Please complete the following Chapter 6 exercises:

6.5   For part (a), use the raw data and a table of algebraic signs to manually (i.e. not using Minitab) estimate each of the following effects: a, b, ab, c, ac, bc, abc. Comment on which effects you expect to be significant.

Consider 2^3 experiment

	I	A	B	AB (G)	C	AC	BC	ABC
						+	+	−
(1)	+	−	−	+	−	+	+	+
a	+	+	−	−	−	−	+	+
b	+	−	+	−	−	+	−	−
ab	+	+	+	+	−	−	−	+
c	+	−	−	+	+	+	−	−
ac	+	+	−	−	+	+	−	−
bc	+	−	+	+	+	−	+	+
abc	+	+	+	+	+	+	+	+

(1)	(1)	78
a	a	104
b	b	99
ab	ab	148
c	c	127
ac	ac	113
bc	bc	164
abc	abc	127

$A = (-78 +104 -99 +148 -127 +113 -164 +127) \times \frac{1}{12}$
$= 0.33$

$B = \frac{1}{12}(-78 -104 +99 +148 -127 -113 +164 +127)$
$= 11.33$

$AB = \frac{1}{12}(78 -104 -99 + 148 +127 -113 -164 +127)$
$= -1.67$

$C = \frac{1}{12}(-78 -104 - 99 -148 +127 +113 +164 +127)$
$= 6.83$

$AC = \frac{1}{12}(78 -104 + 99 - 148 -127 +113 - 164 + 127)$
$= -6.83$

$BC = \frac{1}{12}(78 +104 -99 -148 -127 -113 +164 + 127)$
$= -2.83$

$ABC = \frac{1}{12}(-78 +104 +99 -148 +127 - 113 -164 +127)$
$= -2.17$

I think B, C, and AC will be significant.

Part (b) asks you to fit the full model containing three main effects, three two-way interactions, and the single three-way interaction. In addition, provide the Pareto plot and the half-normal plot.

Analysis of Variance

| Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	7	1612.67	230.381	7.64	0.000
Linear	3	1051.50	350.500	11.62	0.000
A	1	0.67	0.667	0.02	0.884
B	1	770.67	770.667	25.55	0.000
C	1	280.17	280.167	9.29	0.008
2-Way Interactions	3	533.00	177.667	5.89	0.007
A*B	1	16.67	16.667	0.55	0.468
A*C	1	468.17	468.167	15.52	0.001
B*C	1	48.17	48.167	1.60	0.224
3-Way Interactions	1	28.17	28.167	0.93	0.348
A*B*C	1	28.17	28.167	0.93	0.348
Error	16	482.67	30.167		
Total	23	2095.33			
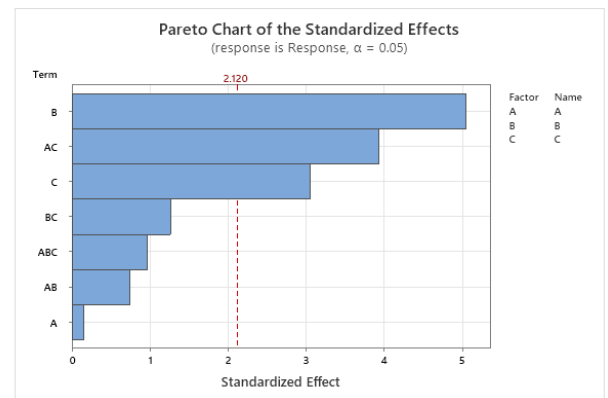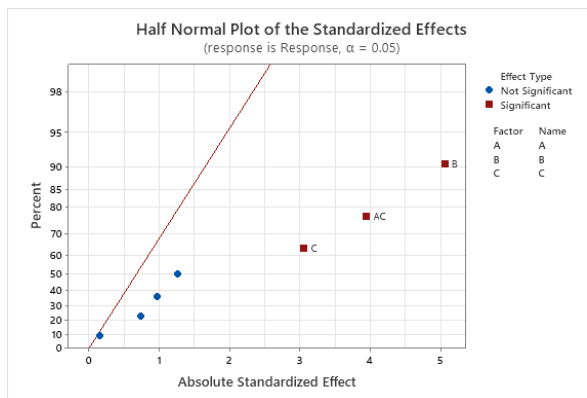
Part (c) asks that you write a regression model after obtaining the most parsimonious model. For example, if you only retain main effects of A and B, plus their interaction, the model would look like:

$$Y = \beta_0 + \beta_1 A + \beta_2 B + \beta_3 AB + \varepsilon$$

You do not need to estimate the regression coefficients; just state the model.

