(a)

i) A Wilson Cloud Chamber or similar device could be used to distinguish between alpha decay and beta decay, as they can work out the number of neutrons, protons, and electrons, discovering whether a particle has undertaken beta or alpha decay. If more neutrons are present, then beta decay has taken place, if gamma rays are found, alpha decay has taken place.

ii) Polonium 218 = Lead 214 + $^{4}_{2}He$ + α

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

$218.00897 = 213.99981 + M + 4.00260$

$M = 0.00656$

Po = Mass nucleus − Mass of constituent nucleons

$= (218.00897) - [(84 \times 1.673 \times 10^{-27}) + (134 \times 1.675 \times 10^{-27})]$

$= (218.00897) - [(84 \times 1.007225) + (134 \times 1.00843)]$

$= (218.00897) - [(84.6069) + (135.12962)]$

$= 1.72755$ u

$= 2.869 \times 10^{-27}$ kg

$E = mc^2$

$E = (2.869 \times 10^{-27})(3 \times 10^{8})^2$

$= 2.583 \times 10^{-10}$ J

$= 1.61$ MeV

(b)

i) $\lambda = (0.2 \times 10^{-6})$

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

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

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

$$V = \frac{(6.626 \times 10^{-34})}{(1.675 \times 10^{-27})(0.2 \times 10^{-6})}$$

$$V = 1.98 \text{ ms}^{-1}$$

ii) Neutron scattering it a useful tool in determining the structure of new materials. By launching neutrons at a substance, and waiting to see what goes through the substance, what reflects, what refracts, the structure of the material can be determined. Overall, by using neutrons, the structure of new materials can be determined.

(c) Bohr's model of the atom was not accepted by society at first. This was due to various limitations. These limitations can include that he used a combination of classical and quantum physics, it did not work for multi electron atoms, and he couldn't account for the fact that various lines on the hydrogen spectrum were actually very small hyperfine lines put together. The introduction of the spectroscope allowed him to study the hyperfine spectral lines on the hydrogen spectrum. Through this, he was able to account for the spectral lines which he previously couldn't do. Overall, the spectroscope was important in the development of the Bohr Model of the atom, as it allowed scientists to account for the hyperfine spectral lines that were previously a limitation of Bohr's atom 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 and Germer fired electrons at a crystal of nickel with in an evacuated glass tube. The glass tube had a crack in it, therefore the nickel oxidised. They heated the tube to remove the oxidisation, however the heating caused the oxidised layer to anneal, becoming thicker and stronger. Their results showed that an electron had wave like particles, as they were diffracted and reflected. Their conclusion was that electrons were a particle with wave like features.

ii) This experiment allowed the Rutherford - Bohr model of the atom to be accepted by society, as it accounted for the limitations, whilst also following Bohr's postulates. The wave and particle features of the electron accounted for the limitations of the Bohr model, whilst also abiding by the 3 postulates. Therefore, the Davisson Germer experiment was extremely significant in relation to the Rutherford - Bohr model of the atom, as it allowed it to be widely accepted in society. The former limitations had been accounted for, therefore allowing people to accept this model without any doubt.

(e)

The advancement in the understanding of the force which keeps a nucleus in tact allows society to increase their knowledge of atoms. Knowing that a strong nuclear force plus the gravitational force must be greater than the electrostatic force for a nucleus to be stable has had an extremly significant impact on the understanding of the atomic nucleus. Bohr's model of the atom has also been significant in the understanding of the atom, as it allows people to view what an atom actually looks like. Knowing that the nucleus is made up of protons and neutrons, causing the nucleus to be positivly charged, whilst the negatively charged electrons orbit the nucleus in certain shells has had an extremly significant impact on the understanding of the atomic nucleus. The Davisson and Germer experiment, which discovered that electrons are a particle that exhibit wave-like properties further allows society to gain a better understanding of atoms, and in turn the atomic nucleus. The Davisson Germer experiment was extremly influential towards the Bohr model of the atom, which was extremly significant in relation to the

understanding of the atomic nucleus. Overall, the knowledge of the forces that keep a nucleus together, the Bohr model, and the Davisson Germer experiment cause a greater understanding of the atomic nucleus. Each of these advances has had a positive impact on the understanding of the atomic 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. ☐