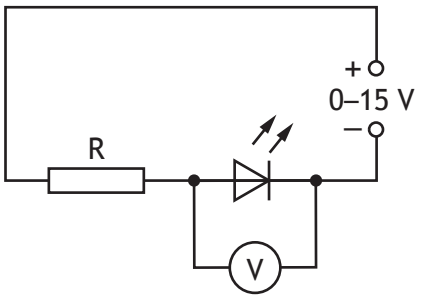
14. A student carries out an experiment to determine the value of Planck's constant h, using various LEDs.

An LED that produces light of known frequency f is connected into the circuit as shown.



The student adjusts the voltage output of the variable power supply until they see the LED start to emit light.

The student records the potential difference across the LED at this point. This is the switch-on voltage V of the LED.

The student repeats this procedure using a number of LEDs, each producing light of a different known frequency.

To determine a value for Planck's constant, the student uses the relationship

$$eV = hf$$

where e is the charge on an electron.

The results obtained by the student are shown in the table.

f ($\times 10^{14}$ Hz)	V (V)
4.5	1.38
5.0	1.62
5.1	1.65
5.3	1.74
6.4	2.32

(a) Using the square-ruled paper on *page 40*, draw a graph of V against f. **3**

(The table of results is also shown on *page 41*, opposite the square-ruled paper).

14. (continued)

(b) Calculate the gradient of your graph. **2**

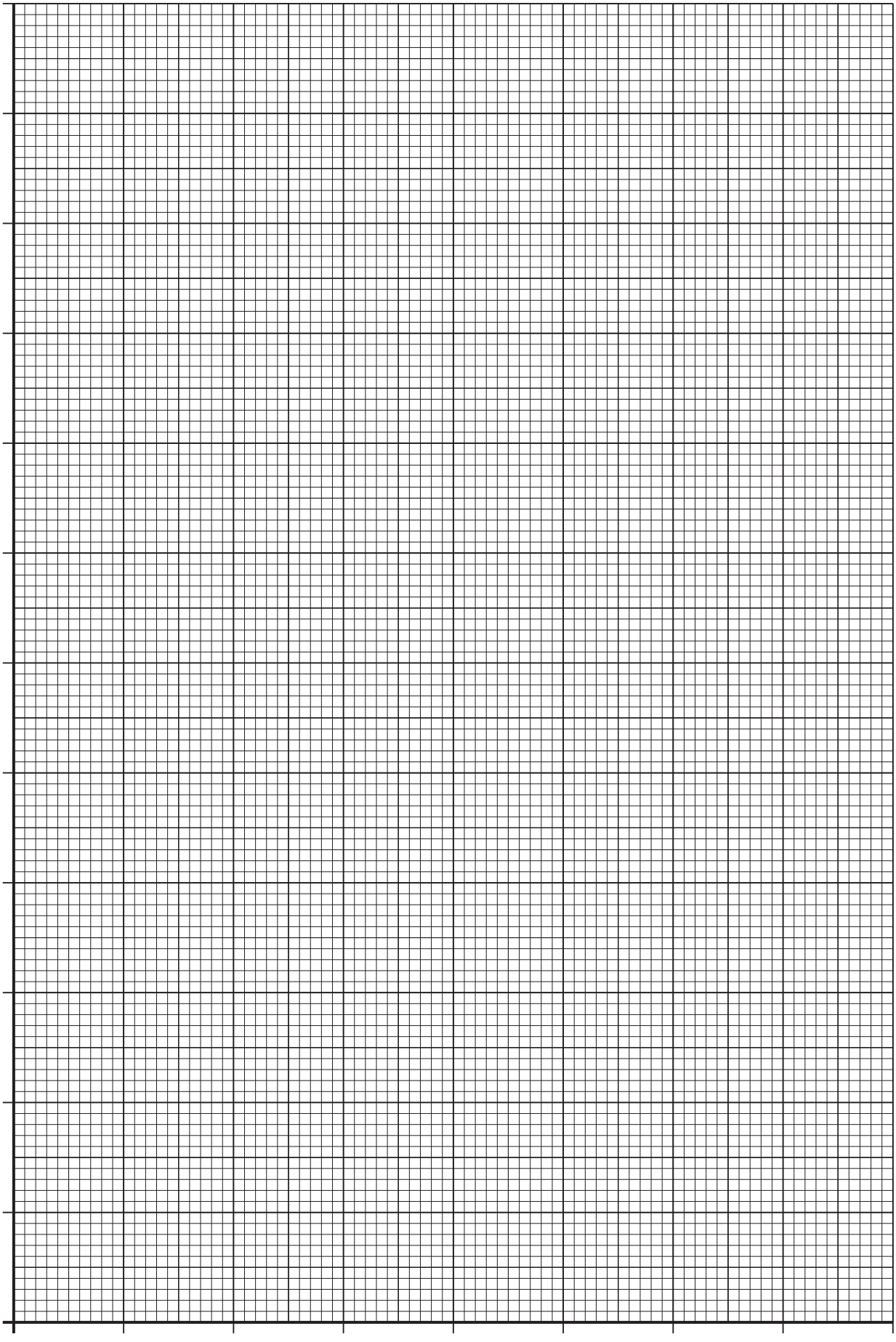
Space for working and answer

(c) **Using the gradient of your graph**, determine a value for Planck's constant h. **2**

Space for working and answer

(d) Suggest one improvement to the experiment the student could make that would improve the accuracy of their final result. **1**

[END OF QUESTION PAPER]



ADDITIONAL SPACE FOR ANSWERS AND ROUGH WORK

Additional table for use with question 14 (a)

f ($\times 10^{14}$ Hz)	V (V)
4.5	1.38
5.0	1.62
5.1	1.65
5.3	1.74
6.4	2.32