21 The planet Kapteyn-b orbits Kapteyn's Star. Scientists think the conditions on Kapteyn-b could enable the long-term survival of humans.

(a) The spectrum of radiation emitted by Kapteyn's Star has a peak of intensity at a wavelength λ_{max} of 8.12×10^{-7} m.

(i) Show that the surface temperature of Kapteyn's Star is about 3600 K.

(2)

(ii) The distance from Kapteyn's Star to the planet Kapteyn-b is 2.55×10^{10} m.

The intensity I_E of light received at the Earth from the Sun is 1380 W m^{-2}.

Show that the intensity of radiation received at Kapteyn-b from Kapteyn's Star is about $0.4\,I_E$.

radius of Kapteyn's Star = 2.03×10^{8} m

(4)

(b) Humans would not be able to survive on a planet with a gravitational field strength 4 times greater than the gravitational field strength at the surface of the Earth.

Deduce whether humans could survive the gravitational field strength at the surface of Kapteyn-b.

radius of Kapteyn-b = 1.02×10^7 m
density of Kapteyn-b = 6.44×10^3 kg m^{-3}

(5)

(Total for Question 21 = 11 marks)