

St John Baptist De La Salle Catholic School, Addis Ababa  
4th Quarter Final Prep

June 18, 2024

1. Explain Coulomb's Law. Calculate the force between two point charges of  $6\ \mu C$  and  $-2\ \mu C$  that are 0.25 meters apart. Use  $k = 8.99 \times 10^9\ N \cdot m^2/C^2$ .
2. Two point charges,  $q_1 = 4\ \mu C$  and  $q_2 = 7\ \mu C$ , are placed 0.3 meters apart. Calculate the magnitude and direction of the force between them.
3. Define the electric field at a point in space. Describe how the electric field due to a single point charge varies with distance. Calculate the electric field at a point 0.15 meters away from a  $5\ \mu C$  charge.
4. A point charge  $q = -3\ \mu C$  creates an electric field. Calculate the magnitude and direction of the electric field at a distance of 0.4 meters from the charge.
5. Describe the pattern of electric field lines for two equal but opposite charges placed close to each other. How would the pattern change if both charges were negative? Draw diagrams to support your explanation.
6. Two charges,  $+4\ \mu C$  and  $-4\ \mu C$ , are placed 0.2 meters apart. Calculate the electric field at a point midway between the charges.
7. Explain the concept of electric potential energy and potential difference. Calculate the potential energy of a  $3\ \mu C$  charge located in an electric field where the potential difference is 120 V.
8. What is the work done to move a  $5\ \mu C$  charge from a point where the electric potential is 200 V to a point where it is 150 V?
9. Derive the expression for the potential difference between two points in a uniform electric field. Given a uniform electric field of  $400\ N/C$  and two points 0.4 meters apart, calculate the potential difference between these points.
10. A uniform electric field of  $250\ N/C$  is directed vertically upward. Calculate the potential difference between two points that are 0.6 meters apart along the field.
11. Derive the formula for the electric potential at a distance  $r$  from a point charge  $q$ . Calculate the potential at a distance of 0.5 meters from a  $6\ \mu C$  charge.
12. What is the electric potential at a distance of 0.25 meters from a point charge of  $-4\ \mu C$ ? Use  $k = 8.99 \times 10^9\ N \cdot m^2/C^2$ .
13. Explain the concept of equipotential lines and their relationship with electric field lines. Sketch the equipotential lines around a single negative point charge and around two positive charges of different magnitudes.
14. Describe the work done to move a charge along an equipotential line. If it takes  $12\ \mu J$  to move a  $4\ \mu C$  charge between two equipotential lines, what is the potential difference between the lines?
15. Describe how a dielectric material affects the capacitance of a capacitor. Given a capacitor with a capacitance of  $8\ \mu F$  without a dielectric, and a dielectric constant  $k = 3$ , calculate the new capacitance when the dielectric is inserted.

