5 When light illuminates a clean surface of potassium, electrons can be emitted. This is the photoelectric effect. Fig 5.1 shows a section of the surface at a microscopic scale.

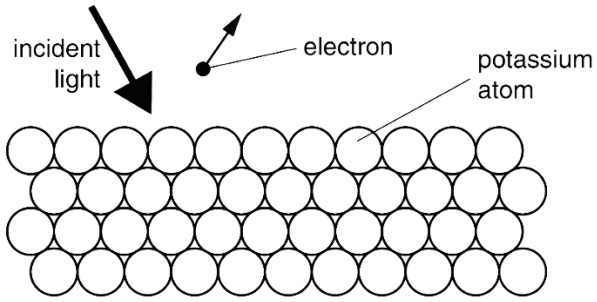

Fig 5.1

(a) Electrons are emitted when the incident light is violet, but not when the incident light is red. Increasing the intensity of violet light causes more electrons to be emitted. Increasing the intensity of red light has no effect.

Use the quantum theory of light to explain these observations. [4]

(b) Einstein explained the photoelectric effect by suggesting that there is a minimum energy ϕ, the work function, which must be supplied to remove an electron from the surface of a metal.

The work function for potassium is 4.5×10^{-19} J.

Show that photons of frequency less than 6.8×10^{14} Hz cannot remove electrons from a potassium surface. [2]

(c) The variation with frequency f of the maximum kinetic energy E_k of the emitted electrons is shown in Fig. 5.2

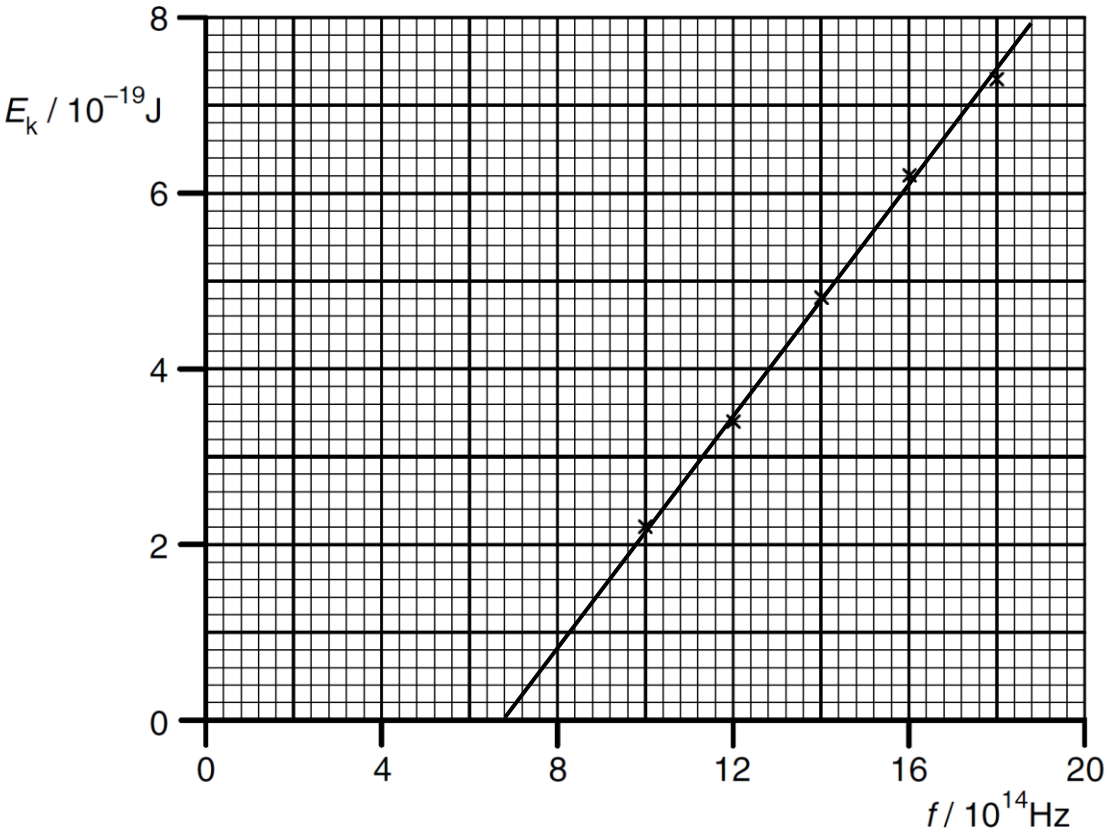

Fig. 5.2

(i) Explain the shape of the graph in Fig.5.2. [2]

(ii) Use Fig. 5.2 to determine a value for the Planck constant. [2]