

Methodology For Using Modern Pedagogical Technologies In Organizing Practical Classes On The Subject “Electricity And Magnetism”

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Abstract: This article explores the methodology of using modern pedagogical technologies in organizing practical classes on the subject “Electricity and Magnetism.” It analyzes teaching methods aimed at developing students’ independent thinking, problem-solving skills, and the ability to integrate theoretical knowledge with practical application. The study also examines the scientific basis and impact of interactive methods, information and communication technologies, and digital learning resources on the educational process. The research findings indicate that organizing practical classes based on modern pedagogical technologies contributes to the development of students’ creative competence, enhances their understanding of the subject matter, and improves their professional preparedness.

Keywords: Electricity and Magnetism, practical classes, modern pedagogical technologies, interactive methods, information and communication technologies, creative competence, learning efficiency.

Introduction: In the modern education system, the task of training highly qualified specialists who are capable of creative thinking and making independent decisions has become more relevant than ever. In particular, when teaching subjects such as “Electricity and Magnetism”, which require the integration of theoretical knowledge and practical skills, traditional approaches need to be enriched with modern pedagogical technologies [1]. The use of pedagogical technologies in the educational process serves as an important factor in increasing learning efficiency, deepening students’ knowledge, bringing it closer to practical application, and developing their independent thinking skills [2].

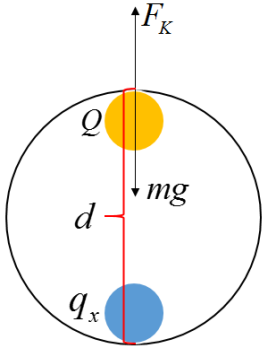
The subject “Electricity and Magnetism” is complex in nature, as it is based on physical laws, formulas, and experimental principles. In its practical classes, the main focus is on developing practical skills grounded in theoretical knowledge, conducting experiments, and analyzing their results. Therefore, the necessity of using modern pedagogical technologies for the effective organization of practical classes is increasing day by day. In this regard, it is essential to develop students not as passive recipients of knowledge but as active participants in the learning process [3].

Furthermore, the methodology for organizing the practical assignments provided in the “Electricity and Magnetism” curriculum in a step-by-step, consistent, and systematic manner-while defining clear objectives, expected outcomes, and evaluation criteria for each lesson-forms the methodological foundation of the teaching process. This approach ensures the purposeful and effective implementation of pedagogical technologies. At this point, the teacher’s methodological competence and openness to innovative approaches play a decisive role [4].

The methodological approaches discussed in the dissertation are aimed at increasing the effectiveness of education, deepening students’ knowledge, enhancing their practical experience, ensuring interdisciplinary connections, and ultimately fostering creative competence. This implies that pedagogical technologies should not merely be regarded as auxiliary tools but as essential elements that contribute to renewing the educational content and improving the learning process.

Below is the methodology for solving some selected problems related to the subject “Electricity and Magnetism”.

1. A small sphere of mass, charge, and diameter is placed inside a smooth spherical surface. What charge should be placed at the lower point of the sphere to keep the small sphere in equilibrium?

Given:	Solution:
m Q d $q_x = ?$	The forces acting on the sphere of mass m are shown in the figure. That is, the sphere of mass m is subjected to the gravitational force and the Coulomb force between the two charges. For the sphere to be in equilibrium, condition $F_K \geq mg$ must be satisfied (Figure 1).  Figure 1 Hence, it is equal to $F_K = \frac{1}{4\pi\epsilon_0} \frac{Q \cdot q_x}{d^2}$. $\frac{1}{4\pi\epsilon_0} \frac{Q \cdot q_x}{d^2} \geq mg$ $q_x \geq \frac{4\pi\epsilon_0 \cdot d^2 \cdot mg}{Q}$ Therefore, for the small sphere to be in equilibrium, a charged sphere with a charge equal to $q_x \geq \frac{4\pi\epsilon_0 \cdot d^2 \cdot mg}{Q}$ must be placed at the lower point of the spherical surface. Answer: $q_x \geq \frac{4\pi\epsilon_0 \cdot d^2 \cdot mg}{Q}$

2. Determine the electric field intensity at point A created by two point charges $q_1 = 9nC1$ and $q_2 = -7nC1$ located on a straight line, as well as the electric field intensity at a distance $r = 8sm$ from the negative charge. The distance between the point charges is $l = 20sm$.

