

2001 HIGHER SCHOOL CERTIFICATE EXAMINATION

Physics

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Centre Number

Section I – Part B (continued)

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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 understanding that crystal structure is composed of regular lattices has led to the developments and use of superconductors. ~~The use of superconductors are utilised~~ and the understandings of how superconductors work.

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

~~x-rays have a very high frequency~~
~~x-rays~~ A beam of x-rays is bombarded on a crystal surface creating a diffraction pattern which can be detected by photographic film. The nature of this diffraction pattern is used to determine the crystal lattice structure. X-rays are used because their wavelengths are similar to the inter atomic spacings in crystals. In this way the arrangements of atoms can be determined and determined.

Marks

Question 25 (6 marks)

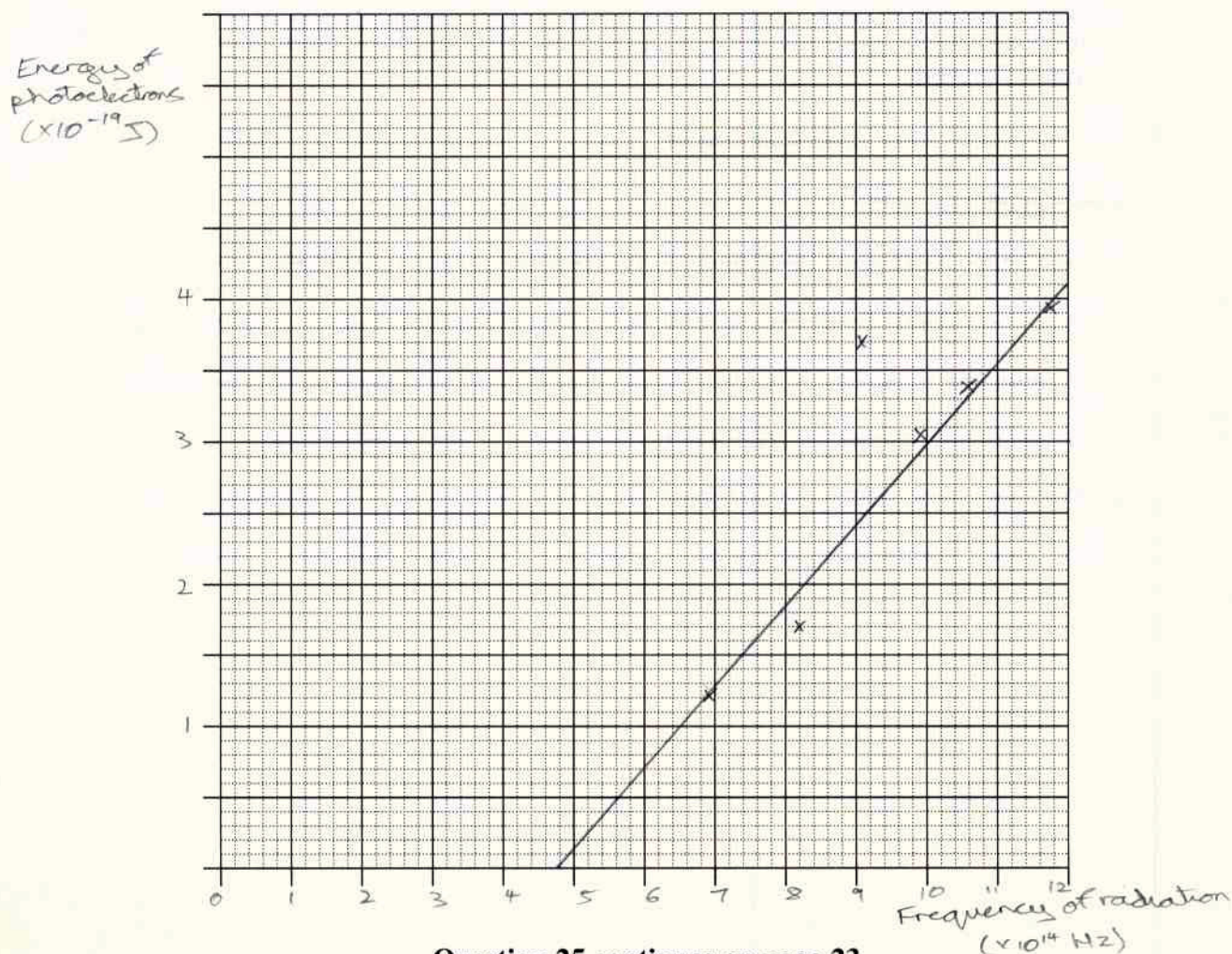
A student carried out an experiment on the photoelectric effect. The frequency of the incident radiation and the energy of the photoelectrons were both determined from measurements taken during the experiment.

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.

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Question 25 continues on page 23

Question 25 (continued)

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

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- Perform multiple repeats of the experiment.....
- Perform the experiment with a larger range of frequencies.....
- Make sure the same metal for the cathode is used.....
- and that it is free from impurities that may.....
 affect the release of electrons.....
- Perform in a darkened, enclosed room so the only incident.....
 radiation comes from the light source used in the experiment.....

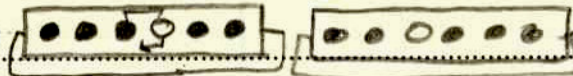
Question 26 (8 marks)

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

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..... In semiconductors, when the material is excited (with.....
 heat or light/radiation), some electrons from the valence.....
 band may jump to the conduction band, allowing them to move.....
 between atoms and conduct electricity. When an electron jumps.....
 up, it leaves behind a positive hole in the valence band. These kinds of holes.....
~~holes~~ can also allow electricity to be conducted, because the holes.....
 moving in one way are equivalent to electrons moving in the other.....

It can be seen in this diagram:



~~the holes~~
 the holes
 move the other
 direction

When the positive hole moves left, it is the same as the electron.....
 next to it moving to the right. * Thus, as the electrons move one way in the.....
 will result in an electric current. This is the idea behind.....

doping; by adding either an electron or a hole, one.....
 can allow ~~electricity~~ a current to flow. Electrons are added when.....
 a small sample of a group V element, such as Arsenic one added.....
 to a semiconductor with a four-bond ~~covalent~~ lattice structure, the extra.....
 atom will bond on four sides with one electron free to move.....
 & carry a current. when a group.....
 III elements, ^{eg gallium} is used in this way, it will bond.....
 on all of its 3 sides, leaving a hole where the 4th.....
 bond should be. As explained above, these.....
 holes can also be used to conduct electricity.....