Speed of the Earth

Key Learning Content

This film shows how to calculate the average speed with which the Earth moves round the Sun by simplifying assumptions about its motion. Assuming a circular orbit of average diameter 300 million kilometres, the Earth will travel approximately 940 million kilometres in one year. The number of seconds in a year is calculated, and hence the speed of the Earth in metres per second is estimated.

Familiarity with circle formulas and speed/distance/time relationships would be useful prior to watching the film.

Core Outcomes

Learning Points

- Be able to understand and use the relationship between average speed, distance and time.
- Be able to make sensible estimates of a range of measures.
- Be able to recognise the terms ‘centre’, ‘radius’, ‘diameter’ and ‘circumference’ of a circle.
- Be able to find circumferences and areas of circles using relevant formulae.

Suggested Activities

- Solve problems involving speed, distance and time.
- Calculate the average speed of different objects and compare with the speed of the Earth.
- Research the precise path of the Earth around the Sun.

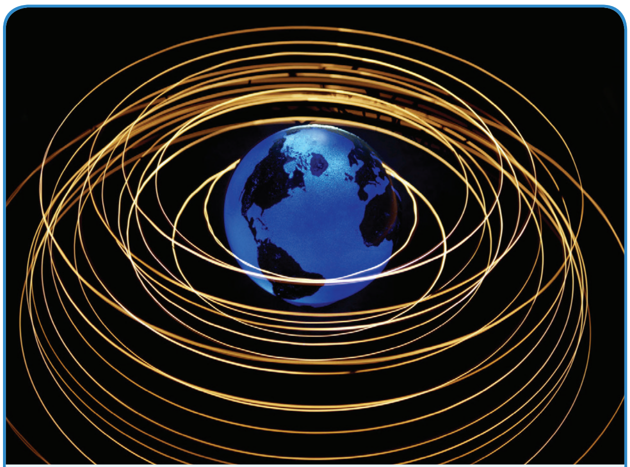
Extension Outcomes

Learning Points

- Be able to convert measurements within the metric system including, for example, km/h to m/s, and vice versa.
- Be able to understand and calculate relative velocities.

Suggested Activities

- Restate the speed of the Earth in different units.
- Take account of the rotation of the Earth in assessing its speed.



The Earth is travelling nearly 30,000 metres each and every second.

Related Films

To use before the lesson plan:

Measuring the Earth	This film shows how it is possible to calculate the diameter of the Earth by climbing a mountain.
Volume: Counting Stars	This film asks if it is possible to count the stars by counting grains of sand.

To use after the lesson plan:

Distance to the Sun and Moon	This film demonstrates the use of trigonometry to calculate relative distances.
Perspective: Parallax	This film looks at ways of calculating the distance to the stars.
Rounding: Snails vs Rockets	This film shows how the measurements of different speeds need different levels of accuracy.

Guide Lesson Plan

Introduction

Ask students what is the fastest they have ever travelled (most likely in an airplane) and get them to estimate the speed in metres per second.

Show Film

Speed of the Earth

Main Activity

Foundation
Recap the relationship between distance, speed and time and set simple problems to test understanding of the concepts. Then get students to recreate the calculation for the speed of the Earth around the Sun. Next, ask students to estimate the speed in m/s of other moving objects which they come across or hear about in everyday life, for example, a person running, a car, an airplane, a bullet... Rank objects by their relative speeds and give prizes for the fastest objects found, other than the Earth.

Advanced
Ask students to restate the speed of the Earth in other units, e.g. km/h, km/day, m/minute etc. Then ask them what effect the spinning of the Earth would have on the calculation of speed. Get them to calculate the speed at which the Earth spins, measured at the Equator, and factor this into the overall speed of the Earth calculated earlier. What difference does it make if you are not at the Equator?

Extension Activity

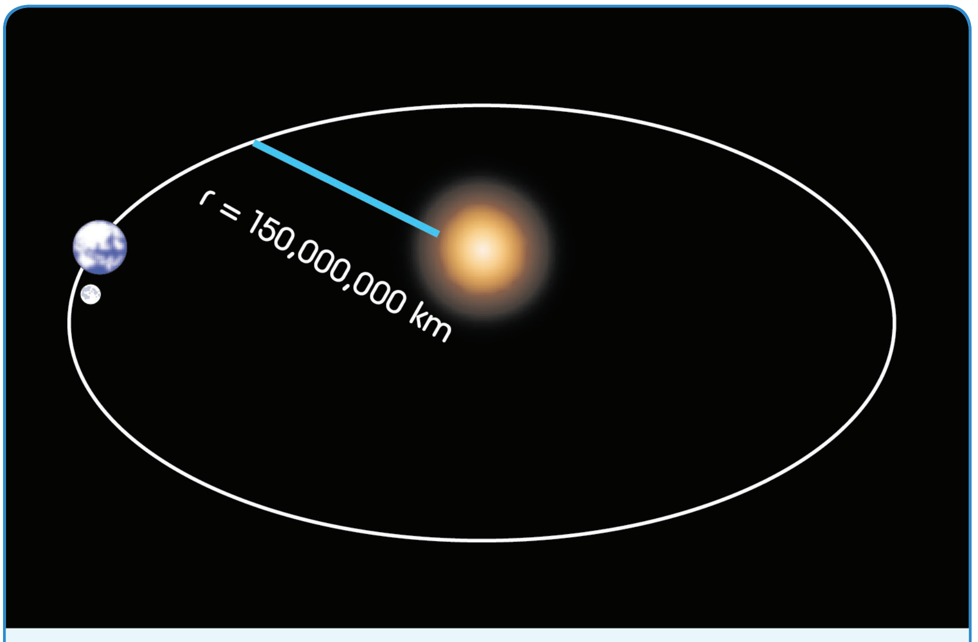
Explain that the Earth is kept in orbit by a gravitational force towards the Sun, and that the size of this force can be estimated using the formula

$$F = m\frac{v^2}{r}$$

where m is the mass of the Earth in kilograms, v is its speed in metres per second and r is the radius of its orbit in metres. The force F is then measured in Newtons (N), where a force of 1N gives a mass of 1kg an acceleration of $1ms^{-2}$. Find an estimate for the mass of the Earth and calculate the force that the Sun exerts on the Earth.

Optional Extra

The precise orbit of the Earth is not a circle, but an ellipse. Research the mathematical equation for an ellipse, and find the greatest and least distance of the Earth from the Sun on its elliptical orbit.



Early astronomers calculated the radius of the Earth's orbit by observing the scale and position of other objects in the sky, such as the transit of Venus.