6 Light of frequency f and wavelength λ is incident on a metal surface of work function energy Φ. Electrons are emitted from the surface with maximum kinetic energy E_{MAX}.

Conservation of energy for this effect may be expressed as

$$E_{MAX} = hf - \Phi$$

where h is the Plank constant.

(a) **(i)** Explain what is meant by threshold frequency.

……

…… [1]

(ii) Light at the threshold frequency for the metal surface has a wavelength λ_o.

Show that

$$E_{MAX} = hc\left(\frac{1}{\lambda} - \frac{1}{\lambda_o}\right)$$

where c is the speed of light.

[1]

(b) The variation with $\frac{1}{\lambda}$ of E_{MAX} is shown in Fig. 6.1.

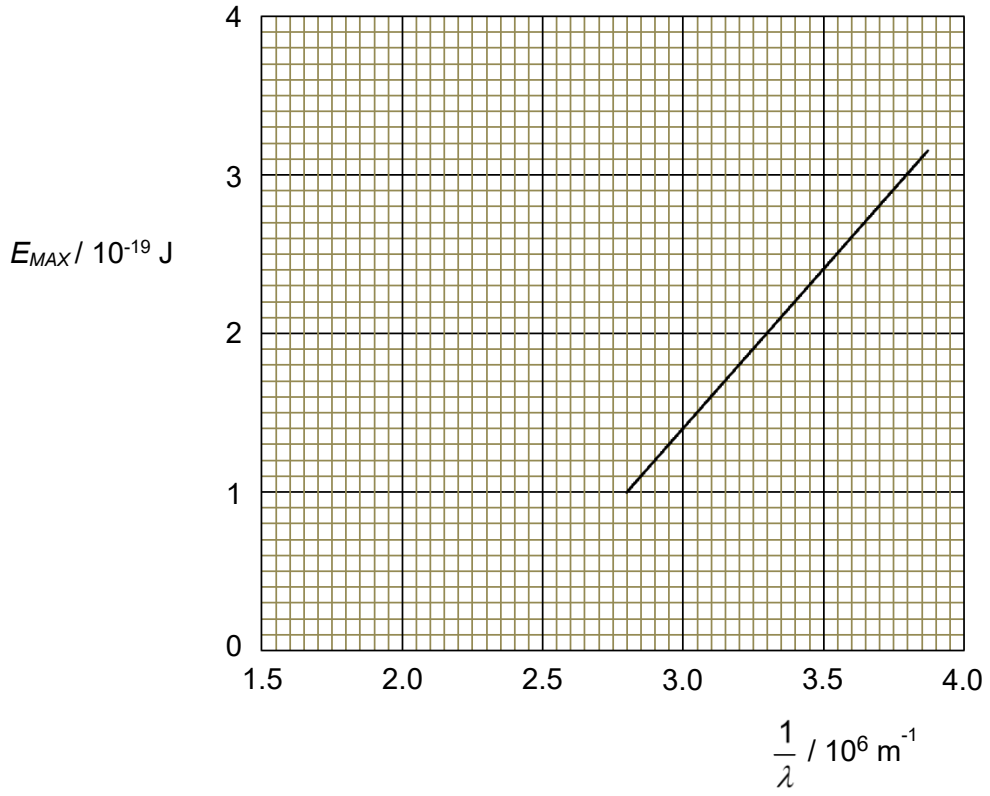

Fig. 6.1

Use Fig 6.1 and the expression in **(a)(ii)** to determine

(i) the maximum wavelength λ_o at which emission of electrons occurs, without using any value of h,

λ_o = …….. m [2]

(ii) the Plank constant *h* using data in Fig. 6.1.

h = …….. J s [2]

(c) The metal is replaced with one that has a smaller work function.

On Fig. 6.1, draw a line to show the variation with $\frac{1}{\lambda}$ of E_{MAX} for this new metal surface. [1]

(d) An isolated sphere of radius *r* made of this material is illuminated by the light of wavelength λ.

By energy consideration, derive an expression of the final charge induced on the sphere in terms of λ, λ_o and *r*.

[3]

[Total: 10 marks]