

**Q3:** The type of material used and the temperature of the usage environment affect the maximum output voltage of a particular storage battery. An experiment is designed to determine the significant source (s) of variability for the maximum output voltage. The following data set shows the laboratory results for this experiment. The data entries are the recorded maximum voltages in proper units. The material type and the temperature are both fixed effects.

Temperature (F)

Material Type	50 Degrees	65 Degrees	80 Degrees
A	130 155 74	34 40 80	20 70 82
B	150 188 159	136 122 106	25 70 58
C	138 110 168	174 120 150	96 104 82

**Part A:** Conduct the proper ANOVA model without including the replication effect as a source of variation. Report **only** the relevant results that explain the significant source(s) of variability for LOS=5%.

**All original hypotheses:**

1.  $H_0 : \mu_A = \mu_B = \mu_C$   
 $H_A : \text{Otherwise}$
2.  $H_0 : \mu_{50} = \mu_{65} = \mu_{80}$   
 $H_A : \text{Otherwise}$
3.  $H_0 : \text{There is not a significant interaction between factors}$   
 $H_A : \text{There is a significant interaction between factors}$

D.R. Reject  $H_0$  if  $P < 0.05$

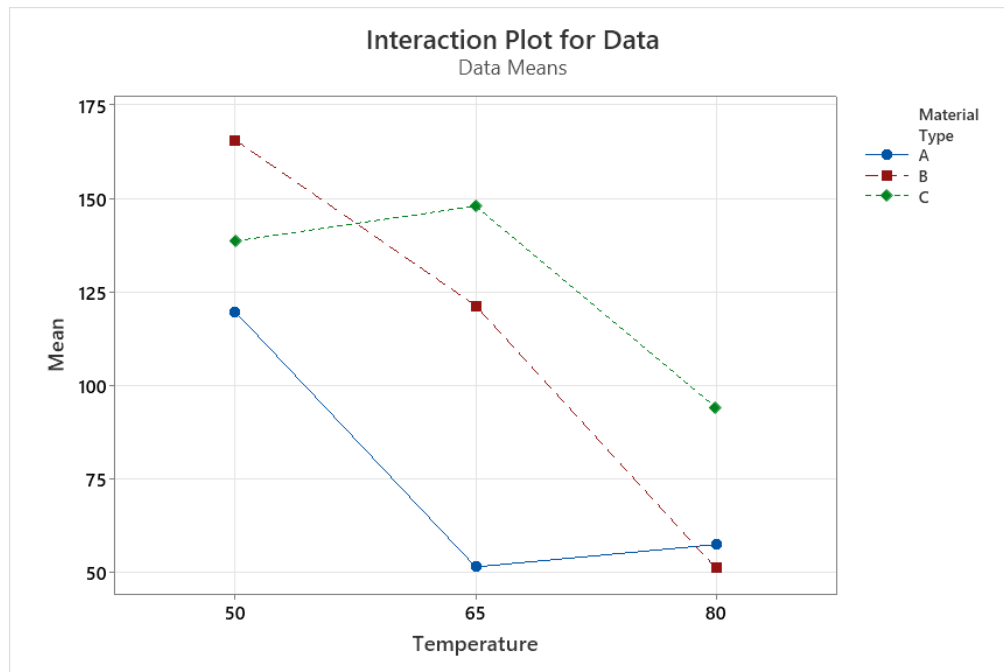
**Results (F and P values for only the impacting hypothesis (ses)):**

**F** = 3.24

**P** = 0.036

**Actionable conclusion (with supportive plots):**

The interaction between material type and temperature is significant since  $P = 0.036 < 0.05$ . The interaction shows that material type B at 50 degrees has the highest mean maximum output voltage in this test.



**Part B:** Do the above analysis but include the replication effect as a source of variation. Again, use  $p < 0.05$ .

**All Hypotheses:**

1.  $H_0 : \mu_A = \mu_B = \mu_C$   
 $H_A : \text{Otherwise}$
2.  $H_0 : \mu_{50} = \mu_{65} = \mu_{80}$   
 $H_A : \text{Otherwise}$
3.  $H_0 : \text{There is not a significant interaction between factors}$   
 $H_A : \text{There is a significant interaction between factors}$

D.R. Reject  $H_0$  if  $P < 0.05$

**Results (F and P values for only the impacting hypothesis (ses)):**

Material Type:  $F = 8.08$ ,  $P = 0.004$

Temperature:  $F = 16.10$ ,  $P = 0.000$

**Actionable conclusion (with supportive plots):**

The interaction effect was notable, but  $P > 0.05$  so it fails to reject the null hypothesis. Both main effects are significant with P-values less than 0.05. The plot below shows that the mean maximum voltage is best for material type C and at a temperature of 50 Degrees.

Main Effects Plot for Data  
Data Means

