Subject: Science
Year 5: Imbalanced Forces
PoS:

- 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

Prior Learning (what pupils already know and can do)

A force is a push or a pull. When an object moves on a surface, the texture of the surface and the object affect how it moves. A toy car travels further on a smooth surface compared to a carpet. The smoother the surface the further the car travels and the rougher the surface the quicker an object slows down. For some forces to act, there must be contact e.g. a hand opening a door, the wind pushing the trees. Some forces can act at a distance e.g. magnetism. The magnet does not need to touch the object that it attracts. Also, poles repel and opposite poles attract.

End Goals (what pupils MUST know and remember)

- Know that friction is the force between surfaces that are touching.
- Know rough surfaces, create lots of friction.
- Know smooth surfaces do not create much friction.
- Know friction produces heat.
- Know air resistance is the force that slows down moving objects as they move through air.
- Know objects, need to be streamlined to travel faster through the air and to travel slower through the air, you need a large surface area.
- Know water resistance is the force that slows down moving objects as they move through water.
- Know if you want to travel more quickly through water, the shape needs to be streamlined e.g. Dolphin has a streamlined body
- Know that buoyancy is an object's ability to float in water or air.
- Know that the force of gravity pulls objects towards the centre of the Earth regardless of where you are on the planet.
- Know that Sir Isaac Newton (a British scientist) devised the laws of gravity
- Know that the size of the gravitational force is more or less the same all over the Earth.
- Know that levers, gears, and pulleys are simple mechanisms that enable a small force to have a greater effect
- Know a lever is made from a long pole and pivot (fulcrum) examples are scissors, a wheelbarrow, and a stapler
- Know a pulley is a rope running through a wheel, examples are window blinds, a flagpole and a well
- Know gears are wheels with teeth that fit together. When one wheel is turned, the other wheel turns too but in the opposite direction.
- Know that a smaller gear will turn faster than a larger one

Key Vocabulary: contact, non-contact, force, push, pull, motion, speed up, slow down, change direction, surfaces, texture, contact, friction, gravity, Sir Isaac Newton, force meter, weight, mass, average, air resistance, parachutes, area, water resistance, streamlined, buoyancy, simple mechanism, pulley, lever, gears, clockwise, anticlockwise, load, exert

Session 1: review prior learning
Watch http://www.bbc.co.uk/learningzone/clips/forces-in-action-no-narration/1601.html how are all the images in the video linked? (Everything was moving) What is a force? Most forces occur when there is contact e.g. wind blowing through the trees makes the tree move. Can you think of any other situations when there is a force?
Discuss the non-contact force – magnetism
Forces can make things speed up, slow down, change direction or stop

Kapow Lesson 1: Gravity.
Only use the Recap and Recall and Attention Grabber sections (stop video before Galileo).
Move on to:
LO: To understand the force of gravity
Watch https://www.youtube.com/watch?v=2ydh7AShMzM
Gravity - the force by which a planet or other body draws objects toward its center. The Earth's gravity is what keeps you on the ground and makes things fall.
Discuss a bouncy ball – ask children to watch as the ball falls to the ground – why does it do this? What is acting upon the ball? Etc.
Children learn that the force of gravity pulls objects towards the center of the Earth regardless of where you are on the planet. Sir Isaac Newton (a British scientist) devised the laws of gravity and that the size of the gravitational force is more or less the same all over the Earth.
Children draw a simple diagram to represent gravity pulling towards the center of the Earth: draw the Earth (a circle), stick men and arrows pointing towards the center of the Earth.
Discuss mass and weight:
Weight is a measurement of the gravitational force on an object.
The mass of an object is a measure of the matter in it. The basic unit of measurement for mass is the kilogram.

Investigate using a force meter: use a sandwich bag to hold different classroom objects and record the results in your class floorbook. Use objects that make this obvious, for example: a sponge, a marble, an empty plastic bottle, an inflated balloon etc

Vocabulary: contact, non-contact, force, push, pull, motion, speed up, slow down, change direction, gravity, Sir Isaac Newton, force meter, weight, mass

Session 2: Recap: What did Newton discover?

- Gravity is greater if the mass is greater
- Gravity is greater if objects are closer together
- All objects have gravity

Use Kapow lesson 2: Air Resistance
LO:
Working scientifically LO: To plan and write a method for a fair test.
Children learn that air resistance is the force that slows down moving objects as they move through air and that objects need to be streamlined to travel faster through the air and to travel slower through the air, you need a large surface area.
In pairs children have 2 identical sheets of paper. One child screws theirs up tightly into a ball, the other leaves theirs flat. They drop their paper at the same time from the same height and discuss what happens and draw conclusions as a class. (Record in Floorbook)
Model the experiment with the balloons. Children record steps on whiteboards/in jotters to use when writing up method. Video experiment on iPad to calculate timings. Repeat several times to get a more accurate result.

