9 **(a)** State what is meant by the photoelectric effect.

.....

.....

..... [2]

(b) The photoelectric effect is investigated using two clean metal plates. One plate is made from metal X and the other is made from metal Y.

Metal X has work function energy Φ. Metal Y has work function energy 2Φ.
Metal X has threshold frequency F.

State expressions, in terms of either or both of Φ and F, for

(i) the threshold frequency of metal Y

threshold frequency = ... [1]

(ii) the Planck constant.

Planck constant = ... [1]

(c) The maximum kinetic energy E_K of photoelectrons is determined for each of the plates in **(b)** for different frequencies f of incident radiation.

On Fig. 9.1, sketch the variation of E_K with f for each plate. Label your lines X and Y to identify which line relates to which plate.

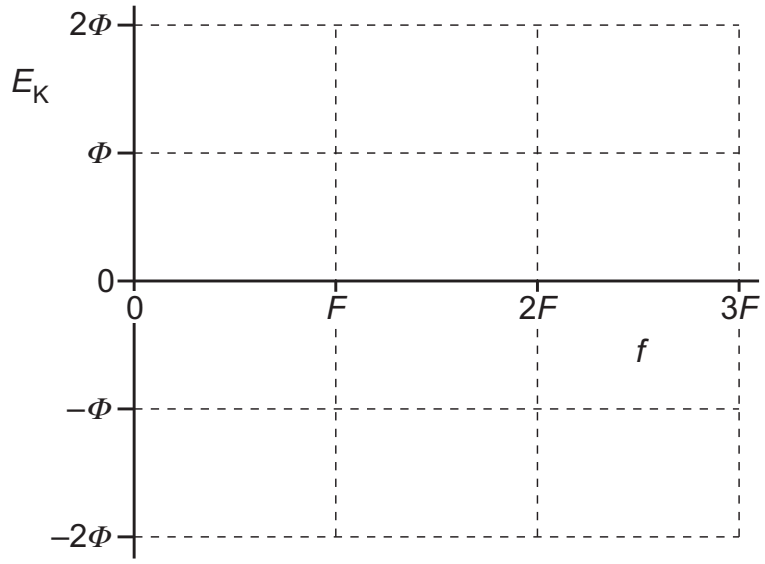

Fig. 9.1

[4]

[Total: 8]

9 **(a)** State what is meant by the photoelectric effect.

.....

.....

..... [2]

(b) The photoelectric effect is investigated in two stages using the circuit shown in Fig. 9.1.

