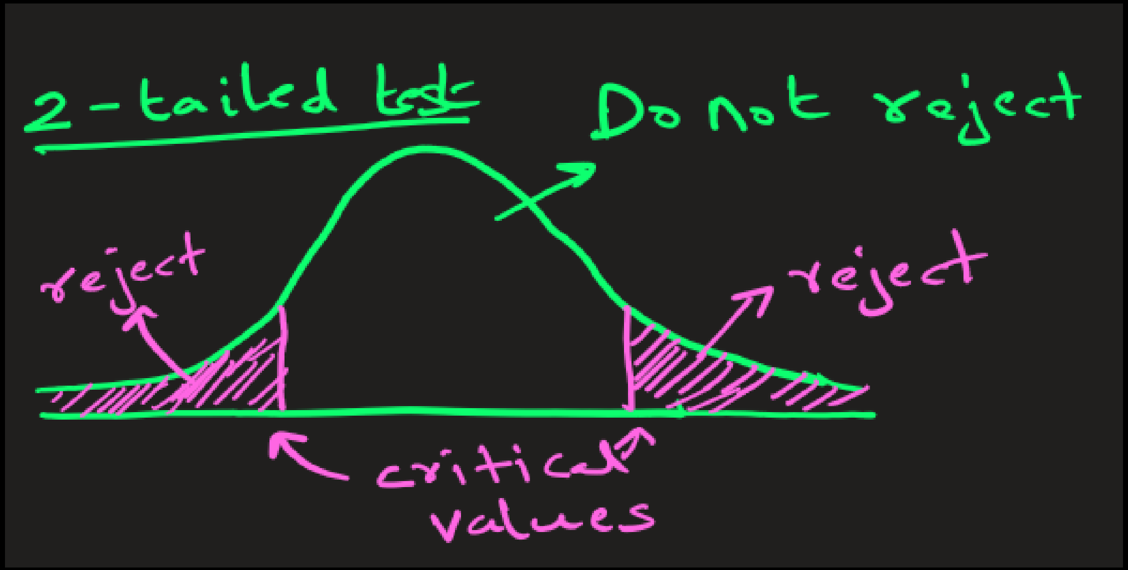
T-Table

Problem:

Find the *t*-critical value for a **95% confidence interval** with **n = 11** samples.



t-table: When Do We Choose t-distribution Over z-distribution ?

1. The population standard deviation (σ) is unknown

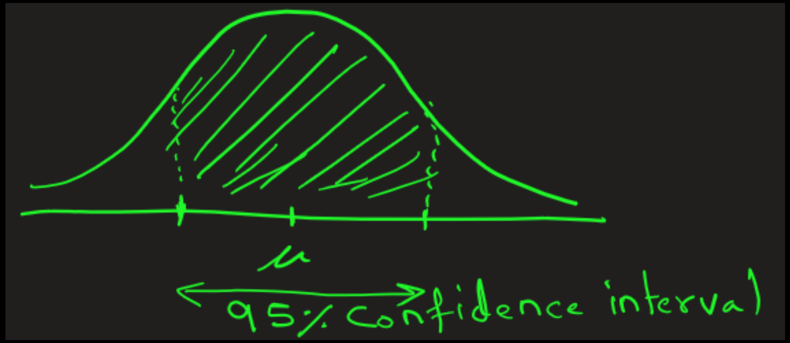
If you **don't know σ**, and instead estimate it using the **sample standard deviation (s)**,
you must use the **t-distribution** instead of the normal (z) distribution.

