

**MATHEMATICS METHODS 4**

**SEMESTER 2 2018**

**INVESTIGATION 2**

**Earthquakes and Fossils**

**Marks: 45 Time: 50 minutes**

**In this Investigation, any answer without sufficient reasoning will not be awarded full marks.**

We know the Richter scale reading, R, is a measure of the magnitude of seismic waves from an earthquake. It was devised in 1935 by the seismologist Charles F. Richter (1900–1985) and technically known as the local magnitude scale, such that

R =

Where is the minimum intensity used for comparison.

1. a) What is the value of R for an earthquake of intensity 50?

[2]

b) An earthquake measures 5.5 on the Richter scale. Write the intensity in terms of .

[2]

c) An earthquake measuring 6.1 on the Richter scale is how many times as intense as one that measures 4.7 on the Richter scale?

[4]

d) Based on your answer to c), write a formula or rule that could be used to determine how many times more intense R1 on the Richter scale is than R2.

[3]

e) A new age seismologist, Solanderi, thought that since earthquakes were a naturally occurring phenomena then the formula should use natural logarithms.

i.e. S = *ln*

i) Using this scale, an earthquake measuring 7.2 on the Solanderi scale is how many times as intense as that of one measuring 5.2 on the Solanderi scale?

[3]

ii) If an earthquake measures 4 on the Solanderi scale, what is the value of S for an earthquake 20 times stronger? [3]

f) Explain, in general terms, what a change in the base of the logarithm used will mean in terms of the R (or S). Give an example to illustrate your reasoning.

[4]

The moment magnitude scale is used by seismologists to measure the size of earthquakes in terms of the energy released. It was developed to succeed the 1930's-era Richter magnitude scale.

The moment magnitude has no units and is defined as

where is the total amount of energy that is transformed during an earthquake, measured in dyncm.

2. a) On 28 June 2016, an estimated dyn∙cm of energy was transformed during an earthquake near Norseman, WA. Calculate the moment magnitude for this earthquake.

[2]

b) A few days later, on 8 July 2016, there was another earthquake with moment magnitude 5.2 just north of Norseman. Calculate how much energy was transformed during this earthquake.

[3]

c) Had this been 5.3 rather than 5.2, how many times more energy would have been transformed?

[3]

(d) Show that an increase of 2 on the moment magnitude scale corresponds to the transformation of 1000 times more energy during an earthquake.

[Hint: let the total amount of energy transformed be *x* before the increase and *y* after.]

[6]

Archaeologists use the exponential radioactive decay of carbon 14 to estimate the date of death of organic material. Carbon 12 is the stable form of carbon, but Carbon 14 decays over time into nitrogen 14 and other particles. This form of dating can be used on samples of bone, cloth, wood and plant fibers.

We can use the formula , where t is the age of the material, and 5730 is the half-life of Carbon 14 in years. is the ratio Carbon 14 compared with the living sample.

3. a) A fossil is found to have 35% of Carbon 14 compared to a living sample. How old is the fossil? [2]

b) Another fossil is said to be 20 000 years old. What percentage of Carbon 14 is left compared to a live sample? [4]

b) It is said that this type of carbon dating is only useful for deaths up to approximately 50 000 years, because of the relatively short half-life of Carbon 14.

Show mathematically why 50 000 years would be a reasonable upper limit. [4]