

Review on uncertainties in counting statistics:

The number of decays by a radioactive source follows a Poisson distribution. The important thing about this distribution for our purpose is that if a single measurement on a radioactive source is made, and  $N$  counts are recorded, the uncertainty in the number of counts is simply  $\sqrt{N}$ . (Here the uncertainty is not in the measurement procedure, but in the random process of nuclear decay itself.)

*Example:* You count an unknown source for 30 minutes and record 600 counts.

The error in the number of counts is \_\_\_\_\_.

The count rate (counts per minute) is  $600/30 = 20$  counts/minute.

The error in the count rate is \_\_\_\_\_ counts/minute.

Report the count rate (counts per minute) with its uncertainty, appropriately rounded:

(Note that finding the uncertainty in the count rate means taking the square root of the counts, then dividing by the time!)

*Example:* You count for one minute with no source present and get 50 counts. With a source present, you get 170 counts in one minute. What is the count rate in counts per minute due to the source alone, and the error in the count rate? Answer: the number of counts in 1 minute due to the source alone is  $170 - 50 = 120$ . The error in this number is the combination of the error in 170 ( $dN_1 = \sqrt{170}$ ) and the error in 50 ( $dN_2 = \sqrt{50}$ ), according to  $dN = \sqrt{(dN_1)^2 + (dN_2)^2} =$  \_\_\_\_\_.

Report the count rate (counts per minute) with its uncertainty, appropriately rounded:

(Note that finding the uncertainty in the number of background-subtracted counts means finding the uncertainty in counts and in background, and then combining them!)

*Example:* You have a container that once held a radioactive material and you would like to see if there is any remaining. With a Geiger counter, you take a 20-minute count with no radioactive sources present and get 2350 counts. Then you place the container in front of the counter, count for 10 minutes, and get 1230 counts. The way to deal with this is to think about count rates for a 10-minute time period.

- What is the number of counts with background subtracted, per 10-minute time period?
- What is the error in the number of counts with the container present, per 10-minute period?
- What is the error in the number of background counts per 10-minute period?
- What is the background-subtracted count rate (in counts per 10 minutes?)
- What is the error in the background-subtracted count rate (in counts per 10 minutes?)
- Do you believe, based on these numbers, that there is any radioactive material left in the container? Explain.