Introduction to Meteorites – KS3 Lesson

Learning Objectives	Curriculum Links
A meteorite is a rock from space that landed on the Earth. It is different from a meteor (which is the light phenomenon that happens when a rock enters the atmosphere, also known as a 'shooting star') or an asteroid (a small rocky body in space, which most meteorites come from). Meteorites can come from all over the Solar System! Some meteorites come from asteroids, but some also come from the Moon and Mars.	**Physics – Space physics** Pupils should be taught about gravity force, weight = mass x gravitational field strength (g), on Earth g=10 N/kg, different on other planets and stars; gravity forces between Earth and Moon, and between Earth and Sun (qualitative only)
Describing meteorites uses the same principles as describing rocks – they can be described based on their colours, textures, whether they contain grains or crystals, and the size of the grains or crystals present.	**Science – Working scientifically** Pupils should be taught to: • use appropriate techniques, apparatus, and materials during fieldwork and laboratory work, paying attention to health and safety • make and record observations and measurements using a range of methods for different investigations; and evaluate the reliability of methods and suggest possible improvements **Geography – Rocks, weathering and soils**
To recognise a meteorite, there are a few features we can look for: a meteorite is often unusually heavy, with a pitted outside appearance, and covered in a dark glassy crust.	**Science – Working scientifically** Pupils should be taught to make and record observations and measurements using a range of methods for different investigations; and evaluate the reliability of methods and suggest possible improvements **Geography – Rocks, weathering and soils**
There are 3 main types of meteorites, based on what they are made of: stony, iron, and stony-iron meteorites	**Chemistry – Earth and atmosphere** Pupils should be taught about: • the structure of the Earth • the rock cycle and the formation of igneous, sedimentary and metamorphic rocks **Geography – Rocks, weathering and soils**
Instead of waiting for a meteorite to fall on Earth to study it, we can study space rocks by sending a rocket to an asteroid to pick up some samples and bring them back. These are called sample return missions.	**Physics – Space physics** Pupils should be taught about gravity force, weight = mass x gravitational field strength (g), on Earth g=10 N/kg, different on other planets and stars; gravity forces between Earth and Moon, and between Earth and Sun (qualitative only)

Materials needed:

- Meteorite samples, to pass around: pallasite (sample 11), lunar (sample 12), Martian (sample 13)
- Meteorite samples, for activity: iron meteorite (samples 9, 10), chondrites (samples 15, 16)
- Terrestrial samples: anorthosite (sample 17), basalt (sample 18), haematite (sample 20)
- Hand lenses
- Worksheets

Lesson length: 45 minutes (50 minutes with optional module)

Lesson Plan

Type/ Slide	Geology	Teaching/Learning activity	Time
Core / 1, 2	**Meteorite** = a rock from space that landed on the Earth. **Meteor** = the light phenomenon that happens when a rock enters the Earth's atmosphere. Also known as a 'shooting star'. **Asteroid** = a small rocky body orbiting the Sun. **Meteoroid** = loose rock fragments (usually, fragments of asteroids) that haven't entered the Earth's atmosphere, and which are not in a fixed orbit.	***Ask students if they know what a rock from space is called?*** *Discuss different terminology.* ***Ask students what force attracts meteorites to the Earth?*** *(Answer: gravity!)* *While this is happening, pass around the samples below:*	5 mins
Core / 3	We have meteorites from the Moon and Mars, which were separated from their homes due to large collisions and made their way to the Earth. They are both too small and/or fragile to be handled outside of their boxes. Pallasites are made of metal (the shiny, metallic, opaque part) and olivines (yellow-green, transparent, glass-like).	***Pass around the meteorites in boxes (lunar, Martian, pallasites) for the students to look at. Remind them not to open the boxes!***	5 mins

