SS 11.9 Consider the three-variable central composite design shown in Table P11.4. Analyze the data and draw conclusions, assuming that we wish to maximize conversion (y_1) with activity (y_2) between 55 and 60.

TABLE P11.4

A Three-Variable CCD

Run	Time (min)	Temperature (°C)	Catalyst (%)	Conversion (%) y_1	Activity y_2
1	−1.000	−1.000	−1.000	74.00	53.20
2	1.000	−1.000	−1.000	51.00	62.90
3	−1.000	1.000	−1.000	88.00	53.40
4	1.000	1.000	−1.000	70.00	62.60
5	−1.000	−1.000	1.000	71.00	57.30
6	1.000	−1.000	1.000	90.00	67.90
7	−1.000	1.000	1.000	66.00	59.80
8	1.000	1.000	1.000	97.00	67.80
9	0.000	0.000	0.000	81.00	59.20
10	0.000	0.000	0.000	75.00	60.40
11	0.000	0.000	0.000	76.00	59.10
12	0.000	0.000	0.000	83.00	60.60
13	−1.682	0.000	0.000	76.00	59.10
14	1.682	0.000	0.000	79.00	65.90
15	0.000	−1.682	0.000	85.00	60.00
16	0.000	1.682	0.000	97.00	60.70
17	0.000	0.000	−1.682	55.00	57.40
18	0.000	0.000	1.682	81.00	63.20
19	0.000	0.000	0.000	80.00	60.80
20	0.000	0.000	0.000	91.00	58.90

① A full factorial in 3 factors requires $2^3 = 8$ runs. Factorial points are indicated by yellow highlighted cells. $n_f = 8$

② Centerpoints have zeros for x_1, x_2 & x_3. Pink highlighted cells are centerpoints. $n_c = 6$

③ axial/star points are highlighted in green.

④ the value of $\alpha = 1.682$

if $\alpha = (n_f)^{1/4}$ the design is rotatable
if $\alpha = \sqrt{K}$, the design is spherical
otherwise, the value of α is Custom

$K = 3$, $\sqrt{3} = 1.732 \rightarrow$ design is not rotatable

$n_f = 8(8)^{1/4} = 1.682 \rightarrow$ design is spherical.

This is a spherical CCD with a full factorial and 6 center points