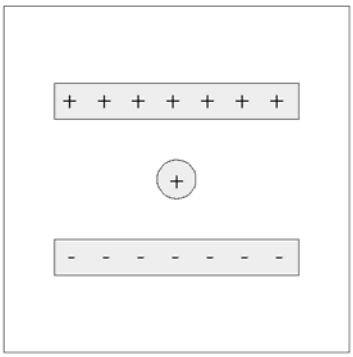
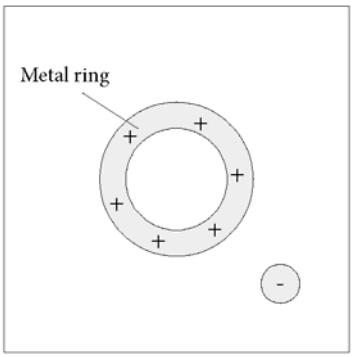
# Electric Field

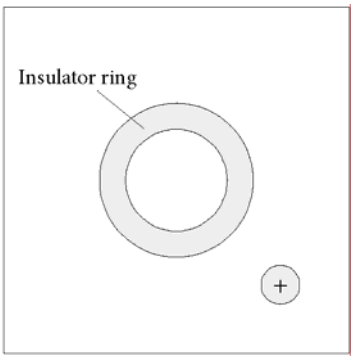
*Basic Problems:* Homework for Thursday, 14 September 06
*Additional Problems:* Voluntary exercises. Hand in your solutions by Friday, 15 September 06

**Basic Problems**

1. Draw some field in the following charge distributions:






2. Prove that the magnitude of the electric field at a distance $r$ from a point charge $q$ is given by:

$$E(r) = k \cdot \frac{q}{r^2}$$

3. Calculate the magnitude of the electric field at $10^{-10}$ m from a hydrogen nucleus.
4. Calculate the magnitude of the electric field halfway between two point charges of magnitude + 2 nC and + 3 nC and a mutual distance of 10 cm? Determine the force acting on a test charge with magnitude 0.1 nC at this position? Redo the calculations for the case where one of the field-producing charges is negative.
5. A test charge of 1.5 nC is placed in the electric field of a copper cube at a point where the electric field has magnitude 2.5 kN/C. Calculate the force the test charge exerts on the cube. Give reasons for your answer.
6. An electron flies parallel to the earth's surface. Determine the magnitude and direction of the electric field close to the surface and discuss the result.
7. A small ball carrying a charge 0.5 nC is placed in a homogeneous field with magnitude 50 N/C. Find a point where the total electric field vanishes.
8. Four identical charges are placed at the corners of a square. Each of them creates an electric field with magnitude 15 N/C at the centre of the square. Find the direction and magnitude of the field vector at the centre of one of the square's sides.

**Additional Problems**

9. A negatively charged ball is surrounded by a positively charged metal ring. Draw some field lines for this charge distribution. Make an educated guess about the electric field outside the ring if the charges on ring and ball have the same magnitude.
10. The magnitude of the electric field in Millikan's experiment that lead to the discovery of the elementary charge was of the order of 1 kN/C. Calculate the mass of a typical oil droplet.
11. A ball with mass 0.4 g carries the charge 52 nC. It is suspended on a 1.8 m long thread in a horizontal electric field. In its equilibrium position the ball is deflected horizontally by 15 mm from the vertical. Calculate the magnitude of the electric field at the ball's position.
12. Two point charges + $Q$ and - 2$Q$ are placed at a distance $d$. Determine the points along the straight line connecting the two charges where the total electric field vanishes.

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Solutions to Basic Problems: 3. 144 GN/C; 4. 3.6 kN/C (18 kN/C), 0.36 µN (1.8 µN); 5. 3.75 µN (actio = reactio); 6. 56 pN/C, downwards; 7. 0.3 m away; 8. magnitude: 11 N/C