basic education

Department:
Basic Education
REPUBLIC OF SOUTH AFRICA

NATIONAL SENIOR CERTIFICATE

GRADE 10

ELECTRICAL TECHNOLOGY

EXEMPLAR 2016

MARKS: 200

TIME: 3 hours

This question paper consists of 13 pages and a 2-page formula sheet.

INSTRUCTIONS AND INFORMATION

1. This question paper consists of THREE sections. SECTION A is COMPULSORY for ALL learners.

2. Learners offering Electrical must answer SECTION A and SECTION B.

3. Learners offering Electronics must answer SECTION A and SECTION C.

4. Learners offering Digital Systems must answer SECTION A and SECTION C.

5. Sketches and diagrams must be large, neat and fully labelled.

6. Show ALL calculations and round off answers correctly to TWO decimal places. Show the units for ALL answers of calculations.

7. Number the answers correctly according to the numbering system used in this question paper.

8. You may use a non-programmable calculator.

9. A formula sheet is provided at the end of this question paper.

10. Write neatly and legibly.

SECTION A: GENERIC SECTION (COMPULSORY)

QUESTION 1: OCCUPATIONAL HEALTH AND SAFETY

1.1 Define an *accident*. (2)

1.2 Define the term *good housekeeping*. (3)

1.3 Name the following signs:

1.3.1  (1)

1.3.2  (1)

1.3.3  (1)

1.4 State TWO unsafe conditions that may result in an injury. (2)

1.5 Define the term *unsafe action*. (2)
[12]

QUESTION 2: TOOLS AND MEASURING INSTRUMENTS

2.1 Explain the function of the following tools:

2.1.1 Combination pliers (2)

2.1.2 Solder sucker (2)

2.2 FIGURE 2.2 below shows a hacksaw. Identify parts 2.2.1 to 2.2.4.

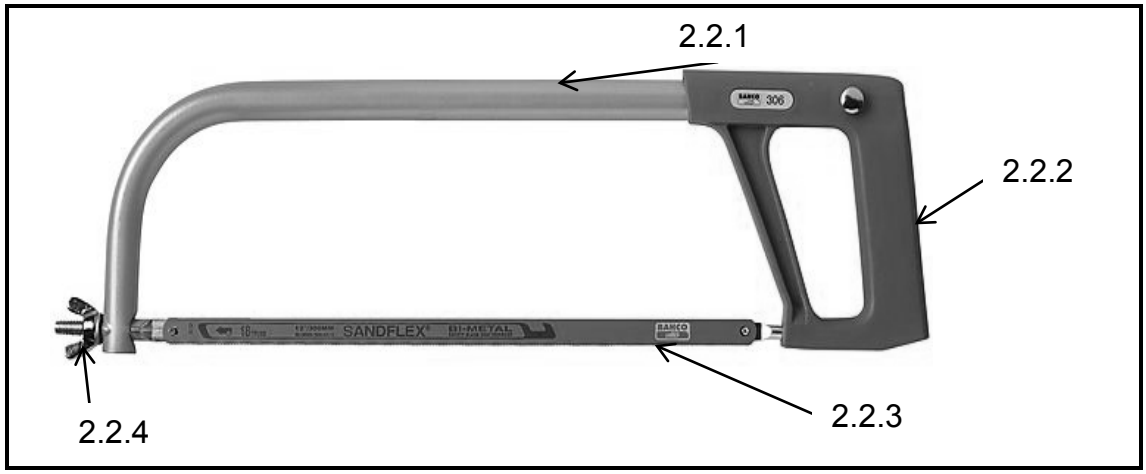

FIGURE 2.2: HACKSAW (4)

2.3 Explain why the handles of electrical tools are insulated. (2)

2.4 Explain why is it important to adjust the tension of a hacksaw blade when working with a hacksaw. (2)

2.5 State TWO maintenance considerations related to screw drivers. (2)

2.6 State ONE safety precaution to be observed when using an ammeter to measure current in an electrical circuit. (2)

2.7 Explain how a voltmeter must be connected in an electrical circuit to measure voltage. (2)

2.8 Explain why it is important to calibrate an oscilloscope before use. (2)
[20]

QUESTION 3: BASIC PRINCIPLES OF ELECTRICITY

3.1 Define the following terms:

3.1.1 Insulator (2)

3.1.2 Negative temperature coefficient (2)

3.2 State ONE characteristic of copper. (1)

3.3 Define the term *tolerance* of a resistor. (2)

3.4 Determine the resistance value of a carbon resistor with the following colour band:

Brown, green, orange and gold (2)

