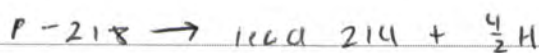


(a)

(i) ⁽¹⁰⁾ A Wilson cloud chamber, can be used to distinguish between alpha decay and beta decay. Due to the ionisation paths that these atoms leave when scattering through the cloud chamber. As the compressed air causes ion of the atoms, that the electron will ion strongly as it loses its negative charge, whereas the alpha particle will not as it will gain a positive ion as its neutral state. Furthermore, the density of the ~~light~~ trails left behind in a Wilson cloud chamber suggests most of the atoms, as the ~~light~~ alpha particle being more massive will have a longer trail whereas the electron will not.

(ii)



$$m_{\text{reactants}} = 218.00897u$$

$$m_{\text{products}} = 213.99991 + 4.00260$$

$$m_{\text{reactants}} - m_{\text{products}} = \text{mass defect}$$

$$m_{\text{mass defect}} = 0.00656$$

$$\text{Energy released} = 0.00656 \times 931.5$$

$$E = 6.11064 \text{ MeV}$$

(b) (i) $c = f \lambda$ $f = \frac{E}{h}$

$0.2 \times 10^{-9} = \lambda$

$\lambda = \frac{h}{mv}$

$v = \frac{h}{m\lambda}$

$v = \frac{6.625 \times 10^{-34}}{(1.675 \times 10^{-27})(0.2 \times 10^{-9})}$
 $= 1977.91 \text{ m s}^{-1}$

(ii) Neutrons are useful at determining the structure of materials, as it is a good ~~mass~~ at probing materials. The ~~neutron~~ neutron has a de Broglie wavelength, thus can ~~compare~~ ~~it~~ ~~with~~ ~~the~~ ~~same~~ ~~size~~ ~~of~~ ~~the~~ ~~electron~~ ~~orbits~~ ~~hence~~, it can ~~penetrate~~ ~~the~~ ~~valence~~ ~~band~~ ~~and~~ ~~probe~~ ~~the~~ ~~nucleus~~. Furthermore, the neutron has no charge, thus it can ~~penetrate~~ ~~deep~~ ~~into~~ ~~an~~ ~~atom~~ ~~without~~ ~~it~~ ~~being~~ ~~deflected~~, ~~due~~ ~~to~~ ~~the~~ ~~strong~~ ~~electric~~ ~~forces~~ ~~of~~ ~~the~~ ~~proton~~ ~~and~~ ~~neutrons~~ ~~in~~ ~~the~~ ~~atom~~. ~~Furthermore~~ Neutrons also possess almost the same mass of protons, with only a 2×10^{-30} kg difference, thus the neutron is efficient at ~~the~~ ~~probing~~ ~~and~~ ~~as~~ ~~it~~ ~~can~~ ~~penetrate~~ ~~and~~ ~~deliberate~~ ~~any~~ ~~atom~~ ~~it~~ ~~collides~~ ~~with~~.

(d)

(i) The conclusion of the Davisson and Germer experiment, was that electrons were a wave, and had ~~various~~ wavelengths. As when the electrons were fired at the accidentally crystallized nickel, it diffracted at them in such a manner a variety of angles. This diffraction is a property of waves thus proving what wave-particle nature of electrons and cathode beams with wave length similar to the interatomic structure of crystal distance 10^{-10}m .

(ii) This was vastly significant to the Rutherford-Bohr atom, as this recognition of electrons having wave properties proved Bohr's postulates, as it explained why the electrons didn't emit EMR, and also proved that electrons had quantised shells, which was the energy level of that specific wavelength of electron as proven by the ~~Bohr~~ discovery of the wave nature. This discovery was also significant as it led to further hypothesis being made such as de Broglie, as he stated that electrons orbited in standing waves, with a particular wavelength. Which then explained the limitations of the Rutherford-Bohr Atom, as not being able to explain hyperfine lines and the Zeeman effect and only being able to explain the ~~hydrogen~~ spectra of hydrogen and not other elements.

(e) This discovery of Chadwick, of the neutron, was a vast impact on the understanding of atomic nuclei, as it meant that this atom, with a definite charge, no charge, and mass similar to a proton, could be the perfect piece required. This perfect piece led to advances in knowledge by Fermi, as the probing of U-235, led to the discovery of fission, and controlled nuclear reactors through the ~~detected~~ probing of neutrons, which then led to the atomic bomb, and nuclear fission reactors the prime of nuclear physics.

Furthermore, the work of Fermi in discovering the forces that the nuclei possessed further led to the development of atomic bombs, as Fermi work with controlled nuclear reactions involved the 4 basic forces of physics, the electromagnetic, weak force, gravitational force and the strong nuclear force, developed an understanding on how the nuclei are held together. As they discovered electromagnetic force and gravitational force, and electromagnetic force \rightarrow the gravitational law theorised that a ~~2nd~~ third strong nuclear force must hold the atom together, which then when broken apart can release vast amounts of energy which led to the development of nuclear fission reactors, enhancing the strong nuclear force to create power.

Furthermore, Fermi's ~~work~~ discovery of fission and fusion lead to the discovery of numerous new radioisotopes, in which have uses of theoretical and medical benefits. As radiotherapy uses C-14 ammonia to give cancerous cells, and free neutrons to become infertile, removing them as a pest. Also these fission created isotopes can be used to detect leaks in pipes. Thus due to the advancement of knowledge by Fermi our society has been greatly impacted.

If you require more space to answer parts (d) and (e) of the question, you may ask for an extra writing booklet.

If you have used an extra writing booklet for parts (d) and (e) of the question, tick here.