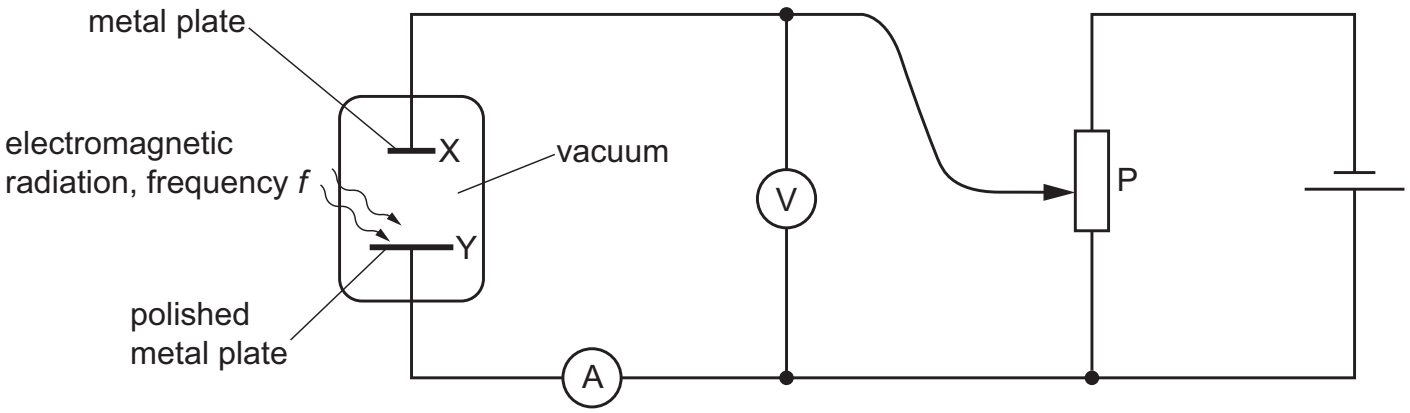

Fig. 9.1

The polished metal plate Y is illuminated with electromagnetic radiation of frequency f and constant power.

In stage 1 of the investigation, frequency f is set to a constant value of 2.5×10^{15} Hz. The current I in the ammeter is varied by adjusting the potentiometer P. Fig. 9.2 shows the variation of I with the voltmeter reading V. There is a value V_S of V at which the current just falls to zero.

In stage 2 of the investigation, stage 1 is repeated for different values of frequency. As frequency f is varied, the voltmeter reading V_S at which the current just falls to zero is measured. Fig. 9.3 shows the variation of V_S with f.

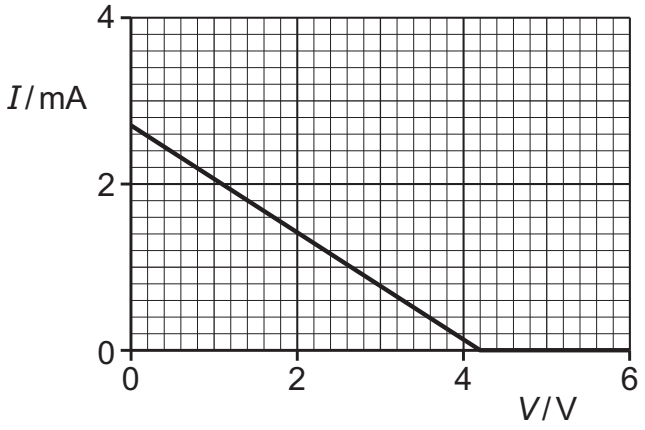

Fig. 9.2

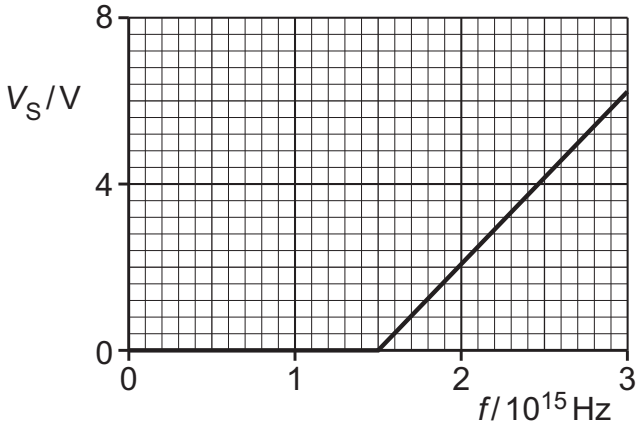

Fig. 9.3

(i) Explain, with reference to photons, why V_S depends on the frequency of the incident electromagnetic radiation.

.....

.....

.....

.....

.....

..... [3]

(ii) State **three** quantitative conclusions that can be drawn from the results in Fig. 9.2 and Fig. 9.3. Use the space for any working.

1 .....

.....

2 .....

.....

3 .....

.....

[3]

[Total: 8]

8 A polished sheet of magnesium in a vacuum emits electrons when it is illuminated by ultraviolet radiation.

(a) State the name of this phenomenon.

..... [1]

(b) For emission of electrons to occur, the frequency of the ultraviolet radiation must be at least 8.8×10^{14} Hz.

