Example 2: In a study of 420,095 cell phone users in Denmark, it was found that 135 developed cancer of the brain or nervous system. If we assume that the use of cell phones has no effect on developing such cancer, then the probability of a person having such a cancer is 0.000340.

a. Assuming that cell phones have no effect on developing cancer, find the mean and standard deviation for the numbers of people in groups of 420,095 that can be expected to have cancer of the brain or nervous system.

$n = 420095$

$p = 0.000340$

$q = 1 - p \rightarrow q = 0.99966$

$\mu = np \rightarrow \mu = (420095)(0.000340) \approx \boxed{142.8 \text{ people}}$

b. Based on the results from part (a), is it unusual to find that among 420,095 people, there are 135 cases of cancer of the brain or nervous system? Why or why not?

$\sigma = \sqrt{npq} \rightarrow \sigma \approx 11.9$ people

$\sigma = \sqrt{(420095)(0.000340)(0.99966)}$

$\mu - 2\sigma <$ usual # who develop this cancer $< \mu + 2\sigma$

$119.0 <$ usual # who develop this cancer < 166.6

No. 135 falls within the usual number.

c. What do these results suggest about the publicized concern that cell phones are a health danger because they increase the risk of cancer of the brain or nervous system?

The publicized concern is not supported by the statistical results.

6.2 THE STANDARD NORMAL DISTRIBUTION

UNIFORM DISTRIBUTIONS

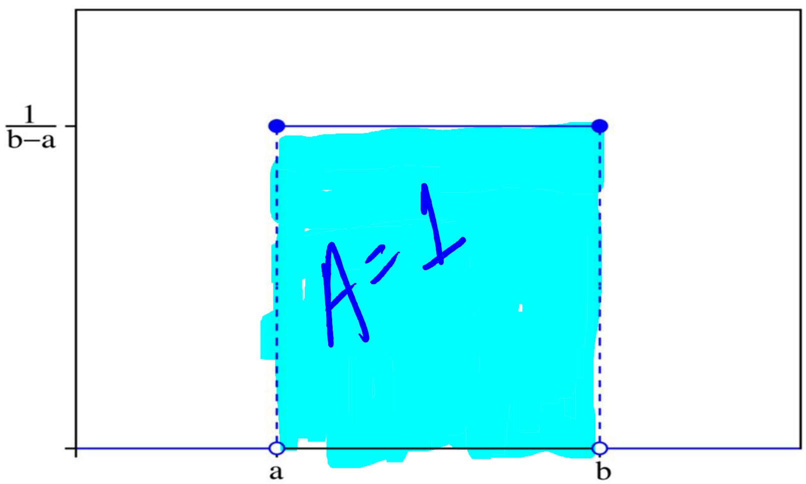
The __uniform__ __distribution__ allows us to see two very important properties:

1. The __area__ under the __graph__ of a __probability__ distribution is equal to __1__.

2. There is a __correspondence__ between __area__ and __probability__ (or __relative__ frequency), so some __probabilities__ can be found by __identifying__ the corresponding __area__.

DEFINITION

A continuous random variable has a **uniform distribution** if its values are spread evenly over the range of possibilities. The graph of a uniform distribution results in a rectangular shape.

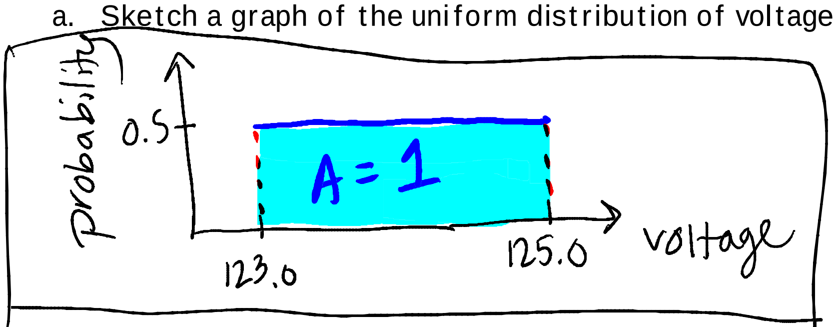


$A=1$ and $A=\text{base}\cdot\text{height}$

So $1=(b-a)\cdot h$

Example 1: The Newport Power and Light Company provides electricity with voltage levels that are uniformly distributed between 123.0 volts and 125.0 volts. That is, any voltage amount between 123.0 volts and 125.0 volts is possible, and all of the possibilities are equally likely. If we randomly select one of the voltage levels and represent its value by the random variable *x*, then *x* has a distribution that can be graphed.

a. Sketch a graph of the uniform distribution of voltage levels.



