Dept. of Education and Science – Physics Higher Level - 2002.

Question 10a.

Name the four fundamental forces of nature.
Which force is responsible for binding the nucleus of an atom? Give two properties of this force.
In 1932, Cockcroft and Walton carried out an experiment in which they used high-energy protons to split a lithium nucleus. Outline this experiment

When a lithium nucleus $^{7}_{3}Li$ is bombarded with a high-energy proton, two α-particles are produced.
Write a nuclear equation to represent this reaction.
Calculate the energy released in this reaction.
(mass of proton = 1.6730×10^{-27} kg; mass of lithium nucleus = 1.1646×10^{-26} kg; mass of α-particle = 6.6443×10^{-27} kg; speed of light, $c = 3.00 \times 10^{8}$ m s^{-1})

Name the four fundamental forces of nature.

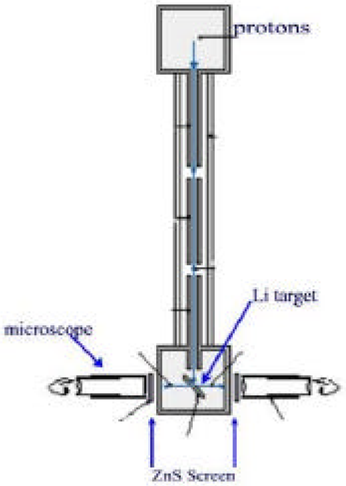
Gravitational, Electromagnetic, Strong and Weak.

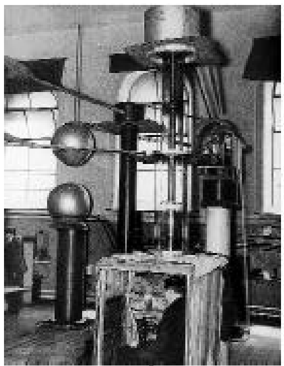
Which force is responsible for binding the nucleus of an atom? Give two properties of this force.

Strong force. It is the strongest of all the natural forces, acts over an extremely short range and binds nuclei together.

In 1932, Cockcroft and Walton carried out an experiment in which they used high-energy protons to split a lithium nucleus. Outline this experiment.

In their experiment they accelerated protons across a large potential difference and onto a lithium target surrounded by zinc sulfide screens. These screens were observed, through microscopes, to undergo scintillations that were identified as being due to α-particles.




Actual apparatus
(not required in exam)

When a lithium nucleus $^{7}_{3}Li$ is bombarded with a high-energy proton, two α-particles are produced. Write a nuclear equation to represent this reaction.

$$^{7}_{3}Li + ^{1}_{1}H \rightarrow ^{4}_{2}H + ^{4}_{2}He$$

Calculate the energy released in this reaction.
(mass of proton = 1.6730×10^{-27} kg; mass of lithium nucleus = 1.1646×10^{-26} kg; mass of α-particle = kg; speed of light, $c = 3.00 \times 10^{8}$ m s^{-1})

Mass defect = $1.1646 \times 10^{-26} + 1.6730 \times 10^{-27} - 2(6.6443 \times 10^{-27})$
= 3.04×10^{-29} kg

E = mc^2
= $3.04 \times 10^{-29} \times (3.00 \times 10^{8})^2$
= 2.7×10^{-12} J