Key Stage 3 – Jet

Perfect properties

Notes for teachers

At a glance

The development of the jet engine is engineering at its most extreme. In this activity, students analyse data to choose materials with suitable properties for different parts of the jet engine.

The activity is best tackled when students are studying materials. It provides a novel and interesting context in which to study ceramic and metal properties.

Learning Outcome

- Students learn how to analyse data on material properties to choose the best materials for different parts of the jet engine.

Each pair of students will need

- 1 copy of the pupil worksheet *Your task* and *engine conditions*
- 1 copy of the *Data table*
- Help sheet (optional)
- Access to an electronic version of the image bank PowerPoint file (optional)
- Access to the Internet (optional)
- Poster-making equipment (optional)

Web link

Clip showing how turbine blades are grown from single crystals
www.bbc.co.uk/programmes/b01fkc5n

Possible Lesson Activities

1. **Starter activity**
    - Show the animation 'Jet plight' to the class. www.oxfordsparks.net/jet
    - Repeat the viewing, focusing on the section from 0:44 to 1:25, which describes the functions of jet engine components.

2. **Main activity**
    - Allow students time to read the first page of the pupil worksheet, which emphasizes key points from the animation and introduces the task.
    - Student groups follow the guidance on the *Your task* pupil worksheet. This involves using information on engine conditions, as well as data from the *Data table,* to choose the best material for each of the four main parts of a jet engine. The correct choices are:
        - Fan – titanium alloy
        - Compressor – nickel-based alloy
        - Combustor wall linings – yttria-stabilised zirconia
        - Turbine blades – nickel superalloy

      If students are having difficulty, suggest they start by finding materials for the fan (must have a low density) and the combustor wall linings (the material with the lowest thermal conductivity). The nickel-based alloy is used for the compressor, which operates at a lower temperature than the turbines. The turbine material is a nickel superalloy. The superalloy melts at 1350 ^{o}C, which is similar to the maximum temperature reached in the turbine section of the engine. However, as indicated on the student sheet, turbine blades are cooled to lower temperatures by air flowing through networks of holes, and over their surface. Turbine blades also have a layer of ceramic material on their surface.
    - If you wish, allow students to enrich their learning by exploring this web site: www.rolls-royce.com/interactive_games/journey03/index.html
    - Students present their findings as a poster, following the format on the *Help sheet* if they wish. Images are available from the *Image bank* PowerPoint.

3. **Plenary**
    - Ask a few students to present their work to the rest of the class. Do others agree on their material choices?
    - If you wish, show the animation again.

Further suggestions

If possible, display samples of materials such as titanium, nickel, and their alloys, as well as ceramic materials.