Homework 3 ANOVA

1. Data: Waste Water
   Let group 1 = “AF”, group 2 = “FS”, group 3: “FCC”
   Scientists concerned with treatment of tar sand wastewater studied three treatment methods for the removal of organic carbon. (Based on W. R. Pirie, Statistical Planning and Analysis for Treatments of Tar Sand Wastewater, Technical Information Center, Office of Scientific and Technological Information, United States Department of Energy.) The three treatment methods used were air flotation (AF), foam separation (FS), and ferric-chloride coagulation (FCC). The organic carbon material measurements for the three treatments yielded the following data:

Treatment Method	Organic Carbon Measurements
AF	34.6, 35.1, 35.3, 35.8, 36.1, 36.5, 36.8, 37.2, 37.4, 37.7
FS	38.8, 39.0, 40.1, 40.9, 41.0, 43.2, 44.9, 46.9, 51.6, 53.6
FCC	26.7, 26.7, 27.0, 27.1, 27.5, 28.1, 28.1, 28.7, 30.7, 31.2

   The data is provided in the file “wastewater.csv”.

a. Test $H_0 : \mu_1 = \mu_2 = \mu_3$ versus $H_a :$ not H_0 at 5% level of significance. State your conclusion.
   Hint: One-Way ANOVA

b. Plot side-by-side boxplots for the three groups and comment on the results. Which method is the best?

2. Data = “fern.csv”
   研究光的波長對蕨類生長的影響
   Astudy is conducted of the effect of light on the growth of ferns. Since plants grow at various rates at different ages. this variable is controlled by blocking. Four young plants (plants grown in the dark for 4 days) and four older plants (plants grown in the dark for 12 days) are utilized in the study. thus producing two blocks each of size 4. Four different light treatments are investigated. Each treatment is randomly assigned to one plant in each block. The treatments consist of exposing-each plant to a single dose of light, returning it to the dark, and measuring the cross-sectional area of the fern tip 24 hours after the light is administered. These data resulted (cross-sectional area is given in square micrometers):

Block (Age)	420 nm	460 nm	600 nm	720 nm
Young	1017.6	929.0	939.8	1081.5
Old	854.7	689.9	841.5	797.4

   a. What is the blocking variable? Please test whether the blocking effect exists or not at 5% level of significance. State your conclusion.

   b. Please test whether the treatment effect (i.e. wavelength of light) exists or not at 5% level of significance. State your conclusion.

3. Data: “Cotinine.csv”
   Cotinine is a major metabolite of nicotine. It is currently considered to be the best indicator of tobacco smoke exposure. A study is conducted to detect possible racial differences in cotinine level in young adults. These data are obtained on the cotinine level in milligrams per milliliter:

	White	Black
Male	210	245
total = 1085	300	347
	150	125
	325	250
	100	260
Female	177	152
total = 893	300	315
	106	267
	150	275
	160	252

   a. Plot the means for the 4 treatment combinations. Comment on whether interaction effect exists.

   b. Perform two-way ANOVA and test whether interaction effect exists or not. Level of significance = 5%.

   c. Test the two main effects at 5% level of significance.

4. In homework 2, you have analyzed the data provided in the file “mood.csv”. Suppose we are interested in studying the effect of different types of music on people’s moods. We collect data on 60 participants and record their mood score (out of 10) after listening to one of three types of music: classical, jazz, or pop. In the file “mood.csv” The data look like

Participant	MusicType	Gender	MoodScore
1	Pop	Female	6.19639294
2	Pop	Female	6.415425525
3	Pop	Female	7.84785533
4	Jazz	Female	6.818517618
5	Pop	Male	7.925675055
6	Jazz	Male	7.888697976
7	Jazz	Female	8.234856128
8	Jazz	Male	7.144747139
9	Pop	Male	6.06780208
10	Classical	Male	7.964462651

a. Plot the means for the 6 treatment combinations. Comment on whether interaction effect exists.

b. Perform two-way ANOVA and test whether interaction effect exists or not. Level of significance = 5%. Explain the result.

c. Test the two main effects at 5% level of significance. Explain the result.