



OVERVIEW

In this lesson, students will investigate some of the meteorites and associated rocks in the loan box.

They will test them for magnetism, do a visual analysis and measure their mass to calculate the densities of their items.

This activity is particularly geared towards getting students to estimate the volume of the rocks in order to obtain a value for density as close to the real values as possible.

They will then use the meteorite identification cards to help them identify which object is which.

CURRICULUM LINKS

Making measurements and examining objects.

Calculating density.

Estimating the volume of an object.

WHAT YOU NEED

A16 PowerPoint

16.1 and 16.2 worksheets
(one per student)

16.3 Space rock information cards
(one per group)

16.4 Space rock station sheet

16.5 Volumes of shapes sheet
(one per station)

4 USB microscopes connected to laptops with VLC media player installed

8 hand lenses (one at each station)

5 magnaprobcs (on their assigned station sheets)

Cloth or bubble wrap underneath the rock samples for protection

Spare paper for calculating volumes of objects

The following samples from the loanbox placed on the appropriate Station information sheet:

- Campo de cielo iron meteorite (*Station 1*)
- Lybian glass impactite (*Station 2*)
- Sahara chondrite (whole chondrite) (*Station 3*)
- Udei station and etched iron meteorites (*Station 4*)
- Sliced chondrite (*Station 5*)
- Tektite (*Station 6*)
- Pallasite (*Station 7*)
- Moldavite (*Station 8*)

Prior to the lesson, place the 8 station cards around the room with their associated rock in the box, a hand lens in the hand lens box and, where stated, a magnaprobe in the magnaprobe box.

METEORITE INVESTIGATORS



STARTER

Go through the introduction slides on the powerpoint with the class. Build up the students understanding of the different types of meteorites and associated rocks.

Set the scene for the investigation

and emphasise how important it is to be very careful when handling these samples.

Show the students the USB microscopes and explain how to vary the focus. These can be used to help in the study of any of the objects – they simply have to go over to a free microscope station.



MAIN ACTIVITY

In eight groups, the students go around the room, spending 3–4 minutes with each sample and completing the table on the worksheet.

Make sure that the USB microscopes are placed with the stations where the table requires a drawing of the surface. Students then match up the specific meteorite to its name.

16.1 METEORITE INVESTIGATION

Around the room are 8 stations with rocks that have either come from space, or been produced as a result of an impact between a meteorite and the Earth. It is your job to study these rocks, perform tests, and calculate densities (of some of the rocks) in order to identify which rock is which.

KEY EQUATION:
Density = $\frac{\text{Mass}}{\text{Volume}}$

To calculate the density, you will need to measure the mass of the object.
At each station there is a sheet that will help you with this by reminding you of how to calculate the volumes of certain shapes.

Explain the approach you took to calculating the volume (what shapes did you model the objects as, how did you measure the objects to get the volume, how did you measure the mass, how did you calculate the density, take your measurements in cm and mass in g to give you a density of grams/cm³.)

Written Observation: Does it have a fusion crust? Does it show bubbles? Can you see metal?

Station 1
Station 2
Station 3
Station 4
Station 5
Station 6
Station 7
Station 8

16.3 SPACE ROCKS INFORMATION

Meteorites: General information

- Most meteorites contain iron and so they are **MAGNETIC**.
- Meteorites are **MORE DENSE** than most Earth rocks.
- Meteorites have a fusion crust – a dark outer coating that can show bubble pits or veins from where the outer rock has melted as the meteorite burns up in the atmosphere.

IRON METEORITES

Description: Large pieces of iron-nickel.

From: The core of large asteroids.

Density: The densest meteorites.

Magnetic?: Yes.

Additional features: Widmanstätten patterns formed due to the slow cooling of the material deep within the body of a large asteroid.

From: Small asteroids.

Density: The least dense meteorites.

Magnetic?: Yes.

CHONDRITE METEORITES

Description: Pieces of stone with 'freckles' – small, spherical rock formations from where the small asteroid gradually came together under the forces of gravity and charge attraction.

From: Small asteroids.

Density: The least dense meteorites.

Magnetic?: Yes.

CHONDRULES

DESCRIPTION: Rock that melted when a meteorite hit the Earth.

From: The Earth – fall back as droplets of molten rock.

Density: Low density.

Magnetic?: No.

GLASS IMPACTITES

Description: Silica rich rock that melted when a meteorite hit the Earth.

From: The Earth – fall back as droplets of molten rock.

Density: Medium density.

Magnetic?: No.

Additional features: Often show holes or bubbles from gases heated up on impact.

From: The core/mantle boundary of large asteroids.

Density: Medium density.

Magnetic?: Yes.

PALLASITE (STONY-IRON METEORITES)

Description: Rock that melted when a meteorite hit the Earth.

From: The Earth – fall back as droplets of molten rock.

Density: Low density.

Magnetic?: No.

Additional features: Glass-like and often coloured due to elements in the rock.

From: The Earth – fall back as droplets of molten rock.

Density: Low density.

Magnetic?: No.

MOLDAVITES

Description: Rock that melted when a meteorite hit the Earth.

From: The Earth – fall back as droplets of molten rock.

Density: Low density.

Magnetic?: No.

16.5 VOLUMES OF SHAPES

Figure	Formula	Variables
CUBE 	a^3	a = length of edge
REGULAR PRISM 	$l \times w \times h$	l = length w = width h = height
CYLINDER 	$\pi \times r^2 \times h$	r = radius of circular face h = height
CONE 	$\frac{1}{3} \times \pi \times r^2 \times h$	r = radius of circular base h = height from tip to base
SPHERE 	$\frac{4}{3} \times \pi \times r^3$	r = radius

16.1 Meteorite investigation & 16.2 Match your space rocks

Please reiterate the importance of carefully handling the meteorites, and of replacing everything in the correct place on the sheet before moving on to the next station.

16.3 Space rocks information
16.5 Volumes of shapes

PLENARY

Go through the answers with the students on the powerpoint slide and discuss. Get the students whose density calculations were closest for

each one to explain how they estimated the volume of the object.

Finish off with showing them the Martian meteorite and ask students how it is possible for a piece of Mars to get to the Earth. What can we say about the energy of such a collision?