KS3 Space
Investigating Gravity, Mass and Weight

Learning Objective

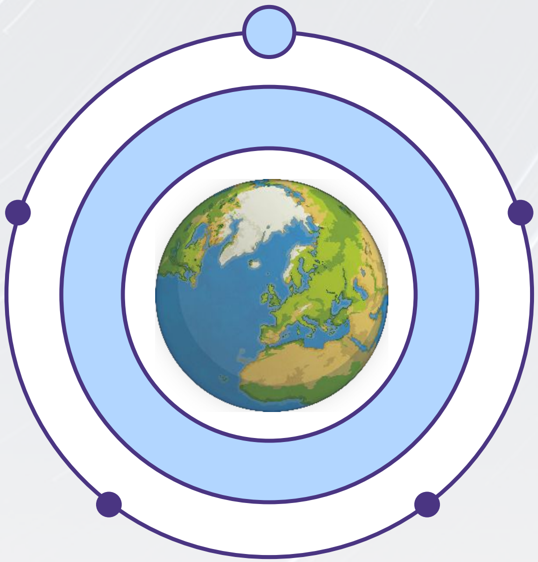
- To understand gravity, mass and weight.

Success Criteria

- To define gravity, mass and weight.
- To calculate mass or weight using gravitational field strength.
- To investigate how craters form on planet surfaces.

Starter Task – Mind Map

Pick one term - gravity, mass or weight – and write down everything you know about it.



gravity

mass

weight

Gravity, Mass and Weight

Gravity, *noun*
The force of gravity prevents everything from floating away from earth.

Mass, *noun*
The amount of stuff (matter) something is made of. Measured in kilograms (kg).

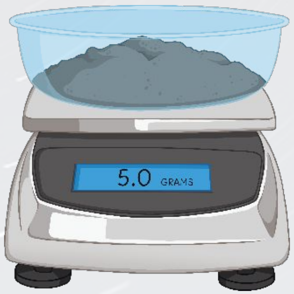
Weight, *noun*
This is a force acting on an object’s mass. Measured in newtons (N).

Mass vs Weight

In everyday language, we use the term weight when we are often describing mass. In science, there is a clear difference in what these two words refer to.

Mass	Weight
Mass is the amount of matter (stuff) that an object contains.	Weight is a force which is the result of gravity acting on an object.
Mass is measured in kilograms (kg).	Weight is measured in newtons (N).
Mass is not affected by the gravitational field strength and so remains unchanged, whichever planet it is measured on. Mass can only be changed by removing or adding matter to the object.	Weight is affected by the gravitational field strength of a planetary body and so can be different for the same object, depending on which planet it is measured on.

Calculating Weight



We can find the mass of an object using a scale or balance to find the value in grams or kilograms.

We can measure the weight of an object using a newton metre or spring balance.

We can also calculate the **weight** using the equation:

weight (N) = mass (kg) × gravitational field strength (N/kg)

We can also rearrange this equation to find the **mass** or **gravitational field strength**.

Have a go at rearranging the equation now.

Weight Equation

weight (N) = mass (kg) × gravitational field strength (N/kg)

Rearranged to find **mass,** the equation is:

