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**

The 3D ~~ordered~~ lattice of solids (embedded in a sea of electrons) allowed the understanding of its good conductivity.

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

- Fired x-rays at a crystal.
- ~~Used a detector and~~ measured the ~~distances~~ angles in which the x-rays diffracted, and hence calculated the distance between atoms of the crystal.
- measured the x-ray diffraction by the constructive and destruction interference patterns.
- The distance calculated led them to determine that the crystal has a 3D ordered lattice.

Marks

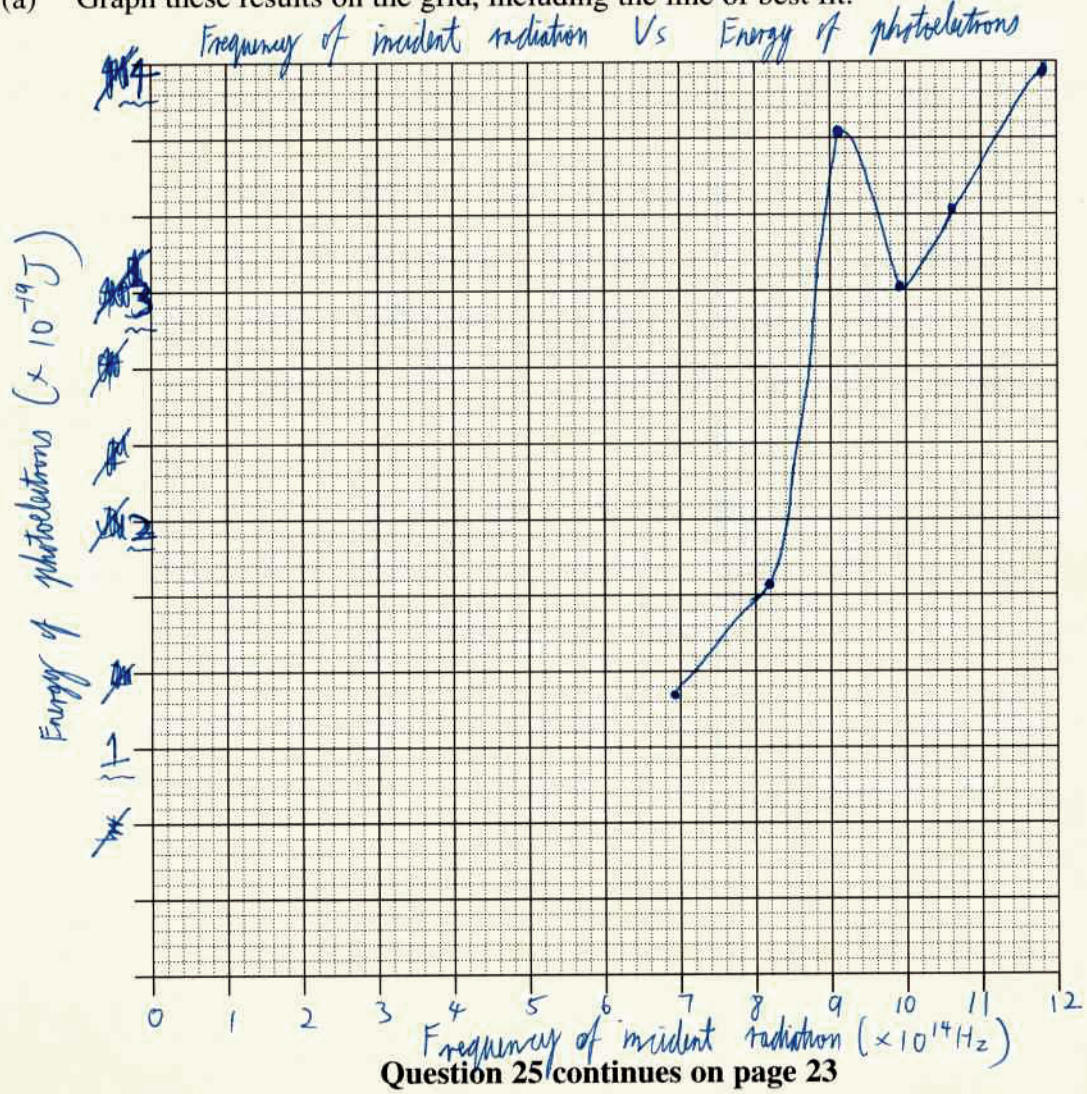
Question 25 (6 marks)

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)

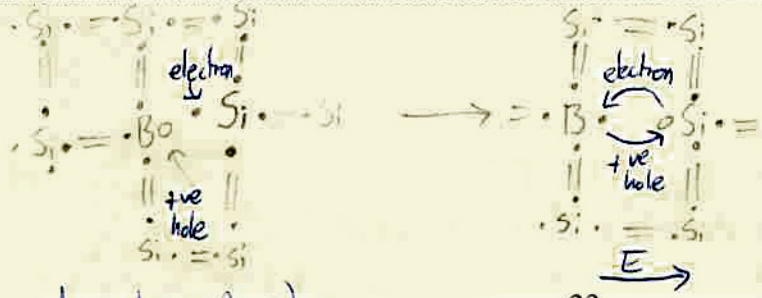
(b) How could the reliability of the experiment be improved? **2**

~~How~~ Have more values of frequency of incident radiation and hence more results can be obtained. Use other materials to observe the different effects. ~~Best~~ Repeat the experiment several times. Use more sensitive and accurate instruments.

Question 26 (8 marks)

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

Semiconductors consist of atoms, such as Silicon and Germanium, that come from Group 4 in the periodic table. They form crystalline structures where covalent bonds form between all electrons. Some of the electrons can move from the ~~conduction~~ valence band into the conduction with ~~thermal~~ energy. This is the essences of semiconductors. Semi-conductors can become more conductive, if doped with a atom from group 3 (p-type) and group 5 (n-type). In p-type doping, there is one less electron ~~missing~~ in the valence shell, which results in a positive "hole". This hole can move thru the conductor when an Electric field is applied, this results in the flow of electrons, thus increasing conductivity. n-type doping works the same except instead of one less electron, it has one more. Again, ~~with~~ this unbonded electron easily moves thru the lattice with the application of an electric field, and thus increases conductivity.



A p-type doped Silicon semiconductor

movement thru semiconductor of electron + hole with electric field