Response = 40.83 + 0.17 A + 5.67 B + 3.42 C - 4.42 A*C

Part (d) asks that you fit the reduced model from part (c), where all predictors are categorical variables, and investigate the residuals.

Normal Probability Plot
(response is Response)

Versus Fits
(response is Response)
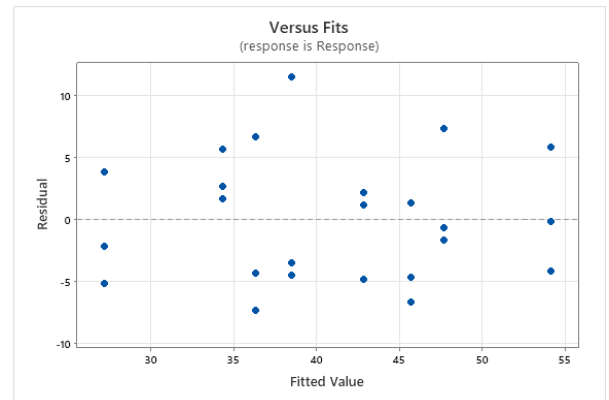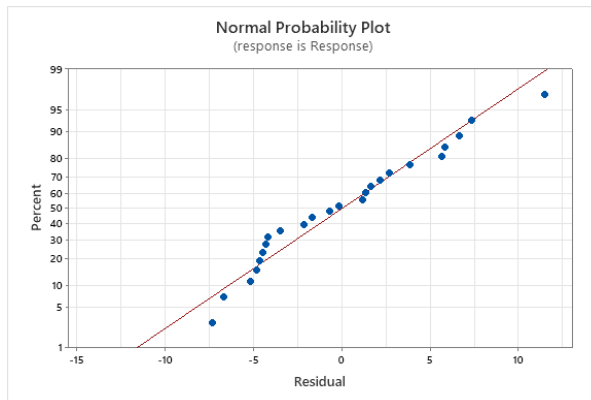
Normality and constant variance assumption isn't violated.

For part (e), provide an interaction plot, then state which levels (low or high) of factors A, B, and C you would recommend.