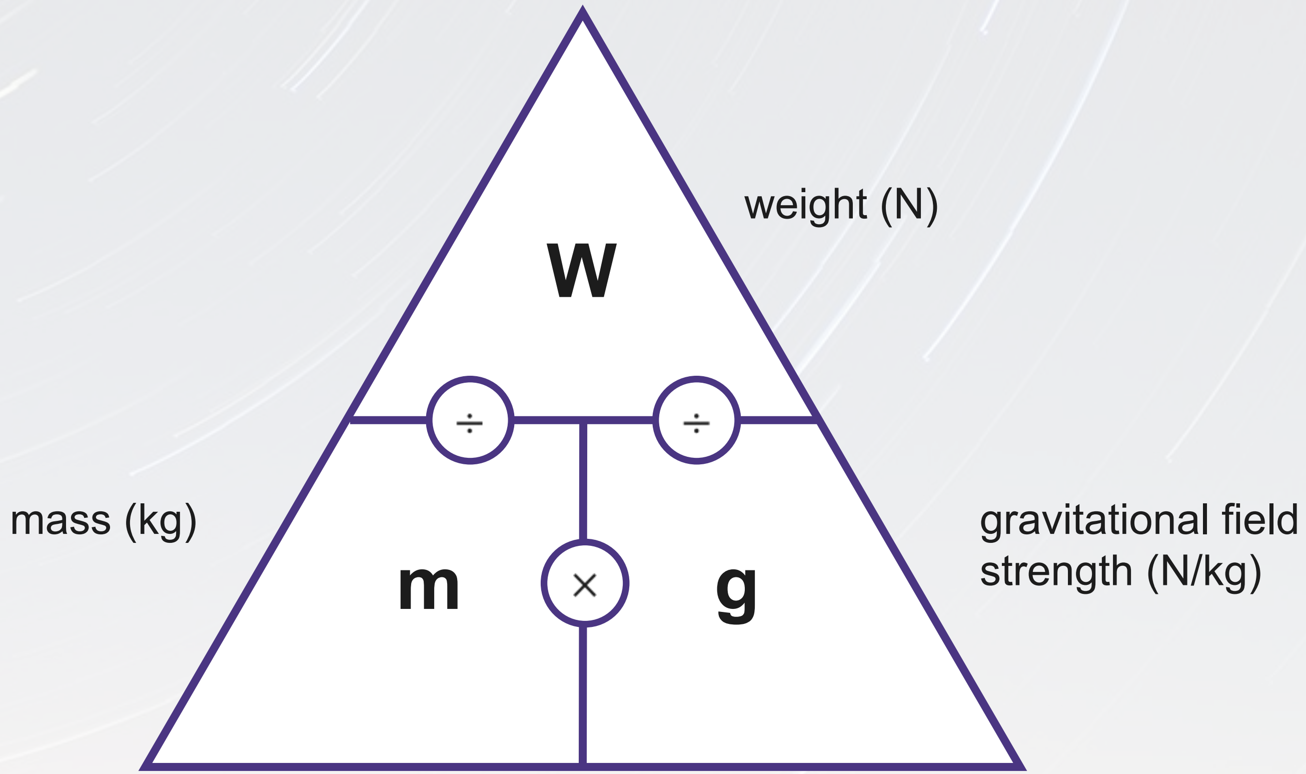
mass (kg) = weight (N) ÷ gravitational field strength (N/kg)

Rearranged to find **gravitational field strength,** the equation is:

gravitational field strength (N/kg) = weight (N) ÷ mass (kg)

You could even put this into a formula triangle…

Weight Equation

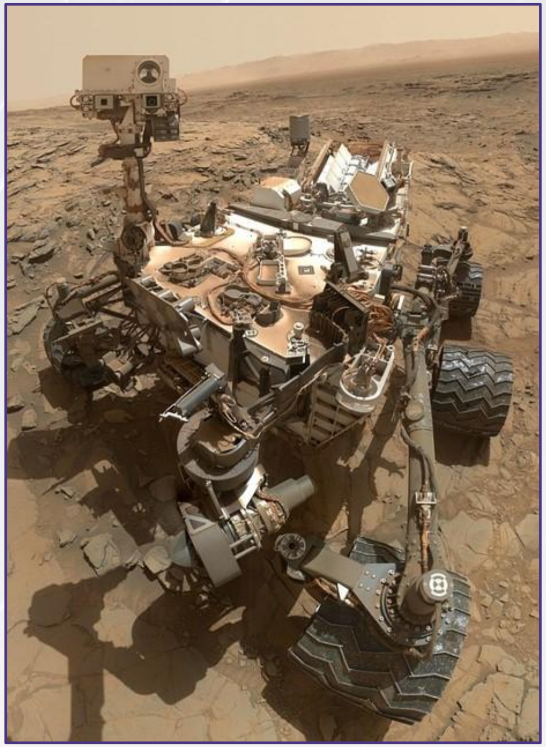


Calculating Weight

The gravitational field strength is the measure of the gravitational pull on an object by the planetary body. The larger the mass of the planet, the greater its gravitational pull will be.

