11 (a) Electromagnetic radiation is incident on a metal surface.

It is observed that there is a minimum frequency of electromagnetic radiation below which emission of electrons does not occur.

This observation provides evidence for a particulate nature of electromagnetic radiation.

State **two** other observations associated with photoelectric emission that provide evidence for a particulate nature of electromagnetic radiation.

1. .....

.....

2. .....

.....

[2]

(b) The maximum kinetic energy E_{MAX} of electrons emitted from a metal surface is determined for different wavelengths λ of the electromagnetic radiation incident on the surface.

The variation with $\frac{1}{\lambda}$ of E_{MAX} is shown in Fig. 11.1.

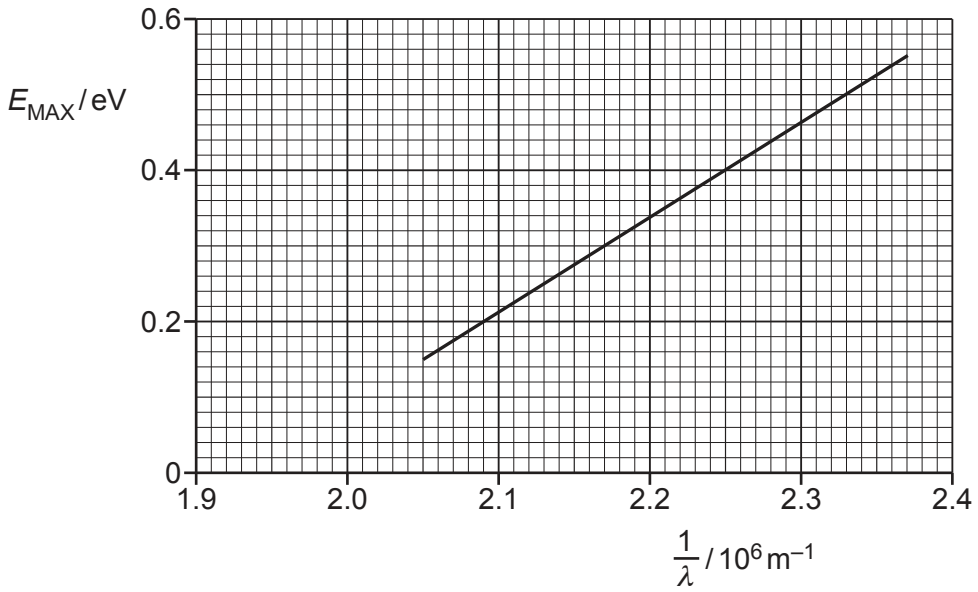

Fig. 11.1

(i) Use Fig. 11.1 to determine the threshold frequency f_0.

f_0 = ... Hz [2]

(ii) Use the gradient of the line on Fig. 11.1 to determine a value for the Planck constant h. Explain your working.

h = ... J s [4]

(c) The electromagnetic radiation is now incident on a metal with a larger work function energy than the metal in **(b)**.

On Fig. 11.1, sketch the variation with $\frac{1}{\lambda}$ of E_{MAX}. [2]

[Total: 10]