16. A parallel-plate capacitor with a capacitance of  $5 \mu F$  is filled with a dielectric material with  $k = 2.5$ . Calculate the new capacitance.
17. Explain the rules for combining capacitors in series and in parallel. Calculate the equivalent capacitance for two capacitors of  $7 \mu F$  and  $12 \mu F$  connected in series, and then for the same capacitors connected in parallel.
18. Three capacitors with capacitances of  $3 \mu F$ ,  $6 \mu F$ , and  $9 \mu F$  are connected in parallel. Calculate the equivalent capacitance.
19. Derive the formula for the energy stored in a capacitor. Calculate the energy stored in a  $7 \mu F$  capacitor charged to a potential difference of 15 V.
20. A  $10 \mu F$  capacitor is connected to a 20 V battery. Calculate the energy stored in the capacitor.
21. Define electric current and describe how it is measured. If a wire carries a current of 4 A, calculate the total charge passing through the wire in 1 minute.
22. If a current of 5 A flows through a conductor for 2 minutes, calculate the total charge that passes through the conductor.
23. State Ohm's Law and explain its significance in electrical circuits. Given a simple circuit with a 24 V battery and a resistor of  $8 \Omega$ , calculate the current flowing through the circuit.
24. A resistor has a resistance of  $15 \Omega$ , and a current of 3 A flows through it. Calculate the voltage across the resistor.
25. Explain the factors that affect the resistance of a conductor. Given a wire with a resistivity of  $2.0 \times 10^{-8} \Omega \cdot m$ , a length of 3 meters, and a cross-sectional area of  $2 \times 10^{-6} m^2$ , calculate its resistance.
26. A copper wire has a resistivity of  $1.68 \times 10^{-8} \Omega \cdot m$ , a length of 1.5 meters, and a cross-sectional area of  $1.5 \times 10^{-6} m^2$ . Calculate its resistance.
27. Describe how to calculate the equivalent resistance for resistors connected in series and in parallel. Calculate the equivalent resistance for three resistors of  $5 \Omega$ ,  $10 \Omega$ , and  $15 \Omega$  connected in parallel.
28. Calculate the equivalent resistance for three resistors of  $4 \Omega$ ,  $8 \Omega$ , and  $12 \Omega$  connected in series.
29. Explain the concept of electromotive force (emf) and terminal voltage. A battery with an emf of 10 V and an internal resistance of  $1.5 \Omega$  is connected to a  $5 \Omega$  resistor. Calculate the terminal voltage and the current in the circuit.
30. A battery has an emf of 15 V and an internal resistance of  $2 \Omega$ . It is connected to a  $10 \Omega$  resistor. Calculate the terminal voltage and the current in the circuit.
31. State Kirchhoff's Junction Rule and Loop Rule, and explain their significance in circuit analysis. Use Kirchhoff's Rules to find the currents in a circuit with two loops, given the following components:  $R_1 = 2 \Omega$ ,  $R_2 = 4 \Omega$ ,  $R_3 = 6 \Omega$ , and two batteries with emf  $E_1 = 5 V$  and  $E_2 = 10 V$ .
32. Use Kirchhoff's Rules to analyze a series circuit with three resistors,  $R_1 = 3 \Omega$ ,  $R_2 = 5 \Omega$ ,  $R_3 = 7 \Omega$ , and two batteries with emf  $E_1 = 6 V$  and  $E_2 = 9 V$ . Find the currents in the circuit. Assume the first two resistors are on the same branch as the first battery, while the second resistor is on the same branch as the second battery.
33. A  $10 \mu F$  capacitor is connected in series with a  $20 \mu F$  capacitor and a  $30 \mu F$  capacitor. Calculate the equivalent capacitance of the combination.
34. A  $5 \mu F$  capacitor is charged to 10 V and then disconnected from the battery. It is then connected in parallel with an uncharged  $15 \mu F$  capacitor. Calculate the final potential difference across each capacitor.
35. A  $2 \Omega$  resistor and a  $4 \Omega$  resistor are connected in parallel. This combination is then connected in series with a  $6 \Omega$  resistor and a 12 V battery. Calculate the current flowing through each resistor.

36. A circuit contains a battery with an emf of  $12\text{ V}$  and internal resistance of  $0.5\ \Omega$ . It is connected to a series combination of resistors  $3\ \Omega$  and  $6\ \Omega$ . Calculate the terminal voltage of the battery.
37. Two point charges,  $1\ \mu\text{C}$  and  $-2\ \mu\text{C}$ , are placed  $0.05$  meters apart. Calculate the electric field at a point  $0.1$  meters from the  $1\ \mu\text{C}$  charge along the line connecting the two charges.
38. A  $10\ \mu\text{C}$  point charge is placed at the origin. Calculate the electric potential at a point  $0.2\text{ m}$  from the charge. Then, determine the work required to move a  $2\ \mu\text{C}$  charge from infinity to this point.
39. A  $50\ \Omega$  resistor is connected across a  $24\text{ V}$  battery. Calculate the power dissipated by the resistor.
40. Three resistors of  $10\ \Omega$ ,  $20\ \Omega$ , and  $30\ \Omega$  are connected in parallel. Calculate the equivalent resistance and the current through each resistor if the total current supplied is  $9\text{ A}$ .

***For the nuclear physics part, studying the slides and understanding the problems on there is enough.***

In full transparency, not everything posted here will be on the exam. For example questions regarding internal resistance & terminal voltage (e.g., q #29, #30, #36), and also common voltage in capacitors (e.g., q #34)