Answer Key: Study Guide 2012: Experimental Design and Scientific Inquiry

A. Scientific Inquiry
1. **Problem** – question to be investigated
2. **Hypothesis** – define and be able to write in “If...then...because format...”
3. **Experiment** – Be able to identify control group and experimental group
4. **Interpret Data** – Be able to design and interpret tables and graphs
5. **Conclusion** – Define
6. **Qualitative Observation and Quantitative Observation**—Define
7. **Infer, Predict, and Observe**—Define
8. **Physical Science, Chemistry, and Physics**—Define

B. Types of Variables/Experimental Setups
1. **Manipulated Variable** = the variable you purposely change
2. **Responding Variable** = the factor that your measure or may change as a result of the manipulated variable
3. **Experimental Group** = the setup whose conditions you change by testing the manipulated variable during an experiment
4. **Control Group** = the Control = the setup with ‘normal’ conditions; conditions are NOT being changed or tested; no manipulated variable; this group is used for comparison
5. **Controlled Experiment** = a properly done experiment which keeps all conditions the same for the experimental and control group, except for the manipulated variable (QUESTION ON SCIENCE NECAP!!!!!!)
6. **Constants** = (a controlled variable) conditions or factors that are kept the same in the experimental and control group so you have a controlled experiment

FOR PRACTICE:

**Focus Question and Hypothesis**

A student is interested in designing several experiments to test the factors that affect how quickly an Alka-Seltzer tablet dissolves in water. For each question, write a hypothesis that could be tested with an experiment. Be sure each hypothesis is in the proper “If...then...because...” format. See example below.

**Example:**
**Question:** What effect does stirring have on the dissolving rate?
**Hypothesis:** If the water is stirred, then the tablet will dissolve faster because stirring increases the dissolving rate.

1. **Question:** What effect does the water temperature have on dissolving rate?
**Hypothesis:** If the tablet is placed in warm water, then the tablet will dissolve faster because an increase in temperature speeds up the dissolving rate of some substances.
2. **Question**: What effect does crushing the tablet have on dissolving rate?

**Hypothesis**: If the tablet is crushed, the tablet will dissolve faster because the particles begin as a smaller piece – smaller particles.

3. **Question**: What effect does adding soda to the water have on solution rate?

**Hypothesis**: If soda is added to the water and tablet, then the dissolving rate will be longer because more substances were mixed to the solution/mixture.

**Identifying Variables**

**Directions**: For the following experiments identify the three variables for each experiment, the manipulated variable, the responding variable and the constants.

1) Different rose bushes are grown in a greenhouse for two months. The number of flowers on each bush is counted at the end of the experiment.
   a. **Manipulated Variable**: types of rose bushes
   b. **Responding Variable**: the number of flowers

2) You water three sunflower plants with salt water. Each plant receives a different concentration of salt solutions. A fourth plant receives pure water. After a two-week period, the height is measured.
   a. **Manipulated Variable**: concentration salt solution
   b. **Responding Variable**: height of the plant

3) Three redwood trees are kept at different humidity levels inside a greenhouse for 12 weeks. One tree is left outside in normal conditions. Height of the tree is measured once a week.
   a. **Manipulated Variable**: humidity levels
   b. **Responding Variable**: height of the tree

4) Pea plant clones are given different amounts of water for a three-week period. Pea plant number one receives 400 milliliters a day. The second pea plant receives 200 milliliters a day. The third pea plant receives 100 milliliters a day. The fourth pea plant does not receive any extra water; the plant only receives natural ways of receiving water. The height of pea plants is recorded daily.
   a. **Manipulated Variable**: amount of water
   b. **Responding Variable**: height of pea plant

5) Does the shape of a container effect how fast water will evaporate from it?
   a. **Manipulated Variable**: shape of the container
   b. **Responding Variable**: evaporation rate

6) How does the record of a baseball team effect attendance ratings?
   a. **Manipulated Variable**: record of baseball team
   b. **Responding Variable**: attendance record
7) How does the temperature of water effect how fast an egg will cook?
   a. Manipulated Variable: water temperature
   b. Responding Variable: cooking time

8) Does the shape of a magnet effect how strong it is?
   a. Manipulated Variable: shape of magnet
   b. Responding Variable: strength of magnet

9) Students of different ages were given the same puzzle to assemble, and the puzzle assembly time was measured.
   a. Manipulated Variable: students of different ages
   b. Responding Variable: assembly time

10. Two groups of students, were tested to compare their speed working on math problems. Each group was given the same problems. One group used calculators and the other group calculated without calculators.
   a. Manipulated Variable: use of calculators
   b. Responding Variable: speed of math problem completion
   c. Constant: math problems

11. A study was done to find out if different tire treads affect the braking distance of a bike.
   a. Manipulated Variable: tire treads
   b. Responding Variable: breaking distance of a bike

12. A farmer wants to test the effects of fertilizer on the growth of his bean plants. He gives a half acre of bean plants fertilizer once a week and gives another half acre of bean plants just water. Both areas of bean plants in the garden receive the same amount of sunlight and the farmer uses the same type of soil and species of bean plant. The same amount of water daily. The farmer harvests beans from the plants every Friday for two months in both areas. He counts the number of beans he harvests from each area and records them on Friday.

<table>
<thead>
<tr>
<th>manipulated variable</th>
<th>fertilizer</th>
</tr>
</thead>
<tbody>
<tr>
<td>responding variable</td>
<td>number of beans harvested</td>
</tr>
<tr>
<td>constants</td>
<td>sunlight, soil, amount of water, species of bean plant</td>
</tr>
<tr>
<td>control group</td>
<td>half acre of bean plants receiving only water</td>
</tr>
<tr>
<td>experimental group</td>
<td>half acre of bean plants receiving fertilizer</td>
</tr>
</tbody>
</table>
Review Rules for Constructing a Line Graph

Draw a graph representing the data below. Use graph paper provided to you. Be sure to label each axis, include units, and provide a title.

Changes in Hearth Rate with Exercise

<table>
<thead>
<tr>
<th>Exercise (min)</th>
<th>Heart Rate (beats per min)</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>65</td>
</tr>
<tr>
<td>1</td>
<td>75</td>
</tr>
<tr>
<td>2</td>
<td>85</td>
</tr>
<tr>
<td>3</td>
<td>95</td>
</tr>
<tr>
<td>4</td>
<td>105</td>
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<tr>
<td>5</td>
<td>125</td>
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<tr>
<td>6</td>
<td>135</td>
</tr>
<tr>
<td>7</td>
<td>145</td>
</tr>
<tr>
<td>8</td>
<td>155</td>
</tr>
<tr>
<td>9</td>
<td>155</td>
</tr>
<tr>
<td>10</td>
<td>155</td>
</tr>
</tbody>
</table>

Show how you calculated the scale on the x-axis.

10 = 0.9 = 1  Count by 1 on the x-axis.

Show how you calculated the scale on the y-axis.

155 = 9.1 = 10  Count by 10 on the y-axis.

[Diagram of a line graph showing changes in heart rate with exercise]

What is the relationship that can be made among the variables in this data? The data shows that as exercise increases, the heart rate increases. The graph does not show a constant increase.