Waves: amplitude and seismic waves from impactors



The scenario

In 2018, a space mission will be launched that plans to land a seismometer on Mars. After a journey of nearly seven months, scientists expect the mission to detect seismic waves from meteorite impacts on the red planet. Satellite images from Mars can be used to identify new impact craters; if we can locate these new craters and work out how much energy it took to create them, scientists will be able use the seismic signals to discover more about the Martian interior.

For this exercise, you are working in one of the project teams for this mission. Each team has been asked to measure the amplitude of the seismic waves produced by a meteorite impact.

The activity: measuring the amplitude

The impactor

For the investigation you will need to practise with various surfaces and impactors; the size and mass of the impactor makes a large difference to the results. A heavy plastic ball from a toy croquet set proved to be the most effective impactor when used with the surface as shown below.

The landing area

The landing surface also needs some practise before this activity is used in class. Very hard surfaces such as floors work very well. The picture below shows a movable science demonstration desk, which proved to be very effective. The lipped sides allowed the area to be filled with softer material like sand to allow comparisons.



Pad, tablet or phone

Learning objectives

- the role impactors have in producing seismic waves
- amplitude of waves
- importance of controlling variables in producing reliable data
- recording data using a remote sensor
- using data to accurately plot line graphs
- analysing data and graphs to report on patterns and relationships

Equipment needed

- balls of varying size
- landing area with lipped sides
- phone or tablet
- seismometer app
- graph paper



The seismometer app

There are number of freely available apps on the market that use the accelerometer function of tablets and phones. The one used in this activity is called Seismometer 6th (SkyPaw Co. Ltd).

The seismometer is set to collect data in the z-axis only as we are looking for amplitude measurements.

The other settings used in the app are shown here.





Procedure

There are three investigations available here:

1. Amplitude and distance of the impactor





Analysis and conclusions

The investigation produced results on the app as shown in the diagram.

Although the app has a scale on it, the height of the wave was measured using a ruler giving artificial units of mm. Care needs to be given here as amplitude is the height of the wave from equilibrium. We have measured 'twice' the amplitude for greater reliability.

These three traces were produced by the same object falling through the same height at the same distance away from the seismometer. This introduces the idea of random error, the results were averaged.



Typical results are shown in the graphs below.







