[redacted]

1) The data given below is milk yield of 28 daughters of 4 sires in 3 herds

Herd	Sire	Milk Yield
1	1	157, 160, 138
	2	96, 110, 115, 120
	3	82, 65
	4	120, 130,110
2	1	140, 142, 145
	2	122, 117, 98
	3	70, 94
3	2	112, 125, 105
	3	110, 92
	4	116, 129, 131

With a variance components analysis on Minitab, which statement is correct?

a) The analysis cannot be carried out because it is an unbalanced design.
b) The milk yield is an independent variable.
c) "Herd" contributed more variability than "Sire".
d) "Sire" contributed more variability than "Herd".
e) All of above.
f) None of above.

(Problem#2~6) The number of pounds of steam used per month by a chemical plant is thought to be related to the average ambient temperature (in °F) for that month. The past year's usage and temperature are shown in the following table:

Month	Temp.	Usage /1000	Month	Temp.	Usage /1000
Jan.	22	185.79	July	68	621.55
Feb.	24	214.47	Aug.	72	675.06
Mar.	32	288.03	Sept.	62	562.03
Apr.	45	424.06	Oct.	50	452.93
May	51	454.58	Nov.	41	369.95
June	59	539.03	Dec.	31	273.98

Let y = steam usage and x = monthly average temperature.

2) What is the correlation coefficient between x and y?
a) Close to 1.00
b) Close to -1.00
c) Close to 0.50
d) Close to -0.50
e) None of above

3) Find a 99% confidence interval for β_1
a) (7.01, 11.90)
b) (8.01, 10.90)
c) (9.01, 9.90)
d) (9.21, 9.70)
e) None of above

4) Find a 99% confidence interval for β_0
a) (-49.16, -14.84)
b) (-39.16, -4.84)
c) (-29.16, 4.84)
d) (-49.16, 14.84)
e) None of above

5) Find a 95% confidence interval on mean steam usage when the average temperature is 55°F
a) (497.20, 508.71)
b) (487.20, 518.71)
c) (477.20, 528.71)
d) (467.20, 538.71)
e) None of above

6) What is the distribution of the residuals?
a) N(0, 7.90)
b) N(0, 62.45)
c) N(46.42, 16.87)
d) N(46.42, 284.63)
e) None of above

(Problem #7)

```
The Regression Equation is Tons mined = 4.359
+ 0.000310 Personnel hours

S = 0.0559431  R-Sq = 39.2%   R-Sq(adj) = 33.1%

Source      DF       SS        MS      F      P
Regression  1   0.0201823 0.0201823  6.45  0.029
Error      10   0.0312964 0.0031296
Total      11   0.0514787
```

7) Which **two** statements are correct for the Regression Analysis displayed above?
a) The regression analysis based on the "p-value" is statistically significant at 95 % confidence.
b) The independent variable is "Tons mined."
c) The regression is statistically insignificant as the R^2 value is < 80 %.
d) The dependent variable is "Tons mined."
e) The input "Personnel hours" has a significant impact on "Tons mined."

8) Given the following incomplete ANOVA table, what is the sum of squares caused by the level?

Source	DF	SS	MS	F	P
Level	3				0.011425
Error	64	44270.29	691.72		

a) 52550
b) 15390
c) 8280
d) 2760
e) None of above

9) When conducting an ANOM, determine the lower and upper decision lines with $\bar{\bar{x}} = 10.0$ and s=2.00 if a significant level of 0.05 is desired. There are 5 levels, where each has 7 observations.
a) LDL=7.14, UDL=12.86
b) LDL=7.73, UDL=12.27
c) LDL=8.16, UDL=11.83
d) LDL=8.37, UDL=11.62
e) None of above

(Problem #10) A meteorologist has measured the amount of rain in four cities for six months. She wants to know if there are different amounts of rain in the four cities. Following is a result from Kruskal-Wallis Test.

```
Kruskal-Wallis Test: Rain versus City
Kruskal-Wallis Test on Rain

City       N  Median  Ave Rank      Z
1          6   90.50      15.5   1.20
2          6   88.00      15.4   1.17
3          6   69.00       6.1  -2.57
4          6   80.00      13.0   0.20
Overall   24              12.5

H = 7.07  DF = 3  P = 0.070
```

10) What conclusion could be made ($\alpha = 5\%$)?
a) Fail to reject the null hypothesis that all means are equal.
b) The null hypothesis that all means are equal should be rejected.
c) Fail to reject the null hypothesis that all medians are equal.
d) The null hypothesis that all medians are equal should be rejected.
e) None of above

(Problem #11) Aircraft primer paints are applied to aluminum surface by two methods: dipping and spraying. A factorial experiment was performed to investigate the effect of primer type and application method on paint adhesion. The resulting ANOVA table is as follows,

