8 When the structure of the Earth near the surface is surveyed in prospecting for oil or minerals, one frequently used method is that of seismic reflection surveying. The process can be very complex because the strata in the Earth's crust are by no means regular, and also the quantity of data that is usually received is very large. Some of the principles behind the practice of seismic reflection surveying are explained and used in this question. The data have, however been simplified.

In a place where there is horizontal change in rock type at a certain depth, an explosion is set off. Fig. 8.1 shows an arrangement of eight detectors (D_1 – D_8) to detect vibrations from the explosion at source S, a short time after the explosion.

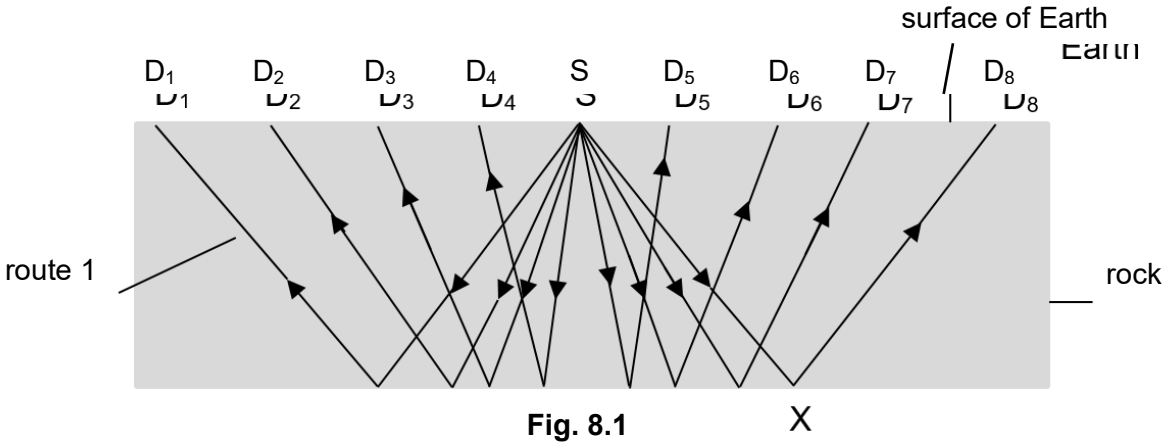

Fig. 8.1

Fig. 8.2 shows the traces received from the eight detectors printed alongside one another. Time t = 0 is the time the explosion commences.

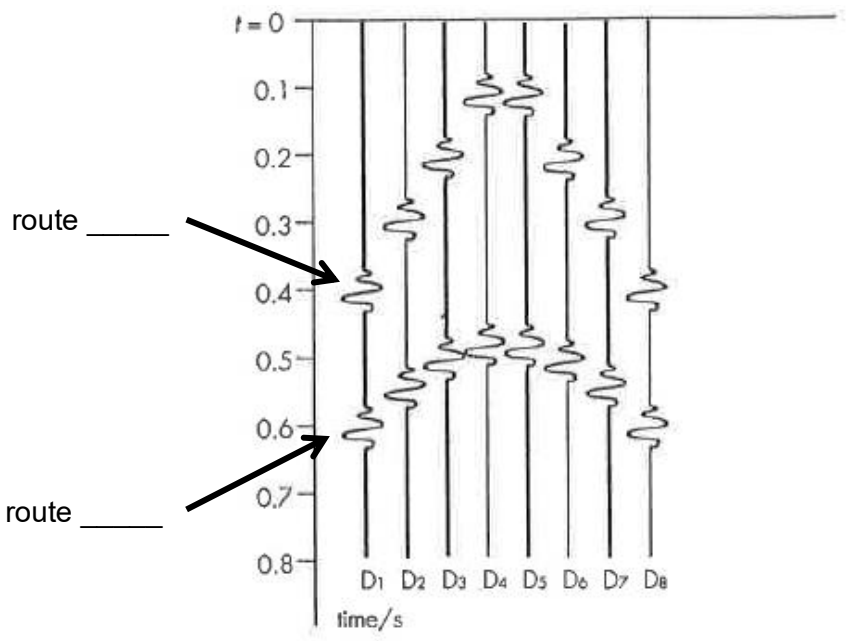

Fig. 8.2

The rock through which the waves are travelling is known to have a density of 2700 kg m^{-3} and in the rock of this density, the speed of P-waves is 3.1 km s^{-1}. P-waves are longitudinal waves and are responsible for the pulses shown in Fig. 8.2.

Answer the following questions, taking data from the diagrams where necessary.

(a) Explain what is meant by a *longitudinal wave*.

.....
.....

.....
.....[1]

(b) The speed *v* of a P-wave is given by

$$v = \sqrt{\frac{A}{\rho}}$$

where A is a constant and ρ is the density of the rock.

Determine the value and unit of A.

value = ……………….……………………… [1]

unit of A = …………..……………….……….. [1]

(c) Apart from route 1 shown in Fig. 8.1, draw, *on the same figure*, another shorter route P-waves can take to get from S to detector D_1. Label it route 2.

