Find the equipotentials for two different physical situations.

- Four equal positive charges arranged in a square.
- Two positive and two negative charges with equal magnitude arranged in a square with like charges on opposite corners. (This distributon of charges is called a quadrupole.)

Use ONLY the iconic formula for the electrostatic potential $V = \frac{1}{4\pi\epsilon_0}\frac{q}{r}$ and the superposition principle. Do NOT use reasoning about electric fields vectors or electric field lines that you may have learned in other courses.

Solution Some observations you may have made are:

- Very near a point charge the potential is very large. The equipotentials are spheres, centered on the charge, because the contribution from charges that are further away is negligible.
- Very far away from an isolated collection of point charges, the equipotential is a sphere, centered on the collection of charges.
- Two equipotentials with different values cannot cross or intersect, because at the intersection point the potential would have two different values.
- By convention, the equipotential curves (surfaces) that one draws should show equal steps in the value of the potential. This means that usually the equipotential curves are NOT evenly spaced.
- If the value of the potential is falling off quickly, the equipotential curves (surfaces) will be closely spaced and vice versa.
- The electrostatic potential is a number at every point in 3-dimensional space, but we often choose to draw only a 2-dimensional cross-section. Which cross-section we choose to draw depends on what we are trying to show.
- The tricky part is to find the shape of the equipotentials between the four small spheres and the one big sphere. It can help to sketch a graph of V along a line that intersects two adjacent charges. Sketch graphs that fall off like $1/r$ on each side of each charge and then use the superposition principle. Where does the potential change the fastest?