These questions test your ability to read ANOVA output from R.

Run the following commands in R using the Friendly data set (Recalling Words).

```
> library(car)
> friendly.aov <- aov(correct ~ condition, data=Friendly)
> summary(friendly.aov)
> par(mfrow=c(1,2))
> plot(friendly.aov, which=1:2)
```

The ANOVA hypotheses for the Friendly data set are

$$H_0 : \mu_1 = \mu_2 = \mu_3 = \mu$$
$$H_a : \mu_i \neq \mu \text{ for at least one } i$$

where Group 1 is SFR, Group 2 is Before, and Group 3 is Meshed.

These hypotheses simply state that the mean words recalled under the three different conditions, SFR, Before, and Meshed are the same (the null) or that at least one differs (the alternative).

The p-value of this ANOVA test is [.02319] showing that there is [sufficient] evidence to conclude that [at least one of the means differs from the others.].

Note that this ANOVA p-value is the probability that a test statistic from an F distribution with [2] and [27] degrees of freedom is as extreme or more extereme than the observed value of [4.341], assuming the null hypothesis is true. This p-value is only meaningful if two important assumptions can be made, (1) that the error term ϵ_{ik} is normal and (2) that the variance σ^2 of the error term is constant, i.e., the same in all groups. Two plots were created in R to check the two requirements of ANOVA. The first plot, the residual plot, shows that the [constant (equal) variance] assumption is reasonable because the points for each group have roughly the same spread. The second plot, the Q-Q Plot of the residuals, shows that the [normal error terms (residuals)] assumption is reasonable because the points hold to the line rather well.

Finally, the conclusion of this ANOVA test is that one of the means differs. This is not a very informative conclusion, but it does give us permission to explore the data. Consider the following plot in R that shows the means of each group with a line as well as the points from each group (jittered or wiggled a little in the horizontal direction so that they don't overlap).

```
> xyplot(correct ~ condition, data=Friendly, jitter.x=TRUE, type=c("p","a"))
```

From this plot (and the p-value of the ANOVA test) we can determine that the [SFR] has a significantly [lower] mean than the other two groups, which happen to both be equal to each other. The plot thus gives us greater insight than the ANOVA test provided, but without the ANOVA, we could not trust the results in the plot. A meaningful plot and hypothesis test always go hand in hand.