Topic 2: Electric Circuits

Subtopic 2.1: Potential Difference and Electric Current

Knowledge	Application
Atoms contain positively charged protons and negatively charged electrons. Objects become charged when electrons are transferred from one object to another or redistributed on one object. Two like charges exert repulsive forces on each other, whereas two opposite charges exert attractive forces on each other. Energy is required to separate positive and negative charges and this charge separation produces an electrical potential difference that can be used to drive current in circuits. The energy available to charges moving in an electrical circuit is measured using electric potential difference (voltage). This is defined as the change in potential energy per unit charge between two defined points in the circuit and is measured using a voltmeter.	Describe electric forces between like charges and between opposite charges. Explain various phenomena involving interactions of charge. Explain how electrical conductors allow charges to move freely through them, whereas insulators do not. Describe how a voltmeter is used in an electric circuit. Explain the purpose of measuring potential difference in electric circuit. Describe how electrical safety is increased through the use of: • fuses or circuit breakers • residual current devices.
Electric current is carried by discrete charge carriers. Charge is conserved at all points in an electrical circuit. Electric current is the rate of flow of charge. An ammeter is used to measure the electric current at a point in a circuit. It is placed in series with the electrical component through which the current is to be measured.	Distinguish between electron current and conventional current. Solve problems involving $I = \frac{q}{t}$.

Subtopic 2.2: Resistance

Knowledge	Application
Resistance for ohmic and non-ohmic components is defined as the ratio of potential difference across the component to the current in the component. The resistance of a conductor depends on its length, area of cross-section, temperature, and the type of the material of which it is composed. Resistance is constant for ohmic resistors, which conform to Ohm’s Law. Ohm’s Law states that current is directly proportional to the potential difference providing the temperature of the conductor remains constant.	Solve problems involving $R = \frac{V}{I}$.

Subtopics 2.3 and 2.4 on next page.

Subtopic 2.3: Circuit Analysis

Knowledge	Application
Circuit analysis and circuit design involve calculation of the potential difference across, the current in, and the power supplied to components in series, parallel, and composite circuits. The current is equal in each series component. The potential difference is equal across each parallel component.	Solve problems involving $V_t = V_1 + V_2 + \ldots V_n$ and $R_t = R_1 + R_2 + \ldots R_n$ for components in series. Solve problems involving $I_t = I_1 + I_2 + \ldots I_n$ and $\frac{1}{R_t} = \frac{1}{R_1} + \frac{1}{R_2} + \ldots \frac{1}{R_n}$ for components in parallel. Undertake experiments to investigate current, resistance, or potential difference in series and parallel circuits using various circuit elements.

Subtopic 2.4: Electrical Power

Knowledge	Application
Power is the rate at which energy is transformed by a circuit component. Electric circuits enable electrical energy to be transferred efficiently over large distances and transformed into a range of other useful forms of energy including thermal and kinetic energy, and light.	Solve problems involving: • $P = \frac{\Delta E}{t}$ • $P = VI$ and the use of Ohm's Law formula. Solve problems involving the cost of electrical energy, using kilowatt-hours. Solve problems involving: $efficiency = \frac{useful\ energy}{total\ energy} \times 100$ or $efficiency = \frac{power\ output}{power\ input} \times 100$