## Question 31

a) i) Davison and Germer scattered accelerated electrons from the surface of a nickel crystal. The crystal was rotated to observe the dependent of angles They found distinct maxima and minima of the reflected scattered electrons. This result showed the interference property of electrons. So the experiment confirmed de Broglie's hypothsis that particle particles like electrons had wave properties.

ii) de Broglie's hypothesis stated that particles such as electrons could have wave-properties, since light was explained as having both wave and particle characteristics. He explain thought de Broglie thought electrons were standing waves around the nucleus rather than orbiting around it. If an integral number of electron's wavelengths fitted into the circumference of the orbit, the electron could be stable without radiating energy. This explained why electrons only existed in stationary energy levels in Bohr's model of atoms.

b). i) Pauli suggested the existance of neutrino.

ii) $^{210}_{83}Bi \rightarrow {}^{210}_{84}P_o + {}^{0}_{-1}e + \bar{\nu}$

209.93857amu 209.93678amu + 0.00055amu + 0.

Mass ~~defea~~ defect = 209.93857 − (209.93678 + 0.00055)

= 0.00124 amu

iii) Energy = 0.00124 × 931.5 = 1.15506 MeV

The expected kinetic energy of the emitted electrons in each β-decay is 1.15506 MeV. However, the graph shows that most emitted electrons have ~~kinetic energy test~~ less than the expected one. From Pauli's suggestion of ~~neutrino~~, the ~~missing~~ energy is carried away by the anti-neutrino in ~~the~~ this β-decay. Since the ~~neutrio~~ ~~next~~ anti-neutrino, same as the neutrino, has zero mass and charge, it escapes ~~without our~~ without our notice.

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[illegible]

(c)(i) Bohr postulated that electrons revolve around the nucleus in discrete orbits, each with its own energy state. An electron can jump between these energy levels, emitting or absorbing energy that corresponds to the difference between energy levels. This means that when electrons fall from a higher energy state to a lower energy state, then only certain amounts of energy, and therefore certain wavelengths can be emitted. The Balmer Series provided a mathematical formulae of calculating the wavelengths emitted when jumps between energy levels are made; $\frac{1}{\lambda} = R_H\left[\frac{1}{(n_f)^2} - \frac{1}{(n_i)^2}\right]$

where $n_f$ = final orbit

$n_i$ = initial orbit and $R_H$ = constant

$\lambda$ = wavelength

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It only allows certain quantised wavelengths to be calculated and hence supports Bohr's model of the atom

(iii) 410 nm corresponds to a drop between 6th energy level to 2nd energy level.

∴ next line = 7th to 2nd

$$\frac{1}{\lambda} = R_H \left[\frac{1}{2^2} - \frac{1}{7^2}\right]$$

$$\frac{1}{\lambda} = 1.097 \times 10^7 \left(\frac{1}{4} - \frac{1}{49}\right)$$

$$\lambda = 397 \text{ nm}$$

d) Both Neutron Scattering and electron Scattering, used in the electron microscope have been used to increase our understanding of matter.

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In Neutron scattering, neutrons are fired at a specimen, and their diffraction pattern is used to determine the structure of the substance. Neutrons are extremely good to use, as their neutral charge means they are not deflected by the substance, and they interact with all matter. Also the wavelength of neutrons is very small, so it can interact and create diffraction and interference patterns with the atomic plane of crystal lattices. Neutron Scattering uses the neutrons wave nature, to create diffraction patterns which can be used to study matter. It has been used to increase our understanding of the internal structure of crystals and in metallurgy. In metals, neutron scattering has been used to increase our understanding of the structure of metal alloys, and shown that alloys do not have regular crystal lattices, but are distorted by the alloy material added to the regular lattice of the metal.

Another process used ~~to~~ which has increased our ~~M~~understanding of matter is in electron microscopes. There are two types of electron microscopes, the TEM (transmission electron microscope) and SEM (secondary electron microscope). In the TEM, an electron beam from a electron gun is focused by magnetic fields and transmitted through a specimen, at a fixed distance always. The electrons which get through the specimen, create a real image on ~~the~~ a phosphor screen. This has been used to study the surface structure of specimens (the topography), it also led to the discovery of the sub-cell, and greater understanding of the structure of DNA and RNA. SEM's also use magnetic fields to focus an electron beam, though the beam zig zags across the specimen, and the secondary electrons off the specimen control an electron gun in a TV screen, which produces a 3D image. This has been used also to increase our understanding of structures in

terms of 3D in crystal lattices and for metallurgy. This has also increased our understanding of disease and viruses in medicine, and the structure of these is able to be determined when using the electon microscope.

Both Neutron scattering and the electon microscope have increased our understanding of matter, and use the wave and particle nature of electons and neutrons to gain a greater degree of the understanding of the structure of matter.