This exercise is designed to help you visualize electric potentials using a computer program. Please follow the directions and answer the questions in the spaces provided.

Start the *EM Fields* program by clicking on the icon on the bottom panel of the computer screen. You may read the instructions now or later. Pull down the **Sources** menu and choose **3D point charges**. Also, select **Show grid** from the **Display** menu. You will see a row of circles along the bottom of the window. The open circles represent negative point charges and the solid circles represent positive point charges. Drag one positive and one negative charge of the same magnitude onto the grid and position them a few centimeters apart.

1. Choose **Potential** from the **Field & Potential** menu. Click on the screen at several locations. The numbers represent the electric potential at each point. Sketch and describe the picture below and explain why there are no arrows.

2. Choose **Equipotential** from the **Field & Potential** menu and click on the screen in several places. What is the relationship between the numbers in step 1 and the equipotentials now on the screen (you may want to go back and choose **Potential** from the **Field & Potential** menu and place some numbers directly on the equipotential lines to answer this question).

3. Choose **Clean up screen** from the **Display** menu.
4. Now select **Equipotentials with numbers** and put 5 or 6 equipotential lines on the screen. Then choose **Potential Difference** from the **Field & Potential** menu. Click on one of the equipotential lines and while holding the mouse button down drag to another equipotential line. Equipotential difference is the number a voltmeter registers between its two probes. How do the numbers that appear on the screen (which represent the electrical potential difference) relate to the numbers on the equipotential lines? Explain how you would get the numbers for equipotential differences from the equipotential numbers.

5. Find the potential difference between two equipotential lines by dragging the mouse. Now drag the mouse back the other way (from the second line back to the first) to find the potential for the reverse trip. How are they related?

6. Clear the screen and put 5 or 6 equipotential lines on the screen as you did in step 4. Now choose the **Field lines** option and put several field lines on the screen. What is the relationship between electrical equipotential lines and electric field lines? How are they related mathematically?