Japan's Trains

Lesson: Electromagnets and their Uses

Learning Objectives:

- Learn about the properties of magnets, electromagnetics and superconducting technology, and understand Maglev as a practical example of its use.
- Understand that electromagnets are different to normal magnets and what factors affect the strength of an electromagnet
- Complete a practical experiment involving magnets

Curriculum Links:

National Curriculum in England for Science KS4 includes:

- Magnetism and electromagnetism
- Exploring the magnetic fields of permanent and induced magnets
- Magnetic effects of currents, how solenoids enhance the effect
- Electricity
- Exploring current, resistance and voltage relationships for different circuit elements

Keywords: SCMaglev, electromagnets, coils, electromagnetic induction.

Resources:

Presentation: Electromagnets and their Uses

Video: About SC Maglev https://youtu.be/xY2BjDp5qEs (0:49, *JR Central*)

Starter Activity

- Ask students to complete the starter activities on slide 2: draw a free body diagram of the train travelling at a constant speed and think about how the travel time can be reduced.
- Ask volunteers to have a go at answering the second starter question.
- Go through slides 3 and 4 with the students by explaining how friction works in a moving train and why it slows the train down.

Estimated Time: 5 minutes

Task 1

- Introduce students to the idea of reducing friction by using magnetic levitation, as well as to the SCMaglev train that utilises its technology (slides 4 and 5).

- Then ask them to think and try to answer what SCMaglev stands for (slide 5).
- Go through the next slides, introducing the Maglev's levitation and speed, as well as the weight and the necessity for strong magnets in Maglev trains.
- Students will learn more about electromagnets, their components and how they work. They will also learn about the difference between a simple wire with a current and a solenoid. Ask students to mimic the slide illustration (Ampere's right-hand rule) to understand how the direction of the current determines the direction of the poles.

Estimated Time: 10 minutes

Task 2

- Have students draw a diagram of a solenoid and its magnetic field (slide 13).
- Introduce the problem of electrical resistance to the students and give them a minute to discuss possible solutions in pairs before asking for feedback (slides 14 and 15).
- Explain the solution to the problem of electrical resistance in the form of cooling and how it helps to create a stronger magnet. Then conduct the learning check on slide 17 before moving on.

Estimated Time: 10 minutes

Task 3

- Explain what an electromagnet is by building on knowledge learned so far
- Use the slides 19 onwards to explain how a SCMaglev train is propelled forwards, including the changing of poles to control the train's speed.
- Conduct a quick learning check on slide 46 before carrying on to the next section.
- Allow the students to complete the in-depth learning check exam-style questions individually then go through the answers as a class.

Estimated Time: 20 minutes

Plenary

- Students should tell a partner 3 things that they learnt today. At least 1 of the facts should be about the SG Maglev. Ask for volunteers to share with the class.

Estimated Time: 5 minutes