3.5 State Ohm's law in words. (3)

3.6 Calculate the resistance of a soldering iron heating element that draws a current of 2 A when connected across a 220 V supply. (3)

3.7 Study FIGURE 3.7 below and answer the questions that follow.

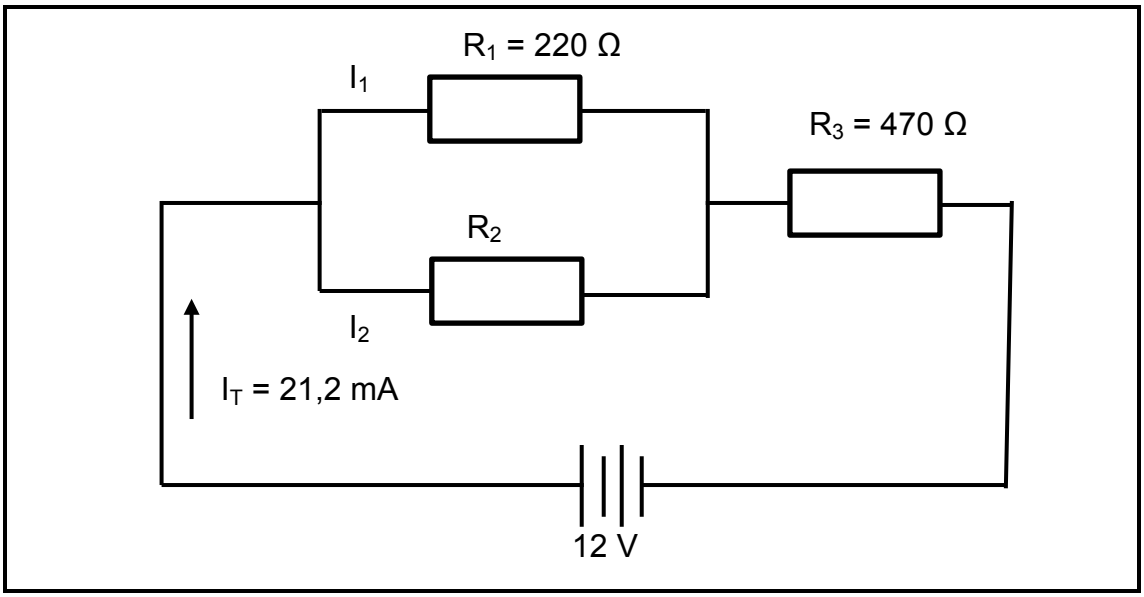

FIGURE 3.7: CIRCUIT

Given:

$R_1 = 220\ \Omega$
$R_3 = 470\ \Omega$
$I_t = 21{,}2$ mA
$V_t = 12$ V

Calculate:

