# Sample Optimization Puzzles

## 1. Thomson's Problem

Download the exe-model from https://yadi.sk/d/LZmJo4uortyKSw and start it. You'll see the app shown below (without English captions).

**Instruction** (based on *Problem statement* and *Help* menus):
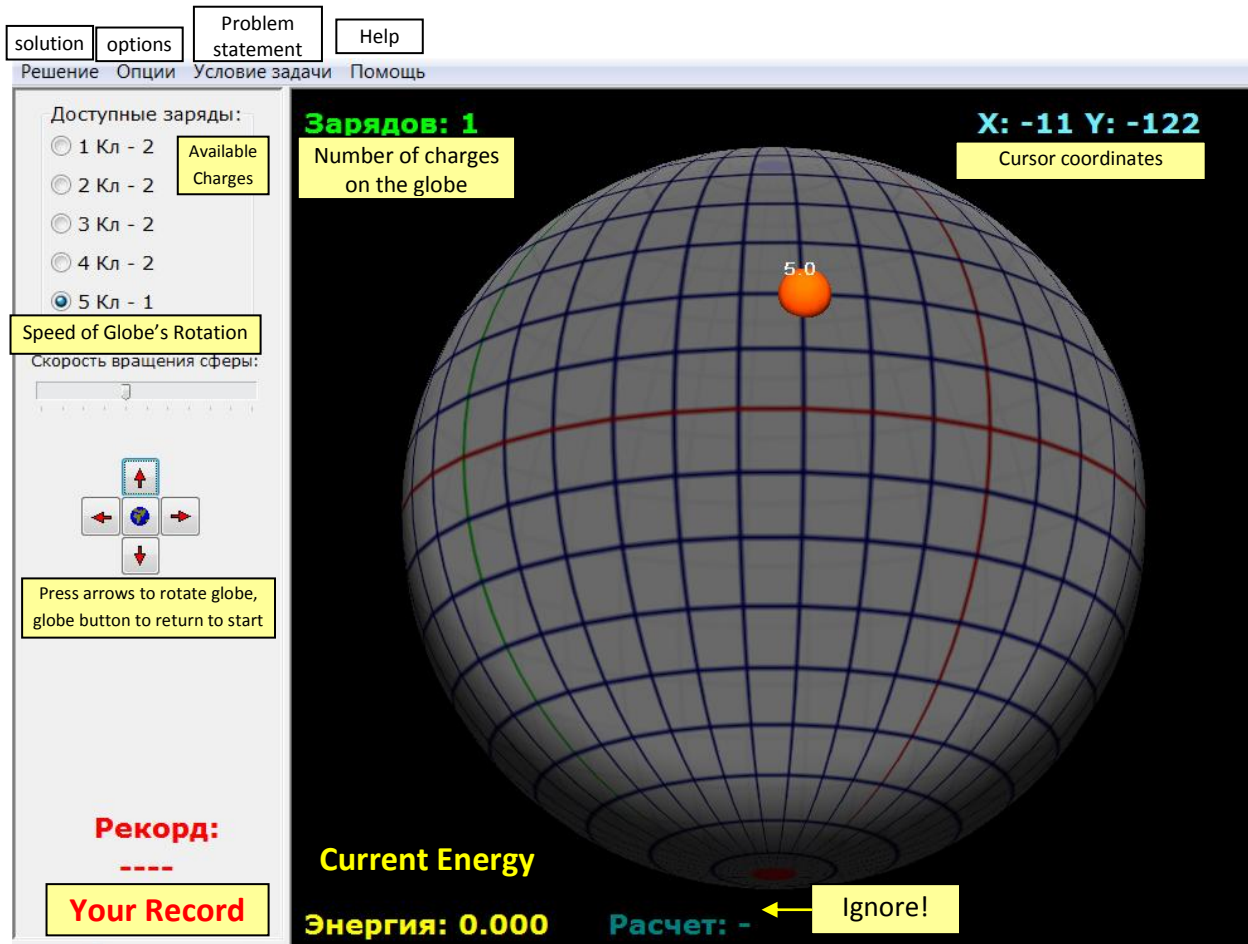


By clicking on the *Available charges* radiobuttons at top left, you are choosing one of 10 point charges of the same sign; two of them are of 5 coulomb (5C or "5 Кл" in Russian), two of 4 coulomb, two 3C, two 2C, and two 1C. The chosen charge can be dragged, placed, and fixed somewhere on the globe; in the figure this is done with one of the two 5C charges. After all the 10 charges are positioned on the globe, the potential energy of the system is automatically computed and shown at the bottom left corner (under *Current Energy* caption).

Note that if the charges could freely "float" around the globe, then, acting on one another, they would arrange themselves so that there potential energy attains a certain minimum value, depending, generally speaking, on their initial arangement.

In Thomson's Problem one has to find the charge arrangement with the minimum potential energy. This problem is completely solved only in a few special cases.

Your task is to move the charges so as to obtain an arrangement with as small potential energy as you can. To this end you can drag the charges with the left mouse button pressed or to turn the sphere (keeping the right mouse button pressed or using the arrows at left. The smallest potential energy you've obtained is your record.

***Additional controls***

Solution menu
*Clear* (restart)
*Load* (previously saved solution *.dat)
*Save*
*Show record* (the program suggests to save the current position before showing the record)
*Exit* (on exit the current arrangement is saved automatically and it will be opened when you relaunch the model)

Options menu
*Detalization* ▶ Low / High (this is just the graphics quality)
*Lighting*
*Coordinate grid*
*Sphere* (show/hide)
*Text behind sphere*
*Convex hull of the charges* (show/hide)

To remove a charge from the globe, right-click on it. The program will signal every time you improve the record and will save the new record (and arrangement) automatically.

## 2. Create a Power of A

Download the exe-model from https://yadi.sk/d/ej9BOvIM-saAyw and start it. You have to obtain $A^{89}$ from A by constructing a chain of two operations: ×A (multiplying by A) and $A^2$. Try to make the chain as short as possible.