2. The sample size is small ($n < 30$)

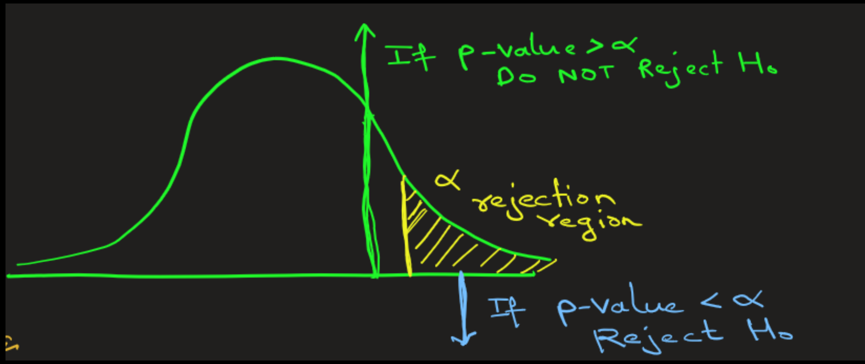
The t-distribution is specifically designed for **small sample sizes**,
where estimates of variability are less reliable and have more uncertainty.

We need a critical t-value (t_a or $t_{a/2}$) when we solving problems of following kind:

- Finding **confidence intervals**



- Performing **hypothesis testing**



- Determining **rejection regions**

For this we look up the t-table critical t-value.

A **t-table** gives **critical values** of *t* for various:
Degrees of Freedom (df) → based on your sample size.
Significance levels (α) → based on how much risk you're willing to accept.

Steps for finding critical values:

step1) Find degree of freedom, df = n-1
n is sample size

Step2) Decide on your significance level α:
This often is provided as a percentage like 95% confidence (α = 1-0.95 = 0.05) or 99% confidence (α = 1-0.99 = 0.01).

Step3) Determine if you need a one-tailed or two-tailed test.

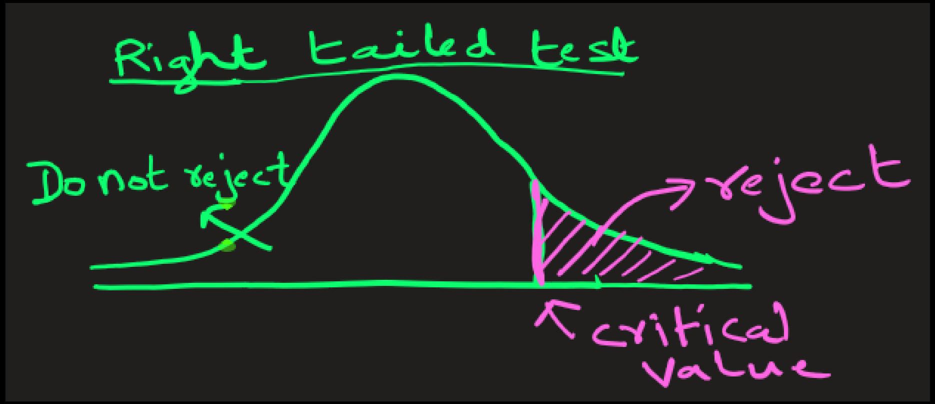
- A one-tailed test is used for directional hypotheses like ">" or "<". Use α.
- A two-tailed test is common for hypotheses like "not equal to". For each tail, use α/2

Step4) Locate the value in t-table

For one-tailed test, use $\boldsymbol{t_{\alpha,\mathrm{d}f}}$

For two-tailed test, use $\boldsymbol{t_{\frac{\alpha}{2},\mathrm{d}f}}$

Problem: Find the *t*-critical value at a **5% significance level** (α = 0.05) with **n = 11** samples.
Assume it is right-tailed test



Ans:
Step 1: Compute degrees of freedom
df = 11−1 = 10

Step 2: Decide on your significance level α:
α = 0.05

Step3) Determine if you need a one-tailed or two-tailed test.
It's a single-tailed test: So α = 0.05

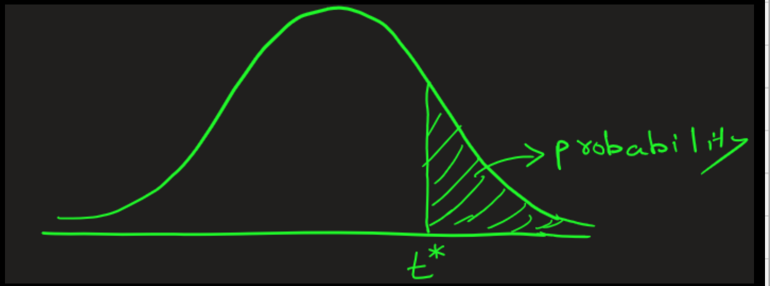
Step4) Locate the value in t-table (see next slide)