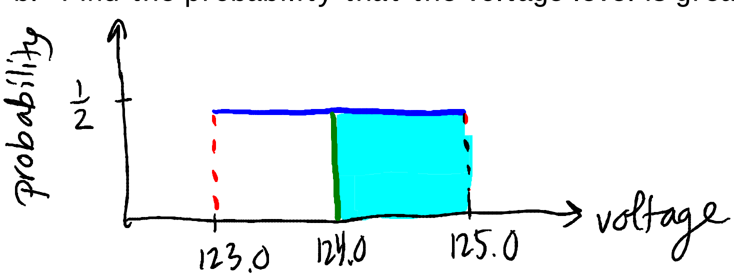
$b-a = 125-123 = 2$

and $A=1$

$1=(b-a)\cdot h$

$1=2\cdot h$ → so $h=0.5$

b. Find the probability that the voltage level is greater than 124.0 volts.



$\boxed{P(X>124.0)=\frac{1}{2}}$

$A=(125-124)\cdot\frac{1}{2}$

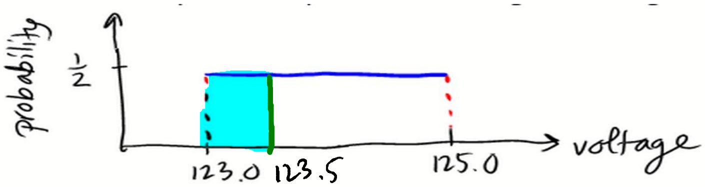
$A=1\cdot\frac{1}{2} \rightarrow A=\frac{1}{2}$

c. Find the probability that the voltage level is less than 123.5 volts.

$A = (123.5 - 123) \cdot \frac{1}{2}$

$A = 0.25$

$\boxed{P(X < 123.5) = 0.25}$



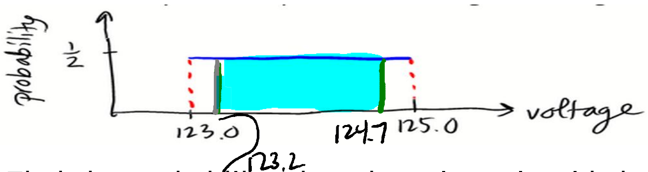
d. Find the probability that the voltage level is between 123.2 volts and 124.7 volts.

$A = (124.7 - 123.2) \cdot \frac{1}{2}$

$A = 1.5 \cdot \frac{1}{2}$

$A = 0.75$

$\boxed{P(123.2 < X < 124.7) = 0.75}$



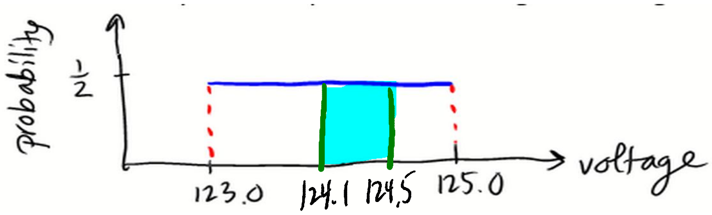
e. Find the probability that the voltage level is between 124.1 volts and 124.5 volts.

$A = (124.5 - 124.1)(\frac{1}{2})$

$A = 0.4 \cdot \frac{1}{2}$

$A = 0.2$

$\boxed{P(124.1 < X < 124.5) = 0.2}$



The graph of a probability distribution, such as part (a) in the previous example is called a

