(a) i. A Wilson cloud chamber tracks the path of radiation by providing a saturated environment that the radiation condenses on. By providing an internal electric field, the movement of alpha & beta particles (positive & negatively respectively) can be tracked & their movement within the field would determine their charge.

ii. α

$${}^{218}_{84}Po \rightarrow {}^{214}_{82}Pb + {}^{4}_{2}He^{+}$$

$$218.00897 \rightarrow 213.99981 + 4.00260$$

$$\text{mass defect} = 218.00897 - [213.99981 + 4.00260]$$
$$= 0.00656$$

$$E = 0.00656 \times 931.5 \ (MeV/c^2)$$
$$E = 6.1 \ MeV$$

(b) i. $\lambda = \frac{h}{mv}$ $\lambda = 0.2nm = 2 \times 10^{-8}$ m

$m = 1.675 \times 10^{-27}$

$2 \times 10^{-8} = \frac{6.626 \times 10^{-34}}{v \times 1.675 \times 10^{-27}}$ $h = 6.626 \times 10^{-34}$

$v = \frac{6.626 \times 10^{-34}}{1.675 \times 10^{-27} \times 2 \times 10^{-8}}$

$= 0.00019$ m/s

$= 1.9 \times 10^{-4}$ m/s

ii. This beam of ~~elec~~ neutrons is moving relatively slow, meaning that they are more easily captured by the nucleus, resulting in a successful bombardment. Since the ~~nucleus~~ neutron is neutral, it is easily able to entre the nucleus. Once inside, it is able to possibley break apart the nucleus through fission, which enables scientists to examine the structure of the atom. Also, being almost the same size & weight of protons, bombarding the nucleus allows for the behaviour of protons to be assessed, which is essential for ~~the~~ understanding the structure of ~~the~~ materials.

(c) The spectroscope showed that ~~the~~ when heated, elements emitted certain colours on the spectrum. For hydrogen, this was termed the hydrogen emission spectrum. This ~~model~~ phenomomen could not be explained by Rutherford's model, and lead to Bohr's ~~prost~~ explanation of the Balmer Series. Although Balmer had already mathematically known the relationship b/w λ and 2°, he had not explained it. Bohr added to his prostulates that when an electron dropped to shell 2, it followed the equation $\frac{1}{\lambda} = R\left(\frac{1}{2^2} - \frac{1}{n_i^2}\right)$ and later showed this for any shell (1 & 3 in regards to UV & IR). When an electron dropped to shell 2, it would release a quantised amount of energy that ~~gave~~ had a wavelength ~~of~~ in the visible light. This effectively explained the Hydrogen emission spectrum, leading to a more complete version of Bohrs model.

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

If you have used an extra writing booklet for parts (a), (b) and (c) of the question, tick here. ☐

(d) i. Davisson & Germer found that the detector recorded a series of maxima & minima, implying that the electrons had undergone refraction and interfered, meaning that they had wave like properties. ~~when compa~~ This led them to conclude that electrons had ~~were both waves & particles~~ wave particle duality

ii. This experiment had a large impact on the Bohr-Rutherford model. firstly, it explained the stability of electrons in orbit, since they are no longer moving charges, they do not produce EMR & lose energy. It also lead to Bohr using a large mix of classical & quantum physics in his model, a move that attracted criticism. Finally, this ~~thou~~ lead to Bohr-Rutherford model improving with contributions of people like de Broglie & Pauli, leading to the model of the atom developing into a more correct representation

(e) <u>Discovery of strong nuclear force</u>: using classicle physics, it was shown that the repulsive force ~~[illegible]~~ (electromagnetic) of the protons in the nucleus was much larger than the gravitational force keeping them together. Following that logic, the nucleus should not be stable, yet it was shown to be so. There had to be another force holding the nucleus together ~~holding the~~ Scientists proposed the strong nuclear force, that acted at very small distances. It was its strongest at ~~[illegible]~~, a similar distance to the space between particles in the nucleus, ~~This allowed for scienti~~ and was almost zero at large distances. This allowed scientists to gain a greater understanding of the stability of the nucleus.

<u>Discovery of the Neutron</u>: when Chadwick discovered the neutron experimentally, it brought about rapid changes to the model of the atom. Rutherfords model had only mentioned a small, positively charged mass as the 'nucleus', and this provided the missing link. The discovery of the nucleus further explained the stability of the nucleus, with neutrons being inbetween protons. It also

~~showed that why larger atoms~~ became ~~were~~
~~unstable, as they had too many protons~~
allowed for neutron scattering, which is used to further investigate the nucleus. Thus the discovery of the neutron was essential in the development of the understanding of the atomic nucleus.

Development of Standard Model & <u>Discovery of the Neutrino</u>: this marked the discovery of the first sub-atomic particle other than p, n, e⁻, and gave birth to the standard model of matter. This included extensive study of neutrons & protons, which are actually quarks (hadrons). The fact that neutrons & protons are each made up of different fundamental particles changed thinking at the time, and allowed for their properties to be examined & explained. For example, it explained why protons & neutrons have a similar mass & different charges. These three discoveries & developments have lead to rapid changes & a large overall understanding of the nucleus.

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. ☐