themselves how to select from a range of practical resources to gather evidence and carry out fair tests to answer a scientific question, recognising and controlling variables. *Forces as pushes/ pulls,rising from interaction between two objects. Forces: associated with deforming objects; stretching and squashing - springs; with rubbing & friction between surfaces, with pushing things out of the way; resistance to motion of air & water. Forces measured in Newtons, measurements of stretch or*	*Can you label and name all the forces acting on the objects in each of these situations?* Compare forces. Interpret data to generate simple comparative statements and illustrations based on their evidence. Identify differences, similarities or changes related to simple scientific ideas and processes. Identify causal relationships/patterns. *Use force arrows in diagrams, adding forces in one dimension, balanced/unbalanced forces. (KS3)*	*What effect does friction have on movement?* Select measuring equipment with suitable scales to give the most precise results. Make decisions e.g. to take repeat readings, increase sample size, adjust angles in order to get accurate data. Communicate findings and record results using relevant scientific language, illustrations, diagrams, tables scatter and bar graphs. *Movement as the turning effect of a force. Rubbing & friction between surfaces, with pushing things out of the way; resistance to motion of air & water. (KS3)*	*How does surface area of parachute affect the time it takes to fall?* *Do all objects fall through water in the same way?* In conclusions, chn identify causal relationships and patterns. Evaluate the choice of method used, the control of variables, and the precision and accuracy of measurements. Identify limitations that reduce the trust they have in their data. *Forces as pushes or pulls, arising from the interaction between two objects. (KS3)*	*Why do unsupported objects fall towards the Earth?* *How do submarines and divers sink if they're full of air?* Talk about how scientific ideas change due to new evidence and how new discoveries change scientific understanding. Report and present findings in oral and written forms. *Forces measured in Newtons, measurements of stretch or compression as force is changed. (KS3)*

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Significant Scientists: **Isaac Newton-** Gravitation (the Earth must have a force at the centre) **Galileo Galilei-** Gravity and Acceleration **Archimedes of Syracuse-** Levers	**End point:** Can demonstrate the effect of gravity acting on an unsupported object and show through simple diagrams. Give examples of friction, water resistance and air resistance. Give examples of when it is beneficial to have high or low friction, water resistance and air resistance. Can demonstrate how pulleys, levers and gears work. Explain results of investigations in terms of the force, showing a good understanding that as the object tries to move through water or air or across the surface, particles in water, air or on the surface slow it down. Can demonstrate clearly the effects of using levers, pulleys and gears.
Science stories: **The tin snail-** Cameron McAllister **Leonardo's Dream-** Hans de Beer	
Cross Curricular Links: **English:** Communicate findings using relevant scientific language and illustrations. **Maths:** measuring force, weight and mass, construct and interpret tables, charts and scatter, bar and line graphs, measure and calculate area of 2D shapes (parachutes). **DT:** Construct a parachute selecting and using materials and components according to their functional properties.	**Oracy:** • ABC- instigator, clarifier, summariser. (testing threads active assessment activity lesson 2) • What goes up must come down Explorify discussion (lesson 4) • "I wonder"- ask and answer a range of scientific questions.
Wider Reading and resources	**Enrichment/ Science capital**
Active Assessment in Science- Naylor, Keogh, Goldsworthy A creative approach to teaching Science- Nicky Waller BBC bitesize www.Explorify.com www.STEM.org.uk	Explore forces through concept of a theme park. Relate friction to every experience including sports and sportswear. Make parachutes to test and take home. Link water resistance to swimming lessons.