(i) Calculate the work function energy of magnesium.

work function energy = ... J [2]

(ii) For ultraviolet radiation with a frequency of 11×10^{14} Hz, calculate the maximum speed of the emitted electrons.

maximum speed = ... $m\,s^{-1}$ [3]

(c) The frequency f of the ultraviolet radiation incident on the magnesium sheet is varied between 8.0×10^{14} Hz and 11×10^{14} Hz.

On Fig. 8.1, sketch the variation with f of the maximum kinetic energy E_{MAX} of the emitted electrons. Use the space below for any working that you need.

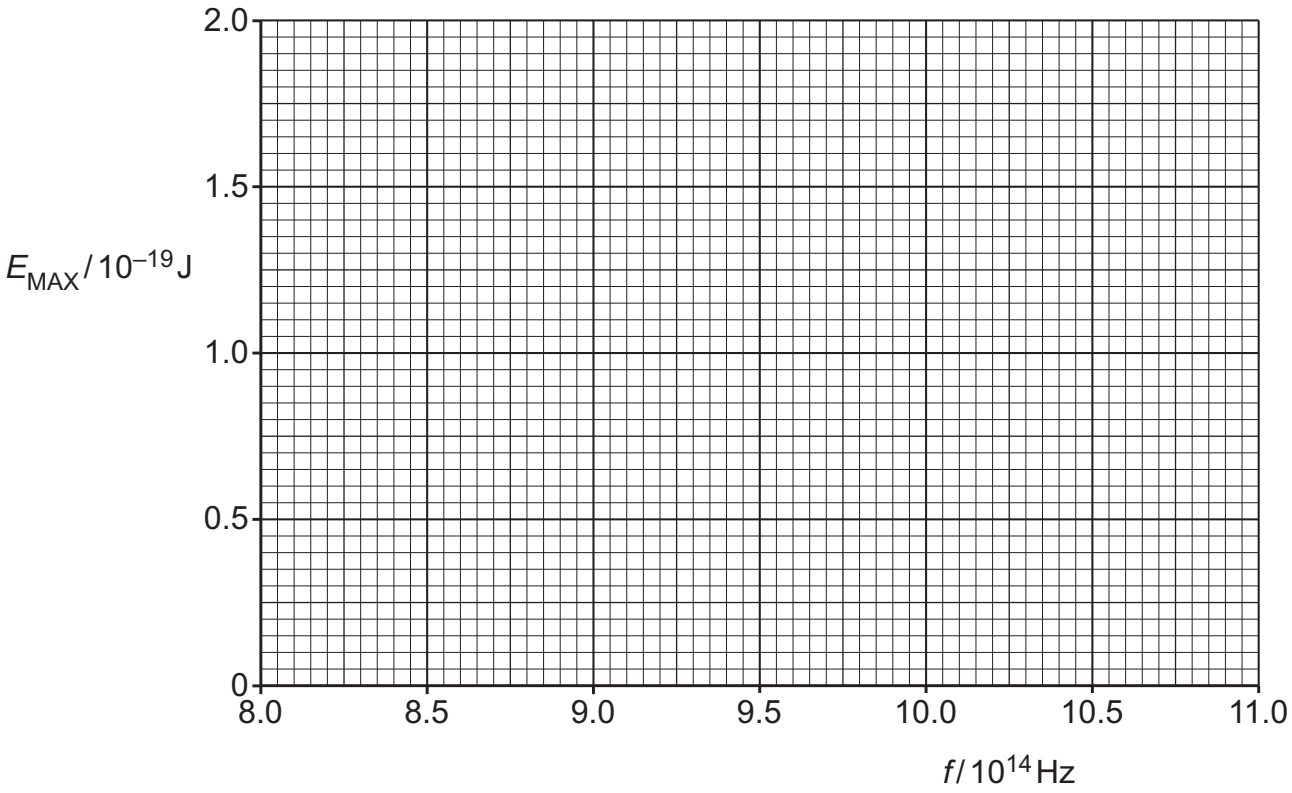

Fig. 8.1

[3]

[Total: 9]