What is the best shape for a drone?

Lesson overview:

In this lesson, children learn how drones are used in sustainable agriculture and the forces that act on drones. They are then challenged to investigate the best shape for a drone in order to minimise air resistance.

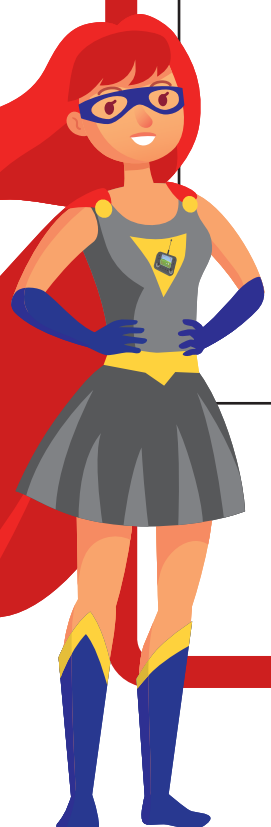
This lesson could be used to start the children thinking about how they might design an idea, invention or innovation that will help farmers continue to care for the environment and be climate superheroes for their Farmvention competition entry.

Equipment needed:

- Card or thick paper to create drone models
- Slow-motion camera on a tablet or smartphone (optional)

Presentation guidance:

Slide 2: Introduction	• Use the presentation to introduce drone technology and how it is being used to support sustainable farming. • Drone technology is a relatively recent development and scientists are finding new creative uses for drones every day. • They are useful because they can easily travel to places that it is difficult for humans to reach and gather lots of data (information) for scientists to analyse. • Agricultural drones can be used in a number of different ways, including crop monitoring, pest control, soil assessment and harvest planning. These can all be done more quickly and effectively using drones.
Slide 3: Drones in farming	• Explain that there are many different ways farmers can use drones to support more sustainable farming. These have potential to save time, money and resources and allow farmers to make the most out of their land. • Some uses include: - Mapping/surveying – drones with cameras and on-board computers can be used to survey large areas of land quickly and monitor plant health, soil quality and water supply. This means farmers can carefully plan for optimal land, water and fertiliser usage and prevent waste. - Crop dusting/spraying – Drones provide a safe way of spraying fertilisers and plant protection products that can be carefully targeted using the data that has been gathered, meaning no resources are wasted on areas that are not in need of them. - Livestock monitoring – Farmers can use drones with cameras to travel the long distances around fields and look out for animals that are missing, unwell or ready to give birth. • This video gives a quick look at some possible uses for drones on farms: https://www.youtube.com/watch?v=i7GLo-2F7_o



Teacher guidance - 2

Slide 4:	• Use the presentation to explore how forces act on drones when they are ascending and descending through the air. • Explain that the two forces acting on objects in the air are gravity and air resistance. Gravity is the force that pulls things down towards the centre of the Earth. • This video gives a good explanation of how gravity works on Earth: https://www.youtube.com/watch?v=ljRlB6TuMOU • When drones are rising through the air, there is also a thrust force created by the propellers. If the upwards thrust force is greater than the force of gravity, the drone will move upwards, if the thrust force is equal to the force of gravity then the drone will hover in the air, and if the thrust force is less than the force of gravity then the drone will fall. • Air resistance is the push back from the gases in our atmosphere that slows down falling objects. This video explains how air resistance can affect the speed at which objects fall: https://www.youtube.com/watch?v=dxcx35x5L9Y • Air is all around us, so air resistance doesn't just exert a force on objects that are falling, but also objects moving in other directions, like drones which move up, down, forwards and backwards. To minimise the amount of air resistance working on a drone, engineers carefully design their shapes. • Ask the children to consider the following questions: - Can you think of examples of these forces acting in everyday life? (Examples include a drink falling to the floor when a cup is tipped up, leaves falling from trees in autumn, a flat piece of paper falling to the floor slowly) - How do you think these forces affect drones? - How do drones overcome the force of gravity and rise up?
Slide 5: The challenge	• Set the scene: You are an engineer designing a drone for farmers to monitor their crops. Your drone needs to be shaped so that it meets the least force from air resistance as possible. • Challenge the children to investigate which shape will be the best for their drone. • Share the important criteria for the drone: - It must be no bigger than 30cm X 30cm - It must have at least four arms for propellers - It must have a shape with an area of 48cm2 for the camera in the centre • Discuss how children could investigate which shape will be the best. • Ask the children to consider the following questions: - What material should we use to make our models? - How can we test how much air resistance there is acting on the models when they move? - How will we make sure our investigation is a fair test? - What shapes do you predict will be the best? - Do you think a symmetrical shape will be better or worse? - Do you think all the arms should be the same shape or same length? • Children may need help to plan their investigation and identify and control variables that could affect their results. • Children can choose how they would like to shape the 48cm2 - this could be a 6 X 8cm rectangle, a 4 X 12cm rectangle, an irregular shape, or any other configuration they would like. • One possible suggestion for carrying out the investigation is to first draw and cut out a number of different possible shapes on thin card (this is a great way to re-use cereal box card or other similar packaging). Then, drop each one from the same height and time how long it takes to hit the ground. Slow-motion cameras on smartphones or tablets are very useful for observing things that happen very quickly. • To make the task less challenging for younger children, you could cut out a 48cm2 rectangle shape for them to use as a template when drawing their models. • **Health and Safety:** Supervise children when using scissors. Ensure they children do not put themselves in danger by climbing to high-up places to drop their drone models.

