Practice Exam 2
(Answers are found on the last page.)

Name:_____

Instructions:

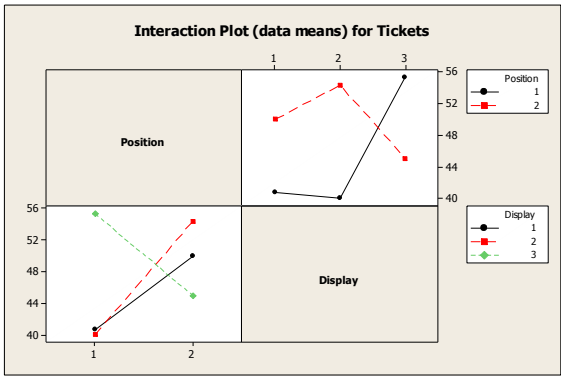
1. Do not start until instructed to do so.
2. You may use a scientific calculator (no graphing calculators allowed).
3. No other aids are allowed.
4. The work you turn in must be your own.
5. Use $\alpha = .05$, unless otherwise specified.
6. SHOW ALL WORK to receive full credit.

Questions 1 – 7: Three different point-of-purchase displays (1, 2, or 3) are being considered for lottery ticket sales at a chain of convenience stores. Two different positions within the store (next to the cash register, mounted on entrance door) are also being considered. A random sample of 18 stores for which lottery ticket sales have been comparable are selected for the study and are randomly assigned to the treatments with the same number of stores being assigned to each treatment. The number of lottery tickets sold during the day of the experiment is observed for each store. We'd like to know if the type and/or the position of the display affect average lottery ticket sales. The data are shown below.

	Type of Display		
Position	1	2	3
Next to register	43, 39, 40	39, 38, 43	57, 60, 49
Entrance door	53, 46, 51	58, 55, 50	47, 42, 46

Two-way ANOVA: Tickets versus Position, Display

Source	DF	SS	MS	F	P
Position	___	88.889	88.889	6.67	0.024
Display	___	71.444	35.722	2.68	0.109
Interaction	___	_____	_____	____	0.000
Error	___	160.000	13.333		
Total	___	830.444			



1. What is the response variable?

2. What is(are) the factor(s)?

3. What are the levels of the factor(s)?

4. List the treatments.

5. Complete the ANOVA table by filling in the blanks.

6. What does a "position*display interaction" mean in terms of this problem?

7. Consider this statement: "We have enough evidence of a difference between the two positions with respect to the mean number of lottery tickets sold for all stores like the ones in our sample." Is this statement justified? Explain.

8. In a one-way analysis of variance (ANOVA), it is determined that the data show enough evidence to reject H_0: $\mu_1 = \mu_2 = \mu_3 = \mu_4 = \mu_5 = \mu_6 = \mu_7 = \mu_8$. How many confidence intervals would have to be constructed to perform the multiple comparisons analysis?

Questions 9 – 10: In a study of the spatial-temporal reasoning of preschool children, 78 preschool children were randomly assigned to 4 groups: (piano lessons, singing lessons, computer instruction, nothing). After six months of intervention, the changes in the children's spatial-temporal reasoning score were recorded (positive changes mean improvement). A one-way analysis of variance (ANOVA) F-test showed that there is enough evidence of differences among the 4 groups with respect to average change in spatial-temporal reasoning score for all preschool children.

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Tukey 95% Simultaneous Confidence Intervals
All Pairwise Comparisons among Levels of Lesson

Individual confidence level = 98.96%

Lesson = Computer   subtracted from:

Lesson       Lower  Center  Upper  ---------+---------+---------+---------+
None        -2.171   0.336  2.842               (------*------)
Piano        1.140   3.168  5.195                        (-----*-----)
Singing     -3.536  -0.750  2.036          (-------*-------)
                                   ---------+---------+---------+---------+
                                         -3.5       0.0       3.5       7.0


Lesson = None       subtracted from:

Lesson       Lower  Center  Upper  ---------+---------+---------+---------+
Piano        0.548   2.832  5.116                      (-----*------)
Singing     -4.064  -1.086  1.893         (--------*-------)
                                   ---------+---------+---------+---------+
                                         -3.5       0.0       3.5       7.0


Lesson = Piano      subtracted from:

Lesson       Lower  Center   Upper  ---------+---------+---------+---------+
Singing     -6.505  -3.918  -1.330  (-------*------)
                                    ---------+---------+---------+---------+
                                          -3.5       0.0       3.5       7.0
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9. Use the multiple comparisons output to summarize where the differences are.

10. Assuming that the sample of 78 preschoolers is representative of the population of all preschool children, would a headline such as, "Give Your Kids Piano Lessons to Improve their Spatial-Temporal Reasoning" be justified? Why or why not?

Questions 11 – 12: A manufacturer of saline solution is concerned that the three machines (a, b, c) used to fill bottles may not be filling the bottles with the same amounts, on average. The researchers want to control for differences in machine operators as well so five machine operators are randomly selected and they take turns operating each of the filling machines. Three bottles are randomly selected for each operator (one from each machine) and the amount of saline solution (in ounces) in each is measured. The data and an analysis is shown below.

