

SECTION B

7. (a) Write down a general expression for the electrostatic energy of a set of n charges, q_1, q_2, \dots, q_n at positions $\mathbf{r}_1, \mathbf{r}_2, \dots, \mathbf{r}_n$ respectively, and a specific expression for the case $n = 4$. [4]

A salt crystal consists of an array of positive Na and negative Cl ions, both carrying an elementary charge of magnitude e . Assume that a small "seed" crystal consists of four ions, forming a square of side 0.25 nm , as shown in Figure 1.

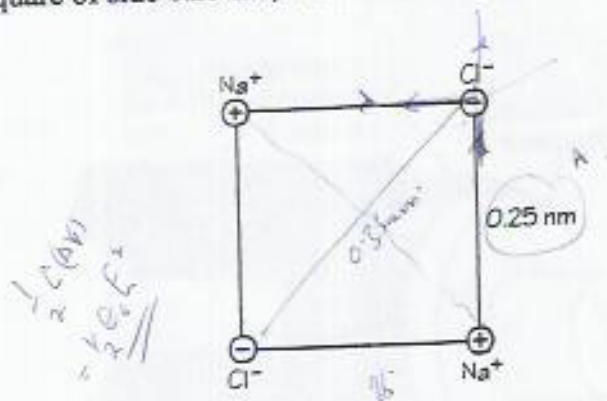


Figure 1

- (b) Calculate the work done in removing one of the ions from the cluster to infinity, assuming that the other three ions remain fixed. [6]
- (c) Find the electric field acting at one of the sodium ion positions due to the other ions of the cluster. [6]
- (d) Hence find the force acting on one of the sodium ions due to the other ions of the cluster. [2]
- (e) What is the energy density of the electric field at one of the ion positions due to the other three ions? [2]