3.7.1 The voltage drop across R_3 (3)

3.7.2 The voltage drop across R_1 (3)

3.7.3 The current through R_1 (3)

3.7.4 The current through R_2 (3)

3.7.5 The value of R_2 (3)

3.8 Explain what will happen to the total current in FIGURE 3.7 if R_3 is removed. (2)
[32]

QUESTION 4: POWER SOURCES

4.1 Define the term *energy*. (3)

4.2 State ONE primary source of energy. (1)

4.3 Draw a labelled diagram of a voltaic cell. (5)

4.4 Explain the difference between a *secondary cell* and a *primary cell*. (2)

4.5 Explain the difference between *potential difference* and *electromotive force* with reference to a battery. (4)

4.6 Study FIGURE 4.6 below and answer the question that follows.

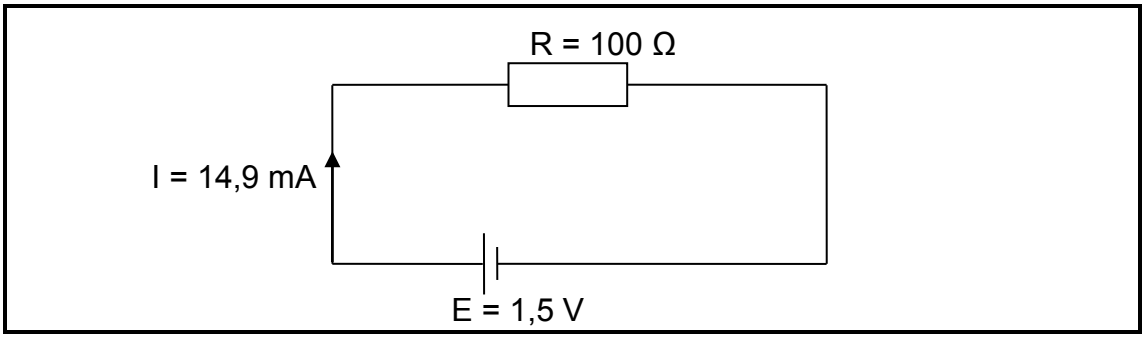

FIGURE 4.6: ELECTRIC CIRCUIT

Given:

E = 1,5 V
I = 14,9 mA
R = 100 Ω

Calculate the internal resistance of the cell. (3)

4.7 Draw the symbol of a photovoltaic cell. (2)
[20]

QUESTION 5: ELECTRONIC COMPONENTS

5.1 Draw the symbols of the following switches:

5.1.1 SPDT switch (2)

5.1.2 DPST switch (2)

5.1.3 Rotary switch (2)

5.2 Explain the purpose of a capacitor. (2)

5.3 Draw the graph of voltage and current versus time for a charging capacitor. (4)

5.4 Two capacitors each have a capacitance of 2 200 µF.

Given:

C_1 = 2 200 µF
C_2 = 2 200 µF

Calculate the capacitance of the TWO capacitors when connected as follows:

5.4.1 In parallel (3)

5.4.2 In series (3)

5.5 A 100 µF capacitor is connected in series with a 50 kΩ resistor. The two components are now connected across a 12 V supply.

Given:

C = 100 µF
R = 50 kΩ
V = 12 V

Calculate the total charging time of the capacitor. (5)

5.6 Explain the term *forward biasing* of a diode. (1)

5.7 State the purpose of a series resistor connected with a LED. (2)
[26]

QUESTION 6: MAGNETISM

6.1 Describe the following terms:

6.1.1 Electromagnet (2)

6.1.2 Mutual inductance (3)

6.2 Explain the difference between *magnetic flux* and *flux density*. (4)

6.3 State TWO types of inductor cores. (2)

6.4 Describe what an *inductor* is. (2)

6.5 Calculate the total inductance of the inductors in FIGURE 6.5 below.

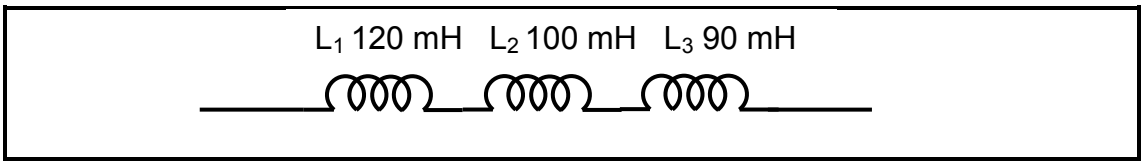

FIGURE 6.5: INDUCTORS (3)

