Solutions to Exercises – chapter 13

13.1) What detectors are suitable for monitoring (i) alpha, (ii) beta and (iii) gamma emissions?

(i) Alpha emissions may be determined using: Geiger-Műller tubes, scintillation counter or semiconductor based detectors.

(ii) Beta emissions similarly to alpha emissions may be determined using: Geiger-Műller tubes, scintillation counter or semiconductor based detectors.

(iii) Gamma emissions are normally measured using Geiger-Műller tubes.

13.2) What are the relative advantages and disadvantages of using neutron activation analyses for analytical purposes?

Neutron activation based analyses are based upon inducing radioactivity within samples by irradiating with neutrons – and so offer a route to allowing radio-based analyses within samples that are normally non-radioactive.

The principle disadvantages associated with neutron activation analyses are that a reactor, an accelerator or radioactive nuclide source must be used to provide the source of neutrons.

13.3) A neutron activation approach is to used to determine the concentration of a pesticide within a soil sample. If the count rate for a sample of 1.5g following activation is 750 counts s^{-1} and the analyte gives a count rate of 234 s^{-1}, what is the mass of the analyte?

The count rate is proportional to the mass of the sample.

The mass of the sample therefore = 1.5 x $\frac{234}{750}$ g = 0.468g

13.4) A mixture is to be analysed for the antibiotic oxytetracycline by a ^{14}C isotope dilution method. A 10 mg sample of pure oxytetracycline having an activity of 5000 counts min^{-1} (above background) is added to the sample. A total of 500 mg of the antibiotic is isolated from the sample and is determined to have an activity of 1800 counts min^{-1} above the background. What is the content in grams of the antibiotic in the original sample?

We can calculate the content in grams of the antibiotic oxytetracyclene using the method outlined in section 13.6 of the book and equation 13.8, ie:

<u>Step 1:</u>

MI = $\frac{R_T}{R_M}$ (M_M – M_T)

Where M_I = mass of the isolated sample

M_M = mass of purified sample

R_T = background corrected count rate for tracer

R_M = background corrected count rate for mixture

Step 2:

It follows R_T = 5000 counts min-1

R_M = 1800 counts min-1

M_M = 500 mg

M_T = 10mg

Substituting into equation gives: $M_I = \frac{5000}{1800} \times (500-10)$

M_I = 2.77 x 490mg

It therefore follows there are 1.361g oxytetracyclene in the original sample.