Sequence of Learning		
Lesson	Key Question	Key learning/notes
1	Why do unsupported objects fall towards the Earth? **Before the main activity:** Set up the scenario for the unit: chn are force consultants for the development of a new theme park. They will need to explore a range of forces and mechanisms to be incorporated into a number of theme park rides and feedback their findings to the development team. Today, chn must demonstrate their forces knowledge to explore forces in a bungee-jump 'ride' and inform the development team of any health and safety issues they will need to consider.	• (Elicit prior knowledge/misconceptions through observing chn & noting comments through this lesson. Use post its to create display of KWL) • Put a "splodge" of poster paint at the top of a piece of paper. What do chn notice about the direction in which the paint drips? What happens if you turn your paper the other way up? Why do you think this happens? Ask chn to jump up for as long as they can without holding on to anything. Can you stay in the air for more than 5 secs? Why not? Demo throwing a ball up into the air. Can it stay in the air for 10 secs? What happens to the ball? What's the longest it can stay up before falling? • **Chn complete the first half of pg 145 Active Assessment "Forces" vocab check.** (Return to complete the second table at the end of the unit) • **Introduce Key scientist Sir Isaac Newton** after whom the unit of force is named. Explain that there is a force driving everything that moves. • Show chn the bungee video: what factors might affect the stretch? Hold one end of an elastic/exercise band, what happens when we pull on the other end? Chn should notice band gets longer as we apply force (pull) to it. What happens if we increase the force? (Band gets longer.) The force of **gravity** is acting as a pull causing the bungee rope to stretch. What could affect the strength of pull of gravity when someone jumps and causes the stretch to increase? Encourage chn to consider weight as a factor. • How can we test the theory that the weight of an object affects the stretch of an elastic band? Hold up a forcemeter. Explain that this measurement of weight in Newtons/'N' is a measurement of pull of gravity. Use premade tables to measure and record forces using force meters. Chn to share their

	Note: Teach chn the difference between weight and mass as they develop their understanding of gravity and balanced forces.	findings for the theme park. Why is it hugely important to know the weight of the person on a ride? (So they don't hit the ground!) • Force causes an object to start moving, stop moving, speed up, slow down or change direction. Gravity is a force that acts at a distance. Everything is pulled to the Earth by gravity. This causes unsupported objects to fall.
2	How can materials affect a force?	• Use sports pictures as a context for introducing friction. Why do gymnasts put chalk on their hands? Why do tennis racquets have rubber grips? What helps an ice skate to glide across the surface? (Make sure that during this discussion, children understand that smooth surfaces do have friction) Why do goalkeepers wear gloves? These materials have been designed to provide maximum grip for safety and control. Present chn with a range of materials. Chn predict which ones would be most suitable for a goalie glove. • Chn to carry out a quick mini comparative test in small groups to investigate the best grip when moved over different surfaces. Use forcemeters to measure the force required to pull a 1kg weight across each sample of material (lycra, sponge, bubble wrap, denim, sandpaper etc). (each group to test a material then collate as a class- not a full write up) • **Display key vocab** (rough, smooth, drag, resistance, grip, force, friction) for chn to verbalise their findings and contribute to a **class write up of I See, I notice, I wonder** (on f/c). Which material had the best grip? What features of the material provided more grip? Compare the textures of the materials. What effect did it have on the force needed to move the weight? • Explain that chn have been investigating friction. They will investigate this force more tomorrow. Come up with a class definition. • Draw a class diagram of a material and direction arrows to show the forces that were acting upon it. How many arrows will we need? Why? (Explain that forces act in pairs!) model an example to show the resisting force and the force of the drag (the "push" of the surface against the pull of the force). • In what other situations would the strength of materials be important? Relate back to theme parks. What would happen if one of the entertainment tents got damaged/torn? How could the development team choose the right material to repair the tear to support the weight of the tent? • **"Testing Threads" pg 53 Active Assessment in Science** (resources) chn construct, organise and interpret data relating to forces and materials. Allow chn to work in small groups to give the opportunity to discuss and argue about the information presented to clarify and consolidate ideas. Use ABC oracy exercise, switching roles to allow differences in interpretations.
3	What effect does friction have on movement? Investigation: Which material would be most suitable for a zip wire?	• What is friction? Recap key ideas and watch this clip from BBC Bitesize for the definition. Discuss and explore friction and how we can detect its presence. Recap how friction occurs in everyday society. • Set up the zip wire enquiry to investigate friction. Can chn design and make a zip wire, including a harness, to carry a soft toy or lego figure from one end of the classroom to the other, or outside from one tree to the next? (Alternatively or as an initial whole class demonstration you could conduct the balloon rockets investigation from STEM) • Guide chn to use the UKS2 template to write a full investigation by first making predictions, then statements about how to create a fair test. Chn use the materials or "type of zip wire" as their variable and measure the time taken for the descent of the figure. • Ensuring it is a fair test by repeating readings and taking averages, children construct their own tables and record measurements. Provide models/scaffolds of how to present their findings. • Using the example material model from yesterday, chn draw a simple diagram of their zipwire investigation- can they use arrows to show the direction of and name and label some of the forces in action? • Challenge chn to reflect and consider what happens when there is too much friction. Can they think of a real-life example where this has happened? (carpet burn, stuck on slide)
4	What is air resistance?	• Take chn outside or into the hall to run from one end to another. Can they feel the air pushing against them? Children should now try this by holding large sheets of card. Does it feel like there is a greater force this time? Did it feel harder/slower when running? Why?

