One-sample inference for a population proportion \( p \) (listed as “Population Proportion” on yellow formula card):

1. Hypotheses: \( H_0: p = p_0 \) vs. \( H_a: p < p_0 \) OR \( p > p_0 \) OR \( p \neq p_0 \)
2. Assumptions: Large sample \( (n p_0 \geq 10; n(1- p_0) \geq 10) \); random sample.
3. Test Statistic: Large sample: \( z \), use Table A.1 to find \( p \)-value
   Small Sample: \( X \); use Binomial Formula to find \( p \)-value.

Two independent samples inference for the difference between two population proportions \( p_1 - p_2 \)
(Two Population Proportions):

1. Hypotheses: \( H_0: p_1 - p_2 = 0 \) vs. \( H_a: p_1 - p_2 < 0 \) OR \( p_1 - p_2 > 0 \) OR \( p_1 - p_2 \neq 0 \)
2. Assumptions: Large samples \( (n p_1 \geq 10; n(1- p_1) \geq 10; n p_2 \geq 10; n(1- p_2) \geq 10) \);
   independent random samples.
3. Test Statistic: \( z \), no degrees of freedom needed

One-sample inference for a population mean \( \mu \) (Population Mean):

1. Hypotheses: \( H_0: \mu = \mu_0 \) vs. \( H_a: \mu < \mu_0 \) OR \( \mu > \mu_0 \) OR \( \mu \neq \mu_0 \)
2. Assumptions: Normal population; random sample.
3. Test Statistic: \( t \), degrees of freedom = \( n-1 \)

Paired samples inference for a population mean difference \( \mu_D \) (under Population Mean column):

- Think: Are there two observations for each unit in the sample, or are comparisons being made on an individual-to-individual (paired) basis? Am I interested in the mean difference?
1. Hypotheses: \( H_0: \mu_D = 0 \) vs. \( H_a: \mu_D < 0 \) OR \( \mu_D > 0 \) OR \( \mu_D \neq 0 \)
2. Assumptions: Differences are from a normal population of all differences; differences form a random sample.
3. Test Statistic: \( t \), degrees of freedom = \( n-1 \)

Two independent samples inference for the difference between two population means \( \mu_1 - \mu_2 \)

- Think: Are comparisons being made between one entire sample and another entire sample? Am I interested in the difference in means?
(Two Population Means – General):
1. Hypotheses: \( H_0: \mu_1 - \mu_2 = 0 \) vs. \( H_a: \mu_1 - \mu_2 < 0 \) OR \( \mu_1 - \mu_2 > 0 \) OR \( \mu_1 - \mu_2 \neq 0 \)
2. Assumptions: Each population must be normal; each sample must be random; samples are independent from each other; not reasonable to assume equal population variances.
3. Test Statistic: \( t \), degrees of freedom = \( n_1 + n_2 - 2 \)
(Two Population Means – Pooled):
1. Hypotheses: \( H_0: \mu_1 - \mu_2 = 0 \) vs. \( H_a: \mu_1 - \mu_2 < 0 \) OR \( \mu_1 - \mu_2 > 0 \) OR \( \mu_1 - \mu_2 \neq 0 \)
2. Assumptions: Each population must be normal; each sample must be random; samples are independent from each other; equal population variances.
   - Note: the difference between the general and pooled versions of the independent samples t-test deals with the assumption of equal population variances. Use the general version of the test when you CANNOT assume equal variances; use the pooled version when you CAN assume equal variances.
   - 3 indications of equal variances: (1) insignificant p-value for Levene’s Test; (2) roughly equal lengths of IQR’s on boxplots; (3) similar sample standard deviations.
3. Test Statistic: \( t \), degrees of freedom = \( n_1 + n_2 - 2 \)

Some things to remember about hypothesis testing:
- Always use the population parameter in the hypotheses, never the sample statistic.
- There is never equality in the alternative hypothesis.
- Get the sign for the alternative from the context of the problem, and use that sign to find the \( p \)-value (it tells you what area to look for). When finding the \( p \)-value, do use equality \( (P(z > z^*) \), \( P(X > k) \)... etc.).

For the interpretations: note that words that appear in bold are key; words that are italics are “blanks” that need to be filled in based on the context of the problem.
- Interpretation of the p-value: A p-value of $0.\#\#$ means that if the null hypothesis is true, we would expect to see our test statistic or something more extreme in about $\#\%$ of repeated random samples of size $n$ from the population.
- Type 1 Error: Supporting $H_a$ when in fact $H_0$ is true.
- Type 2 Error: Supporting $H_0$ when in fact $H_a$ is true.
- Power: Supporting $H_a$ when in fact $H_a$ is true (i.e. the probability of making the correct decision). Note that power will be increased by anything that increases the probability of rejecting $H_0$ (and therefore also increases the possibility of making a Type 1 Error).

Confidence Intervals and TWO-sided hypothesis tests:
- When testing a single population parameter, fail to reject $H_0$ if the null value is contained in the interval.
- When comparing two confidence intervals for two population parameters, conclude there is a significant difference between the two parameters is the confidence intervals do not overlap at all. If the two confidence intervals have some of the same values, conclude that there is not a significant difference between the population values.

Some things to remember about confidence intervals:
- Confidence intervals are for the population parameter, but are constructed using the sample statistic.
- The probability that the population parameter is in any given confidence interval is either 0 (meaning the parameter is not in the interval) or 1 (meaning the parameter is in the interval).
- Interpretation of the $\#\%$ Confidence Interval: We are $\#\%$ confident that the true population parameter is contained in this interval.
- Interpretation of the $\#\%$ Confidence Level: If we were to take all possible samples of size $n$ and construct $\#\%$ confidence intervals for each sample, then we would expect $\#\%$ of these intervals to contain the true population parameter.

A few more interpretations:
- A standard error of $\#$ means that we would estimate that the average distance of the possible sample mean values (obtained by taking repeated samples of size $n$) from the population mean to be roughly $\#$ units.
- An observed test statistics $t$ means that the observed sample mean was $t$ average distances (i.e. $t$ standard errors) above the hypothesized mean.

For the interpretations: note that words that appear in bold are key; words that are italics are "blanks" that need to be filled in based on the context of the problem.