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Problems set # 4 **Physics 167** February 28, 2023

1. Seven equal charges q are located at the corners of a cube of side s. Find the electric potential at one corner, taking zero potential to be infinitely far away.

2. Four point charges are fixed at the corners of a square centered at the origin, as shown in Fig. 1. The length of each side of the square is $2a$. The charges are located as follows: $+q$ is at $(-a, +a)$, $+2q$ is at $(+a, +a)$, $-3q$ is at $(+a, -a)$, and $+6q$ is at $(-a, -a)$. A fifth particle that has a mass m and a charge $+q$ is placed at the origin and released from rest. Find its speed when it is a very far from the origin.

3. Five identical point charges $+q$ are arranged in two different manners as shown in Fig. 2: in once case as a face-centered square, in the other as a regular pentagon. Find the potential energy of each system of charges, taking the zero of potential energy to be infinitely far away. Express your answer in terms of a constant times the energy of two charges $+q$ separated by a distance a.

4. Consider a system of two charges shown in Fig. 3. Find the electric potential at an arbitrary point on the x axis and make a plot of the electric potential as a function of x/a.

5. A point particle that has a charge of +11.1 nC is at the origin. *(i)* What is (are) the shapes of the equipotential surfaces in the region around this charge? *(ii)* Assuming the potential to be zero at $r = \infty$, calculate the radii of the five surfaces that have potentials equal to 20.0 V, 40.0 V, 60.0 V, 80.0 V and 100.0 V, and sketch them to scale centered on the charge. *(iii)* Are these surfaces equally spaced? Explain your answer. *(iv)* Estimate the electric field strength between the 40.0-V and 60.0-V equipotential surfaces by dividing the difference between the two potentials by the difference between the two radii. Compare this estimate to the exact value at the location midway between these two surfaces.

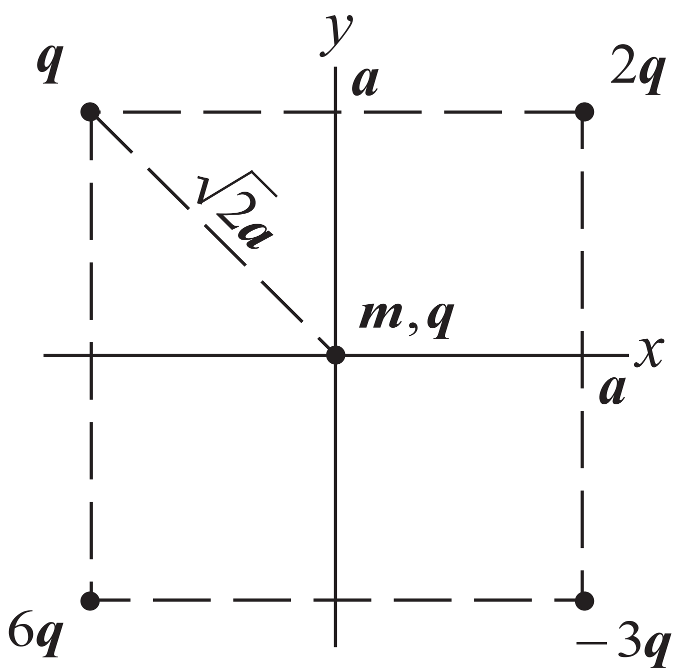

Figure 1: Problem 2.

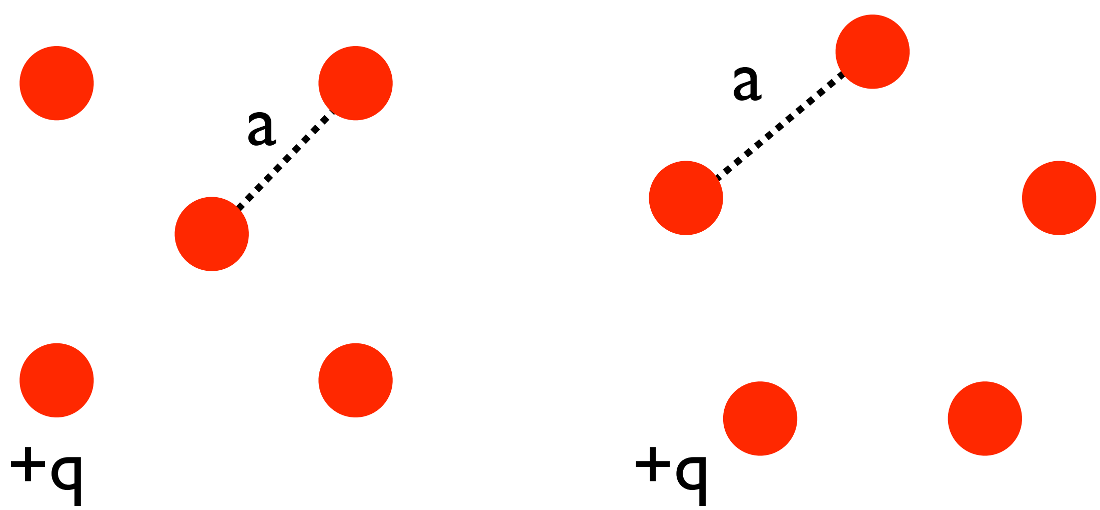

Figure 2: Problem 3.

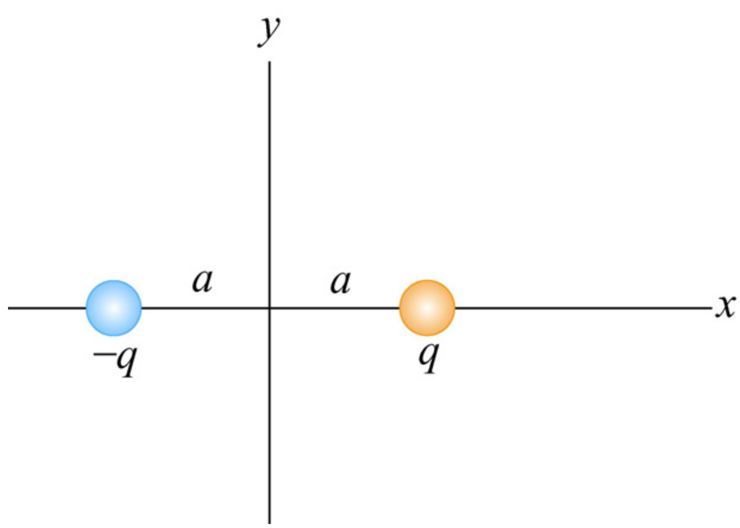

Figure 3: The electric dipole of problem 4.