I use the following mnemonic devices to help students remember the steps required in carrying out a hypothesis test or confidence interval: **PHANTOMS** and **PANIC**.

P arameter
H ypotheses
A ssumptions
N ame the test
T est statistic
O btain p-value
M ake decision
S tate conclusion in context

P arameter
A ssumptions
N ame the interval
I nterval
C onclusion in context

Example:
A study of iron deficiency in infants compared samples of infants whose mothers chose different ways of feeding them. One group contained breast-fed infants. The children in another group were fed a standard baby formula without any iron supplements. Here are summary results on blood hemoglobin levels at 12 months of age.

Group	n	$\bar{x}$	s
Breast-Fed	23	13.3	1.7
Formula	19	12.4	1.8

Is there significant evidence that the mean hemoglobin level is different amoung breast-fed babies? Give a 95% confidence interval for the mean difference in hemoglobin level between the two populations of infants.

HYPOTHESIS TEST:

P

μ_{breast} : the mean blood hemoglobin level at 12 months of age for breast-fed babies
$\mu_{formula}$: the mean blood hemoglobin level at 12 months of age for formula-fed babies

H

$H_0 : \mu_{breast} = \mu_{formula}$
$H_0 : \mu_{breast} \neq \mu_{formula}$

A

It is reasonable to assume that the samples were chosen randomly and independently. It is also reasonable to assume that at least 230 breast-fed babies and 190 formula-fed babies are present in the population. Although we cannot check for outliers or strong skewness, the combined sample size of 42 is sufficiently large.

N Therefore, a two-sample t-test may be used.

T $$t = \frac{\left(\bar{x}_{breast} - \bar{x}_{formula}\right) - \left(\mu_{breast} - \mu_{formula}\right)}{\sqrt{\frac{s^2_{breast}}{n_{breast}} + \frac{s^2_{formula}}{n_{formula}}}} = \frac{(13.3 - 12.4) - (0)}{\sqrt{\frac{1.7^2}{23} + \frac{1.8^2}{19}}} \approx 1.6537$$

O $df \approx 37.5976$ $\quad$ $p = 2P(t \geq 1.6537) \approx 2(0.0533) \approx 0.1065$

$tcdf(1.6537, 1E99, 37.5976) \approx 0.0533$

M Do not reject H_0.

S There is not strong enough evidence to conclude that the mean blood hemoglobin level at 12 months of age for the breast-fed group is significantly different than that of the formula-fed group. If there truly is no difference between breast-fed and formula-fed babies, we would expect a result at least this extreme in about 10 out of every 100 samples due to chance.

CONFIDENCE INTERVAL:

P μ: the mean difference in blood hemoglobin level at 12 months of age between breast-fed babies and the formula-fed babies

A It is reasonable to assume that the samples were chosen randomly and independently. It is also reasonable to assume that at least 230 breast-fed babies and 190 formula-fed babies are present in the population. Although we cannot check for outliers or strong skewness, the combined sample size of 42 is sufficiently large.

N Therefore, a two-sample t-interval may be used.

$$\left(\bar{x}_{breast} - \bar{x}_{formula}\right) \pm t * \sqrt{\frac{s^2_{breast}}{n_{breast}} + \frac{s^2_{formula}}{n_{formula}}} = (13.3 - 12.4) \pm 2.021\sqrt{\frac{1.7^2}{23} + \frac{1.8^2}{19}} = 0.9 \pm 1.0999$$

I (-0.2021, 2.0021)

C We are 95% confident that the true mean level of hemoglobin at 12 months of age in breast-fed babies is between about 0.2 units lower and 2.0 units higher than that of formula-fed babies, since 95% of all samples of this size would produce a mean difference within 1.10 units of the true mean difference.