# Einstein Photoelectric Equation And How Did Millikan Prove the Validity Of This Equation

The photoelectric effect was – well known by the end of the 19th century. Its explanation was one of Einstein's first applications of his photon model for light. He devised an equation relating the energy of the photoelectrons to the frequency of the light and the work function of the metal used. In 1916, American physicist Robert Millikan completed some experiments that tested Einstein's equation. Though Millikan had been firmly against quantum theory, the results convinced him that Einstein was right.
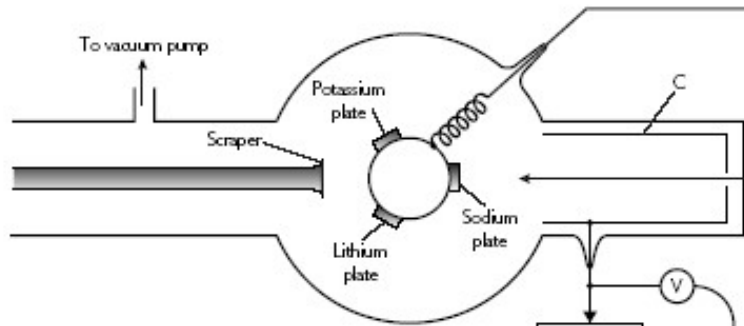
In Millikan's photoelectric apparatus, monochromatic light was incident on each of the newly-cleaned metal plates in turn. The resulting photoelectrons were collected by electrode C and flowed, via the variable resistor and microammeter, back to the plate assembly. By adjusting the potentiometer, Millikan found the potential difference that was just large enough to stop the electrons moving round the circuit. For each metal, he used radiation of several different frequencies, noting the `stopping voltage' for each. This graph shows some of his results for sodium.
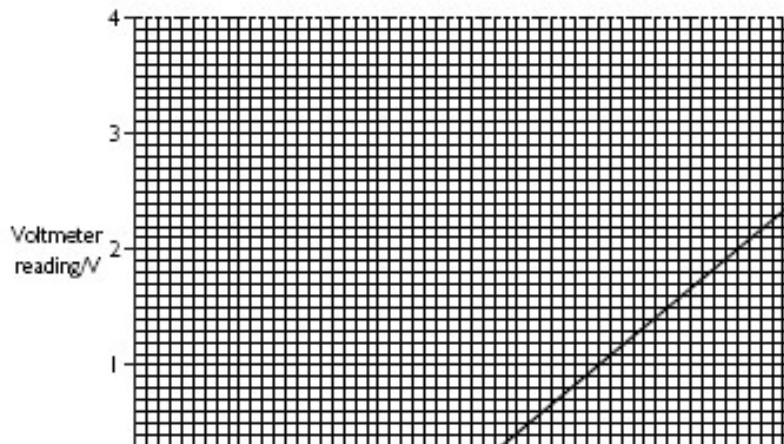
(a)   Use the graph to find the threshold frequency for sodium.

(b)   Calculate the work function for sodium using your answer to (a). $h = 6.63 \times 10^{-34}$ J s.

(c)   Use your answer to (b) to find the maximum kinetic energy of photoelectrons emitted from sodium when the frequency of the incident light is 10×10^{15} Hz. Give your answer in joules and in electronvolts. $e = 1.6 \times 10^{-19}$ C

External reference

Answers and worked solutions

(a) 5.6×10^{14} Hz

(b) $\phi = hf$ (since $E_k = 0$)

$\quad = 6.63 \times 10^{-34}$ Js $\times 5.6 \times 10^{14}$ Hz

$\quad = 3.7 \times 10^{-19}$ J

(c) $E_k = hf - \phi$

$\quad = 6.63 \times 10^{-34}$ Js $\times 1.0 \times 10^{15}$ Hz $- 3.$

$\quad = 2.9 \times 10^{-19}$ J

External reference