

1. The Perseids meteor showers occur in early August with a mean counting rate of 50. per hour on nights around their peak. Assume you set up a camera to take images with 30 s exposures, and that the camera's limited field of view only allows 10% of the meteors to be detected.
 - (a) What is the probability of catching exactly one meteor in a single 30 s exposure?
 - (b) What is the probability of catching one or more meteors in a single 30 s exposure?
 - (c) If you took 10×30 s exposures, what is the probability of recording at least one meteor?
2. Amongst university students aged 18-22 it is found that the time taken to run 100 m follows a normal distribution with a mean of 15.0 s and a standard deviation 1.0 s.
 - (a) What time difference would you expect between the fastest student in Ireland and the fastest in the U.K.? (Assume Ireland has 50,000 students and the U.K. has 500,000)
 - (b) What time difference would you expect between the Irish and U.K. 4×100 m teams?

Note: the `scipy.stats.norm.ppf()` (inverse cumulative distribution function) will be useful.

3. Snell's Law:

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$

Given

- n_1 is known (1.000, no uncertainty)
- θ_1 measured to be $(22.03 \pm 0.2)^\circ$
- θ_2 measured to be $(14.45 \pm 0.2)^\circ$

Find n_2 and its uncertainty. Briefly comment on whether you think your answer is reasonable or not.

4. A student is determining the volume of a cylinder by measuring its diameter and height with a gauge. The student asks nine of their fellow students to also make measurements with the same device, giving ten measurements for the diameter and height of the cylinder (table 1). The students believe they can read the gauge accurately to 0.1 mm.
 - (a) Find the best estimates of the diameter and height of the cylinder and their uncertainties.

diameter	height
1.96	5.17
2.12	5.08
1.94	4.94
1.96	5.14
2.22	5.10
2.04	4.73
1.75	4.96
1.89	5.07
2.07	5.05
2.07	5.00

Table 1: Repeated measurements of the diameter and height of the cylinder (in cm)

- (b) Using propagation of errors estimate the volume (in cm^3) of the cylinder and its error.
- (c) Calculate the ten volumes individually from the data from each of the students and compare best estimate of the volume and its uncertainty to your answer to the previous question.