Since this is one-tailed test, use $t_{\alpha,\mathrm{d}f} = t_{0.05,10}$ = 1.812

At 5% significance level and 10 df, the critical t-value is **+ 1.812**

$$t_{\alpha,\mathrm{df}} = t_{0.05,10} = 1.812$$

The value in the t-table represents the area of the t-distribution curve towards **the right** of t-test value for a given d.f. and α



	Alpha values (Upper-tail probability p)											
df	**0.25**	**0.2**	**0.15**	**0.1**	**0.05**	**.025**	**0.02**	**0.01**	**0.005**	**0.0025**	**0.001**	**0.0005**
1	1	1.376	1.963	3.078	6.314	12.71	15.89	31.82	63.66	127.3	318.3	636.6
2	0.816	1.061	1.386	1.886	2.92	4.303	4.849	6.965	9.925	14.09	22.33	31.6
3	0.765	0.978	1.25	1.638	2.353	3.182	3.482	4.541	5.841	7.453	10.21	12.92
4	0.741	0.941	1.19	1.533	2.132	2.776	2.999	3.747	4.604	5.598	7.173	8.61
5	0.727	0.92	1.156	1.476	2.015	2.571	2.757	3.365	4.032	4.773	5.893	6.869
6	0.718	0.906	1.134	1.44	1.943	2.447	2.612	3.143	3.707	4.317	5.208	5.959
7	0.711	0.896	1.119	1.415	1.895	2.365	2.517	2.998	3.499	4.029	4.785	5.408
8	0.706	0.889	1.108	1.397	1.86	2.306	2.449	2.896	3.355	3.833	4.501	5.041
9	0.703	0.883	1.1	1.383	1.833	2.262	2.398	2.821	3.25	3.69	4.297	4.781
10	0.7	0.879	1.093	1.372	1.812	2.228	2.359	2.764	3.169	3.581	4.144	4.587
11	0.697	0.876	1.088	1.363	1.796	2.201	2.328	2.718	3.106	3.497	4.025	4.437
12	0.695	0.873	1.083	1.356	1.782	2.179	2.303	2.681	3.055	3.428	3.93	4.318
13	0.694	0.87	1.079	1.35	1.771	2.160	2.282	2.65	3.012	3.372	3.852	4.221
14	0.692	0.868	1.076	1.345	1.761	2.145	2.264	2.624	2.977	3.326	3.787	4.14
15	0.691	0.866	1.074	1.341	1.753	2.131	2.249	2.602	2.947	3.286	3.733	4.073
16	0.69	0.865	1.071	1.337	1.746	2.120	2.235	2.583	2.921	3.252	3.686	4.015
17	0.689	0.863	1.069	1.333	1.74	2.110	2.224	2.567	2.898	3.222	3.646	3.965
18	0.688	0.862	1.067	1.33	1.734	2.101	2.214	2.552	2.878	3.197	3.611	3.922
19	0.688	0.861	1.066	1.328	1.729	2.093	2.205	2.539	2.861	3.174	3.579	3.883
20	0.687	0.86	1.064	1.325	1.725	2.086	2.197	2.528	2.845	3.153	3.552	3.85
21	0.686	0.859	1.063	1.323	1.721	2.080	2.189	2.518	2.831	3.135	3.527	3.819
22	0.686	0.858	1.061	1.321	1.717	2.074	2.183	2.508	2.819	3.119	3.505	3.792
23	0.685	0.858	1.06	1.319	1.714	2.069	2.177	2.5	2.807	3.104	3.485	3.768
24	0.685	0.857	1.059	1.318	1.711	2.064	2.172	2.492	2.797	3.091	3.467	3.745
25	0.684	0.856	1.058	1.316	1.708	2.060	2.167	2.485	2.787	3.078	3.45	3.725
26	0.684	0.856	1.058	1.315	1.706	2.056	2.162	2.479	2.779	3.067	3.435	3.707
27	0.684	0.855	1.057	1.314	1.703	2.052	2.158	2.473	2.771	3.057	3.421	3.69
28	0.683	0.855	1.056	1.313	1.701	2.048	2.154	2.467	2.763	3.047	3.408	3.674
29	0.683	0.854	1.055	1.311	1.699	2.045	2.15	2.462	2.756	3.038	3.396	3.659
30	0.683	0.854	1.055	1.31	1.697	2.042	2.147	2.457	2.75	3.03	3.385	3.646
40	0.681	0.851	1.05	1.303	1.684	2.021	2.123	2.423	2.704	2.971	3.307	3.551

