FYSP110 Experimental methods in physics 30.8.2013

Answer to five questions

1. a) Explain what is meant with random and systematic errors. How do we deal with them? b) Consider the time taking using an ordinary stop watch in 100 m running. Persons measuring the elapsed time are standing at the finish line. They start their clocks when they hear the sound from the start pistol close to the runners and stop when runners cross the finish line. Ponder what error sources are involved in time measurement and what their magnitude is. c) Time takers clocks showed following times for the winner: 10,51, 10,42, 10,57, 10,47 and 10,60 s. What is the winner's time together with uncertainty?

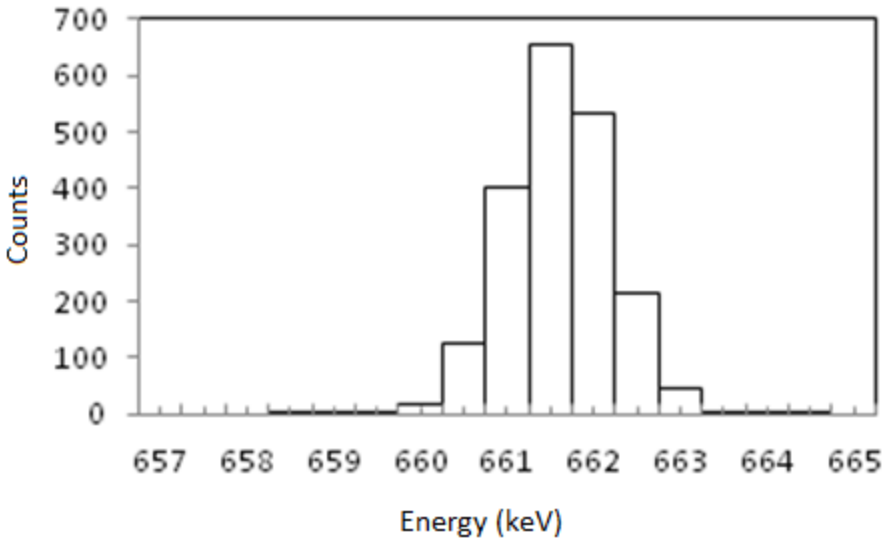
2. A general purpose meter was used to measure the voltage over a resistor, and a result of 0,632 V was obtained. Later suspicion about the value arose. To check the meter, the reading was compared to a voltage calibrator. It turned out, that for 1 V voltage meter displayed value of 0,910 V. What is the corrected value together with uncertainty for the original measurement? According to the manufacturer accuracy of the meter is 1% + 2 digits.

3. In the literature following half lives are given for a certain nuclide: (21 ± 1) s, (20,3 ± 0,4) s and (20,6 ± 0,2) s. a) A nuclear physicist want to combine these results to a single value. Should this be done using the normal average or weighted average? State clearly, why! b) Calculate this value and its uncertainty.

4. Let's suppose that measurements x_1, x_2, … x_N are normally distributed with width parameter σ. Apply the principle of maximum likelihood to best estimate for the width parameter σ. Hint: $P(x_i) \propto \frac{1}{\sigma} \cdot e^{-(x_i - X)^2 / 2\sigma^2}$

5. List five phenomena that can be used for measuring temperature. In each case describe shortly how the sensor works.

6. In the measurement of an environmental sample a following γ-ray spectrum (see the other side of paper) was obtained. In the nuclei γ transitions have a sharp energy, but in the spectrum one sees a Gauss distribution whose center equals to the transition energy (broadening is due to interaction processes of the γ rays and the detector material). Based on the data in figure determine the energy of the γ transition together with its uncertainty. (hint: full width at half maximum FWHM = 2,35σ)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