6.6 Describe the operation of a relay. (4)

6.7 Label parts **6.7.1** to **6.7.4** in FIGURE 6.7 below.

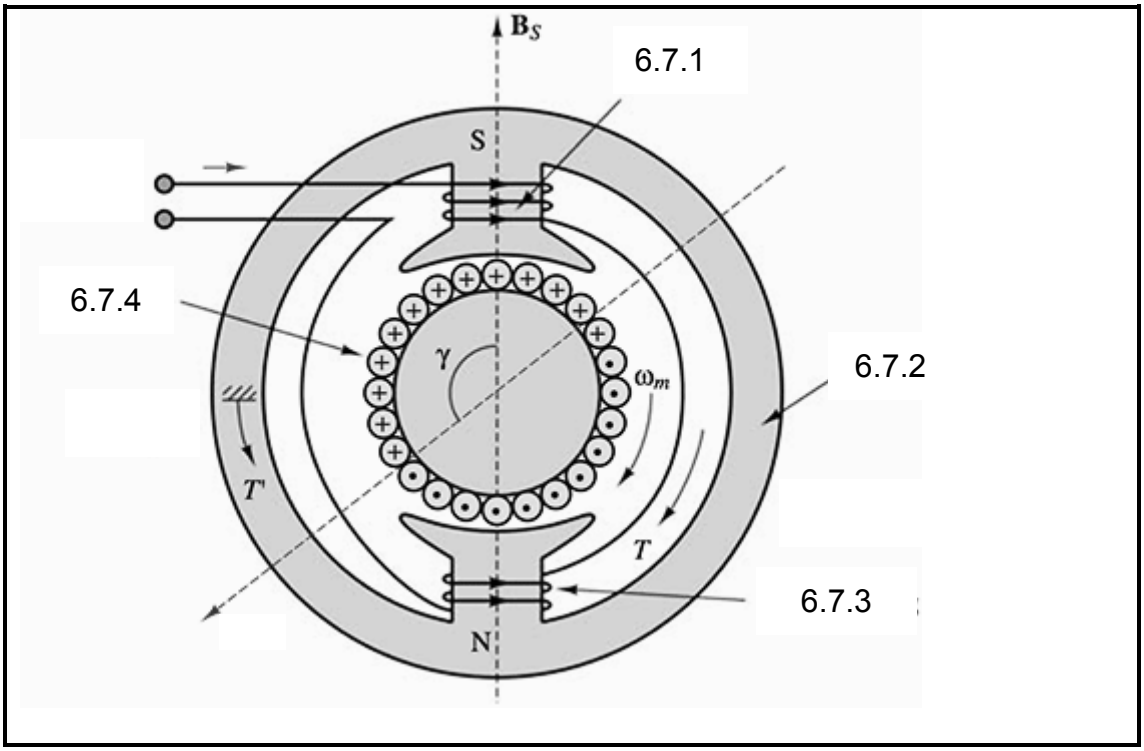

FIGURE 6.7: SECTIONAL VIEW OF A DC MOTOR (4)

6.8 Explain the purpose of the brushes in a DC machine. (2)

[26]

TOTAL SECTION A: 136

SECTION B: ELECTRICAL

QUESTION 7: DOMESTIC INSTALLATIONS

7.1 Define the term *domestic installation*. (2)

7.2 State the standard value of the following items in South Africa with reference to a domestic installation:

7.2.1 Frequency (1)

7.2.2 Mains voltage (1)

7.3 Draw a block diagram that shows the sequence of electrical connection from supplier to consumer. Label the diagram. (4)

7.4 What does the abbreviation *SANS* stand for? (4)

7.5 Describe the aim of *SANS*. (4)

7.6 State TWO conditions under which an electrical installation must activate protection to protect devices. (2)

7.7 Safety principles are important in electrical installations. Describe what principles must be adhered to with reference to the following:

