14 When an earthquake occurs, two types of wave travel through the Earth. The two types of wave are P-waves (longitudinal) and S-waves (transverse).

(a) The velocities of P-waves and S-waves as they travel through the Earth are related to the density ρ of the material they are travelling through.

The velocity v_p of P-waves and the velocity v_s of S-waves are given by the following equations:

$$v_p = \sqrt{\frac{K + \frac{4}{3}G}{\rho}} \qquad v_s = \sqrt{\frac{G}{\rho}}$$

where K and G are constants for a particular material below the Earth's surface.

(i) The density of one material is $2700\,\text{kg}\,\text{m}^{-3}$.

Calculate v_p and v_s in this material.

$K = 7.55 \times 10^{10}\,\text{Pa}$
$G = 2.61 \times 10^{10}\,\text{Pa}$

(4)

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$v_p =$ .....

$v_s =$ .....

(ii) The Earth contains layers of liquid. The value of G for liquids is 0.

Explain whether S-waves can travel through liquids.

(2)

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(b) During a single earthquake, S-waves can be produced by more than one source. If two coherent S-waves meet, interference can take place.

(i) Explain what is meant by coherent.

(2)

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(ii) A scientist created a model to predict the effect of two coherent S-waves at different distances from the source. The model predicted the amplitude of the S-waves at positions A and B shown on the diagram.

The amplitude of the waves at position A was zero. The amplitude of the waves at position B was greater than zero.

Explain why the amplitude of the waves at position A was zero.

(3)

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(Total for Question 14 = 11 marks)