Meteorite Impacts - KS3 Lesson

Learning Objectives	Curriculum Links
An impact crater is a depression on a rocky body (planet, moon, asteroid) formed by impact of a smaller body, usually a meteorite. Impact craters are found on all rocky bodies, including the Earth, the Moon, Mars and Mercury.	**Physics – Forces** Pupils should be taught about non-contact forces: gravity forces acting at a distance on Earth and in space **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)
There are four main crater features (rims, walls, floor, and ejecta), which form when energy is conserved between a meteorite and a planet, causing an explosion in which lots of rock is thrown out of the newly formed crater. In larger craters, other features may be present (for example, a central peak).	**Physics – Energy** Pupils should be taught about: • other processes that involve energy transfer: changing motion, dropping an object • energy as a quantity that can be quantified and calculated; the total energy has the same value before and after a change **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
Meteorite impacts can modify the bedrock – rocks can melt, get squashed or break. These rocks are called impactites, and they are a type of metamorphic rock.	**Chemistry – Earth and atmosphere** Pupils should be taught about the rock cycle and the formation of igneous, sedimentary and metamorphic rocks **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**

Samples needed:

- 3D crater samples (samples 1-8)
- Impact rocks: bicolite (sample 22), Libyan desert glass (sample 23), suevites (samples 24, 25)
- Hand lenses
- Handouts

Lesson length: 45 minutes / 60 minutes with optional modules

Lesson Plan

Type/ Slide	Geology	Teaching/Learning activity	Time
Core / 1-4	An impact crater is a depression on a rocky body (planet, moon, asteroid) formed by impact of a smaller body, usually a meteorite. Impact craters are found on all rocky bodies, including Mars, Mercury and the Moon. We also have impact craters on the Earth (e.g. the Barringer crater in Arizona), but most of them are buried or erased (like the Chicxulub crater, made by the meteorite which killed the dinosaurs, which is buried).	***Ask students what happens when a rock from space hits a planet?*** ***Play up to a minute of NASA video of the Moon, highlighting craters formed from meteorites.*** ***Can they name a planet which has impact craters?***	5 mins
Core / 5-6	There are four main crater features: • Crater **rims**: the edges of a crater, which is elevated from the surrounding topography because of excavated material • Crater **walls**: the interior sides of a crater, usually steep • Crater **floor**: the bottom of a crater, usually flat or bowl-shaped • **Ejecta**: material excavated and thrown out of a crater, usually forming outward-radiating rays surrounding a crater	***Activity 1: studying crater features*** *Divide students into 3-4 groups and hand out tactile samples.* *Show images of craters on the slides .* ***Ask pupils to identify main crater features*** *(crater rims, walls, floor, ejecta rays), noting any feature that does not fit into one of these categories.* ***Ask students to sketch a crater and label its features.***	10 mins
Core / 7 - 8	A crater is caused by a smaller object (like a meteorite) crashing into a bigger object (like a planet). At planetary scale, the small object travels very fast, so it carries a lot of energy. When it hits the bigger object, that energy causes an explosion where rock gets thrown out from the impact site. This material forms rims which are taller than the surrounding area. At the same time, the explosion causes a depression (hole) that's either flat (more common for large impacts) or bowl-shaped (more common for small impacts). The flat or bowl-shaped bottom of the depression is called a crater floor, and the sides are called walls.	*Show sketch or photo of a crater with features annotated. Explain how the features formed.*	5 mins

Optional / 9	The main complex feature of a crater is the **central peak(s)**, which is a peak formed in the central area of a large crater. They form when the impact is very powerful – immediately after the initial impact, the pressure drops quickly, so the rocks relax and lift back up, forming a peak in the middle (you can use a bouncy castle analogy, which is not perfect but may help them visualise the process better). Other features that they might notice are below, with explanations for your reference. • **Multiple rings**: Very large craters (termed impact basins) can have as many as 5 or 6 circular rings of mountain chains surrounding the main crater. Their formation is not fully understood, but one proposed theory is that the central peak is so large that it becomes unstable, collapsing to form several rings. An example of a multi-ring basin is Mare Orientale on the Moon. • **Terraced walls (stair-like)**: sometimes, the walls become too steep to remain stable, so they form several terraces.	***Ask students if they noticed any crater features other than the ones above?*** *If the students don't have an answer, point out the central peak and briefly tell them how it forms.*	5 mins
Core / 10 - 11	In a powerful impact, the impacted rock undergoes changes due to the shock and heating. The changes often include impact melting (extremely fast melting due to the heating from the impact) following by rapid redistribution of molten material, forming unique crystalline and glassy features. Rocks also get shocked and broken up, forming impact breccias. Rocks created or modified by impacts are called impactites. We will look at two types today: **1. Impact glasses** • Formed when rock melts, gets thrown out of a crater and cools very quickly in the air. • Usually found in the **ejecta** outside the crater. **2. Impact breccias** • Breccia = rock containing broken up fragments of other rocks. • Formed when the bedrock is fragmented by the force of impact. It can contain molten or	***Ask students what do they think happens to a rock when it is hit by a meteorite?*** *(Answers: it melts, it gets squashed, it gets broken up etc.)* ***Introduce the two types of impactites that they will look at next.***	5 mins

