3. (15 points)
Four charged particles are held fixed at the corners of a square of side $s$. All the charges have the same magnitude $Q$, but two are positive and two are negative. In Arrangement 1, shown above, charges of the same sign are at opposite corners. Express your answers to parts (a) and (b) in terms of the given quantities and fundamental constants.

(a) For Arrangement 1, determine the following.
   i. The electrostatic potential at the center of the square
   ii. The magnitude of the electric field at the center of the square

(b) For Arrangement 2, determine the following.
   i. The electrostatic potential at the center of the square
   ii. The magnitude of the electric field at the center of the square

(c) In which of the two arrangements would more work be required to remove the particle at the upper right corner from its present position to a distance a long way away from the arrangement?
   ___ Arrangement 1   ___ Arrangement 2
Justify your answer.
3. (15 points)

The figure above shows two point charges, each of charge $-2Q$, fixed on the $y$-axis at $y = +a$ and at $y = -a$. A third point charge of charge $-Q$ is placed on the $x$-axis at $x = 2a$. Express all algebraic answers in terms of $Q$, $a$, and fundamental constants.

(a) Derive an expression for the magnitude of the net force on the charge $-Q$ due to the other two charges, and state its direction.

(b) Derive an expression for the magnitude of the net electric field at the origin due to all three charges, and state its direction.

(c) Derive an expression for the electrical potential at the origin due to all three charges.

(d) On the axes below, sketch a graph of the force $F$ on the $-Q$ charge caused by the other two charges as it is moved along the $x$-axis from a large positive position to a large negative position. Let the force be positive when it acts to the right and negative when it acts to the left.