Tareas 2 Tópicos de la Física Moderna

8 de Septiembre 2020

1. In plotting the data of a distribution function, what happens if we make the bin size smaller than the experimental resolution? Explain.

2. Can you give an example of the discrete distribution whose possible values are not integer?

3. Define two distribution functions, one discrete and one continuous, that effect your everyday life. Make a qualitative sketch of the distributions, indicating the horizontal and vertical scales and units.

4. Make a histogram of the following 23 test scores:

   58, 61, 63, 68, 69 71, 71, 72, 72, 74, 75, 76, 77, 78, 79, 79, 79, 80, 82, 82, 86, 91, 98.

   (a) Use your histogram to make a quick estimate of the average score and the standard deviation. (b) Determine the exact values of the average and standard deviation.

5. A *bunch* of 10^6 particles emerges from an accelerator at $x = 0\,\mathrm{m}$ and is directed at a detector located at $x = 1\,\mathrm{m}$. The speed of the particle is very nearly equal to the speed of light. If the particle lifetime is $10^{-6}\,\mathrm{s}$, how many (N) particles are expected to decay before reaching the detector? Make a sketch of the decay distribution dN/dx versus x.

6. A proportional wire chamber contains an array of parallel wires that are used to detect the x coordinate of a particle that passes through the chamber. (The axis of each wire is along the y direction.) The chamber is used to detect particles that pass through at random locations. An electrical signal is detected on the wire closest to which the particle passes. The measurement of the particle x coordinate is the x coordinate of the wire with the electrical signal. If the wire spacing is 1 mm, what is the position resolution (σ) of the chamber?

7. Does the mean free path of a molecule in a gas depend on the temperature?

8. Make an estimate of the number of collisions per second that a nitrogen molecule makes with other molecules at STP.

9. The ideal gas law is sometime written as $pV = \nu RT$, where ν is the number of moles of molecules and R is a constant called the *ideal gas constant*. Determine the numerical value of R.

10. A soccer goalie lets the ball in the net an average of 2.3 times per game. Make an estimate of the probability per game that the goalie records a shutout (zero goals). What assumption did you make?

11. (a) Determine the typical speed of a *thermal* neutron at room temperature, that is, a neutron that has a kinetic energy equal to kT. (b) At what temperature is the typical neutron speed equal to 1 % of the speed of light?

12. The average speed of the molecules of a certain gas at room temperature is 440 m/s. Identify the gas.

13. Why does the earth's atmosphere get colder with increasing altitude?

14. In an atmosphere of nitrogen at a constant temperature of 300 K, what change in altitude corresponds to a pressure change of 10 %? What is the result at a temperature of 250 K?

15. Consider a gas of helium atoms (He). At what temperature is the average molecular speed equal to 10^3 m/s?

16. An oxide cathode of a vacuum tube has a work function of 2.0 eV. Calculate the electron flux (number per time per area) from thermal emission when the cathode is heated to 1000 K.

17. Electrons are emitted at the rate of one per second from a cathode of area $5 \times 10^{-4}\,\mathrm{m}^2$ at room temperature. (a) What is the work function of the cathode? (b) At what rate are electrons emitted of the cathode is cooled to liquid nitrogen temperature (77 K)?

18. Read the article *WA89 Collaboration, M.I. Adamovich et al., "Measurement of the Ω_c^0 lifetime"*, published in Physics Letters B 358 (1995) 151-161. You can obtain it also as preprint hep-ex/9507004. What did you learn?

19. In the hydrogen atom the energy of the electron is usually defined to be the kinetic plus the potential energy. There are two states with the energy of -13.6 eV (the lowest possible energy) and eight states of -3.4 eV (the first exited state). There are no states with energies between these two values. At what temperature would 1 % of the hydrogen atoms be in the first excited state?