	glassy bits, especially closer to the initial impact. • Usually found inside a crater. **Note to teachers**: this is highly simplified, and in reality, impactites are quite complex. Here are a few things we omitted for simplicity: • Impact glasses can be found inside craters if that is where they fell, or if sedimentary processes brought them back into the crater. • Equally, impact breccias are not only found inside craters. It's possible for them to be thrown out of the crater as ejecta too. Some might also be underneath the crater, if they impact fractured the bedrock. • There are types of impactites not mentioned here: - Impact melts = rocks that melt completely because of an impact. If they cool down slowly, they don't become glassy, instead resembling igneous rocks (even though their impact origin makes them metamorphic). Impact glasses are a subtype of impact melts. - Shocked rocks = rocks affected by shock metamorphism. Shocked rocks don't melt or brecciate, but the pressure and heat of an impact causes different minerals and textures to form through shock metamorphism.		
Core / 12	In this activity, students look at some rocks that come from impact craters on Earth, and they make basic rock descriptions. Rocks can be described based on their physical characteristics, including: • Colour(s) • Does it contain grains, crystals or clasts? • Size of grains/crystals/clasts • What does the outside look and feel like? (smooth, rough, shiny, glassy, pitted?) • Other features Don't forget to look closely using hand lenses or magnifying glasses!	***Activity 2: Impact rock handling*** *Set up 4 rock stations around the classroom and ask students to circulate the room to look at each rock.* *Alternatively, pass the rocks around. Ideally, each pupil can look at one glass and one breccia.*	10 mins

	Grains: very small (less than a few mms) piece of mineral or rock. You can tell if a rock has grains if the small pieces are visibly different to the rest of the rock. **Crystals:** individual minerals which have grown in crystal form in a rock **Clasts:** pieces broken off a pre-existing rock, larger than grains and you can tell if a rock is made up of clasts if pieces are visibly different to the rest of the rock. **Glassy:** a rock that looks like a block of glass (doesn't need to be clear), there are no visible mineral crystals. **Pitted:** covered with lots of small shallow holes **Mineral:** a naturally occurring substance made up of elements **Differentiation suggestion:** If you are short on time, we recommend reducing the number of rocks to 1 impact glass and 1 impact breccia.		
Core / 13 - 17		*Start showing slides with the answers. For each rock:* • ***Ask the students who looked at this rock to tell us their observations*** • *Point out anything that they missed* *Tell them what each rock is, where it was found and how it formed.* ***Think about the rock cycle and the characteristics of each rock type – what type of rock (sedimentary, igneous or metamorphic) do you think these impact rocks are similar to?*** *(Answer: metamorphic, because they are modified by the heat and pressure of an impact.)*	10 mins

Optional / 18	There are a few reasons why there are so few craters on the Earth compared to other bodies. Firstly, it's important to note that large meteorite impacts are rare nowadays, but they were very common a long time ago (when planets like the Earth were forming), simply because there were more asteroids back then. The Earth and the other planets probably experienced a similar number of impacts, but on the Earth, they were erased due to several reasons: • **Tectonics** and **the rock cycle**: plate tectonics and reprocessing of the Earth's crust mean that the rocks on the surface of the Earth now are not the same as early in the planet's history, so craters were buried or destroyed. The Moon has no tectonic activity. • **Water**: unlike all other planets in the Solar System, the Earth's surface is 70% covered by water, which erased most craters or may have prevented them from forming in the first place. • **Vegetation**: more recent craters may be covered by vegetation.	*Ask students to close their eyes and imagine a full moon in as much detail as they can. At the very least, the moon will include white areas and grey areas (the grey areas are formed by impacts too), and some of them may even have put some craters on.* ***Can they think of a crater on the Earth?*** *(Answer: probably not, or they may say the dinosaur crater, but that's buried in rock.)* ***Ask students why they think there more craters on other planets and on the Moon than on the Earth?*** *Discuss how the factors influence crater exposure.*	10 mins

Did your students enjoy this lesson? Consider running our ~20-minute crater-making demo, provided in a separate document.