BepiColombo Lesson Plan 2 – Experiment

LESSON OBJECTIVES

1. To develop practical and experimental skills
2. To learn more about the planet Mercury, specifically cratering
    I. Explain what a crater is
    II. Learn how a crater is formed
    III. Appreciate differences between impact and volcanic craters
3. To learn how MIXS will determine what the surface of Mercury is made of

BACKGROUND

See lesson plan part 1.

LESSON- Total time: 40 minutes

Introduction – 10 minutes

Recap what was learnt in the previous lesson. Ask the class questions such as 'Who can remember the name of ESA's mission to Mercury?', 'How many spacecraft is BepiColombo made up of, and what are their names?' (Answer: Bepi and Mio).

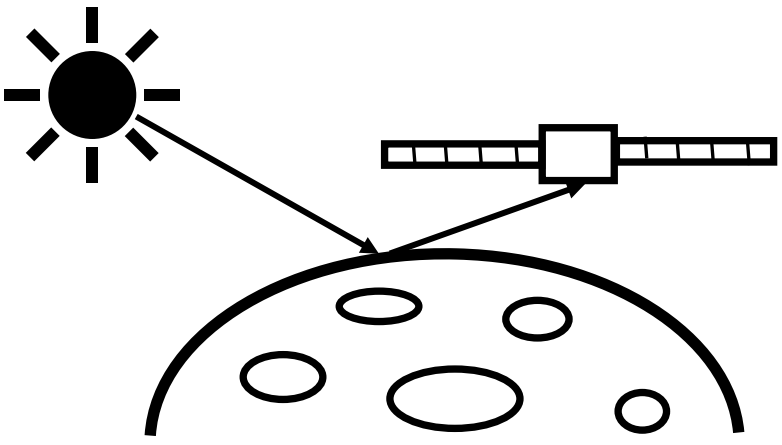
You may show a picture of MIXS on the board, included on slide 2 of the supporting powerpoint.

Explain that MIXS is the UK's contribution to the mission, developed by the University of Leicester. You may choose to write its full name on the board, 'Mercury Imaging X-ray Spectrometer'.

Ask the class if they know what X-rays are. Expect answers referring to an X-ray you may receive at the hospital or dentist.

X-rays are a type of light. Explain that the Sun emits X-rays, which are absorbed into the surface of Mercury and then emitted (can make analogy to sponge absorbing water then squeezing to "emit" it). These X-rays can tell us what the surface is made of, and MIXS will collect these X-rays. (Similar to taking a photo, however X-rays tell us the elements that make up the surface).

The diagram below may be useful to draw on the board.



Craters – 5 minutes

Explain that MIXS will look at craters because then it can learn about the different layers of the planet. Ask the class why this may be – prompt them with questions such as 'What happens when something hits the surface of a planet?

Explain that when a meteor hits the surface of the planet, it can bring up material from lower layers. This causes what is called an *ejecta pattern*, which you will be able to simulate in the experiment. Show the next slide which has an interesting example of a crater on Mercury.

Experiment – 20 minutes, or could be extended over more than one class depending on what you want to explore.

The slide shows an example of a crater created via this practical.

This practical can be adjusted for different classes and learning outcomes. The experiment can be done in small groups.

You will need:

- Clear Perspex boxes
- A variety of coloured powder*, e.g. Holi powders
- Sieve (a disposable cup with holes in the bottom works well)
- Marbles/ ball bearing/ wooden balls

*If you can't find coloured powder, you can mix corn starch with either dye powder or water with food colouring in. If you choose the latter option, leave the mixture on a tray in the Sun for about 4 hours, until the water has ***completely*** evaporated. Once this has occurred, just break the mixture apart and create into a fine dust. Or you can use cocoa powder. Another cheaper option is to use a thick layer of flour, and then a single layer of coloured flour. Chalk can be crushed into a fine powder to do this.

Notes: The powder can get very messy! It would be useful to run through this practical before the class starts, and experiment with the thickness of layers and objects that you are dropping into it.

Method:

Depending on the time available for the experiment, you may wish to set up the boxes with the powder before the class starts. It would be advisable to either do this experiment in the playground, or put old sheets on the floor, so clean up is easier.