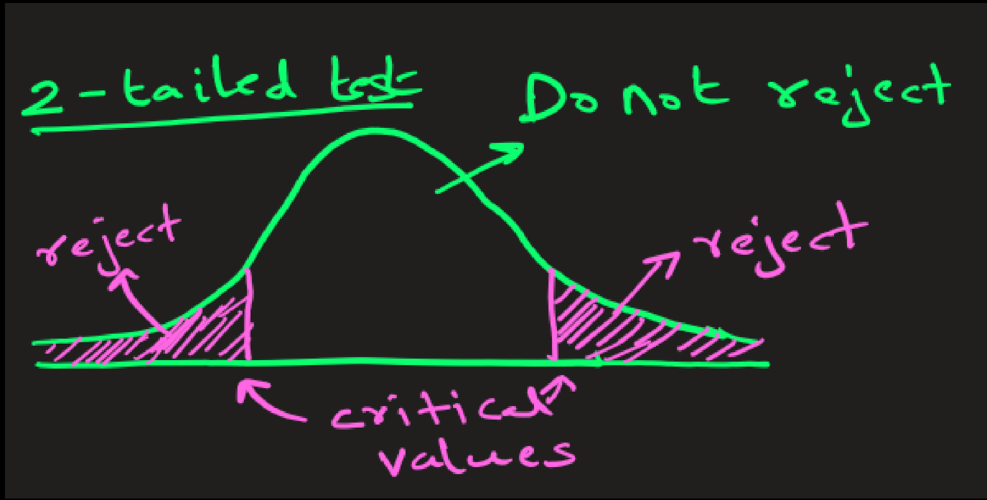
Problem: Find the *t*-critical value for **80% confidence interval** with **n = 7** samples.

Ans:
Step 1: Compute degrees of freedom
df = 7−1 = 6

Step 2: Decide on your significance level α:
80% confidence → α = 1-0.80 = 0.20

Step3) Determine if you need a one-tailed or two-tailed test.
It is a confidence interval problem.
So, it is two-tailed test → α/2 = 0.10

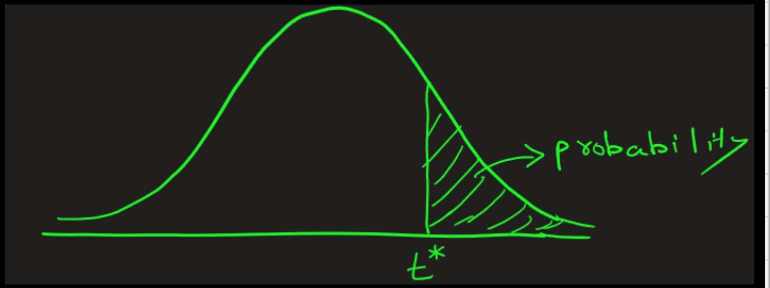
Step4) Locate the value in t-table (see next slide)
Since this is two-tailed test, use $t_{\frac{\alpha}{2},df} = t_{0.10,6}$ = 1.44



For 80% confidence with **n = 7** samples, the critical t-value is **± 1.44**

$$t_{\frac{\alpha}{2},df} = t_{0.10,6} = 1.44$$

The value in the t-table represents the area of the t-distribution curve towards **the right** of t-test value for a given d.f. and α



	Alpha values (Upper-tail probability p)											
df	0.25	0.2	0.15	0.1	0.05	.025	0.02	0.01	0.005	0.0025	0.001	0.0005
1	1	1.376	1.963	3.078	6.314	12.71	15.89	31.82	63.66	127.3	318.3	636.6
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Problem: Find the t-critical value for **5% significance level** (α = 0.05) with **n = 23** samples.
Assume it is for right-tailed test.

