Exercise set 1 (for week 38)

Exercises related to determination of amount of radioactivity (counting)

27) A sample which emits β-particles at a rate of 10 kBq are measured in different detector set-ups. Calculate the expected count rate and uncertainty when (give the answers in cps):
   a) The detector efficiency is 10%
   b) The detector efficiency is 90%

28) The counting efficiency of a γ-detector was determined. A source with a disintegration rate of 25 kBq was used. The source emits γ-quanta with an intensity (= I_γ) of 30% (i.e. that on average per 100 disintegrations 30 γ's will be emitted). The source was counted for 30 minutes and gave 2.15×10^6 counts. What is the counting efficiency?

29) γ radiation from ^{99m}Tc was measured with a NaI-detector. The γ intensity, I_γ, for the 141 keV line which was used is 89.1%. The number of counts was 3712 during an 180 seconds measurement. The background had been measured earlier and was 8.2 ± 0.3 cps. What is the disintegration rate of the source? Remember to specify the uncertainty in the measurement.

30) Given two measured numbers A and B, with uncertainty σ_A and σ_B respectively. What is the uncertainty in C when:
   a) $C = A + B$
   b) $C = A \cdot B$
   c) $C = A / B$

31) What is the uncertainty in the radioactivity measurements below? Specify your answers in both cps and percent.
   a) A measurement time of 300 seconds gave 10104 counts.
   b) A measurement time of 300 seconds gave 998 counts.
   c) A measurement time of 300 seconds gave 10 counts.
   d) A measurement time of 10 seconds gave 998 counts.

32) A sample was measured in 15 minutes and gave 900 counts in total. The background was measured in 30 minutes was calculated to be 30 cpm. Calculate the count rate due to the sample, with standard deviation.

33) Your sample gives you 500 dpm and the detector efficiency is 10%. How long must you count to achieve an uncertainty level of 2%?

34) Three successive countings of a sample gave 1055, 990, 920 respectively. Do you think the variations are reasonable (i.e. due to statistical variations) or due to a faulty counter or procedure?

Exercise I from the KJ250 exam given 29. november 1985

35) This exercise consists of five tasks.

a) Calculate the disintegration rate of 1 g newly prepared ^{231}Pa. Your answer should be given in units of Bq (dps).

b) Write down the most important disintegration chain from ^{235}U to stable Pb. What is the relationship between the disintegration rate of ^{231}Pa and ^{235}U in an old uranium mineral?

c) 1 g ^{231}Pa is to be extracted from a mineral which contains 70 weight-percent uranium. How many kg mineral do you need if you assume the chemical yield is 90%?

d) ^{231}Pa disintegrates by α emittion. The α energy is 5.0 MeV. Calculate the dose rate in ^{231}Pa and specify your answer in Gy/year (1 Gy = 1 joule/kg). Assume that all the α radiation is absorbed and that the protactinium has just been prepared.

e) When the pure protactinium sample gets older, the dose rate will increase. Explain this, and estimate the doserate after 20 years when you assume that all the α radiation is absorbed and that all β radiation escapes.

Exercise 1 from the KJ250 exam 16. december 1998

36) To solve this exercise you need a table of mass excess. For example, you can find one at this web-address: http://ie.lbl.gov/toi2003/MassSearch.asp

a) Calculate the masses to the following particles and nuclei: n, ^{1}H, ^{4}He, ^{56}Fe, ^{142}Ce, and ^{238}U.

b) Which of the nuclei in a) is most stable?

c) Assume that 1.00 kg ^{2}H fusions and gives pure ^{4}He. What will the change in mass (in kg) be and how much energy is liberated (in MeV and kWh)?

d) Assume that 1.00 kg ^{233}U fissions spontaneously and that the products are ^{92}Rb and ^{238}Cs , pluss 2 neutrons per fission. What will the change in mass and the energy produced be?

e) Which form of primary energy do you get in fission? Is it radiation or other forms of energy?

Exercise 1 from the KJ250 exam 16. december ????

37) When handling radioactive material different degrees of carefulness must be exercised based upon which material/nuclei we work with. International comities have put together lists of nuclei and their radiotoxicity.

a) One important value is ALI. What does ALI mean and what is it about?

b) Write down at least three properties of radioactive nuclei which make them particularly dangerous and select some examples from the nuclear chart.