Please show all work to receive full credit.

1. Golden Torch Cactus, a columnar cactus native to Argentina, is regarded as having excellent landscape potential. Two researchers at the Boyce Thompson Southwestern Arboretum are conducting a thorough investigation of the optimal method for producing these cacti. They wish to examine, among other things, the effects of a hydrophilic polymer and irrigation regime on weight gain. Hydrophilic polymers are used as soil additives to keep moisture in the root zone. The hydrophilic polymer will either be used or not be used and three irrigation regimes will be employed: none, medium, and heavy. Ninety cacti are available for the experiment.

(a) Identify the experimental units, the factor(s), and the response variable.

(b) Identify the levels of each factor.

(c) Use a diagram to outline the design of an appropriate experiment.
(d) Use Table B, starting at line 115, to select the first five experimental units for the first group.

(e) Identify the three principles of experimental design, and explain how they are used in the experiment in (c).

2. The two-way table given below describes the gender and minutes spent online per day for 450 adults.

<table>
<thead>
<tr>
<th>Gender</th>
<th>Minutes online</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td>&lt;30</td>
</tr>
<tr>
<td>Male</td>
<td>55</td>
</tr>
<tr>
<td>Female</td>
<td>93</td>
</tr>
</tbody>
</table>

(a) What is the probability that an adult selected at random is male?

(b) What is the probability that an adult selected at random is female and spends 30 to 60 minutes online per day?
(c) What is the probability that an adult selected at random is female or spends fewer than 30 minutes online per day?

(d) What is the probability that an adult selected at random is male given that the person spends more than 60 minutes online per day?

3. A standard 52-card deck contains 26 red and 26 black cards. Suppose that two cards are selected from the deck with replacement and the colors of the cards are recorded.

   (a) List the sample space of possible outcomes.

   (b) Assign probabilities to the outcomes in (a).
(c) Let the random variable $Y$ be the number of red cards. Give the probability distribution of $Y$.

(d) Find the mean of $Y$.

4. Show that $\mu_{X-Y} = \mu_X - \mu_Y$. 
5. Laboratory data show that the time required to complete two chemical reactions in a production process varies. The first reaction has a mean time of 50 minutes and a standard deviation of 4 minutes; the second has a mean time of 10 minutes and a standard deviation of 0.5 minute. The two reactions are run in sequence during production. There is a fixed period of 2 minutes between them as the product of the first reaction is pumped into the vessel where the second reaction will take place.

(a) Find the mean time required for the entire process.

(b) The times for the two reactions are independent. Find the standard deviation of the time required for the entire process.

6. According to genetic theory, the blossom color in the second generation of a particular cross of sweet peas should be red or white in a 3:1 ratio. That is, each plant has probability $3/4$ of having red blossoms, and the blossom colors of separate plants are independent. Let $Y$ be the number of plants in a sample of size ten that have red blossoms.

(a) What are $n$ and $p$ in the binomial distribution of $Y$?

(b) What is the probability that all ten of the plants have red blossoms?
(c) What is the probability that at least eight of the plants have red blossoms?

(d) What are the mean and standard deviation of $Y$?