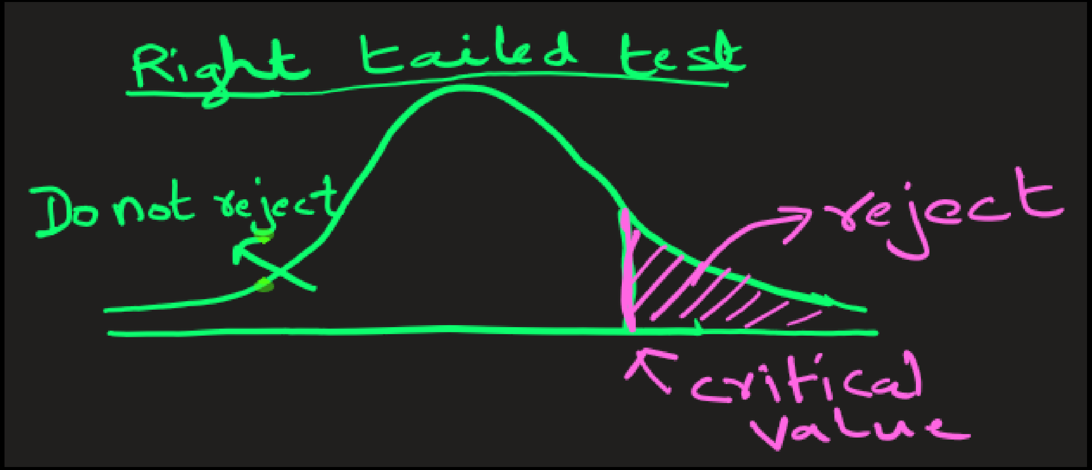
Ans:
Step 1: Compute degrees of freedom
df = 23−1 = 22

Step 2: Decide on your significance level α:
α = 5% → α = 0.05

Step3) Determine if you need a one-tailed or two-tailed test.
It's a one-tailed test (right-tail): So α = 0.05

Step4) Locate the value in t-table (see next slide)
Since this is two-tailed test, use $\boldsymbol{t_{\alpha,df}}$ = $\boldsymbol{t_{0.05,22}}$ = 1.717

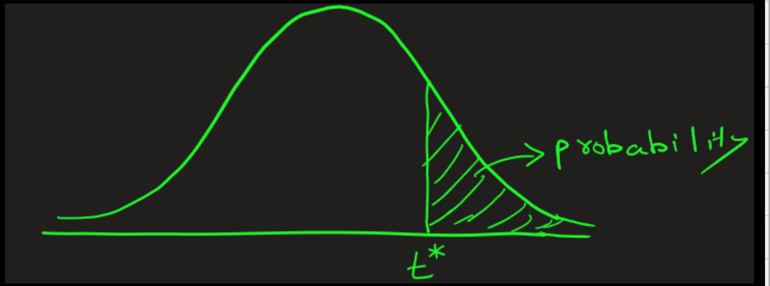
For 80% confidence with **n = 7** samples, the critical t-value is **1.717**



If your computed statistic $t_{calc} > 1.717$, you **reject the null hypothesis** H_0.

$$t_{\alpha,df} = t_{0.05,22} = 1.717$$

The value in the t-table represents the area of the t-distribution curve towards **the right** of t-test value for a given d.f. and α



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27	0.684	0.855	1.057	1.314	1.703	2.052	2.158	2.473	2.771	3.057	3.421	3.69
28	0.683	0.855	1.056	1.313	1.701	2.048	2.154	2.467	2.763	3.047	3.408	3.674
29	0.683	0.854	1.055	1.311	1.699	2.045	2.15	2.462	2.756	3.038	3.396	3.659
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40	0.681	0.851	1.05	1.303	1.684	2.021	2.123	2.423	2.704	2.971	3.307	3.551

Same problem as before but Left-tailed:
Find the t-critical value for **5% significance level** (α = 0.05) with **n = 23** samples.
Assume it is for left-tailed test.

