2001 HIGHER SCHOOL CERTIFICATE EXAMINATION

Physics

Centre Number

Section I – Part B (continued)

Student Number

Marks

Question 24 (6 marks)

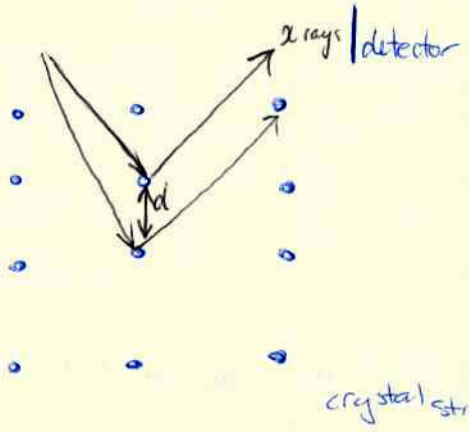
Sir William Bragg and his son Sir Lawrence Bragg shared the Nobel prize for physics in 1915 for their work on X-ray diffraction and crystal structure analysis.

(a) Describe ONE way in which an understanding of crystal structure has impacted on science. **2**

It has allowed scientists to understand why crystals have specific properties such as hardness which means that they can attempt to ~~replicate~~ ~~exact~~ synthetically replicate desired properties

(b) Outline the methods of X-ray diffraction used by the Braggs to determine the structure of crystals. **4**

The Braggs knew the wavelength of x-rays. They aimed x-rays at a crystal structure from a range of angles and noted the resultant interference pattern that was produced. By looking ~~using~~ at the maxima and minima of interference and ~~the data~~ analysing these with the use of the wavelength of x-rays they were able to determine the distance 'd' between atoms within the crystal. Repeating these methods and calculations ensured that their results were reliable.



crystal structure

Marks

Question 25 (6 marks)

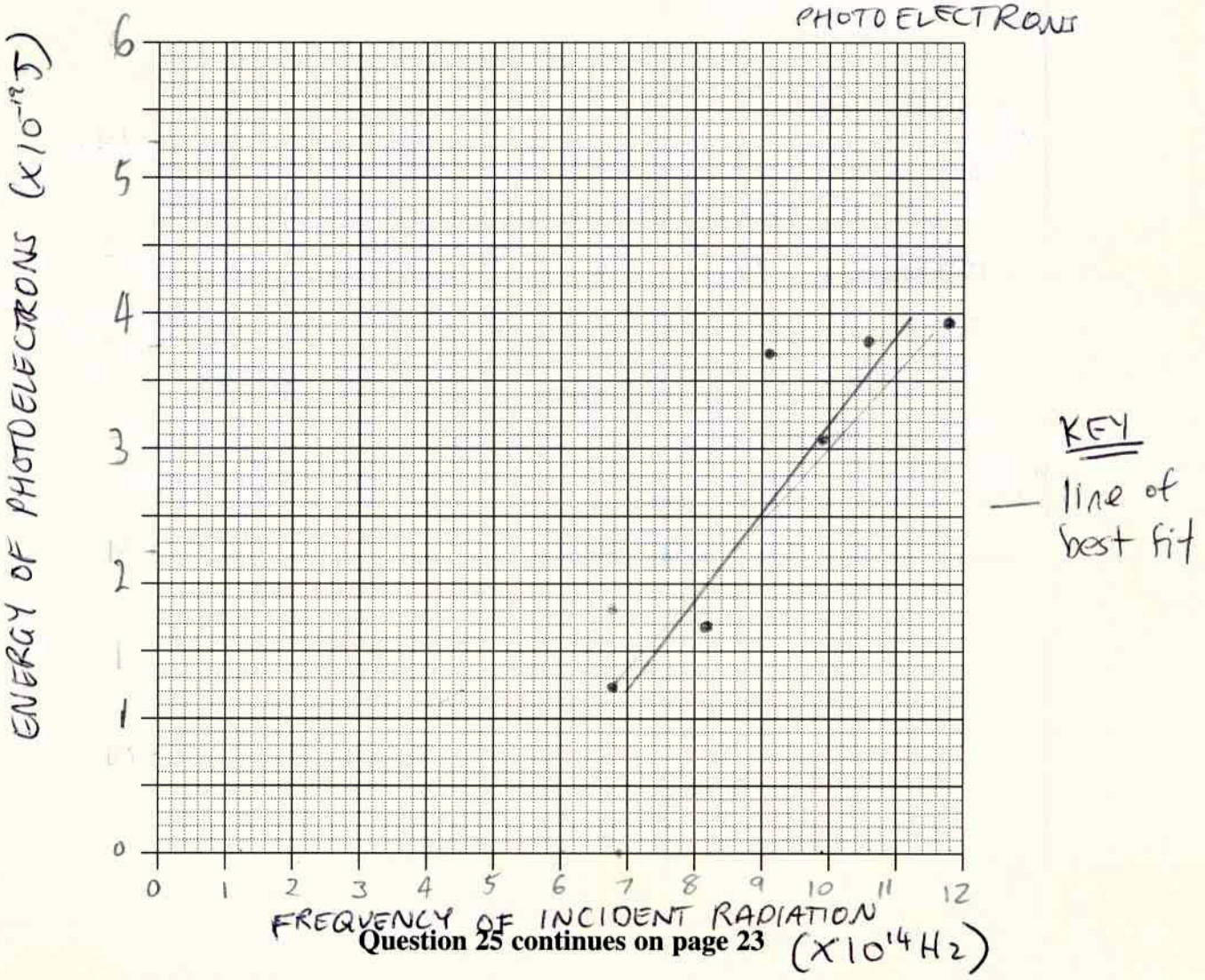
A student carried out an experiment on the photoelectric effect. The frequency of the incident radiation and the energy of the photoelectrons were both determined from measurements taken during the experiment.

The results obtained are shown in the table:

Frequency of incident radiation ($\times 10^{14}$ Hz)	*Energy of photoelectrons* ($\times 10^{-19}$ J)
6.9	1.22
8.2	1.70
9.1	3.70
9.9	3.05
10.6	3.38
11.8	3.91

(a) Graph these results on the grid, including the line of best fit. **4**

GRAPH OF FREQUENCY OF INCIDENT RADIATION VS ENERGY OF PHOTOELECTRONS



Question 25 continues on page 23

Marks

Question 25 (continued)

(b) How could the reliability of the experiment be improved? **2**

could be
- The energy at each frequency should have measured 3 times each and the average taken.
- More ~~measurements made~~ frequencies tested to get a more accurate line of best fit.

Question 26 (8 marks)

In the context of semiconductors, explain the concept of *electrons* and *holes*. **8**

Semiconductors ~~are~~ consist of an element such as silicon that has been doped (an impurity has been added) or a group 5 or a group 3 ~~metal~~ element. In the lattice structure of such a semiconductor, a Group 3 element will have one less electron in its outer shell. In comparison to the silicon atoms, this 'gap' can be seen as a positively charged hole. Conversely, in comparison to the silicon a Group 5 element has a ~~excess~~ electron. ‡ ~~The~~ electrons migrate ~~across or~~ through a semiconductor the 'hole'* made by the Group 3 element appears to migrate in the opposite direction to the electron flow as the electrons filling the hole ~~make~~ left leave a gap where they had been. The excess electrons ~~also~~ migrate in the direction of the electron flow, ~~in this~~ with a negative charge. ~~For this reason~~ ~~Both~~ ~~other~~ For this reason semiconductors are named p-type (positive) or n-type (negative) according to the way charge flows through them.

* with a positive charge

‡ When the semiconductor does conduct a current,