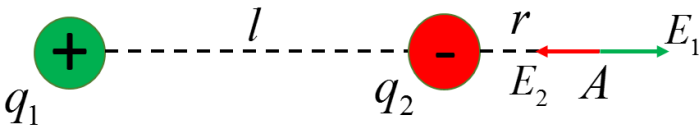
Given:	Solution:
$q_1 = 9nC1 = 9 \cdot 10^{-9} C1$ $q_2 = -7nC1 = -7 \cdot 10^{-9} C1$ $r = 8sm = 0,08m$ $l = 20sm = 0,2m$ $\epsilon = 1$ 1) $E = ?$ 2) $E = ?$	We determine the direction of the electric field lines produced by two point charges located on a straight line (Figures 2a and 2b). 1) 

Figure 2a

According to the principle of superposition, the resultant electric field intensity E in the first case is given by the following expression:

$$E = E_2 - E_1 \quad (1)$$

In this case:

$$E_1 = k \frac{q_1}{(l+r)^2} \quad (2)$$

$$E_2 = k \frac{q_2}{r^2} \quad (3)$$

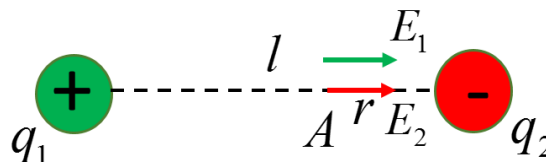
By substituting formulas (2) and (3) into formula (1), we derive the working formula for the problem and determine the resultant electric field intensity.

$$E = E_2 - E_1 = k \frac{q_2}{r^2} - k \frac{q_1}{(l+r)^2} = k \left(\frac{q_2}{r^2} - \frac{q_1}{(l+r)^2} \right)$$

$$E = k \left(\frac{q_2}{r^2} - \frac{q_1}{(l+r)^2} \right) = 9 \cdot 10^9 \frac{N \cdot m^2}{Cl^2} \left(\frac{7 \cdot 10^{-9} Cl}{(0,08m)^2} - \frac{9 \cdot 10^{-9} Cl}{(0,08m + 0,2m)^2} \right) =$$

$$= 8810,58 \frac{N}{Cl} \approx 8,81k \frac{N}{Cl}$$

2)

**Figure 2b**

According to the principle of superposition, the resultant electric field intensity in the second case is given by the following expression:

$$E = E_1 + E_2 \quad (1)$$

In this case:

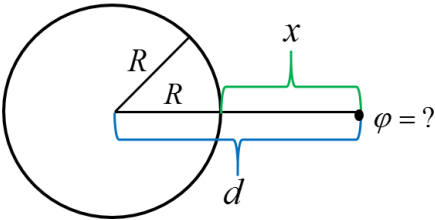
$$E_1 = k \frac{q_1}{(l-r)^2} \quad (2)$$

$$E_2 = k \frac{q_2}{r^2} \quad (3)$$

By substituting formulas (2) and (3) into formula (1), we derive the working formula for the problem and determine the resultant electric field intensity.

	$E = E_1 + E_2 = k \frac{q_1}{(l-r)^2} + k \frac{q_2}{r^2} = k \left(\frac{q_1}{(l-r)^2} + \frac{q_2}{r^2} \right)$ $E = 9 \cdot 10^9 \frac{N \cdot m^2}{Cl^2} \cdot \left(\frac{9 \cdot 10^{-9} Cl}{(0,2m - 0,08m)^2} + \frac{7 \cdot 10^{-9} Cl}{(0,08m)^2} \right) = 1718,75 \frac{N}{Cl} \approx 1,71k \frac{N}{Cl}$ Answer: 1) $E \approx 8,81k \frac{N}{Cl}$; 2) $E \approx 1,71k \frac{N}{Cl}$
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3. Find the potential of a point in the electric field located 10sm from the center of a charged sphere with a radius of 2sm. Solve the problem for the following cases: 1) The surface charge density of the sphere is $10^{-10} \frac{Cl}{sm^2}$; 2) The potential of the sphere is 300V.