On Earth, the gravitational field strength is 9.81 N/kg.

NASA's Mars rover Curiosity reached the planet surface in 2012. It is 3 metres long, 2.8 metres wide and 2.1 metres tall. The Curiosity has a mass of 900kg. That's as big as a large family car!



Calculate the weight of Curiosity here on Earth. Remember that W = mg.

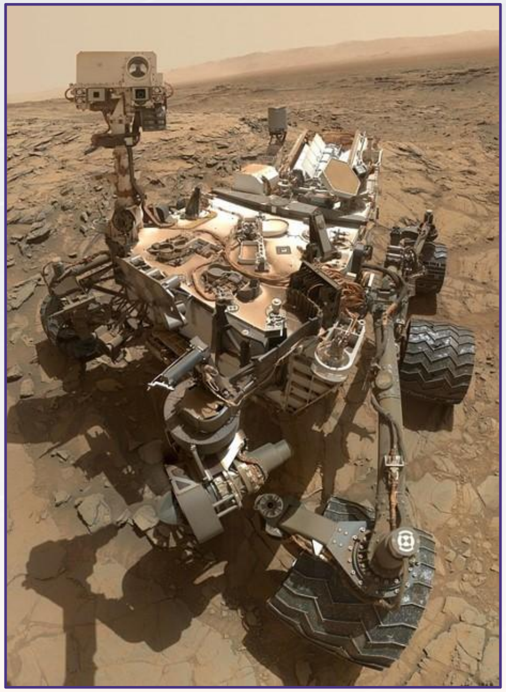
W = 900 × 9.81

W = 8829N

Calculating Weight

Find the mass of the Mars rover Curiosity on each of the other seven planets in our Solar System.

Record your calculations into the table on the worksheet.



Calculating Weight

Silver

Calculate the weight of the Mars rover Curiosity on each of the planets in our Solar System.

Remember to use the equation **W = mg.**

Earth has already been done for you.

Planet Name	Gravitational Field Strength (N/kg)	Mass of Mars rover Curiosity (kg)	Weight (N)
Mercury	3.70		
Venus	8.87		
Earth	9.81	900	8829
Mars	3.71		
Jupiter	25.00		
Saturn	10.40		
Uranus	9.00		
Neptune	11.70		

Extra Questions

1. Which planet has the greatest gravitational field strength?

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2. On which planet does the Curiosity have the least weight?

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3. On Pluto, the Curiosity has a weight of 441N. Calculate the gravitational field strength of Pluto.

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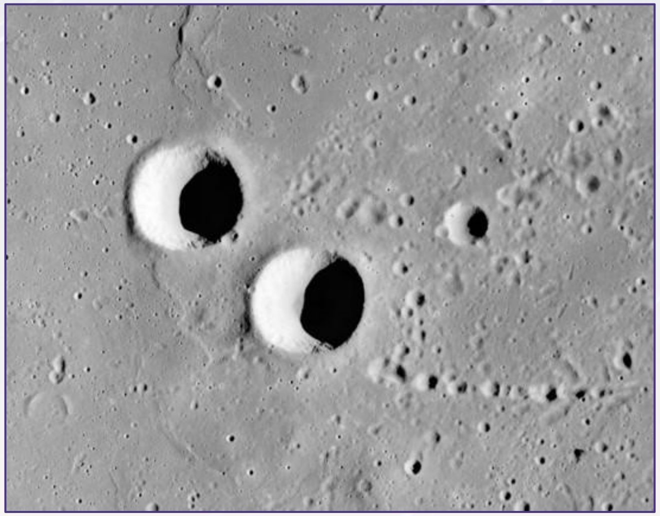
Planet Surfaces

The surfaces of terrestrial planets (Mercury, Venus, Earth and Mars) and satellites, such as the Moon, are often rocky, uneven and littered with craters.

How do you think the craters form?

Craters form when other objects in space, such as comets or asteroids, collide with the surface of the planets.



