Hint 2

IMPORTANT! The next task is both a hint and an alternative to the main task. Three important points:

1. You can continue to send the solution to the main problem.
2. At any moment before the final deadline you can start to solve the Alternative problem. If you do so, at the beginning of the solution write: *I am doing the Alternative problem!* In this case a penalty coefficient for the Alternative problem is

$$0{,}7 \cdot \sum_i \frac{k_i \cdot p_i}{10},$$

   where p_i is a point for the problem item, and k_i is a penalty coefficient for the corresponding problem's item at the moment of moving to the Alternative problem. In other words, maximal points for the alternative problem equals to the maximal points you can gain at the moment of moving to the alternative one multiplied by 0,7. Also, we remind you that a penalty coefficient can't be less than 0,1. Solutions of the main problems from that moment will not be checked. Be careful!
3. The task consists of several items. The penalty multiplier earned by **before** is applied to all points. In the future, each item is evaluated as a separate task. If you send a solution without any item, this item's solution is considered as Incorrect. For more information about scoring points for composite tasks, see the rules of the Cup.

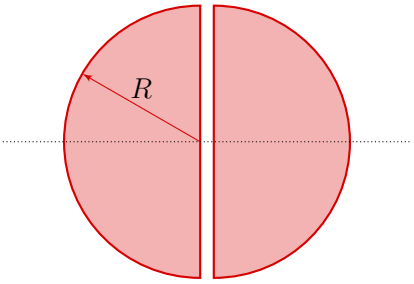
Alternative problem

1. *(0 points)* Spherical cavity of radius r was cut out in a uniformly charged ball of radius R. The center of the cavity is located at a distance l from the center of the ball. Bulk charge density ρ. Find the strength of the electric field in the cavity.

At the intersection of two balls of radius R, the centers of which are at a distance l from each other, two «crescents» are formed, uniformly charged with opposite electric charges. The density of the electric charge on the left is $-\rho$, on the right is ρ.

2. *(0 points)* Find the strength of the electric field.
3. *(0 points)* In the limit $l \to 0$, find the charge density on the surface of the resulting sphere.

4. (Final of All-Russian School Physics Olympiad 2016) *(0 points)* It is widely believed that bodies with the same charges always repel each other. Not at all! This effect is observed not all the time. Imagine that a solid metal ball of radius R was cut in half, and the resulting halves were brought together with flat sides so that the gap d between them was extremely small ($d \ll R$). Find the force of the electrostatic interaction of the halves with the same charges q_1 and q_2 (fig.). At what ratio of charges they will be attracted? **Note.** The force acting on a unit surface of a charged conductor of arbitrary shape is related to the strength of the electric field near the surface by the same ratio as in a flat capacitor.



5. *(2 points)* Two isolated conducting concentric spheres, the radius of the inner one is r_1, and the outer one is r_2. On the inner sphere, there is a positive charge Q_1, and on the outer one, there is a negative charge Q_2. Find the electrostatic pressure acting on the outer sphere.

6. *(4 points)* The metal ball was cut into two parts so that the plane of the cut is at a distance of 1/4 of the ball's diameter from its center. With the parts pressed against each other, the ball was charged to a potential $\varphi = 300$ V. What is the repulsive force of these parts of the ball, due to the ball's charge?

A flat capacitor with a plate area S is charged to a voltage U and is disconnected from the voltage source. Distance between its plates d. A positive charge q of mass m is held near a positively charged plate. The charge is released

7. *(0 points)* Find the charge speed at the center of the capacitor.

8. *(0 points)* Find the charge speed near the negative plate.

9. *(2 points)* Let a small hole be made in the negatively charged plate through which the charge q flies out of the capacitor. Find the charge speed at a distance of $50d$ from the center of the capacitor.

10. *(2 points)* Find the charge speed at an infinitely large distance from the capacitor.