7.7.1 Live parts (3)

7.7.2 Temperature (3)

7.8 Answer the following questions with reference to a distribution board.

7.8.1 Define the term *distribution board.* (3)

7.8.2 Name ONE place where a distribution board may NOT be mounted. (1)

7.8.3 Describe how the size of a busbar is determined in a distribution board. (2)

7.9 Answer the following questions with reference to miniature circuit breakers.

7.9.1 Describe the function of a miniature circuit breaker. (3)

7.9.2 Describe the operation of the electromagnetic miniature circuit breaker shown in FIGURE 7.9 below.

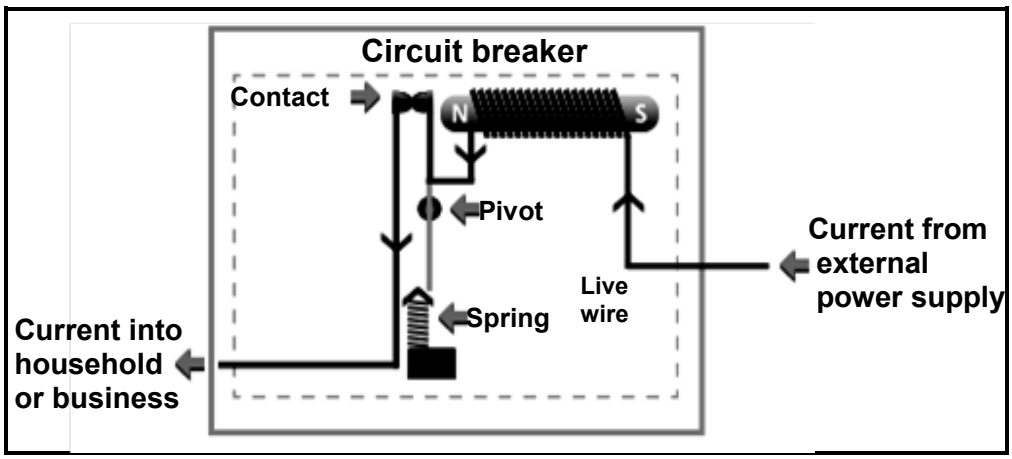

FIGURE 7.1: ELECTROMAGNETIC MINIATURE CIRCUIT BREAKER (5)

7.9.3 Give the current rating of a miniature circuit breaker used to protect a lighting circuit. (1)

7.9.4 Describe TWO methods used to rate miniature circuit breakers. (4)

7.9.5 The thermal-type miniature circuit breaker operates with the use of a bimetal strip. Describe how a bimetal strip works. (4)

7.10 Answer the following questions with reference to earth leakage devices.

7.10.1 State the THREE functions of an earth-leakage device. (3)

7.10.2 Give ONE practical example of an earth fault that may occur in a domestic installation. (3)

7.11 Answer the following questions with reference to the earthing of electrical systems.

7.11.1 Define the term *earthing.* (2)

7.11.2 State the purpose of earthing. (2)

7.11.3 Describe what type of resistive value an earthing system should have. (4)

7.11.4 Explain the term *earth spike.* (3)

TOTAL SECTION B: 64

SECTION C: ELECTRONICS AND DIGITAL ELECTRONICS

QUESTION 8: LOGIC

8.1 Study FIGURE 8.1a and FIGURE 8.1b below that shows two clocks and answer the questions that follow.

FIGURE 8.1a: CLOCK

FIGURE 8.1b: CLOCK

8.1.1 Name the system used in the clock in FIGURE 8.1a. (1)

8.1.2 Name the system used in the clock in FIGURE 8.1b. (1)

8.2 Name any TWO number systems used commonly in digital circuits. (2)

8.3 Convert 19_{10} to a binary number. (5)

8.4 Convert 1001_2 to a decimal number. (4)

8.5 Find the sum of 011_2 and 100_2. (3)

8.6 Subtract 0111_2 from 1100_2. (3)

8.7 Do the following with reference to a two-input AND gate:

8.7.1 Draw the symbol of the gate. (2)

8.7.2 Write out the Boolean expression for the gate. (2)

8.7.3 Draw the truth table for the gate. (4)

8.8 Draw a neat logic circuit for the following Boolean expression:

X = AC + AB + BC (5)
[32]