A at the low level, B at the high level, C at the high level

6.6   Note that if using the DOE menu in Minitab, the factors do not need to be explicitly treated as continuous covariates (fitting a GLM *would* require use of continuous covariates). It is not enough to simply provide contour plots and the AC surface plot: explanation is required. Convince me that you know what is happening in the plots.
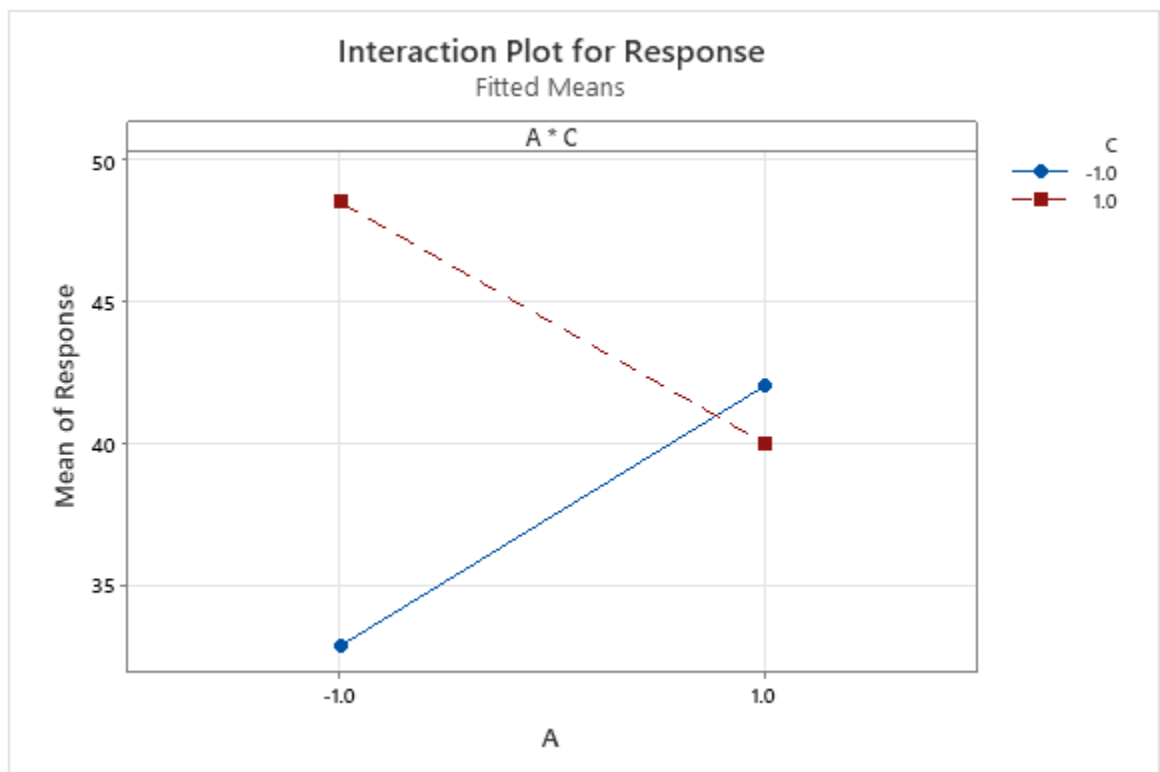
The graph isn't parrel so there is definitely some type of interaction between A and C. We would want C at a high level and A at a low level.

Main Effects Plot for Response
Fitted Means
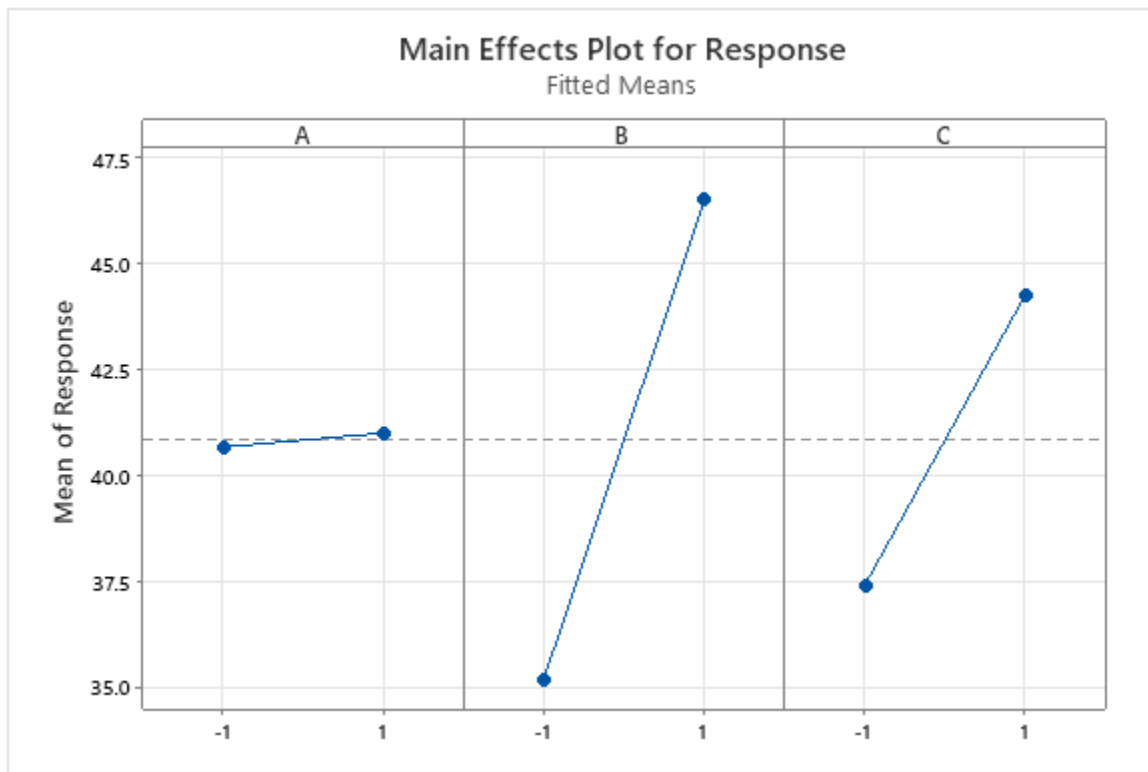
B and C has a huge difference between low and high level. A barely matters by itself.

