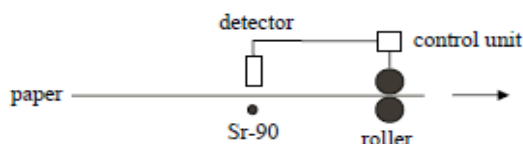


State Examination Commission – Physics Higher Level, 2011

Question 12d

In the manufacture of newsprint paper, heavy rollers are used to adjust the thickness of the moving paper. The paper passes between a radioisotope and a detector, and a pair of rollers, as shown.

The radioisotope used is Sr-90 and it emits beta-particles, which are recorded by the detector. The output from the detector adjusts the gap between the rollers, so that the paper is of uniform thickness.



- Name a suitable detector. (6)
 - Describe how the reading on the detector may vary as the paper passes by. (9)
 - Why would the radioisotope Am-241, which emits alpha-particles, **not** be suitable for this process? (4)
 - Calculate the number of atoms present in a sample of Sr-90 when its activity is 4250 Bq. The half-life of Sr-90 is 28.78 years. (9)
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- Name a suitable detector. (6)

Geiger muller tube

- Describe how the reading on the detector may vary as the paper passes by. (9)

The number of beta particles reaching the detector is determined by the thickness of the paper; the thicker it is, the more beta particles get absorbed, which leads to a smaller reading on the detector.

- Why would the radioisotope Am-241, which emits alpha-particles, **not** be suitable for this process? (4)

alpha-particles are very weakly penetrating and the bulk of them would be absorbed, even by thin paper.

- Calculate the number of atoms present in a sample of Sr-90 when its activity is 4250 Bq. The half-life of Sr-90 is 28.78 years. (9)

decay constant, $\lambda = 0.693/t_{1/2} = 0.693/(28.78 \times 365 \times 24 \times 60 \times 60) = 7.6 \times 10^{-10} \text{ s}^{-1}$

Now, $dN/dt = -\lambda N$

So, $4250 = 7.6 \times 10^{-10} \times N$

$$N = 5.6 \times 10^{12} \text{ atoms}$$