- **The standard normal critical value for a 95% interval**: 1.96
- **Confidence interval formula**:
$$\bar{x} \pm Z_{(1-\frac{\alpha}{2})} \times \frac{\sigma_X}{\sqrt{n}}$$
estimate for the mean ± multiplier ± standard error for the mean
- **The standard normal critical value for a 99% interval**: 2.58
- **Multiplier formula**:
$$z = \frac{x - \textbf{mean}}{\textbf{sd}}$$
- **What is the α in the multiplier**: tail probability
- **Multiplier pattern**: when CI is bigger (e.g., 95% to 99%), the multiplier will be bigger
- s_X: sample standard deviation
- **In practice the true standard deviation σ_X is not known**: We estimate it with the sample standard deviation.
- **This means our critical values must now come from the 't' distribution, not the standard normal**.
- **t distribution CI**:
$$\bar{x} \pm t_{(1-\frac{\alpha}{2},\nu)} \times \frac{sX}{\sqrt{n}}$$
- **ν (degree of freedom) for t-distribution**: $\nu = n - 1$
- **The t-distribution will be the correct sampling distribution if**: either the underlying distribution of X is normal, and/or the sample size is sufficiently large (Central Limit Theorem holds).
- **What is the degree of freedom in t-distribution**: to replace the mean and sd in a normal distribution (because t-distribution is always standardised)
- **When to use t-distribution**: when the sample size is small
- **Calculate the estimate sample size when knows the CI**: assuming knows the sd and mean (normally given in the question), solve the equation, rounding UP
- **Comparing means with CI**:
$$(\bar{x}_1 - \bar{x}_2) \pm t_{(1-\frac{\alpha}{2},\nu)} \times \sqrt{\frac{s_1^2}{n_1} + \frac{s_2^2}{n_2}}$$
- **Using CLT to test appropriate normal distribution**:
$$n\pi \pm 3\sqrt{n\pi(1-\pi)}$$
gives two values between 0 and n, if not, then fails the test. This approximation is good only when: n is large, π is not close to 0 or 1 (this increases symmetry)

- **Formula for estimating π**:
$$P = \frac{X}{n}$$
,
$$p = \frac{x}{n}$$
, x is the observed value of X. (and more) Using the Central Limit Theorem, the resulting distribution of these proportions is approximately normal if, n is large enough, π far enough from 0 or 1. As before, we judge this using:
$$n\pi \pm \sqrt{n\pi(1-\pi)}$$
gives values between 0 and n.

- **Derivation of the mean of the sampling distribution**: If $P = \frac{X}{n}$, then $\mu_P = \pi$, **sd** $= \sigma_P = \sqrt{\frac{\pi(1-\pi)}{n}}$

- **95% confidence interval for π** (use the sample proportion (p) to estimate the unknown true population proportion (π)):
$$p \pm 1.96\sqrt{\frac{p(1-p)}{n}}$$

- **Margin of error**:
$$multipliers * sd$$

- **Note for CI**: This confidence interval (and margin of error) is correct only if the normal approximation to the binomial is appropriate. In practice, bias due to non-response should also be considered in our interpretation of an estimate.