6.32

a) Make a normal graph. Which factors have large effects?

Normal Plot of the Effects
(response is Response, $\alpha = 0.05$)

Lenth's PSE = 1.125
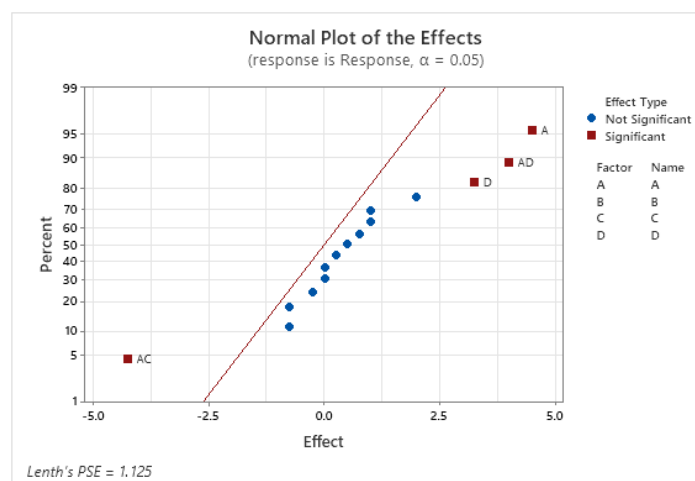
A, AD, D, AC have all significant effects

For part (b), provide the ANOVA table for the most parsimonious model (you do not need to show the intermediate ANOVA tables).

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	5	275.50	55.100	33.91	0.000
Linear	3	139.25	46.417	28.56	0.000
A	1	81.00	81.000	49.85	0.000
C	1	16.00	16.000	9.85	0.011
D	1	42.25	42.250	26.00	0.000
2-Way Interactions	2	136.25	68.125	41.92	0.000
A*C	1	72.25	72.250	44.46	0.000
A*D	1	64.00	64.000	39.38	0.000
Error	10	16.25	1.625		
Total	15	291.75			

c) Write a regression model after obtaining the most parsimonious model

Response $=$ 17.375 + 2.250 A + 1.000 C + 1.625 D - 2.125 A*C + 2.000 A*D

d) Analyze the residuals
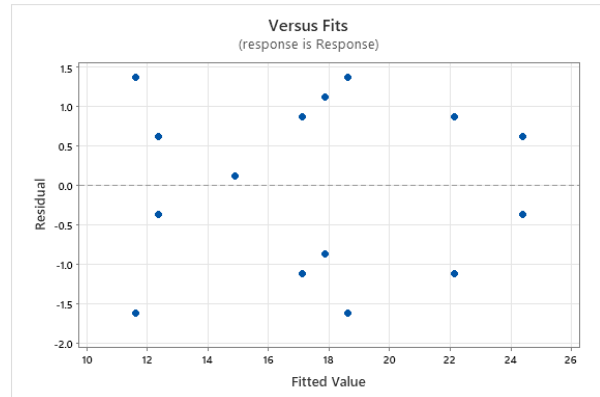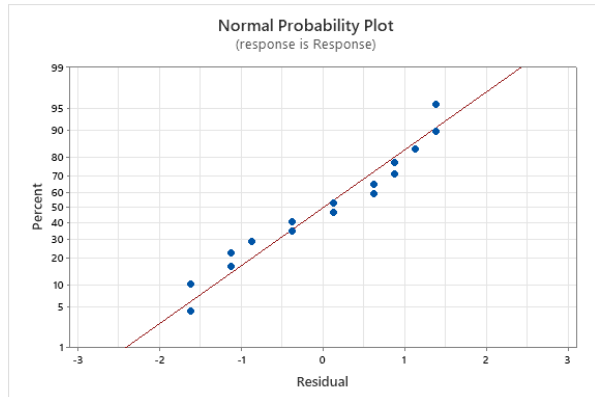
Normality and variance assumptions are not violated.