__density__ __curve__. A density curve must satisfy the following two requirements.

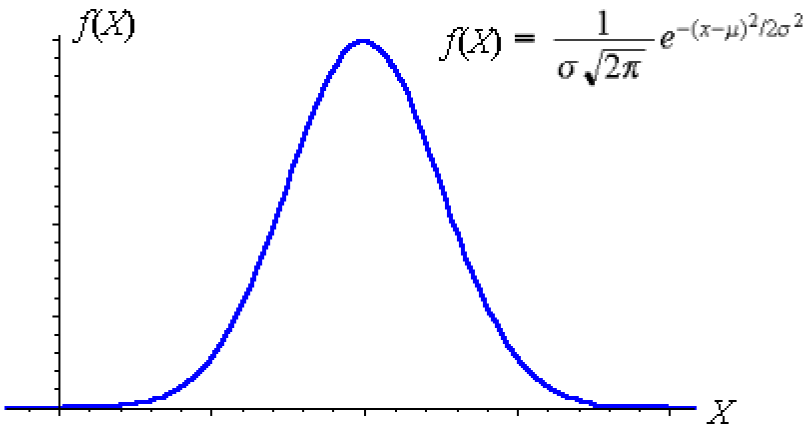
1. The total __area__ under the __curve__ must equal __1__.

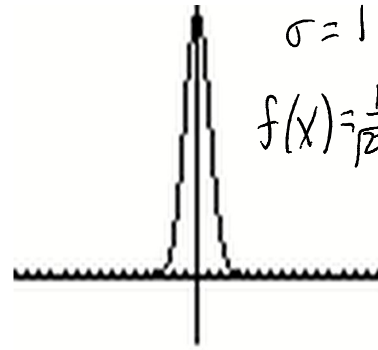
2. Every point on the __curve__ must have a vertical __height__ that is

   __0__ or __greater__.

DEFINITION

The **standard normal distribution** is a __normal__ __probability__ __distribution__ with __$\mu = 0$__ and __$\sigma = 1$__. The total __area__ under its __density__ __curve__ is equal to __1__.





$\mu = 0$

$\sigma = 1$

$f(x) = \frac{1}{\sqrt{2\pi}} e^{-x^2/2}$

FINDING PROBABILITIES WHEN GIVEN *z* SCORES

Using table A2, we can find areas or probabilities for many different regions. Such areas can also be found using a graphing calculator. When using Table A-2, it is essential to understand these points:

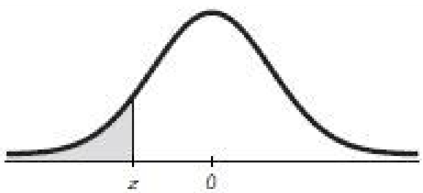
1. Table A-2 is designed only for the Standard normal distribution, which has a mean of $\mu = 0$ and a standard deviation of $\sigma = 1$.
2. Table A-2 is on 2 pages, with one page for negative z scores and the other page for positive z scores.
3. Each value in the body of the table is a Cumulative area from the left up to a vertical boundary above a specific z score.
4. When working with a graph, avoid confusion between z scores and areas.

z score: Distance along the horizontal scale of the standard normal distribution; refer to the left-most column and top row of Table A-2.

Area: ___Region___ under the ___curve___; refer to the values in the ___body___ of Table A-2.

5. The part of the ___z score___ denoting ___hundredths___ is found across the ___top___ ___row___ of Table A-2.

NEGATIVE *z* Scores



$\boxed{P(z < -3.02) = 0.0013}$

$\boxed{P(z > -3.02) = 1 - P(z < -3.02)} = 0.9987$

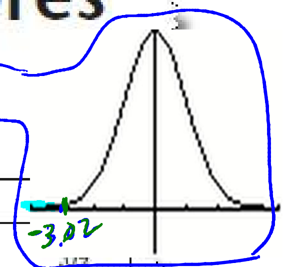


TABLE A-2 Standard Normal (*z*) Distribution: Cumulative Area from the LEFT

z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
−3.50 and lower	.0001									
−3.4	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0003	.0002
−3.3	.0005	.0005	.0005	.0004	.0004	.0004	.0004	.0004	.0004	.0003
−3.2	.0007	.0007	.0006	.0006	.0006	.0006	.0006	.0005	.0005	.0005
−3.1	.0010	.0009	.0009	.0009	.0008	.0008	.0008	.0008	.0007	.0007
−3.0	.0013	.0013	.0013	.0012	.0012	.0011	.0011	.0011	.0010	.0010
−2.9	.0019	.0018	.0018	.0017	.0016	.0016	.0015	.0015	.0014	.0014
−2.8	.0026	[illegible]	[illegible]	.0023	.0023	.0022	.0021	[illegible]	.0020	.0019