Children write up method for the balloon experiment in their books.
Children learn that friction is the force between surfaces that are touching and rough surfaces, create lots of friction whilst smooth surfaces do not create much friction. Friction produces heat.
LO: to observe what happens as objects move across surfaces

Why is the boy finding it hard to pull the sledge?
Watch https://www.youtube.com/watch?v=m9aJImtsEpM
Friction - the resistance that one surface or object encounters when moving over another.
Children investigate an object moving across different surfaces explain what happens using term friction. Could use a force meter and a trainer/shoe on different surfaces

Vocabulary: surfaces, texture, contact, friction

Session 3:
Use Kapow lesson 3: Water Resistance
LO: To describe water resistance and its effects.
Recap and recall: Air resistance using the presentation provided
Use the Attention grabber focusing on the questions:
What direction do both air and water resistance work in? (Against motion.)
What are the effects of air and water resistance? (They slow, and sometimes stop, moving objects.)
What are some examples of streamlining in nature? Dolphin etc.
Children learn water resistance is the force that slows down moving objects as they move through water and if you want to travel more quickly through water, the shape needs to be streamlined e.g. Dolphin has a streamlined body. They learn that buoyancy is an object's ability to float in water or air.

Complete the 'missiles' investigation (using dough) in the Main Event section. Design a results table as a class and complete it together for the floorbook.
Children write a conclusion in their books that explains their results.

Vocabulary: aerodynamics, streamlining, water resistance

Session 4: Friction
Recap and recall: Play the Pupil video: Investigation friction method to recap Year 3 'Forces and magnets' lesson 3
Ask the following questions:
What is friction? (A force between two surfaces in contact that opposes motion.)
How does the roughness of a surface affect friction? (The rougher the surface of the, the more friction)
What force was pulling the car down the ramp? (Gravity)
LO: To describe friction and its effects.
Working scientifically LO: To evaluate a method.
The presentation: The effects of forces in the Attention Grabber section can be used to aid understanding. Focus on slide 6 and 8 to demonstrate the effect of friction when balanced against a forward push (steady speed) and when stronger (slowing down) or weaker (speeding up) than a forward push. Teacher to demonstrate and explain to speed up understanding.

Use the Main Event section of the lesson but complete the investigation as a class (not in groups) as there may be limited space to do this.

Session 5: Levers, pulleys and gears (part 1)
Use Kapow lesson 5
Recap and recall: Do the 'What is the question?' activity where children write questions to match information on the knowledge organiser for this unit.

LO: To describe the effects of levers, pulleys and simple machines on movement.

Working scientifically LO: To draw and label a diagram.

Use the Attention Grabber section to teach the children how forces can be amplified by using levers, pulleys and gears.

Children learn that levers, gears, and pulleys are simple mechanisms that enable a small force to have a greater effect. A lever is made from a long pole and pivot (fulcrum) examples are scissors, a wheelbarrow, and a stapler. A pulley is a rope running through a wheel, examples are window blinds, a flagpole and a well. Gears are wheels with teeth that fit together. When one wheel is turned, the other wheel turns too but in the opposite direction. A smaller gear will turn faster than a larger one.

Main Section: If time allows and resources are available children make wind-powered pulleys in groups (they do not need to research windmill designs). However, the focus is on how a pulley works so the teacher could make one in advance and demonstrate it to the children. Children can suggest improvements to the design.

Children draw and label a diagram of the wind-powered pulley.

Vocabulary: effort, gear, lever, load, machine, pivot, pulley

Session 6: Levers, pulleys and gears (part 2)
Recap and recall: Do the 'Spot the simple machine' activity- children identify and classify the simple machines (levers, pulleys and gears)

LO: To describe the relationship between lever length and effort.

Watch the BBC teach suggested in the Attention Grabber section and focus on the following questions:

The further away the effort from the pivot, the… it is to lift the load. (Easier.)
What can levers be used for? (Answers may include lifting, opening and cutting.)
What three things are needed for a lever? (A load, an effort/force and a pivot.)

Children make catapults and record data in a table. Children plot their data (or the model data) on a line graph.

Vocabulary: simple mechanism, pulley, lever, gears, clockwise, anticlockwise, load, exert

Link to career:
Automotive engineer, civil engineer
Mechanical engineer https://www.youtube.com/watch?v=UrT1_TuvZmQ
Robotic technician https://www.youtube.com/watch?v=IKlZw8XAsOc

Scientists who have helped develop understanding in this field: Sir Isaac Newton https://www.youtube.com/watch?v=2ydh7AShMzM Archimedes buoyancy theory