For part (e), provide a cube plot (use Minitab's DOE menu; don't sketch anything). Use an interaction plot to recommend how to maximize yield.

Cube Plot (fitted means) for Response
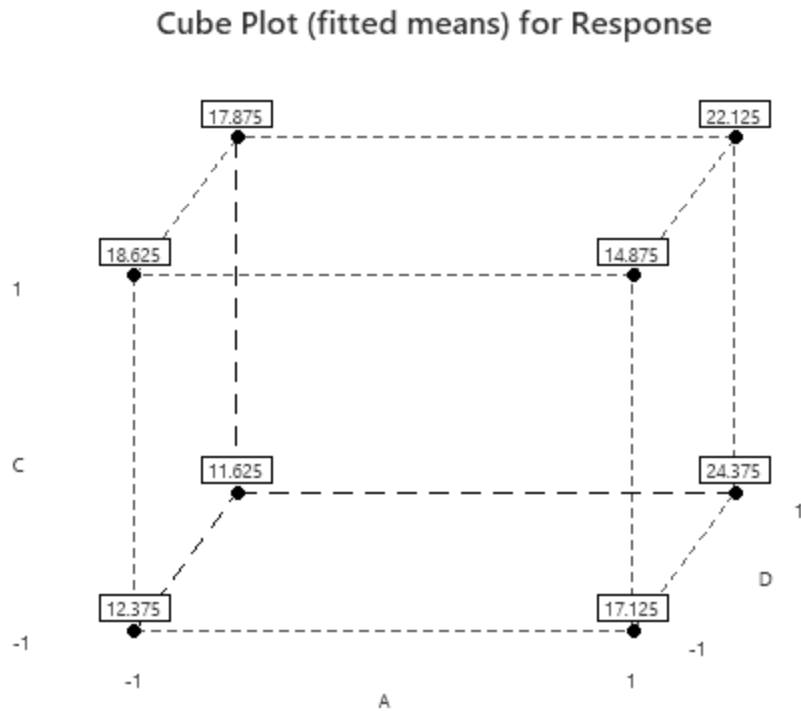
A and D at the high level, and C at the low level.

6.34   a) Analyze the data

Analysis of Variance

Source	DF	Adj SS	Adj MS	F-Value	P-Value
Model	7	93.250	13.3214	2.20	0.047
Linear	3	90.375	30.1250	4.98	0.004
A	1	72.250	72.2500	11.95	0.001
B	1	18.063	18.0625	2.99	0.089
C	1	0.063	0.0625	0.01	0.919
2-Way Interactions	3	2.625	0.8750	0.14	0.933
A*B	1	0.062	0.0625	0.01	0.919
A*C	1	1.563	1.5625	0.26	0.613
B*C	1	1.000	1.0000	0.17	0.686
3-Way Interactions	1	0.250	0.2500	0.04	0.840
A*B*C	1	0.250	0.2500	0.04	0.840
Error	56	338.500	6.0446		
Total	63	431.750			

Pan material and stirring method seems to be significant.

b) Is the analysis from part a fine?

No because there are too many people trying to judge one batch of brownies. The error variance would be too big

For part (c), analyze the data as if it were a one-way ANOVA experiment, where the single factor (Brownie Batch) has 8 levels, and $n_i = 8$ for $i = 1, 2, ...,8$. Is there a single batch that seems to be preferred?

Coefficients

Term	Coef	SE Coef	T-Value	P-Value	VIF
Constant	11.563	0.307	37.62	0.000	
Level					
1	-1.813	0.813	-2.23	0.030	1.75
2	0.562	0.813	0.69	0.492	1.75
3	-0.562	0.813	-0.69	0.492	1.75
4	1.937	0.813	2.38	0.021	1.75
5	-1.437	0.813	-1.77	0.083	1.75
6	0.563	0.813	0.69	0.492	1.75
7	-0.438	0.813	-0.54	0.593	1.75

Batch 4 seems to be favored heavily.