Operator	Oz_a	Oz_b	Oz_c
1	46.2	46.5	46.1
2	46.2	47.0	46.2
3	46.0	46.4	46.3
4	46.1	46.3	46.3
5	46.1	46.4	46.0

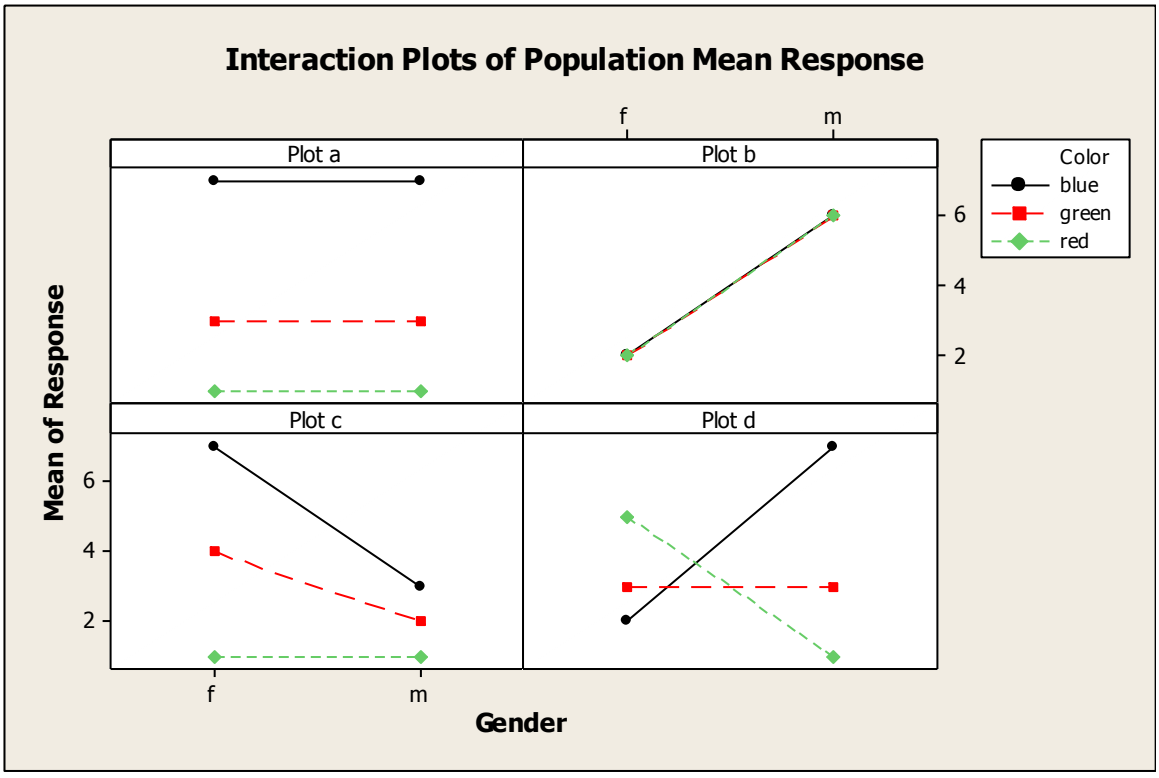
	N	Mean	StDev	Variance
Ounces_a	5	46.120	0.0837	0.0070
Ounces_b	5	46.520	0.277	0.077
Ounces_c	5	46.180	0.130	0.0170

Source	DF	SS	MS	F	P
Machine				0.015	
Operator				0.361	
Error		0.248000			
Total		0.869333			

11. The block source of variation is statistically significant.
    a. True
    b. False

12. Perform the test for the machine effect. Give the hypotheses, the value of the test statistic, the rejection region, and state your conclusion in terms of the problem. (Hint: Compute the SS as you would in a one-way ANOVA.)

13. **2 points** Consider the plots below which summarize a numeric response in a population characterized by two factors: gender (female, male) and color (blue, green, red).



Which plot(s) show no interaction, no main effect of gender, and a main effect of color?

a. Plot a
b. Plot b
c. Plot c
d. Plot d

Answers

1. number of lottery tickets sold each day

2. position of the display; type of display

3. levels of position: next to cash register, on entrance door
   levels of type: 1, 2, 3

4. next to register, 1 | next to register, 2 | next to register, 3
   entrance door, 1 | entrance door, 2 | entrance door, 3

5.

Source	DF	SS	MS	F	P
Position	1	88.889	88.889	6.67	0.024
Display	2	71.444	35.722	2.68	0.109
Interaction	2	510.111	255.0555	19.13	0.000
Error	12	160.000	13.333		
Total	17	830.444			

6. The effect of position on mean number of lottery tickets sold per day depends on the type of display.
   or
   The effect of type of display on mean number of lottery tickets sold per day depends on the position.

7. No. This is a statement about the main effect of position which is not valid in the presence of interaction.

8. 28

9. $\mu_{Piano} > \mu_{Computer}, \mu_{None}, \mu_{Singing}$

10. Yes. Since there was random assignment to the treatments, we can make cause/effect conclusions. The piano lessons were the cause of the improvements over nothing, computer instruction, and singing lessons.

11. False

12. H_0: $\mu_a = \mu_b = \mu_c$ H_a: $not\ H_0; at\ least\ 2\ means\ are\ different$

    $F = 7.505$ RR: $F > 4.46$

    We have enough evidence of differences among the three machines with respect to the mean saline amounts in all bottles.

13. Plot a