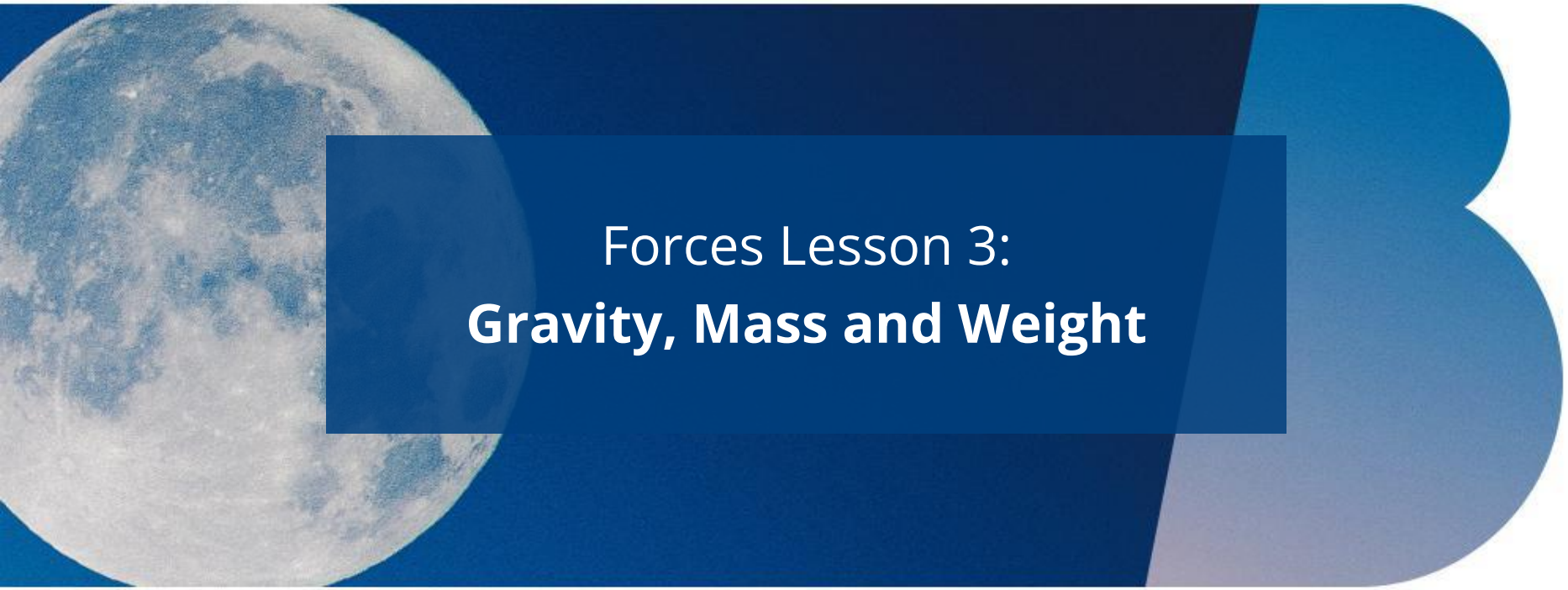

# Forces Lesson 3:
# **Gravity, Mass and Weight**

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# Learning Objective

To investigate what happens to mass and weight on different planets.

# Success Criteria

- To accurately measure weight using a newton meter.
- To calculate weight and gravitational field strength.
- To explain the difference between mass and weight.

# The Man on the Moon

The Man on the Moon weighs 10kg. If he was on Earth, he would weigh more.

No, he would weigh the same because he is made of the same amount of stuff as he was when he was on the Moon.

What do you think?

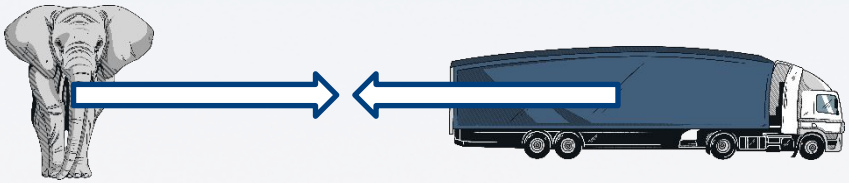
# Gravity

Gravity is a force exerted by one object on another when they are near each other.

Gravity is affected by the mass and the proximity of the objects.

A gravitational force acts between this pineapple and this mouse.

There is a larger gravitational force between this elephant and this lorry because they have a bigger mass.



There is a larger gravitational force between this elephant and this lorry because they are closer together.

