

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.

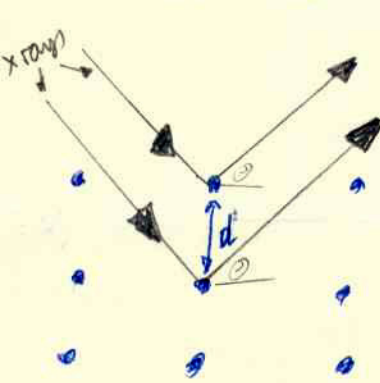
- (a) Describe ONE way in which an understanding of crystal structure has impacted on science. 2

Understanding of crystal structure allowed scientists to understand for example how electricity is conducted. They can improve the properties of different materials by understanding the crystal structure, and changing it by the addition of other materials, such as carbon to iron to make it into stronger, harder, steel.

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

X rays ~~was~~ were directed at the crystal structure, and were reflected ~~back~~ and ~~reflected~~ diffracted back. By measuring the interference pattern of these ~~reflected~~ ~~x~~ diffracted x-rays, they could find the inter-atomic spacing between ~~atoms~~ particles of the lattice (d), by using the formulae $n\lambda = d \sin \theta$. They could also determine the angle at which the ~~etc~~ x rays ~~are~~ are diffracted, and thus could determine the crystal structure.

$n\lambda = d \sin \theta$



↑ atoms in crystal lattice

Marks

Question 25 (6 marks)

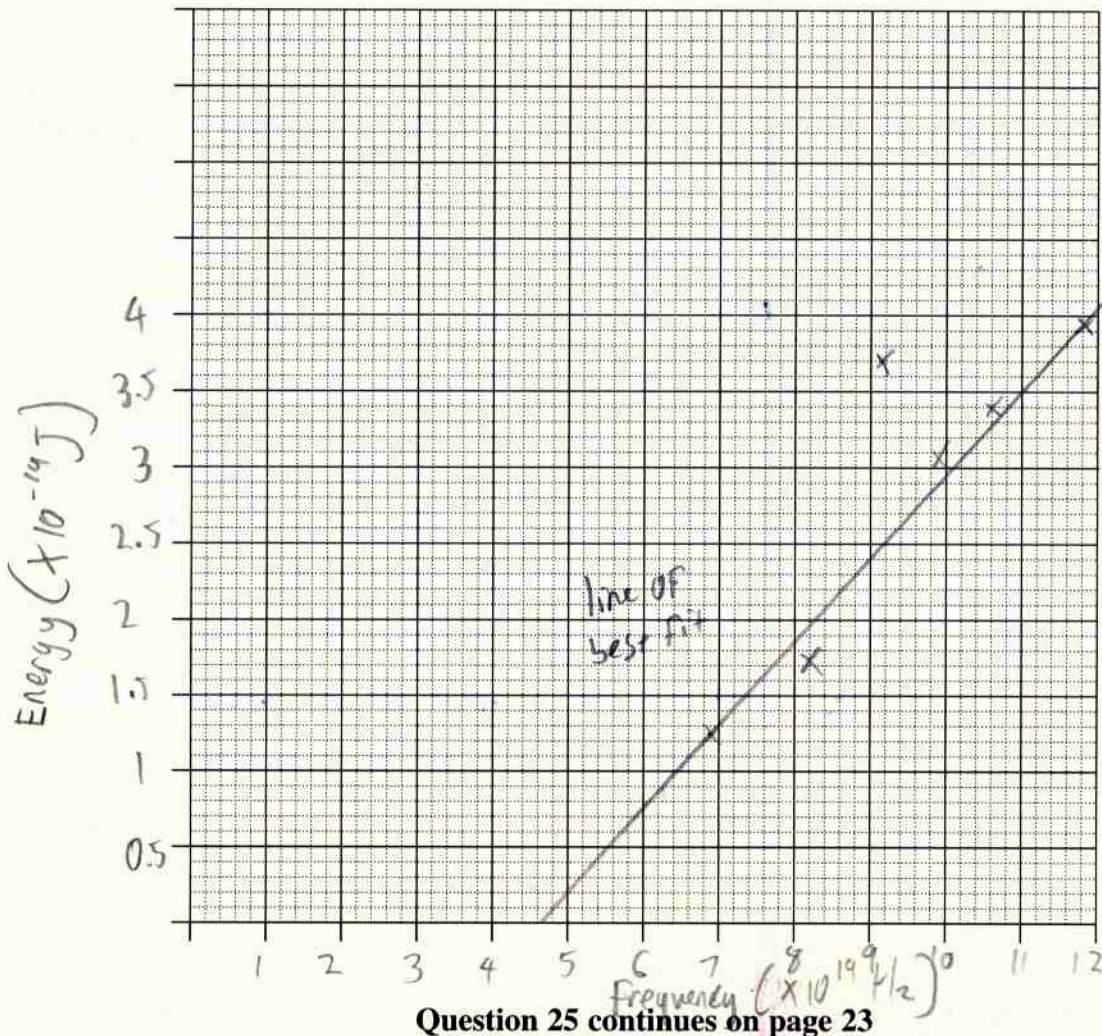
A student carried out an experiment on the photoelectric effect. The frequency of the incident radiation and the energy of the photoelectrons were both determined from measurements taken during the experiment.

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



Question 25 continues on page 23

Marks

Question 25 (continued)

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

2

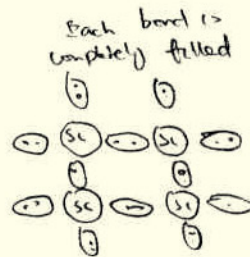
Reliability could be significantly improved by repetition. The value for frequency $9.1 \times 10^{10} \text{ Hz}$ was so inconsistent that the ~~experimenter~~ ^{student} should have taken many measurements for that frequency. ~~A better method~~ ^{is} ideally, lots of repetitions should occur, with accurate measurements, and the mean should be found (discounting erroneous or inconsistent figures).

Question 26 (8 marks)

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

8

Semiconductors conduct through the use of ~~se~~ holes and electrons. Generally, a semiconductor has 4 electrons in its valence shell. When it is bonded tightly in a crystal lattice all the electrons are used and hence no electricity is allowed to flow through the semiconductor. Refer to diagram on right. However if sufficient heat or energy is injected into the semiconductor this results in some electrons which are able to escape this band. However with the heat allowing electrons to escape into the valence band a subsequent hole is left in the ionic bond. This creates an area of positive influence and hence a nearby electron is attracted into the bond but the electron subsequently creates another hole. This is continually repeated and as a result the semiconductor is able to conduct a current. This form of conduction is classified as intrinsic semiconduction. Both electron and holes are the majority charge carriers. Please refer to diagram at the bottom for diagrammatical representation of the above explanation.



The hole created creates a positive region which attracts a nearby electron

