Notes for teachers

At a glance

This activity introduces students to quantitative reasoning problems in Earth science and physics. It supports students in using ‘back of the envelope’ reasoning to help them gain an instinctive understanding of the timescales and magnitudes of geological processes. The activity provides excellent preparation for university interviews, and the skills developed will be of value to students throughout their future studies in science.

In the activity, students take turns to introduce a problem to others in their group. They support their classmates in solving the problems, and take students through provided solutions if necessary. A version of this activity that students can use independently is also available from Oxford Sparks.

Learning Outcomes

- Students develop experience in the use of quantitative reasoning techniques.
- Students gain an understanding of the timescales and magnitudes of geological processes.

Each group of four students will need

- One each of the four pupil sheets (problem A, problem B, problem C, problem D);
- Four A5 used envelopes, or two copies of the envelope pupil sheet, each cut into two;
- One each of the four solution sheets (solution A, solution B, solution C, solution D).
Possible Lesson Activities

1. Starter activity
   - Show the animation ‘Underwater volcano disaster’ from start to finish. Focus on the section from 0:52 to the end in which Ossie travels through cracks in the Earth’s crust, and through the plumbing system of the volcano, to reach the surface.
   - Elicit that it is not always easy to comprehend the enormity of geological timescales and the vast magnitude of many geological processes. Tell students that this activity – focusing on ‘back of the envelope’ quantitative reasoning techniques – will help them to get a feel for these values.
   - Point out that Dmitri Mendeleev wrote the first periodic table on an envelope.

2. Main activity
   - Divide students into groups of four. Within each group, give each student one of the four pupil sheets problem A, problem B, problem C, problem D so that each student in the group has a different problem.
   - Allow students time to read the instructions on the sheet. Then clarify the task.
   - Give students time to tackle their problem using the data provided on the sheet, and to obtain any other data required. You might like to supply small used envelopes for this task, or the envelope pupil sheet.
   - Some students are likely to get stuck at this stage. When they do, give out the relevant solution sheets. Ask students to use these sheets to help them tackle the remaining tasks listed under the heading What to do on their problem sheet.
   - In turn, get each student to present their question to the rest of their group, and to support the other members of their group in tackling it.

2 Plenary
   Lead a discussion to address the issues below:
   - What are the benefits of tackling problems using quantitative reasoning techniques?
   - How did students overcome the difficulties they faced?
   - In what other areas of science might students apply their learning from today’s lesson?

Answers to practice questions

1 day = 60 x 60 x 24 = 3.6 x 2.4 x 10^4 = 8.6 x 10^3 s

1 week = 60 x 60 x 24 x 7 = 3.6 x 2.4 x 7 x 10^4 = 6 x 10^5 s

1 year = 365 x 8.6 x 10^4 = 3.1 x 10^7 ≈ π x 10^7 s

Further note

Problem A states that the typical depth from the volcano to the top of the Benioff zone is 100 km. In the Stromboli example this depth is slightly greater (190 – 200 km.)