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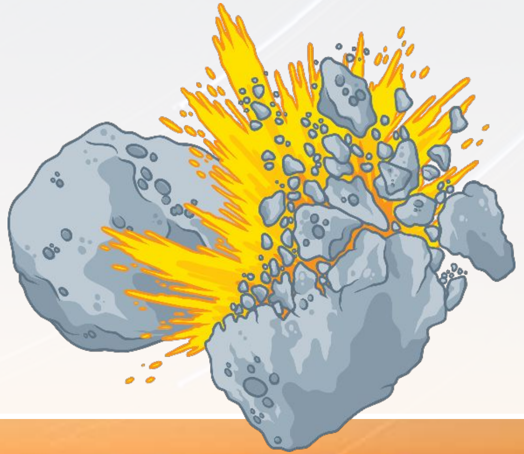
Asteroids

An asteroid is a rocky body which is orbiting the Sun. They can be as small as two metres or as large as a small moon. Asteroids themselves are often irregular shaped and covered in craters. They can be solid masses or sometimes they are a group of smaller rocks, held together by gravity.

They orbit the Sun along an elliptical pathway, but can often become trapped in the gravitational pull of other planet's moons, such as Mars' moons: Phobos and Deimos.

Due to their shape, they often orbit in quite an erratic motion, tumbling and twisting as they follow a general pathway. When they collide with one another, pieces of asteroid are thrown off the orbital pathway and can start on a pathway of collision with planets such as Earth or Mars.



Crater Formation Investigation

Let's carry out a short practical investigation to see which factors can affect the size and shape of a crater.

You will work in small groups and will investigate one of the following independent variables:

- composition of the planet surface – gravel, sand and flour
- diameter of the asteroid – 1cm, 5cm, 10cm
- mass of the asteroid – light, medium or heavy

What type of data is the diameter of the asteroid?

quantitative data/continuous data

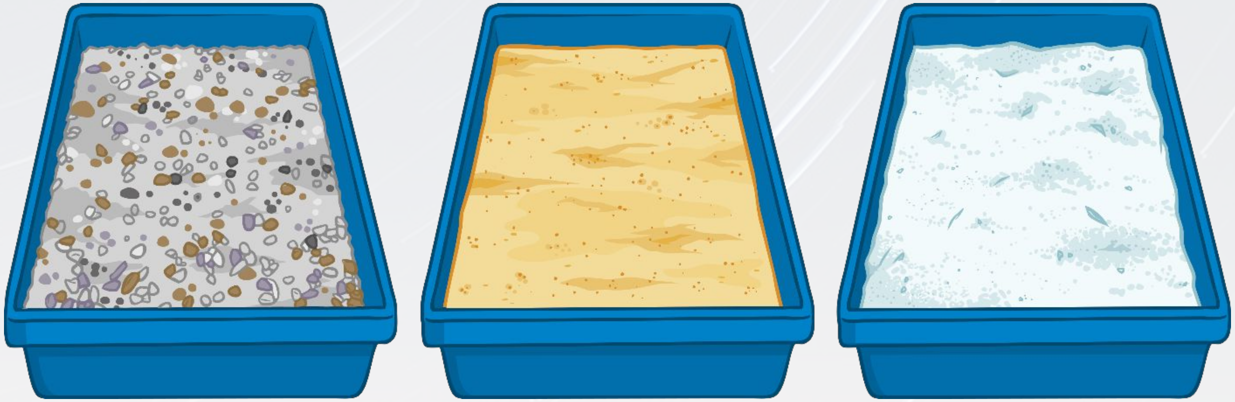
What type of data is the mass of the asteroid?

