Be sure to have studied the warpbreaks example in your Math 325 Notebook before answering these questions. (Two-Way ANOVA Example.)

Consider the ToothGrowth dataset in R.

> ?ToothGrowth

Test the following hypotheses all at the same time with a single Two-Way ANOVA Test in R.

Hypotheses about the effects on tooth growth due to the supplement type:

$$H_0 : \mu_{VC} = \mu_{OJ}$$
$$H_a : \mu_{VC} \neq \mu_{OJ}$$

Hypotheses about the effects on tooth growth due to the dosage level:

$$H_0 : \mu_{0.5} = \mu_{1.0} = \mu_{2.0} = \mu$$
$$H_a : \mu_i \neq \mu \text{ for at least one dosage level } i = 0.5, 1.0, \text{ or } 2.0$$

Hypotheses about the effects on tooth growth due to the interaction of supplement type and dosage level:

$$H_0 : \text{the effect of dosage on tooth growth is the same for all levels of supplement type.}$$
$$H_a : \text{the effect of dosage on tooth growth is not the same for all levels of supplement type.}$$

Before looking at the p-values of your test, it is always important to check the degrees of freedom of the test. **Remember**, degrees of freedom should be one less than the number of levels of the factor. If this is not the case, then use **as.factor(...)** to fix the problem.

Degrees of freedom that should be showing for dose: 2

Degrees of freedom that should be showing for supp: 1

Degrees of freedom that should be showing for the interaction of supp and does: 2

Once your degrees of freedom all check out, then your p-values and conclusion will be correct.

The Two-Way ANOVA test shows that supplement type has a significant effect on tooth growth (p-value = 0.000231), dosage level has a significant effect on tooth growth (p-value < 2e-16), and the interaction of dosage level and supplement type has a significant effect on tooth growth (p-value = 0.021860).

The effect of supplement type is demonstrated in the following plot.

> xyplot(len ~ supp, data=ToothGrowth, type=c("p","a"))

The effect of dosage level is demonstrated in the following plot.

> xyplot(len ~ dose, data=ToothGrowth, type=c("p","a"))

The effect of the interaction of supplement type and dosage level is demonstrated in the following plot.

> xyplot(len ~ supp, data=ToothGrowth, groups=dose, type=c("p","a"), auto.key=TRUE)