		• Chn discover that travelling through air involves another drag force: air resistance. Briefly discuss Galileo- gravity and acceleration. • Show Explorify odd one out activity What goes up must come down. Have a discussion and explore the background Science. • What is air resistance? Teach chn about surface area- what it is and the effects it can have on air resistance. • Parachutes are often used on European Space Agency missions to slow down vehicles and landers as they descend. Develop the children's understanding of contact and non-contact forces by investigating parachutes. Chn make different sized parachutes from fabric or thick plastic (measure/calculate area of 2D shapes). • Chn use their parachutes to investigate how long it takes for one to fall through the air from an agreed height. Chn should understand that a larger parachute will have a greater surface area for the air to push against it and so should fall more slowly. • Children to write conclusions to explain what their investigation has revealed about surface area. What wonders do they have? **Alternative activities:** Check out the Soft Landings activity in ESERO's Rosetta Primary Resource Book or take a look at the low altitude practice parachute drop or Schiaparelli's descent to Mars in action. Have a go at Build an egg parachute or STEM Learning's The Mars Mission: Landing and Exploring to put the learning into action or have a think what life would be like if There was no gravity?
5	What is water resistance?	• Ask chn: Have you ever tried running through water? It's harder work than running through air! Water resistance (drag force) can slow objects passing through it. Encourage chn to think about their swimming lessons and how their movement feels different in the water compared to land! • Explain that it is possible to reduce the effects of water and air resistance and introduce the concept of streamlining. Can chn think of examples of streamlining e.g in transport? (planes, trains ships) How about in nature? (sharks) Explain that like air resistance, water resistance is dependent on the surface area of an object- the bigger the area to work against, the greater the resistance. Explore examples and show diagrams to show the forces in action. • Allow children the opportunity to make streamlined shapes e.g paper aeroplanes, model plasticine to explore floating/sinking etc. • How could we investigate this further? Chn generate their own questions to carry out enquiries about the weight of objects in water, boat designs and the effect of different waters. Discuss a range of ideas as a class and write a bank of possible questions to explore with question stems to support the LA. Allow chn to carry out investigations and record however they choose. (provide scaffolds for LA pupils to choose from if they wish but let them decide) Can chn write detailed conclusions to explain the cause and effect of streamlining and water resistance on their objects? • **Research:** How do submarines/divers stay underwater if they are full of air?
6	How can pulleys and levers help us to transfer a force more easily? Read the tin snail before this lesson or to kickstart the lesson.	• Mechanical devices that we use in everyday life help us transfer forces or motion and make tasks easier. Watch simple machines clips to support understanding. Explore and discuss simple gears, levers and pulleys which are all simple machines and elastic bands and springs. • Challenge chn to create a pulley by tying a strong rope around the handle of a heavy object e.g bucket of sand and lift to an agreed height. Children should experience how difficult it is due to working against the pull of gravity. Now throw the rope over the branch of a tree or sturdy beam- as chn to pull on the rope to lift the bucket again. The container should feel easier to lift because they are pulling down with the force of gravity rather than working against it. • Create the scenario where chn need to lift a very heavy load to a specified height. We could use a lever: explain that the load goes at one end and we apply the effort (force) to the other end. How do levers work? For our investigation to work, we need a fulcrum. • Chn investigate using a 30cm ruler, a pencil (fulcrum) and a weight (eg 500g) deciding the best place to position the fulcrum to ensure the load can be

		lifted easily. Fix the fulcrum and weight down with masking tape/sticky tack. Use a push meter to measure the force applied at the other end of the ruler to lift the load. What happens to the force required to lift the load when the fulcrum if positioned at different measurements along a ruler?
7	How do forces create or control motion? Assessment lesson	• Display "big hitters" odd one out activity on Explorify. Chn to reflect on all of their knowledge of forces from the unit to discuss. (appearance, how they are used, the level of force needed to move them, factors that could affect how far they travel etc) • What forces can you identify in this clip? (list on their whiteboards) Rpt as necessary. (gravity, air and water resistance, friction acting upon objects, pushes, pulls, twists.) • Chn return to their **active assessment vocabulary check** from lesson 1 and fill in the second table. How has their understanding changed? Encourage them to add any new knowledge of forces to their pages or to your working Science display board. Take a photo of your whole class KWL display for your WS floor book.