# Unreplicated 2^k Factorial Designs

*Do the following problem in R*

In a process development study on yield, four factors were studied, each at two levels: time (A), concentration (B), pressure (C), and temperature (D).

| **Run Number** | **Actual Run Order** | A | B | C | D | **Yield (lbs)** |
| --- | --- | --- | --- | --- | --- | --- |
| 1 | 5 | − | − | − | − | 12 |
| 2 | 9 | + | − | − | − | 18 |
| 3 | 8 | − | + | − | − | 13 |
| 4 | 13 | + | + | − | − | 16 |
| 5 | 3 | − | − | + | − | 17 |
| 6 | 7 | + | − | + | − | 15 |
| 7 | 14 | − | + | + | − | 20 |
| 8 | 1 | + | + | + | − | 15 |
| 9 | 6 | − | − | − | + | 10 |
| 10 | 11 | + | − | − | + | 25 |
| 11 | 2 | − | + | − | + | 13 |
| 12 | 15 | + | + | − | + | 24 |
| 13 | 4 | − | − | + | + | 19 |
| 14 | 16 | + | − | + | + | 21 |
| 15 | 10 | − | + | + | + | 17 |
| 16 | 12 | + | + | + | + | 23 |

1. Display the halfnormal plot for this data and determine which factors appear to be significant.
2. Pull terms that do not appear to be significant into error and test for the significance of the other effects at the 0.05 level of significance.