Ans: (Everything remains same as before, except the sign.)
Step 1: Compute degrees of freedom
df = 23−1 = 22

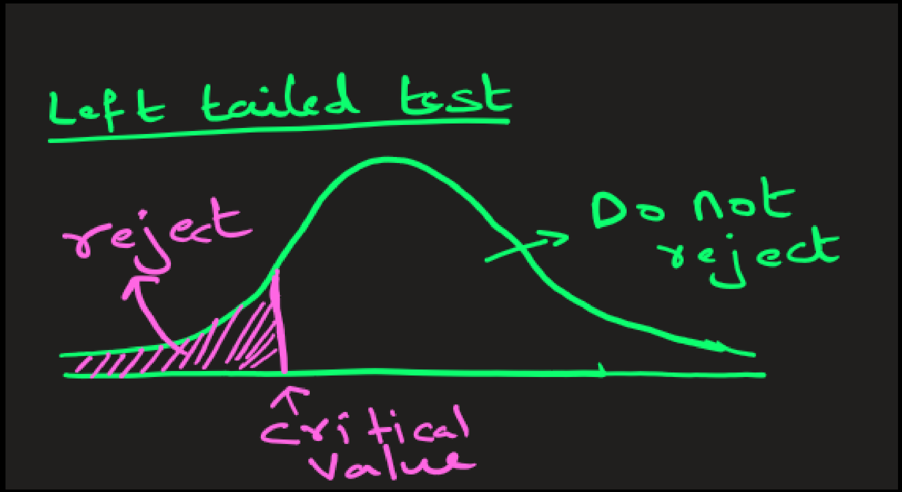
Step 2: Decide on your significance level α:
α = 5% → α = 0.05

Step3) Determine if you need a one-tailed or two-tailed test.
It's a one-tailed test (left-tail): So α = 0.05

Step4) Locate the value in t-table (see next slide)
Since this is two-tailed test, use $\boldsymbol{t_{\alpha,\mathrm{df}}}$ = $\boldsymbol{t_{0.05,22}}$ = 1.717

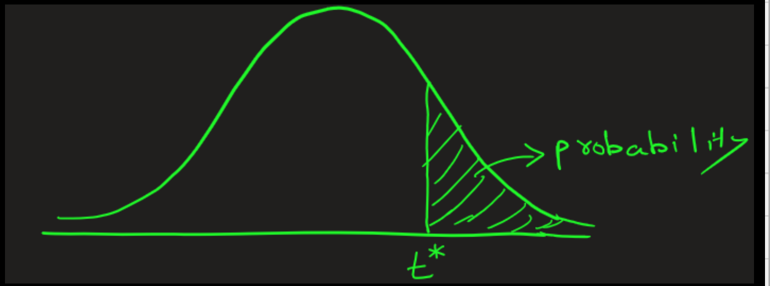
Since this is left-tailed, we take negative of this value: **- 1.717**
For 80% confidence with **n = 7** samples, the critical t-value is **- 1.717**

If your computed statistic $t_{calc} < -1.717$, you **reject the null hypothesis** H_0.



$$t_{\alpha,df} = t_{0.05,22} = 1.717$$

The value in the t-table represents the area of the t-distribution curve towards **the right** of t-test value for a given d.f. and α



