CHEMISTRY: COMBUSTION AND PROPULSION IN THE SPITFIRE'S MERLIN ENGINE

Presenter Ngaire Bushell is a Producer in the Public Engagement and Learning Team at IWM. In this resource she is at IWM Duxford to look at the science behind the iconic Spitfire and its Merlin engine before introducing you to a challenge set by The Skylab and a 3D resource created by Perception Codes.

Once the students have watched the film, they can tackle the challenge set by IWM’s partner, the STEM-based charity and social enterprise - The Skylab. Geoff Coxon introduces the chemical processes involved in the combustion of fuel inside the Merlin engine which in turn drives the propeller.

Geoff is shown creating a model propeller and explains how students will make and use their own model to test the theory that the higher the power exerted, the faster the prop will spin.

Students will require hairdryers to stand in for the Merlin engine!

**Materials for the challenge:**
- Propeller template
- Card
- Glue
- Scissors
- Sharpened pencil
- Two small rubber bands
- Hairdryer with two speeds

**The challenge:**

The purpose of the challenge is demonstrated by Geoff in the film, and each of the steps required to create the model propeller are outlined here.

1. Students will need to carefully cut out their propeller, glue it to card and when dry cut out the reinforced propeller again. Students should also cut along the red dotted line on each propeller blade.
2. Each propeller blade needs to be folded back along the blue dotted line.
3. Using a sharp pencil, students should carefully punch through the white circle at the centre of the propeller; they may want to push the pencil into a ball of plasticene (or similar) placed under the white circle so that the model is not bent or damaged in the process.
4. The propeller should spin very easily on the pencil.
5. Two small rubber bands should be wrapped around the pencil in front of, and behind, the propeller.
6. Students should make predictions as to what they expect to happen when the air flow from the hairdryer is pointed at the propeller firstly on its slowest speed and then on its fastest.
7. To conduct the test, and prove the validity of their predictions, students should hold the hairdryer – which is standing in for the Merlin engine - towards the side of the propeller rather than in front of it and make adjustments to ensure that the angle is right for the propeller to spin.
Notes on the Challenge:
Students should be aware that the accuracy with which they cut out their propeller, and fold each blade to create pitch, will be fundamental to the success of their experiment. Students could discuss the concept of increasing drag and reducing the aerodynamics with rough-edged blades. The impact of friction could be discussed when the propeller is attached to the 'axle' of the pencil. The challenge is also a useful way to introduce/ reinforce the idea of a fair test and how they will ensure this is achieved in their challenge.

Glossary of Terms:
Aerodynamic - having a shape which reduces the drag from air moving past
Atom – the smallest part of a chemical element that can exist
Combustion – the process of burning something
Drag – an aerodynamic force which opposes the direction of an aircraft
Elliptical – the Spitfire’s wings are an elongated circle stretched into an oval shape
Fuselage – the main body of an aircraft
Molecule - a group of atoms bonded together, representing the smallest fundamental unit of a chemical compound that can take part in a chemical reaction
Pitch - Propeller blades are fixed to their hub at an angle, this is called the pitch and it determines how quickly it moves you forward when it is turned
Propulsion – the action of driving or pushing something forwards
Streamlined – a form that presents very little resistance to a flow of air or water
Squadron – a group of aircraft and their crew
Thrust – a powerful aerodynamic force with a pushing or pulling effect

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