Given:	Solution:
$R = 2sm = 2 \cdot 10^{-2}m$ $d = R + x = 10sm = 0,1m$ 1) $\sigma = 10^{-10} \frac{Cl}{sm^2} = 10^{-6} \frac{Cl}{m^2}$ 2) $\varphi_0 = 300V$ $\varphi_1 = ?$ $\varphi_2 = ?$	According to the problem statement, we are required to determine the potential of the sphere at a point located at a distance d from the center of the sphere (Figure 3).  Figure 3 We know that the potential of the sphere is determined using formula (1). $\varphi_1 = k \cdot \frac{q}{\varepsilon \cdot d} \quad (1)$ 1) Since the charge of the sphere is given by formula (2) and $\left(k = \frac{1}{4\pi \cdot \varepsilon_0} \right)$, expression (1) can be rewritten as follows. $q = \sigma \cdot S = \sigma \cdot 4\pi \cdot R^2 \quad (2)$ $\varphi_1 = k \cdot \frac{\sigma \cdot S}{\varepsilon \cdot d} = \frac{1}{4\pi \cdot \varepsilon_0} \cdot \frac{4\pi \cdot R^2 \cdot \sigma}{\varepsilon \cdot d} = \frac{\sigma \cdot R^2}{\varepsilon \cdot \varepsilon_0 \cdot d}$ $\varphi_1 = \frac{\sigma \cdot R^2}{\varepsilon \cdot \varepsilon_0 \cdot d} \quad (3)$ Expression (3) is the formula used to determine the potential at a certain distance from the center of a sphere when the surface charge density and the radius of the sphere are known.

$$\varphi_1 = \frac{\sigma \cdot R^2}{\varepsilon \cdot \varepsilon_0 \cdot d} = \frac{10^{-6} \frac{Cl}{m^2} \cdot (2 \cdot 10^{-2} m)^2}{1,8,85 \cdot 10^{-12} \frac{F}{m} \cdot 0,1m} = 4,52 \cdot 10^2 V = 452V$$

2) The potential of a charged sphere with radius R is given by the following expression:

$$\varphi_0 = k \frac{q}{\varepsilon \cdot R} \quad (4)$$

Taking into account that $k = \frac{1}{4\pi \cdot \varepsilon_0}$, we determine the charge of the sphere from formula (4).

$$q = 4\pi\varepsilon\varepsilon_0 \cdot R \cdot \varphi_0 \quad (5)$$

The potential of the sphere at a point located a distance d from its center (Figure 3) is given by equation (6).

$$\varphi_2 = k \cdot \frac{q}{\varepsilon \cdot d} \quad (6)$$

Substituting expression (5) into formula (6), we find the potential value for the second case given in the problem statement.

$$\varphi_2 = k \cdot \frac{q}{\varepsilon \cdot d} = \frac{4\pi\varepsilon\varepsilon_0 \cdot R \cdot \varphi_0}{4\pi\varepsilon\varepsilon_0 \cdot d} = \frac{R \cdot \varphi_0}{d}$$

$$\varphi_2 = \frac{R \cdot \varphi_0}{d} \quad (7)$$

Expression (7) is the formula used to determine the potential at a certain distance from the center of the sphere when the initial potential and the radius of the sphere are known.

$$\varphi_2 = \frac{R \cdot \varphi_0}{d} = \frac{2 \cdot 10^{-2} m \cdot 300V}{0,1m} = 60V$$

Answer: $\varphi_1 = 452V$; $\varphi_2 = 60V$.

CONCLUSION

In conclusion, the methodology of applying pedagogical technologies in organizing practical classes on "Electricity and Magnetism" represents one of the most relevant directions of modern pedagogy, based on scientific and theoretical foundations [5]. Through this methodology, students can acquire not only theoretical knowledge but also deep practical skills, while developing their professional competence and creative thinking abilities. Based on the above considerations and taking into account the positive outcomes of using modern pedagogical technologies in classroom instruction, a teaching manual entitled

"Electricity and Magnetism (Practical Classes)", a methodological guide titled "Solving Problems Related to the Section on Direct Current Laws", and a monograph entitled "Using Modern Pedagogical Technologies in Teaching the Subject Electricity and Magnetism" have been developed, along with a methodology for their effective implementation in the educational process.

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