Short Problem Set 6

A quantitative method for the determining the concentration of ceruloplasmin, an important copper-carrying protein in blood, takes advantage of its ability to oxidize *p*-phenylenediamine. To improve the method's ability to detect small concentrations of ceruloplasmin we need to maximize the reaction's initial rate. Possible factors that might affect the rate are pH, temperature, and the concentration of *p*-phenylenediamine; the following factor levels and coded equivalents are used

factor	–1	+1
A: temperature (°C)	35	40
B: [*p*-phenylenediamine] (mM)	0.5	27.3
C: pH	6.4	4.8

A 2^3 full-factorial design yields the following initial rates in coded factor space

experiment	A^*	B^*	C^*	Rate (min^{-1})
1	+1	–1	+1	6.69
2	+1	+1	+1	11.71
3	+1	+1	–1	14.79
4	+1	–1	–1	8.05
5	–1	–1	+1	6.33
6	–1	+1	+1	11.11
7	–1	+1	–1	14.08
8	–1	–1	–1	7.59

Use this data to find the parameters in the coded model

$$R = b_0 + b_a A^* + b_b B^* + b_c C^* + b_{ab} A^* B^* + b_{ac} A^* C^* + b_{bc} B^* C^* + b_{abc} A^* B^* C^*$$

The following table, which is partially filled out, will help you organize your work

experiment	b_0	b_a	b_b	b_c	b_{ab}	b_{ac}	b_{bc}	b_{abc}	rate (min^{-1})
1	+1	+1	–1	+1					6.69
2	+1	+1	+1	+1					11.71
3	+1	+1	+1	–1					14.79
4	+1	+1	–1	–1					8.05
5	+1	–1	–1	+1					6.33
6	+1	–1	+1	+1					11.11
7	+1	–1	+1	–1					14.08
8	+1	–1	–1	–1					7.59

Based on your model, what is the initial rate when the temperature is 36°C, the concentration of *p*-phenylenediamine is 10.0 mM, and the pH is 5.0?