	Earthquakes and Mathematics	*Lesson Plan*
Activity **1**	**Introduction** The news item or the photograph on OS1 shows the devastation and destruction caused by an earthquake. T: Working in pairs answer the following questions: What are earthquakes? What do you understand by the *magnitude*, *epicentre* and *focus* of an earthquake? The key points to be looking for in the feedback are: An earthquake is a sudden movement of the earth's surface. An earthquake occurs where the tectonic plates forming the earth's surface meet (at plate margins). The plates move past, towards or away from each other but friction can cause them to get stuck, resulting in a build-up of pressure. When the pressure is released an earthquake occurs. *Magnitude* is the word used to describe the strength of an earthquake. As the pressure is released it produces shock waves called seismic waves. The waves spread out from the point where the earthquake starts – the *focus* – like the ripples spreading out when a stone is dropped into a pond. The point at ground level, directly above the focus, is called the *epicentre*.	*Notes* T: Teacher P: Pupil If an earthquake has recently been reported in the news then either show a TV news item of the devastation and destruction it has caused or use OS1 (a photograph of the effects of the earthquake in ....) T orchestrates feedback/discussion from class, taking an answer or an idea from different pairs pf Ps, praising them for sensible suggestions and definitions. T should ensure that the key points are brought out in discussion. OS2 has a summary of the answers as a diagram.
2	**Measuring the magnitude of an earthquake** T: Does anyone know the name of the scale used to measure the magnitude of an earthquake? P: Richter Scale T: And the name of the device used to measure seismic waves …? P: A seismometer T: The magnitude of earthquakes as described on the Richter Scale is measured using a *logarithmic* scale. This means that an earthquake of magnitude 5 is 10 times stronger than an earthquake of magnitude 4. Similarly, an earthquake of magnitude 6 is 100 times stronger than an earthquake of magnitude 4. T: Have you come across any other logarithmic scales? (e.g. pH values for liquids; decibels and sound)	Some Ps will have heard of the Richter Scale. Discussion on their knowledge of the scale. OS3 shows the effects of earthquakes of different magnitudes. T must ensure that Ps understand the concept of logarithmic scales. T praises any well explained answers.

3

Working with large and small numbers

T: Very large numbers often have many zeros; for example

One million = 1 000 000

One billion = 1 000 000 000

T can ask Ps to write these numbers on the board (quickly).

In order to write these numbers in a more compact form we adopt the scientific notation or standard index form. This means writing the number as a power of 10.

100	10×10	10^2
1000	$10 \times 10 \times 10$	10^3
1 000 000	$10 \times 10 \times 10 \times 10 \times 10 \times 10$	10^6

Use the following tasks as a mental activity

Write the following as powers of 10.

Number	Powers of 10
10	
10 000	
100 000 000	
1 000 000 000	

Either:

volunteer Ps can fill in the powers on tables prepared previously by T on the board or OS, describing aloud what they are writing;

or:

these can be mental activities.

Write these powers of 10 as ordinary numbers.

Number	Powers of 10
	10^5
	10^7
	10^{10}

What do you think we mean by 10^0?

This will probably need to be discussed and explained.

We've seen how to deal with large numbers – how do you think we deal with numbers that are very small?

Number	Powers of 10
0.01	
0.0001	
0.000001	
0.000000001	

4	**Definition of Logarithms** T: Logarithms are just an alternative method of writing down numbers, especially very large or very small numbers of the type you have just been working with. The simplest logarithms are those based on the powers of the number 10. The logarithm of $100 = 10^2$ is 2; the logarithm of $100000 = 10^5$ is 5 and so on. The logarithm is written as $\log_{10} 100 = 2$ etc. *Set Question 1 on the worksheet (without a calculator)* *Answers to Question 1* $\log_{10} 1000 = 3$; $\log_{10} 1000000 = 6$ $\log_{10} 0.001 = -3$ $\log_{10} 0.1 = -1$ $\log_{10} 1 = 0$ **Working with logarithms and the calculator** T introduces the log button (key) on the calculator. This may depend on the type of calculator that pupils have. T demonstrates how to use the log button by repeating the tasks on the Question 1 of the worksheet. T explains that whereas we do not need a calculator to find the logarithms of powers of 10, for other number we do. *Set Question 2 on the worksheet (with a calculator)* *Answers to Question 2* $\log_{10} 152 = 2.181844$ $\log_{10} 467 = 2.669317$ $\log_{10} 1\,132\,567 = 6.054064$ $\log_{10} 1\,995\,262 = 6.300000$ $\log_{10} 17 = 1.230449$ $\log_{10} 0.00145 = -2.838632$	Stress the importance of a universal notation for mathematics. Individual work, monitored. Class agrees/disagrees. Mistakes discussed and corrected. Individual work, monitored. Class agrees/disagrees. Correct answers praised. Mistakes discussed and corrected.
5	**Logarithms and the Richter Scale** T: We'll return to earthquakes. We know that an earthquake of magnitude 5 on the Richter Scale is 10 times stronger than an earthquake of magnitude 4 because 10^5 is 10 times larger than 10^4. What about an earthquake with magnitude 4.7 on the Richter Scale? How much stronger is it than an earthquake of magnitude 4? The challenge now is to find the number when the logarithm is not an integer. For example, using the log key on the calculator helped us to work out that $\log_{10} 467 = 2.669317$. But suppose we started with 2.669317, how do we find x so that $\log_{10} x = 2.669317$.	Discuss this in pairs for a short time. Feedback and praise any good insight.

	T: The clue is that logarithms are related to powers of 10. So to recap: $\log_{10} 100 = \log_{10} 10^2 = 2$ $\log_{10} 10\,000 = \log_{10} 10^5 = 5$ $\log_{10} 100\,000\,000\,000 = \log_{10} 10^{11} = 11$ and going backwards $2 = \log_{10} 10^2$ $5 = \log_{10} 10^5$ $11 = \log_{10} 10^{11}$ so $2.669317 = \log_{10} 10^{2.669317}$ Using a calculator, $10^{2.669317} = 467.000128$ (not exactly 467 because of the rounding error) Now we can apply these ideas to earthquakes. An earthquake of magnitude 4.7 comes from $\log_{10} 10^{4.7}$ and $10^{4.7} = 50\,118$. and $10^4 = 10\,000$. The earthquake is 5 times stronger than an earthquake of magnitude 4 on the Richter Scale. *Set Question 3 on the worksheet (with a calculator)* *Answers* (a) The 1995 Kobe earthquake: 15.8 (b) The 1999 Turkish earthquake: 7.9 (c) The 2005 Pakistan earthquake : 39.8	Individual work, monitored. T asks individual Ps for answers; other Ps agree or give their own responses. Discussion and agreement.
Home work	Set Question 4 for homework.	