

This can be accomplished directly using a convolution. Define one vector to be  $a = (q_1, q_2, \dots, q_n)$ . Define the other vector to be  $b = (n^{-2}, (n-1)^{-2}, \dots, 1/4, 1, 0, -1, -1/4, \dots, -n^{-2})$ . Now, for each  $j$ , the convolution of  $a$  and  $b$  will contain an entry of the form

$$\sum_{i < j} \frac{q_i}{(j-i)^2} + \sum_{i > j} \frac{-q_i}{(j-i)^2}.$$

From this term, we simply multiply by  $Cq_j$  to get the desired net force  $F_j$ .

The convolution can be computed in  $O(n \log n)$  time, and reconstructing the terms  $F_j$  takes an additional  $O(n)$  time.

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<sup>1</sup>ex726.26.783