	Alpha values (Upper-tail probability p)											
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1	1	1.376	1.963	3.078	6.314	12.71	15.89	31.82	63.66	127.3	318.3	636.6
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3	0.765	0.978	1.25	1.638	2.353	3.182	3.482	4.541	5.841	7.453	10.21	12.92
4	0.741	0.941	1.19	1.533	2.132	2.776	2.999	3.747	4.604	5.598	7.173	8.61
5	0.727	0.92	1.156	1.476	2.015	2.571	2.757	3.365	4.032	4.773	5.893	6.869
6	0.718	0.906	1.134	1.44	1.943	2.447	2.612	3.143	3.707	4.317	5.208	5.959
7	0.711	0.896	1.119	1.415	1.895	2.365	2.517	2.998	3.499	4.029	4.785	5.408
8	0.706	0.889	1.108	1.397	1.86	2.306	2.449	2.896	3.355	3.833	4.501	5.041
9	0.703	0.883	1.1	1.383	1.833	2.262	2.398	2.821	3.25	3.69	4.297	4.781
10	0.7	0.879	1.093	1.372	1.812	2.228	2.359	2.764	3.169	3.581	4.144	4.587
11	0.697	0.876	1.088	1.363	1.796	2.201	2.328	2.718	3.106	3.497	4.025	4.437
12	0.695	0.873	1.083	1.356	1.782	2.179	2.303	2.681	3.055	3.428	3.93	4.318
13	0.694	0.87	1.079	1.35	1.771	2.160	2.282	2.65	3.012	3.372	3.852	4.221
14	0.692	0.868	1.076	1.345	1.761	2.145	2.264	2.624	2.977	3.326	3.787	4.14
15	0.691	0.866	1.074	1.341	1.753	2.131	2.249	2.602	2.947	3.286	3.733	4.073
16	0.69	0.865	1.071	1.337	1.746	2.120	2.235	2.583	2.921	3.252	3.686	4.015
17	0.689	0.863	1.069	1.333	1.74	2.110	2.224	2.567	2.898	3.222	3.646	3.965
18	0.688	0.862	1.067	1.33	1.734	2.101	2.214	2.552	2.878	3.197	3.611	3.922
19	0.688	0.861	1.066	1.328	1.729	2.093	2.205	2.539	2.861	3.174	3.579	3.883
20	0.687	0.86	1.064	1.325	1.725	2.086	2.197	2.528	2.845	3.153	3.552	3.85
21	0.686	0.859	1.063	1.323	1.721	2.080	2.189	2.518	2.831	3.135	3.527	3.819
22	0.686	0.858	1.061	1.321	1.717	2.074	2.183	2.508	2.819	3.119	3.505	3.792
23	0.685	0.858	1.06	1.319	1.714	2.069	2.177	2.5	2.807	3.104	3.485	3.768
24	0.685	0.857	1.059	1.318	1.711	2.064	2.172	2.492	2.797	3.091	3.467	3.745
25	0.684	0.856	1.058	1.316	1.708	2.060	2.167	2.485	2.787	3.078	3.45	3.725
26	0.684	0.856	1.058	1.315	1.706	2.056	2.162	2.479	2.779	3.067	3.435	3.707
27	0.684	0.855	1.057	1.314	1.703	2.052	2.158	2.473	2.771	3.057	3.421	3.69
28	0.683	0.855	1.056	1.313	1.701	2.048	2.154	2.467	2.763	3.047	3.408	3.674
29	0.683	0.854	1.055	1.311	1.699	2.045	2.15	2.462	2.756	3.038	3.396	3.659
30	0.683	0.854	1.055	1.31	1.697	2.042	2.147	2.457	2.75	3.03	3.385	3.646
40	0.681	0.851	1.05	1.303	1.684	2.021	2.123	2.423	2.704	2.971	3.307	3.551

t-values for common confidence level:

Confidence Level	Two-Tailed α	One-Tailed α	Common Critical t (large df)
90%	0.10	0.05	1.645
95%	0.05	0.025	1.960
99%	0.01	0.005	2.576

Extra

α significance level	Test Type	Critical z-value(s) (Found from z-table)
0.10	Two-tailed	+- 1.645
0.10	One-tailed	±1.28 (+ for Right Tailed and – for Left Tailed)
0.05	Two-tailed	±1.96
0.05	One-tailed	±1.645 (+ for Right Tailed and – for Left Tailed)
0.01	Two-tailed	±2.576
0.01	One-tailed	±2.33 (+ for Right Tailed and – for Left Tailed)