A4. This question is about the photoelectric effect.

(a) State **three** pieces of evidence provided by the photoelectric effect that support the particle nature of electromagnetic radiation. *[3]*

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2. . . . . .
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3. . . . . .
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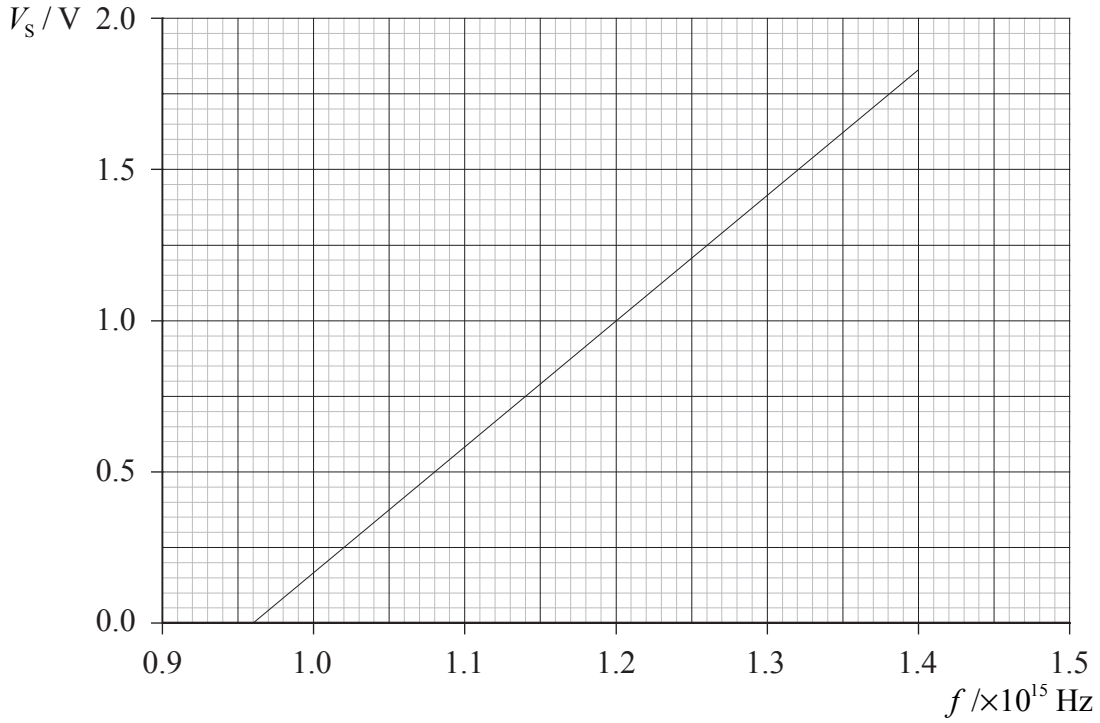
The graph below shows the variation with frequency f of the stopping potential V_S for photoelectrons emitted from a metal surface.



The photoelectric equation may be written in the form of the word equation

photon energy = work function + maximum kinetic energy of electron.

(b) (i) State this equation in terms of f and V_S, explaining all other symbols you use. *[3]*

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(Question A4 continued)

(ii) Use your equation to deduce that the gradient of the graph is $\frac{h}{e}$. *[2]*

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(iii) Given that the Planck constant is $6.6\times10^{-34}\,\text{J s}$, calculate a value for the work function of the surface. *[2]*

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A4. This question is about the wave nature of matter.

(a) Describe the concept of matter waves and state the de Broglie hypothesis. *[3]*

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(b) An electron is accelerated from rest through a potential difference of 850 V. For this electron

(i) calculate the gain in kinetic energy. *[1]*

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(ii) deduce that the final momentum is 1.6×10^{-23} N s. *[2]*

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(iii) determine the associated de Broglie wavelength. (Electron charge $e = 1.6\times10^{-19}$ C, Planck constant $h = 6.6\times10^{-34}$ J s) *[2]*

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