[1]

(d) For the detector D_1 shown in Fig. 8.2, indicate the route number corresponding to the two routes in which the P-waves arrive at the detector in **(c).**

[1]

(e) The amplitude for each pulse of the same detector in Fig. 8.2 should **not** be the same. Suggest why this is so.

…….……………………………………………………………………………...……………
……

..……...…………………………………….………………………………….…..…………
……

..…………………………………………………………………………….………………
……....[2]

(f) Determine

(i) the distance SD_8 and

distance = ……..……..……..…….

km [1]

(ii) the distance SXD_8.

distance

= ……..……..……..…….. km [1]

(g) Use your answer in **(f)** to determine the depth of the rock in Fig. 8.1.

depth = ……..……..……. km

[2]

(h) S-waves are transverse waves and always arrive after the P-waves. In Fig. 8.2, the arrow patterns develop when the eight detectors are used.

(i) Sketch, on Fig. 8.3, the arrow patterns obtained when S-waves, travelling at 2.4 km s^{-1} are added.

[2]

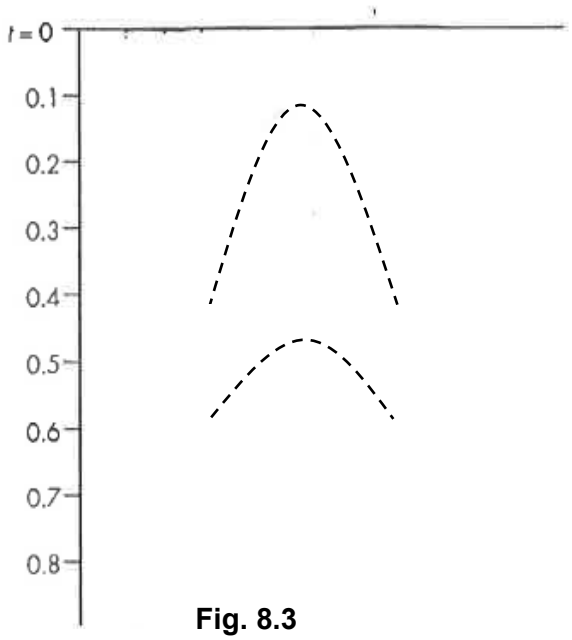

Fig. 8.3

(ii) Sketch, on Fig. 8.5, the arrow patterns obtained when P-waves travelled through a rock of uneven depth as shown in Fig.8.4. [2]

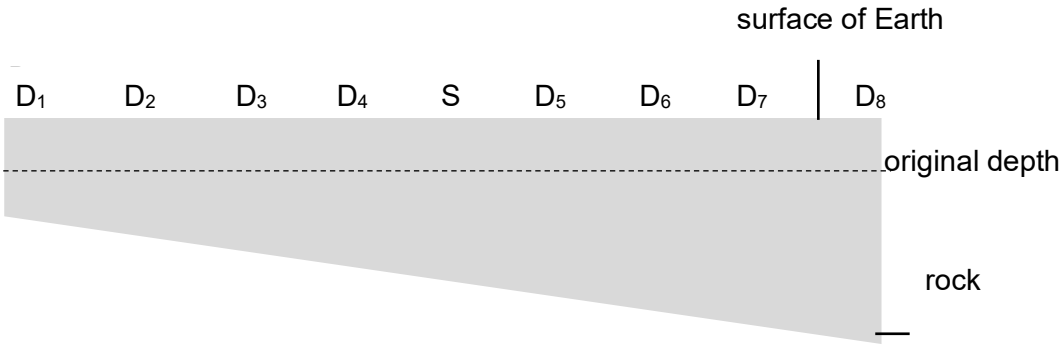

Fig. 8.4

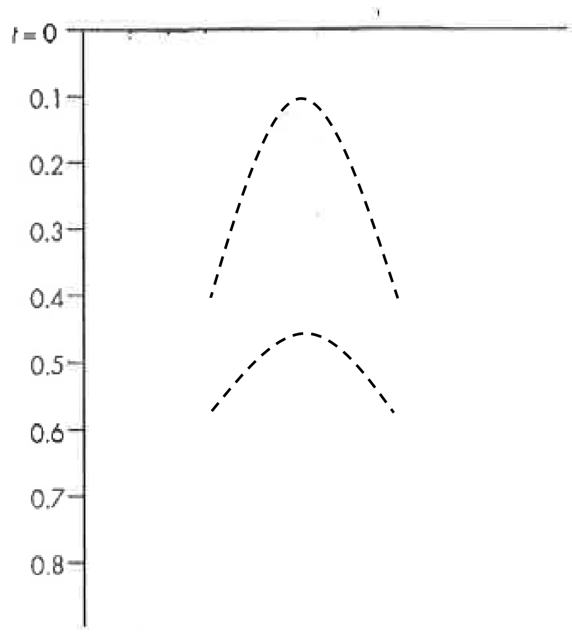

Fig. 8.5

(iii) State another factor, besides the speed of the waves and the depth of the rock, which may affect the traces shown in Fig. 8.2.

……………………………………………………………………………………………

……………………………………………………………………………………………[1]

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