# Topic 03. Electricity and Magnetism. Part 1

1. A positive point charge 50 $\mu$C is located in the $xy$-plane. Its position is described by the radius-vector $\vec{r}_0 = 2.0\vec{i} + 3.0\vec{j}$ (m). Calculate the electric field and its magnitude at the point with radius-vector $\vec{r} = 8.0\vec{i} - 5.0\vec{j}$ (m).

2. A thin half-ring of radius $R = 20$ cm is uniformly charged with a total charge $q = 0.70$ nC. Find the magnitude of the electric field produced by the half-ring at its curvature center (i.e., at the center of the ring of the same radius).

3. A point charge $q$ is located at the center of a thin ring of radius $R$ which is uniformly charged with charge $-q$. Find the magnitude of the electric field vector at the point on the central axis of the ring at distance $z$ from the center of the ring (assume $z \gg R$).

4. Find the electric field if its potential is given by $V(x, y) = ay\left(\frac{y^2}{3} - x^2\right) + const$, where $a$ is a constant.

5. Find the potential difference between $A$ and $B$ of the circuit shown on Fig.1 if the emf is equal to $\mathcal{E} = 110$ V and the capacitance ratio $C_2/C_1 = \eta = 2.0$.

6. Calculate the potential energy of a system of point charges located at the corners of a square with the side $a$ (see Fig.2).

7. **[ADVANCED LEVEL]** Fig.4 shows a generic electric quadrupole. It consists of two dipoles with dipole moments that are equal in magnitude but opposite in direction. Find the value of $E$ on the axis of the quadrupole for a point $P$ a distance $z$ from its center (assume $z \gg d$). Introduce the quadrupole moment $Q = 2qd^2$ into your answer by the corresponding substitution of quantities.

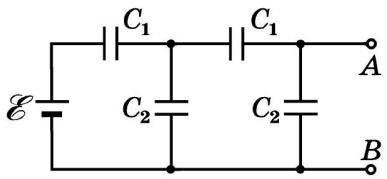


Figure 1

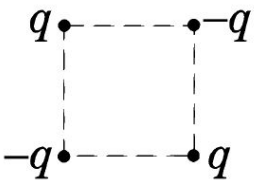


Figure 2

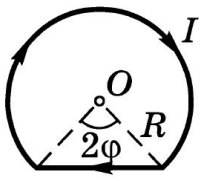


Figure 3

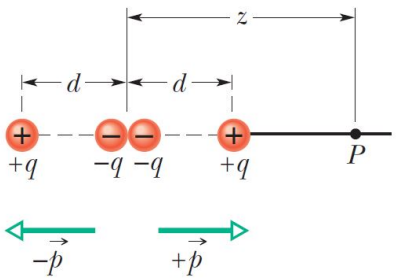


Figure 4