Two-way ANOVA: Adhesion versus Primer_Type, Apply_Method

```
Source         DF       SS       MS      F      P
Primer_Type     2   4.5811  2.29056  27.86  0.000
Apply_Method    1   4.9089  4.90889  59.70  0.000
Interaction     2   0.2411  0.12056   1.47  0.269
Error          12   0.9867  0.08222
Total          17  10.7178

S = 0.2867   R-Sq = 90.79%   R-Sq(adj) = 86.96%
```

11) What conclusion could NOT be made ($\alpha = 5\%$)?
a) Primer type is statistically significant.
b) Application method is statistically significant.
c) The interaction is not statistically significant.
d) All of above.
e) None of above

(Problem #12) A collector is considering to buy one of 3 classical violins. He asked 10 musicians to play the violins and evaluate the violins on a scale 1~10 (10 is the best). Following is a result from Friedman Test.

```
Friedman Test: Score versus Violin
blocked by Player

S = 9.95  DF = 2  P = 0.007

                Est  Sum of
Violin   N  Median   Ranks
1       10   8.083    26.5
2       10   7.167    21.0
3       10   6.000    12.5

Grand median = 7.083
```

12) What conclusion could be made ($\alpha = 1\%$)?
a) Fail to reject the null hypothesis that all violins are the same.
b) The null hypothesis that all violins are the same should be rejected.
c) Violin #1 is the best.
d) Violin #3 is the best.
e) None of above

13) In selecting factors to be included in the regression model, we could use "best subset" analysis. What criteria we should consider?
   a) Look for the highest R-sq value with the same number of predictors.
   b) Look for the highest Adj. R-sq value with different number of predictors.
   c) Look for the smallest Mallow's Cp and close to the number of parameters in the model.
   d) Look for the smallest s (std. deviation about the regression).
   e) All of above.

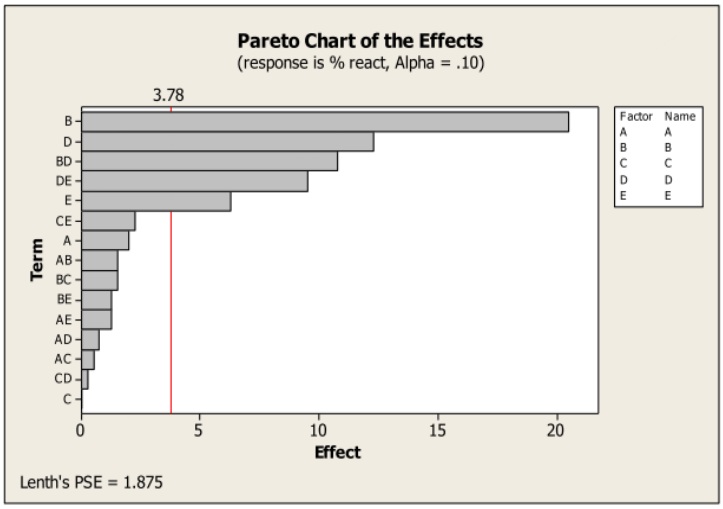
(Problem #14~16) A fractional factorial design was used to study 4 factors in a chemical process. The factors are A=temperature, B=pressure, C=concentration, and D=stirring rate, and the response is filtration rate. The design and the data are as follows,

Run	A	B	C	D	Response
1	−	−	−	−	45
2	+	−	−	+	100
3	−	+	−	+	45
4	+	+	−	−	65
5	−	−	+	+	75
6	+	−	+	−	60
7	−	+	+	−	80
8	+	+	+	+	96

14) What is the resolution of this DOE?
   a) III
   b) IV
   c) V
   d) V+
   e) None of above

15) What is the estimated effect of A?
   a) 141.50
   b) 78.00
   c) 70.75
   d) 19.00
   e) None of above

16) What is the estimated magnitude of contrast column A dispersion effects?
   a) -0.0905
   b) -0.1810
   c) 0.0905
   d) 0.1810
   e) None of above



17) Which of the following statements is **false** of the Pareto Chart Effects diagram output shown by Minitab above?
   a) There are 5 factors varied in this experimental effort.
   b) Factor "B" has the highest effect on the output measured in this experiment.
   c) Three-Way interaction effects have a significant effect on the output.
   d) Factor "C" has the lowest effect on the output measured in this experiment.
   e) Two-Way interactions and Main effects are to be pursued in further trials.

18) For a DOE with 6 2-level factors, resolution IV design, write down the contrast column numbers.

19) Write down the 2-factor interaction confounding in the contrast column of the previous question.

20) Construct a 5x5 Latin square design using factors a, B, C, D, and E.