qualitative data/discrete data

Crater Formation Investigation

- **composition of the planet surface – gravel, sand and flour**

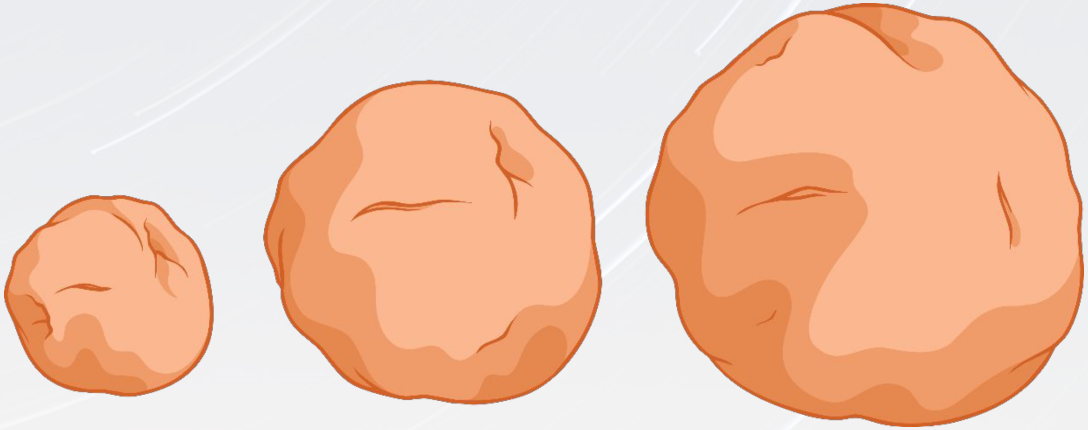
You will have three trays, each filled with one of the materials above. Drop your ‘asteroid’ into the tray and measure the size of the crater formed. Repeat the measurement three times for each tray and record your results in a table.



Crater Formation Investigation

- **diameter of the asteroid – 1cm, 5cm, 10cm**

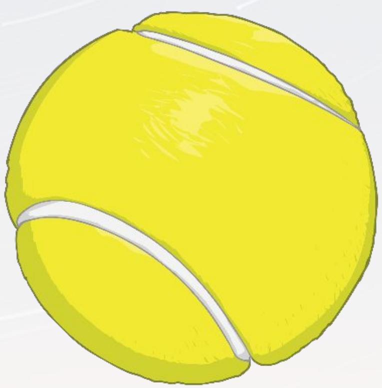
You will have a tray of sand and some modelling clay. You need to form three balls of clay, measuring 1cm, 5cm and 10cm in diameter. Drop your 'asteroid' into the tray and measure the size of the crater formed. Repeat the measurement three times for each size asteroid and record your results in a table.

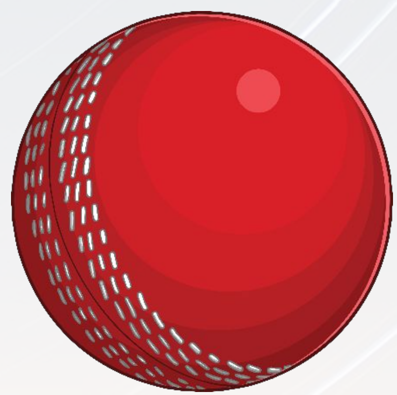


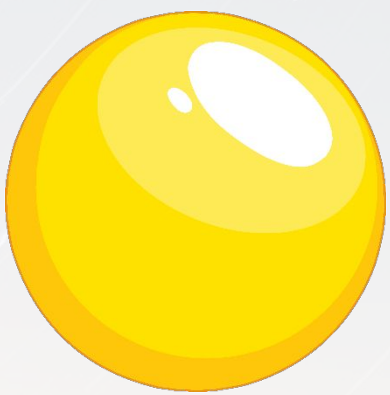
Crater Formation Investigation

- **mass of the asteroid – light, medium or heavy**

You will have a tray of sand and three balls; they should be the same size but different masses e.g. a hollow ball from a ball pit, a tennis ball and a cricket ball. Drop your 'asteroid' into the tray and measure the size of the crater formed. Repeat the measurement three times for each mass of ball and record your results in a table.







Crater Formation Investigation

- In each investigation, what is the dependent variable?
  The diameter (size) of the crater, measured in cm.

- Why is it important that you repeat each measurement 3 times?
  To be able to calculate an average result and avoid any anomalous data.

- Which variable should you keep the same each time (control variable)?
  The height from which the 'asteroid' is dropped.

