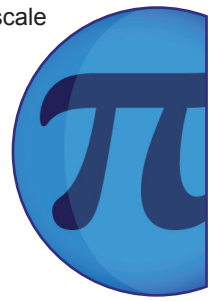
The Richter Scale

Key Learning Content

This film explains how the strength of earthquakes is measured using the Richter Scale, a logarithmic scale on which every number represents a power of ten. Hence an earthquake of magnitude 5 is 10 times stronger than an earthquake of magnitude 4. The exponential curve $y = 10^x$ is shown on screen and its terms defined. Logarithms are then formally defined as the inverse of exponentials. The film ends with the observation that the number of earthquakes decreases exponentially with the scale of the earthquake, so that there are 10 times more earthquakes of magnitude 7 as magnitude 8, or 10 times more magnitude 6 as magnitude 7, and so on.



Familiarity with indices would be useful prior to watching the film.

Core Outcomes

Learning Points

- Be able to understand the concept of a logarithm.
- Be able to recognise the link between exponentials and logarithms.
- Be able to plot graphs of exponential curves.
- Be able to estimate probabilities from previously collected data.
- Be able to understand and use estimates or measures of probability from theoretical models.

Suggested Activities

- Plot a graph of the amplitude of waves measured by a seismograph against the corresponding Richter value.
- Plot a graph of the number of earthquakes recorded over a fixed time period by Richter value.
- Make predictions for the number of earthquakes by size for the coming year.

Extension Outcomes

Learning Points

- Be able to understand the properties of logarithms.
- Be able to multiply and divide numbers using logarithms.
- Be able to solve simple exponential equations using logarithms.

Suggested Activities

- Calculate the logarithms of numbers from first principles.
- Calculate the amplitude of waves measured by a seismograph for earthquakes of given Richter values.
- Calculate the Richter values corresponding to given amplitudes of waves by solving exponential equations.

Related Films

To use before the lesson plan:

The Biggest Number Ever	This film describes how powers and power-towers are used to define the biggest numbers used in mathematics.

To use after the lesson plan:

Benford's Very Strange Law	This film shows that the distribution of first digits of naturally occurring numbers is not random and can be explained using logarithms.
Spirals in Nature	This film looks at the different types of spiral that occur in nature, including the logarithmic spiral.

Guide Lesson Plan

Introduction

Ask students what they know about measuring earthquakes. Ask how many students have heard of the Richter Scale, and ask if they know what it is. What is the difference between an earthquake measuring two on the Richter Scale, and an earthquake measuring three? Discuss alternative explanations.

Show Film

The Richter Scale

Main Activity

Foundation

Illustrate how a seismograph works and explain that one definition of a Richter value is in terms of the amplitude of waves measured by the seismograph. Give a table of Richter values x and corresponding amplitudes 10x and get students to plot these on a graph. Draw a smooth curve through the points and explain that the shape is the shape of an exponential curve. Explore why it is more useful to use Richter values than actual amplitudes when recording earthquakes.

Advanced

Give the formal definition of a logarithm as

$$a^b = c \Leftrightarrow \log_a c = b$$

Define the Richter value as the logarithm to base 10 of the amplitude of waves measured by a seismograph, and give examples. Then get students to use the log button on their calculators to check that log $(10^n) = n$ for different values of n. Set exercises to work out the logs of numbers to different bases. Then ask: What are the Richter values of earthquakes where the amplitude of waves measured by a seismograph is 200, or 4000, or 30,000?

Extension Activity

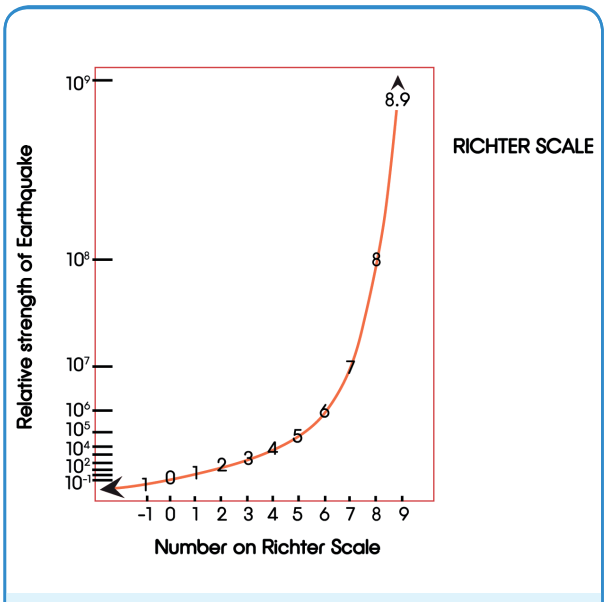
Find a reputable source on the internet which describes earthquake activity, e.g. *http://earthquake.usgs.gov/earthquakes/eqarchives/year/eqstats.php* and give students a table of number of earthquakes by Richter value >4.

Plot these points on a graph and get students to comment on the shape of the curve. Get students to multiply the number of earthquakes by the amplitude of the earthquake and comment on the result. Use the data to make predictions for the number of earthquakes by size for the coming year.

Optional Extra

Exponential or logarithmic relationships occur throughout nature. Get students to use the internet to find other examples. If they need help, tell them to look for graphs using log scales.

The energy of earthquakes can be quantified using the Richter Magnitude Scale.



Every number on the Richter Scale represents 10 times more power than the last.