# Gravity

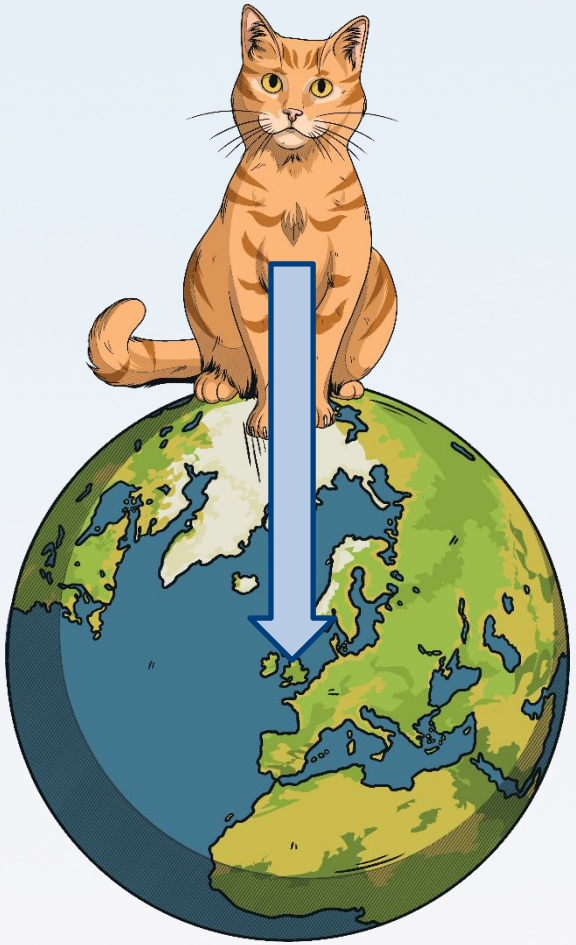
The Earth has a large mass compared with everything that is on Earth.

The Earth's gravitational field strength is larger than our own, so we don't notice the gravitational force that our own bodies exert.

On Earth, everything is pulled to the Earth's centre.

The Earth has a **gravitational field strength** of 10 newtons per kilogram (N/kg).

This means every kilogram on Earth has a force of 10 newtons acting on it.



# Mass

Mass is the amount of matter (stuff) an object is made up of.

The unit of mass is kilograms (kg).

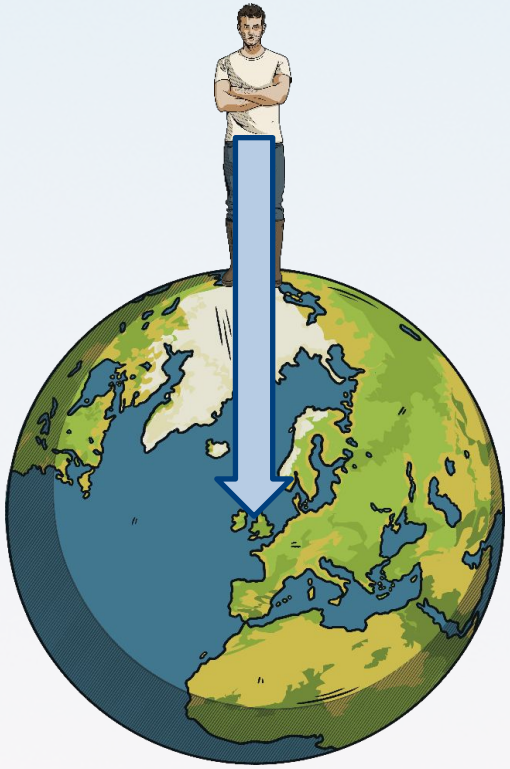
This is Gary.
Gary has a mass of 80kg.

# Weight

Gary has a **mass** of 80kg.

He is standing on Earth which has a **gravitational field strength** of 10N/kg.

This means every kilogram of Gary has a force of 10 newtons acting on it.



The total amount of force acting on Gary is his **weight**.

What is Gary's weight?

800N

Since weight is a force its unit is newtons.

# Weight

To calculate weight we use the equation:

weight = mass × gravitational field strength

Gary has a mass of 80kg.

The gravitational field strength on Earth is 10N/kg.