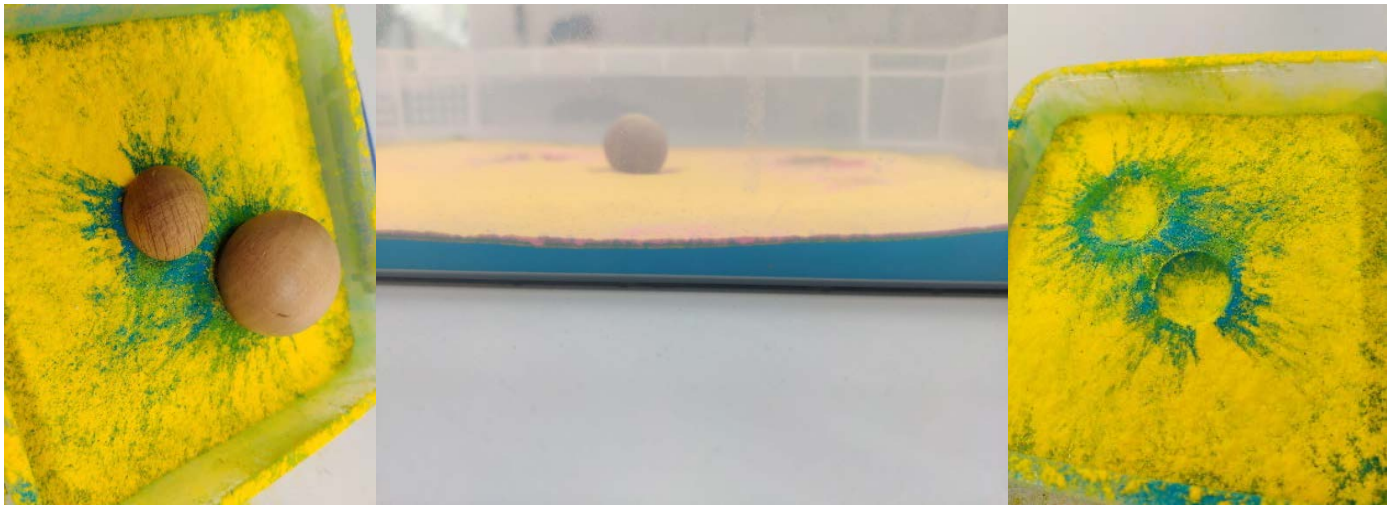
Method 1 (using lots of coloured powders):

Create the layers with alternating colours. The bottom layer can be quite thick, however subsequent layers can be thinner, and the top layers should be sieved. Looking through the side of the clear box, the layers should be visible and differentiable. You can experiment with the number of layers.

Method 2 (using fewer coloured powders):

Create a thick bottom layer using uncoloured flour. On top of this layer, sieve on a thin layer of coloured powder. You may need to experiment with the thickness of this sieved layer to get a good result.

Drop the marbles into the powder. A Crater will be created. Remove the marble so the crater is easier to see. The number of layers that will show is dependent on how high you drop the marble from. If the marble has too much energy it will bounce, which will damage the crater.



Questions to ask the students about the experiment:

Q1. **What causes unsupported objects to fall to the Earth?**

The force of gravity attracts the object to the Earth's surface.

Q2. **If a heavier marble is dropped, how is this reflected by the crater left behind?**

The crater would be deeper, therefore showing a greater number of layers and having a larger ejecta pattern

Q3. **What about if the marble was dropped from a greater height?**

The crater would be deeper, therefore showing a greater number of layers and having a larger ejecta pattern

Q4. **Can you measure how large the ejecta pattern is?**

Q5. **Can you measure the depth and diameter of the crater formed?**

Get the student to fill in the worksheet provided at the end of this document whilst completing the practical. The table may be edited to reflect the variables being recorded, e.g. to include crater diameter.

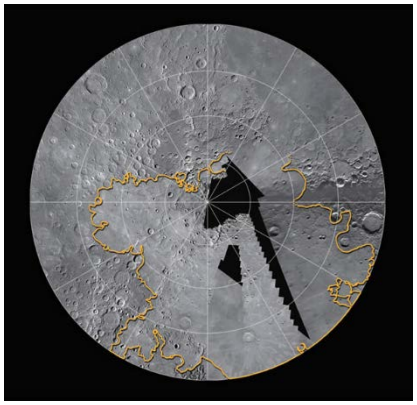
If your class has access to recording equipment, it may be interesting to see the craters form in slow motion.

For students that finish the experiment quickly – they could do repeats. Ask then why repeats of experiments are useful/ important.

To develop scientific writing skills, a homework activity may be to write up or make a poster about the experiment.

Conclusion – 5 minutes

Ask the class why it is useful for MIXS to look at craters. (So that we can learn about the different layers that make up the planet Mercury).



The last slide shows a crater on Mercury that has been filled in by lava from volcanic activity on the planet. Ask what differences they may expect to find between impact and volcanic craters. (How are they formed? Will volcanic craters have a raised ridge around them, like impact craters did as seen from our experiment? Think about a magma chamber collapsing inwards.) (Volcanic sites may have smoother surroundings due to lava flow).

Explain that this is only one of the goals of MIXS, and that there are also other instruments on BepiColombo which will collect all sorts of data.

Name _____

BepiColombo - Craters Experiment

Predictions

What do you think the surface of your planet will look like after you drop the marbles onto it? Use colours to show what you think will happen – how many layers will be revealed?

Before	After

Experiment and Results

Drop the marbles into the box of powder. For each one, fill in the table below to record your results. Remember to use colour to show the different layers of the planet the crater reveals!

Marble/meteor size	Number of Layers brought up to the Surface	Drawing of crater
Small		
Medium		
Large		

Conclusion

MIXS is an instrument that is part of the _____ mission.

MIXS will use X-rays to work out what the surface of _____ is made of.

Craters form when objects hit the _____ of the planet.

surface BepiColombo Mercury

In our experiment, we found that **larger/smaller** objects cause bigger craters. We saw _____ layers of the planet.