1. The color of a fabric depends on the dye used and also on how the dye is applied. This matters to clothing manufacturers, who want the color of the fabric to be just right. A manufacturer dyes fabric made of ramie with the same "procion blue" die applied in four different ways. She uses a colorimeter to measure the lightness of the color on a scale in which black is 0 and white is 100. Here are the data for 8 pieces of fabric dyed in each way:

Method A	41.72	41.83	42.05	41.44	41.27	42.27	41.12	41.49
Method B	40.98	40.88	41.30	41.28	41.66	41.50	41.39	41.27
Method C	42.30	42.20	42.65	42.43	42.50	42.28	43.13	42.45
Method D	41.68	41.65	42.30	42.04	42.25	41.99	41.72	41.97

(a) This is a randomized comparative experiment. Outline the design.

(b) The clothing manufacturer wants to know which method gives the darkest color. Carry out the approriate test and write a brief summary which answers this question.

2. Businesses know that customers often respond to background music. Do they also respond to odors? Nicolas Guéguen and his colleagues studied this question in a small pizza restaurant in France on Saturday evenings in May. On one evening, a relaxing lavender odor was spread through the restaurant; on another evening, a stimulating lemon odor; a third evening served as a control, with no odor. The three evenings were comparable in many ways (weather, customer count, and so on), so we are willing to regard the data as independent SRSs from spring Saturday evenings at this restaurant. The tables below contain data on how long (in minutes) customers stayed in the restaurant on each of the three evenings.

Lavender Odor

92	126	114	106	89	137	93	76	98	108
124	105	129	103	107	109	94	105	102	108
95	121	109	104	116	88	109	97	101	106

Lemon Odor

78	104	74	75	112	88	105	97	101	89
88	73	94	63	83	108	91	88	83	106
108	60	96	94	56	90	113	97		

No Odor

103	68	79	106	72	121	92	84	72	92
85	69	73	87	109	115	91	84	76	96
107	98	92	107	93	118	87	101	75	86

(a) Make stemplots of the customer times for each evening. Do any of the distributions show outliers, strong skewness, or other clear deviations from Normality?

(b) Do a complete analysis to see whether the groups differ in the average amount of time spent in the restaurant. Did you find anything surprising?

3. Favorable weather has been shown to be associated with increased tipping. Will just the belief that future weather will be favorable lead to higher tips? The researchers gave 60 index cards to a waitress at an Italian restaurant in New Jersey. Before delivering the bill to each customer, the waitress randomly selected a card and wrote on the bill the same message that was printed on the index card. Twenty of the cards had the message "The weather is supposed to be really good tomorrow. I hope you enjoy the day" Another 20 cards contained the message "The weather is supposed to be not so good tomorrow. I hope you enjoy the day anyway" The remaining 20 cards were blank, indicating that the waitress was not supposed to write any message. Choosing a card at random ensured that there was a random assignment of the diners to the three experimental conditions. Here are the tips as a percent of the total bill for the three messages:

Good Weather	20.8	18.7	19.9	20.6	22.0	23.4	22.8	24.9	22.2	20.3
Report	24.9	22.3	27.0	20.4	22.2	24.0	21.2	22.1	22.0	22.7
Bad Weather	18.0	19.0	19.2	18.8	18.4	19.0	18.5	16.1	16.8	14.0
Report	17.0	13.6	17.5	19.9	20.2	18.8	18.0	23.2	18.2	19.4
No Weather	19.9	16.0	15.0	20.1	19.3	19.2	18.0	19.2	21.2	18.8
Report	18.5	19.3	19.3	19.4	10.8	19.1	19.7	19.8	21.3	20.6

Do the data support the hypothesis that there are differences among the tipping percents for the three experimental conditions? Does a prediction of good weather seem to increase the tip percent?

Be sure to check the conditions for ANOVA and to include an appropriate graph that compares the tipping percents for the three conditions.

4. "Durable press" cotton fabrics are treated to improve their recovery from wrinkles after washing. Unfortunately, the treatment also reduces the strength of the fabric. A study compared the breaking strength of untreated fabric with that of fabrics treated by three commercial durable press processes. Five specimens of the same fabric were assigned at random to each group. Here are the data, in pounds of pull needed to tear the fabric:

Untreated	60.1	56.7	61.5	55.1	59.4
Permafresh 55	29.9	30.7	30.0	29.5	27.6
Permafresh 48	24.8	24.6	27.3	28.1	30.3
Hylite HF	28.8	23.9	27.0	22.1	24.2

The untreated fabric is clearly much stronger than any of the treated fabrics. We want to know if there is a significant difference in breaking strength among the three durable press treatments.

Analyze the data for the three processes and write a clear summary of your findings.

Which process do you recommend if breaking strength is a main concern? (Although the standard deviations do not quite satisfy our rule of thumb, that rule is conservative, and many statisticians would use ANOVA for these data.)

5. The data in another exercise show that durable press treatment greatly reduces the breaking strength of cotton fabric. Of course, durable press treatment also reduces wrinkling. How much? "Wrinkle recovery angle" measures how well a fabric recovers from wrinkles. Higher is better. Here are data on the wrinkle

Untreated	79	80	78	80	78
Permafresh 55	136	135	132	137	134
Permafresh 48	125	131	125	145	145
Hylite HF	143	141	146	141	145

The untreated fabric once again stands out, this time as inferior to the treated fabrics in wrinkle resistance. Examine the data for the three durable press processes and summarize your findings.

Explain why we can't trust the ANOVA F test in this situation.