4 Ground-penetrating radar (GPR) uses radio waves to detect changes in material underground.

(a) (i) State the formula linking the speed, frequency and wavelength of a wave.

(1)

(ii) GPR radio waves have a frequency of 170 MHz.

The speed of radio waves is 3.0×10^8 m / s.

Calculate the wavelength of the waves.

(3)

wavelength = ... m

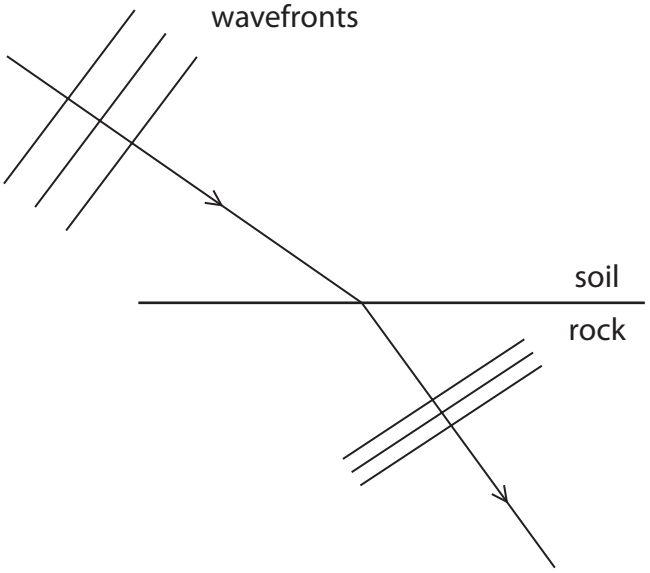
(b) (i) A radio wave passes through the ground and refracts at the boundary between soil and rock.

The diagram shows three wavefronts of the wave before and after refraction.

The wave is also reflected at the boundary between the soil and the rock.

Complete the diagram to show three wavefronts after the wave has been reflected at the boundary.

(3)



(ii) Explain why the radio waves passing through the rock have a smaller wavelength than the radio waves passing through the soil.

(3)

(Total for Question 4 = 10 marks)