Conclusion and Evaluation

- **Composition of the planet surface – gravel, sand and flour**

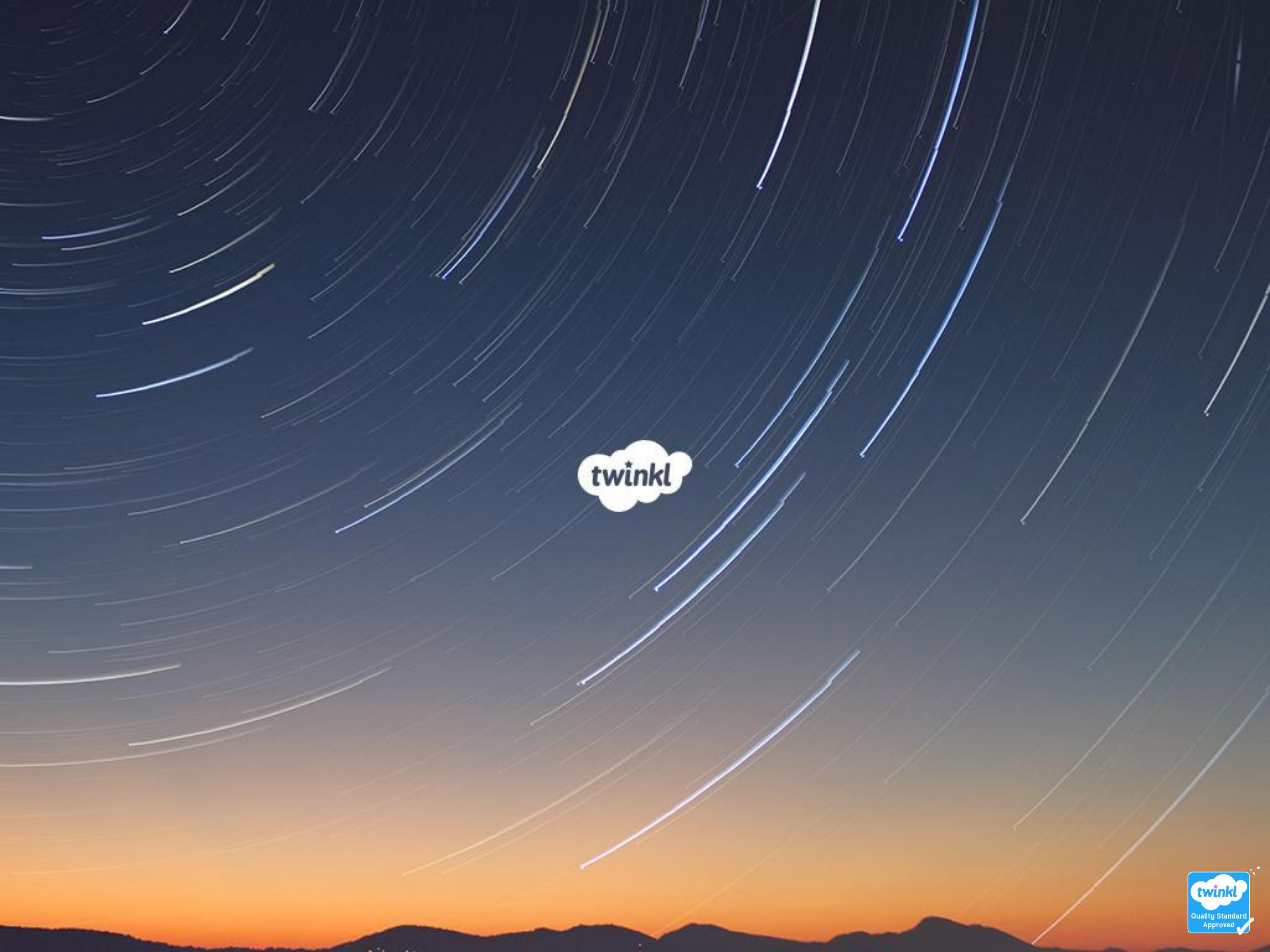
Did you notice any correlation between surface material and the size of the crater formed?
How might you record the independent variable as a quantitative value?

- **Diameter of the asteroid – 1cm, 5cm, 10cm**

Did you notice any correlation between asteroid diameter and the size of the crater formed?
How might you increase the validity of the investigation?

- **Mass of the asteroid – light, medium or heavy**

Did you notice any correlation between asteroid mass and the size of the crater formed?
What further question might you ask now?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