POSITIVE *z* Scores

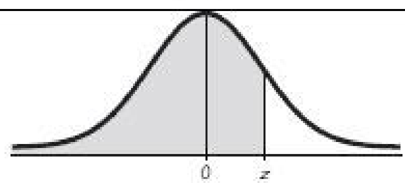
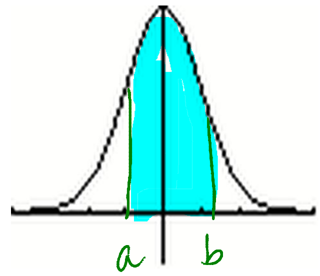


TABLE A-2 (continued) Cumulative Area from the LEFT

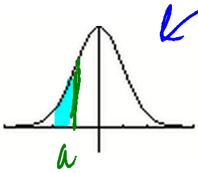
z	.00	.01	.02	.03	.04	.05	.06	.07	.08	.09
0.0	.5000	.5040	.5080	.5120	.5160	.5199	.5239	.5279	.5319	.5359
0.1	.5398	.5438	.5478	.5517	.5557	.5596	.5636	.5675	.5714	.5753
0.2	.5793	.5832	.5871	.5910	.5948	.5987	.6026	.6064	.6103	.61[illegible]
0.3	.6179	.6217	.6255	.6293	.6331	.6368	.6406	.6443	.6480	.6517
0.4	.6554	.6591	.6628	.6664	.6700	.6736	.6772	.6808	.6844	.6879
0.5	.6915	.6950	.6985	.7019	.7054	.7088	.7123	.7157	.7190	.7224
0.6	.7257	.7291	.7324	.7357	.7389	.7422	.7454	.7486	.7517	.754[illegible]
0.7	.7580	.7611	.7642	.7673	.7704	.7734	.7764	.7794	.7823	.7852
0.8	.7881	.7910	.7939	.7967	.7995	.8023	.8051	.8078	.8106	.813[illegible]
0.9	.8159	.8186	.8212	.8238	.8264	.8289	.8315	.8340	.8365	.8389
1.0	.8413	.8438	.8461	.8485	.8508	.8531	.8554	.8577	.8599	.862[illegible]
1.1	.8643	.8665	.8686	.8708	.8729	.8749	.8770	.8790	.8810	.8830
1.2	.8849	.8869	.8888	.8907	.8925	.8944	.8962	.8980	.8997	.901[illegible]
1.3	.9032	.9049	.9066	.9082	.9099	.9115	.9131	.9147	.9162	.91[illegible]
1.4	.9192	.9207	.9222	.9236	.9251	.92[illegible]	.9279	.9292	.9306	.93[illegible]

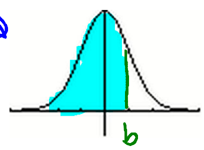
NOTATION

$$P(a<z<b)$$

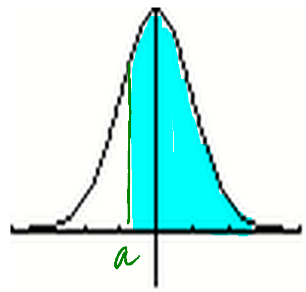


$P(z<b) - P(z<a)$





$P(z>a)$ 2 ways to find this...

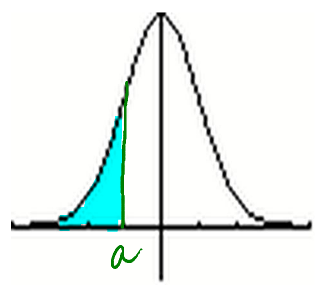


$P(z>a) = 1 - P(z<a)$

OR

$P(z>a) = P(z<-a)$

$$P(z<a)$$



Example 2: Assume that thermometer readings are normally distributed with a mean of 0ºC and a standard deviation of 1.00 ºC. A thermometer is randomly selected and tested. In each case, draw a sketch and find the probability of each reading. The given values are in Celsius degrees.

a. Less than -2.75

b. Greater than 2.33