Core / 4, 5, 6	When a planet forms, it is usually all molten and squishy at the start. When it's molten, the heavy things go to the centre because of **gravity**, and the light things go to the surface. In time, this creates a layered body, with a crust, a mantle and a core. Just like planets, some asteroids are layered too. Different layers have different compositions, so meteorites from different layers are called different things. At the surface of an asteroid, we find **stony meteorites.** They are mostly made of stone, like rocks on Earth. Some of these come from the surface of the Moon and Mars! In the middle of a rocky body, we find **iron meteorites**, which are almost entirely metallic. We can never reach the Earth's core, so looking at iron meteorites is the closest we will get! **Stony-iron meteorites** are approximately 50-50 stone and metal. They form when the surface and the middle get mixed up because asteroids collide with each other a lot! The pallasite that they saw earlier is an example of a stony-iron meteorite.	*Explain how meteorites form in the context of planetary* ***differentiation.*** *Play PowerPoint animation.* *Introduce* ***types of meteorites*** *and how they formed.* ***Think about the rock cycle – if stony and iron meteorites formed when molten material crystallised, what types of rocks are they?*** *(Answer: igneous, if nothing happened to them after they cooled down)*	5 mins
Core / 7	Rocks can be described based on their physical characteristics, including: - Colour(s) - Does it contain grains or crystals? - Does it contain metal? - Does the inside look different from the outside? How? - Does it feel unusually heavy, unusually light, or just right? - Any other features? Don't forget to look closely using hand lenses or magnifying glasses! **Differentiation suggestion**: if you need to run the activity with fewer samples, we recommend including the rocks on station 2 (iron meteorite), 3 (basalt) and 5 (stony meteorite) as shown on the accompanying PowerPoint.	***Activity 1: Describing rock and mineral samples*** *Ask students to visit each of the 6 rock stations and make observations about the rocks. They can start at any station, so they should spread out!* ***Ask students to write down their observations in the worksheets.*** *Circulate the room and give pointers.*	15 mins

Core / 8	In this activity, the students will learn how to distinguish meteorites from Earth rocks (meteor-wrongs). They should answer these questions: 1. Is it unusually heavy? 2. Does it have a dark outside crust? 3. Does the outside have an irregular shape, with fingerprint-sized pits? (note for later: these are called regmaglypts) 4. Can you see metal? **Outside Crust:** some samples are broken and you should be able to see a lighter colour inside, if the outside looks 'burnt' then it has a dark outside crust. **Irregular shape:** a regular shape would mean the rock is round, showing evidence of earth process by being transported via water, wind or ice. Meteorites burn up so will melt and break as they fall to earth, giving them a jagged shape. Not all answers have to be 'yes' for a rock to be a meteorite, but the more 'yes's, the more confident we can be that we found a meteorite!	***Activity 2: Meteorite detectives (work out meteorites from meteor-wrongs)*** *Using their observations from before, they can now have a go at finding the meteorites using some questions that we provide.* *If they need to quickly go back to the rocks they can, but they should hopefully already have the right observations and will just need to tick the boxes!* *This could be combined with the previous activity.*	5 mins
Core / 9-16		***Give answers*** *For each slide, go through each question and reveal if it's a meteorite.* *(When you get to the iron meteorite)* ***Ask students how do we know that iron meteorites come from the middle of an asteroid?*** *They may remember that iron meteorites are very heavy, so it's just because iron is relatively heavy, and it sunk to the centre.*	10 mins

Optional / 17	Instead of waiting for space rocks to fall on Earth, we can instead go and collect them ourselves. There are several recent sample return missions that space agencies have done, to asteroids Itokawa, Ryugu and Bennu. We also have returned Moon samples from the Apollo missions. **Pros**: - When a meteorite lands on Earth, it's extremely hard to find out which asteroid it came from originally. If we collect samples from asteroids and they have the same composition, we can be very sure that a meteorite came from that asteroid! - Meteorites burn as they fall through the Earth's atmosphere, which can change their composition. That's not a concern with samples that have come from asteroids. **Cons**: - Sample return missions are very expensive! - The missions are also high risk, so they can fail, costing a lot of time and money. - In the unlikely event of finding microbial life on an extraterrestrial body, we have to be very careful not to introduce the microbes to the Earth because no living creature is immune to them, so they could potentially be dangerous.	***Ask students if they can think of another way to get our hands on space rocks?*** *Introduce asteroid sample return missions.* ***Ask students what are the pros and cons of going to an asteroid and bringing back samples?***	5 mins