

Section 1: Exponential functions and logarithms

Exercise level 3 (Extension)

1. The Richter Scale is often quoted to illustrate the size of an earthquake, and to estimate its potential to cause damage. (In fact, it has been replaced in most circumstances by a different measure, but the results are similar.)
The Richter Scale is a logarithmic scale, and, to give an unscientific explanation, it is designed so that at a point where an earthquake occurs, the amplitude of a surface ‘wave’ during a quake of magnitude 5 on the scale is 10 times greater than the amplitude during a quake of magnitude 4. Similarly, each point on the scale involves a factor of 10.
 - (i) At a certain point and time, the amplitude of surface waves during a quake of magnitude 4 is L . Write down a formula for A_k , the amplitude of waves during a quake of magnitude k , written in terms of L and k .
 - (ii) Find an expression for the magnitude k , in terms of L and A_k .
 - (iii) In a particular city where a quake occurs, the local amplitude of waves during a quake of magnitude 4 is 1 centimetre. A further quake of magnitude 6 occurs. What amplitude of waves would be expected?
 - (iv) In a further subsequent quake, waves of amplitude 2 meters are recorded. What was the approximate size of the quake on the Richter Scale?
 - (v) The total energy released in an earthquake is closely correlated with the amount of destruction that occurs. The energy increases with the amplitude of surface waves, approximately to the power of 1.5. What is the relative increase in energy released between the quake of magnitude 4 and the quake in part (iv) above?