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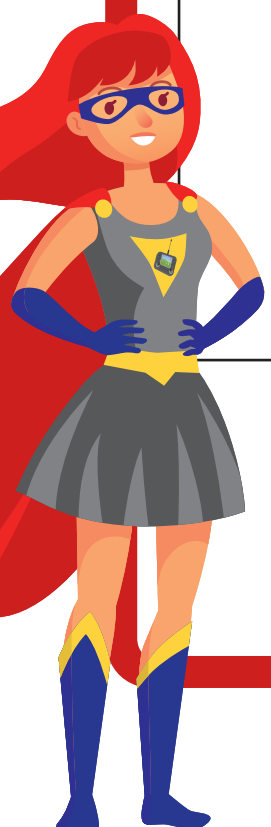
Slide 6: Drone inspiration	• Here are some possible ideas for drone shapes made out of cereal box cardboard. You may wish to wait and see how children begin designing their drone shapes before showing them these examples or, if they are finding it difficult to come up with ideas it might be better to show these pictures early on.
Slide 7: Conclusion	• Lead a discussion on what the children found out from their investigation. • Ask the children to consider the following questions: - Which shape was best to reduce air resistance? - Was your prediction correct? - Were you surprised by your results? - If you were making a real drone, what material would you make it out of and why? - Where could we take our project next? • The children could use junk-modelling materials to create a better model of their drone or draw a labelled sketch, thinking about how it will look and have visual appeal. They could think about how they would market their drone to farmers and design advertising. They could do some more research about how drones work and what materials they are made out of.
Slide 14: Farmventing	• Encourage the children to think about how they could use their learning about drone technology to help them design an idea, invention or innovation that will help farmers continue to care for the environment and be climate superheroes.

Possible links to the National Curriculum

Subject	Topic	Objectives
Science	Working Scientifically	During years 3 and 4, pupils should be taught to use the following practical scientific methods, processes and skills through the teaching of the programme of study content: • Setting up simple practical enquiries, comparative and fair tests • Making systematic and careful observations and, where appropriate, taking accurate measurements using standard units, using a range of equipment • Reporting on findings from enquirues, including oral and written explanations, displays or presentations of results and conclusions • Using results to draw simple conclusions, make predictions for new values, suggest improvements and raise further questions • Using straightforward scientific evidence to answer questions or to support their findings



		During years 5 and 6, pupils should be taught to use the following practical scientific methods, processes and skills through the teaching of the programme of study content: • Planning different types of scientific enquiries to answer questions, including recognising and controlling variables where necessary • Taking measurements, using a range of scientific equipment, with increasing accuracy and precision, taking repeat readings when appropriate • Using test results to make predictions to set up further comparative and fair tests • Reporting and presenting findings from enquiries, including conclusions, causal relationships and explanations of and degree of trust in results, in oral and written forms such as displays and other presentations
	Forces	• 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
Maths	Year 3 Measurement	• Record and compare time in terms of seconds, minutes and hours • Compare durations of events [for examples to calculate the times taken by particular events or tasks]
	Year 5 Measurement	• Calculate and compare the area of rectangles (including squares), and including using standard units, square centimetres (cm2)
	Year 4 Geometry	• Plot specified points and draw sides to complete a given polygon