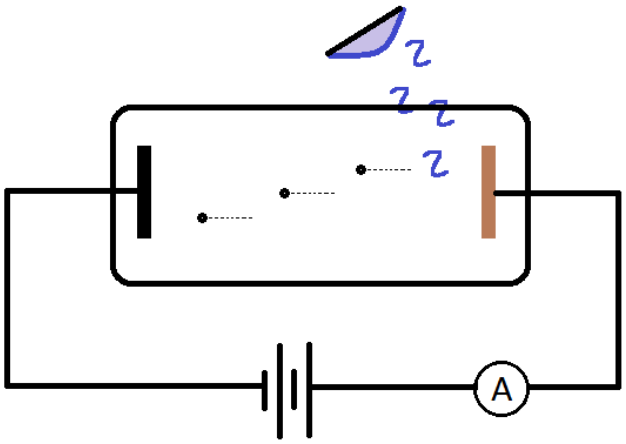
Question 19 **(14 marks)**

A photoelectric effect experiment using copper as the target anode is shown in the diagram below.



The required stopping voltage (V) to reduce the current reading in the ammeter to zero for a variety of light frequencies was recorded.

Frequency ($\times 10^{15}$ Hz)	Stopping voltage (V)	Max Kinetic Energy of Photoelectrons ($\times 10^{-19}$ J)
1.0 ± 0.2	-	-
1.5 ± 0.2	1.10	1.76
1.9 ± 0.2	2.76	4.42
2.3 ± 0.2	4.42	7.07
2.9 ± 0.2	6.90	

(a) The lowest incident frequency used did not have a stopping potential measurement. Suggest a reason why. (2 marks)

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(b) Calculate the maximum kinetic energy of the photoelectrons produced from a 2.90×10^{15} Hz light source. Add this value to the table of results. (2 marks)

(c) Draw a graph maximum kinetic energy (E_k) of the photoelectrons (in joules) vs frequency (f). Place E_k on the vertical axis for which the scale is already provided. Add error bars for the frequency values. Include a line of best fit. (5 marks)

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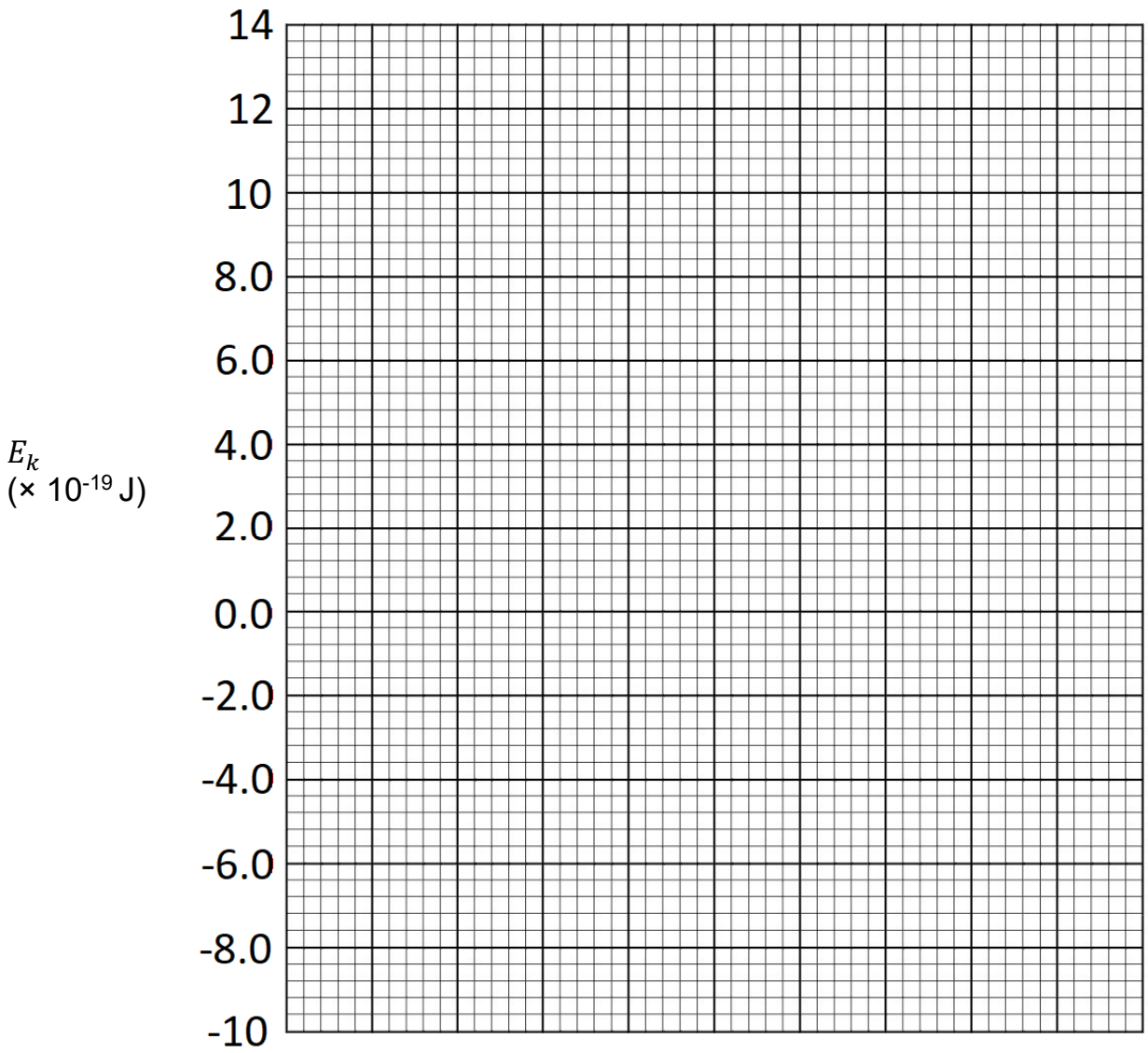

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(d) Using the graph, determine the work function (W) of copper. Justify your answer.
(2 marks)

Work Function: _____

Justification:

_____

_____

_____

(e) Calculate the gradient of the graph and use this value to determine Planck's constant.
(3 marks)

Planck's constant : _____ J s