State Examination Commission – Physics Higher Level, 2007

Question 12d

Explain the term half-life. (6)
A sample of carbon is mainly carbon-12 which is not radioactive, and a small proportion of carbon-14 which is radioactive. When a tree is cut down the carbon-14 present in the wood at that time decays by beta emission.
Write a nuclear equation to represent the decay of carbon-14. (9)
An ancient wooden cup from an archaeological site has an activity of 2.1 Bq. The corresponding activity for newly cut wood is 8.4 Bq.
If the half-life of carbon-14 is 5730 years, estimate the age of the cup. (6)
Name an instrument used to measure the activity of a sample.
What is the principle of operation of this instrument? (7)

_____

Explain the term half-life. (6)

basic term

A sample of carbon is mainly carbon-12 which is not radioactive, and a small proportion of carbon-14 which is radioactive. When a tree is cut down the carbon-14 present in the wood at that time decays by beta emission.
Write a nuclear equation to represent the decay of carbon-14. (9)

$$^{14}C_6 \quad \rightarrow \quad ^{14}N_7 \quad + \quad ^{0}\beta_{-1}$$

An ancient wooden cup from an archaeological site has an activity of 2.1 Bq. The corresponding activity for newly cut wood is 8.4 Bq.
If the half-life of carbon-14 is 5730 years, estimate the age of the cup. (6)

Activity has dropped from 8.4 Bq to 2.1 Bq.
Activity has dropped to ¼ (or (½)^2) its original value   => two half-lives have passed.
   =>   age of crop = 11,460 y

Name an instrument used to measure the activity of a sample.

Geiger-Muller tube

What is the principle of operation of this instrument? (7)

Gas particles inside the tube are ionised by the passage of radiation through the tube and a large p.d. within the tube causes an electric pulse to flow in an external circuit as a result.