80kg × 10N/kg = 800N

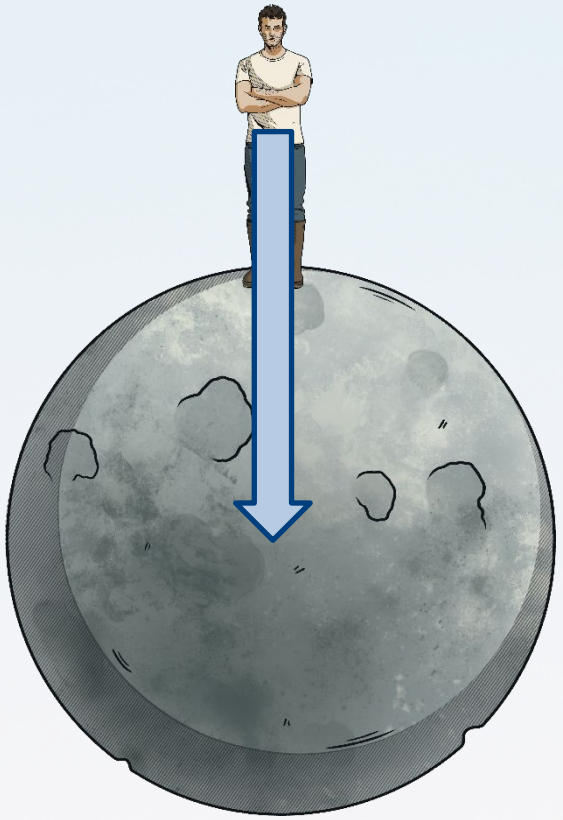
Gary flies to the moon. The gravitational field strength on the moon is 1.6N/kg.

What is Gary's mass on the moon?

**80kg**

What is Gary's weight on the moon?

**128N**



# The Man on the Moon

The Man on the Moon weighs 10kg. If he was on Earth, he would weigh more.

No, he would weigh the same because he is made of the same amount of stuff as he was when he was on the Moon.

What do you think now?

Can you improve the students' statements?

# Measuring Weight

The gravitational field strength on Earth is 10N/kg.

Use a newton meter to measure the weight of the container you have been given. This is the weight of the container on Earth.

Calculate the mass of the container.
To do this we need to rearrange the equation we used before.

# Rearranging Equations

mass × gravitational field strength = weight

We need to make mass the subject of this equation.

Mass is currently multiplied by gravitational field strength, so we need to divide it by gravitational field strength to make it the subject.

$$\frac{\text{mass} \times \text{gravitational field strength}}{\text{gravitational field strength}} = \frac{\text{weight}}{\text{gravitational field strength}}$$

$$\frac{\text{mass} \times \cancel{\text{gravitational field strength}}}{\cancel{\text{gravitational field strength}}} = \frac{\text{weight}}{\text{gravitational field strength}}$$

On the left-hand side of the equation, gravitational field strength cancels out.

So we are left with:

$$\text{mass} = \frac{\text{weight}}{\text{gravitational field strength}}$$

# Measuring Weight

Imagine the same container is taken on a tour of the solar system. The mass will not change as the container still contains the same amount of ‘stuff’.

Move to the next planet and measure the weight of the container on that planet.

Record your measurements in the table.

Using your measurements and the mass you calculated before, calculate the gravitational field strength on each planet.

To do this we need to rearrange the equation in a different way.

# Rearranging Equations

mass × gravitational field strength = weight

We need to make gravitational field strength the subject.

Gravitational field strength is currently multiplied by mass, so we need to divide it by mass to make it the subject.

$$\frac{\text{mass} \times \text{gravitational field strength}}{\text{mass}} = \frac{\text{weight}}{\text{mass}}$$

$$\frac{\cancel{\text{mass}} \times \text{gravitational field strength}}{\cancel{\text{mass}}} = \frac{\text{weight}}{\text{mass}}$$

On the left-hand side of the equation, mass cancels out.

So we are left with:

$$\text{gravitational field strength} = \frac{\text{weight}}{\text{mass}}$$

# Measuring Weight

| Planet | Weight (N) | Mass (kg) | Gravitational Field Strength (N/kg) |
|---|---|---|---|
| Earth | 2 | 0.2 | 10 |
| Mercury | 0.74 | 0.2 | 3.7 |
| Venus | 1.78 | 0.2 | 8.9 |
| Mars | 0.74 | 0.2 | 3.7 |
| Jupiter | 5 | 0.2 | 25 |
| Saturn | 2.08 | 0.2 | 10.4 |
| Uranus | 1.78 | 0.2 | 8.9 |
| Neptune | 2.24 | 0.2 | 11.2 |

# Mass vs Weight

| Mass | Weight |
| --- | --- |
| | |

Sort the statements below into the correct columns.

The total amount of force acting on an object due to gravity.

The amount of matter an object is made up of.

Measured in newtons (N).

Measured in kilograms (kg).

The value does not change when an object's location changes.

The value does change when an object's location changes.

# Mass vs Weight

| Mass | Weight |
| --- | --- |
| The amount of matter an object is made up of. | The total amount of force acting on an object due to gravity. |
| Measured in kilograms (kg). | Measured in newtons (N). |
| The value does not change when an object's location changes. | The value does change when an object's location changes. |

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