QUESTION 9: COMMUNICATION

9.1 Describe the purpose of communication systems. (3)

9.2 Define *radio wave propagation* in communication systems. (3)

9.3 State THREE types of radio-wave propagation. (3)

9.4 Define the term *frequency* with reference to radio waves. (3)

9.5 Label part **9.5.1** and part **9.5.2** in FIGURE 9.5 below.

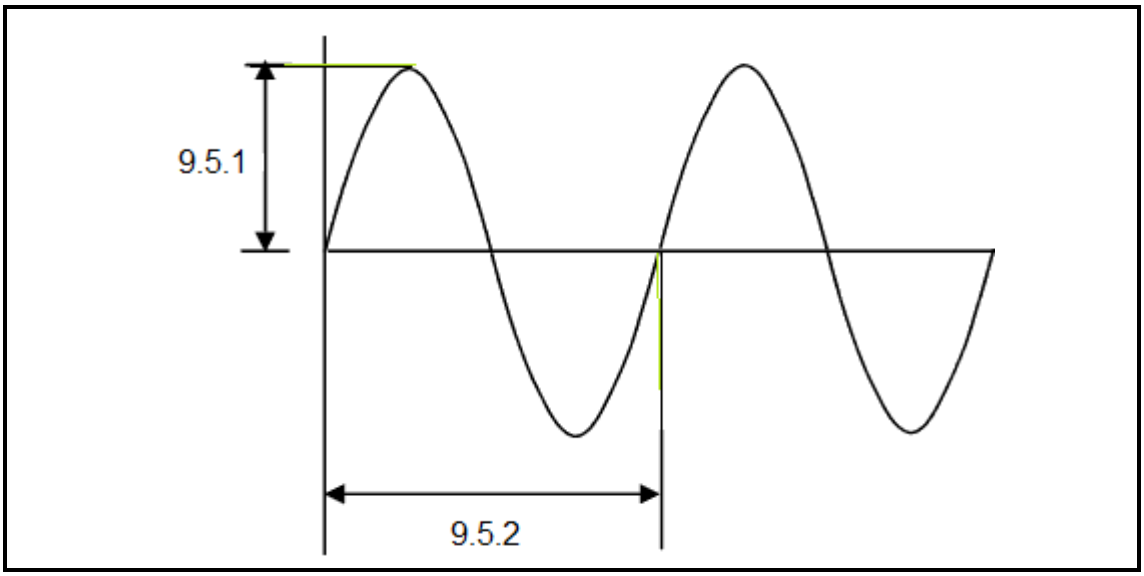

FIGURE 9.5: WAVE FORM (2)

9.6 Describe the function of an antenna in communication systems. (3)

9.7 Name TWO types of antennas used in communication systems. (2)

9.8 Describe what is meant by *commercial broadcasting*. (4)

9.9 Label parts **9.9.1** to **9.9.4** in FIGURE 9.9 below.

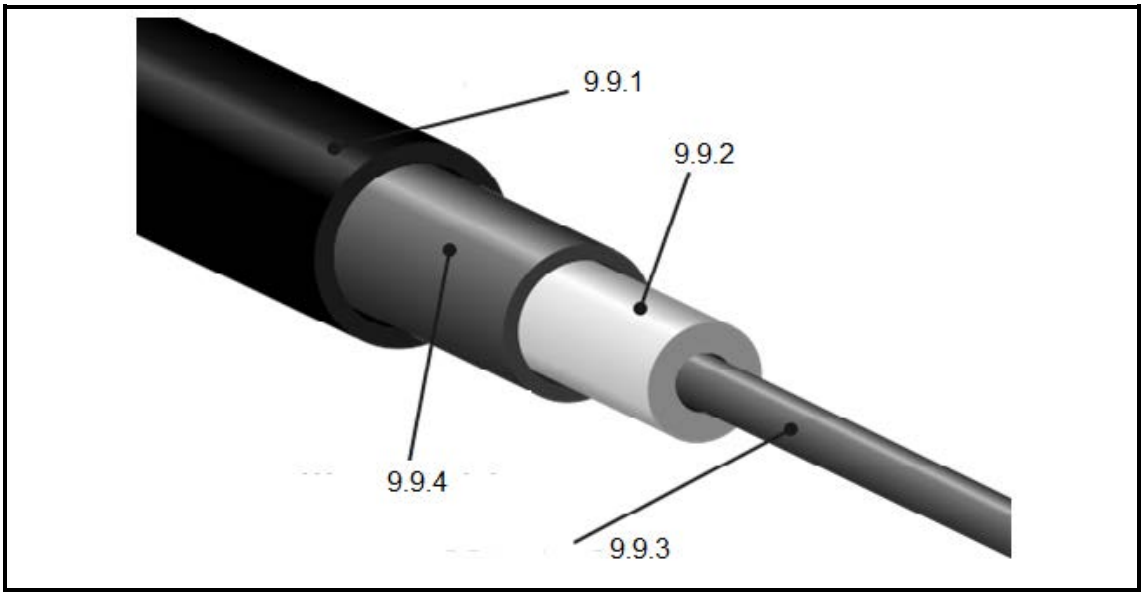

FIGURE 9.9: COAXIAL CABLE (4)

9.10 Describe why cellphones have become the most popular choice in communication. (5)

[32]

TOTAL SECTION C: 64
GRAND TOTAL: 200

FORMULA SHEET

PRINCIPLES OF ELECTRICITY

Charge
$$Q = I \times t \qquad (C)$$

Specific resistance
$$R = \frac{\rho \text{ x } l}{A} \qquad (\Omega)$$

Ohm's law
$$R = \frac{V}{I} \qquad (\Omega)$$

Resistors in series
$$R_T = R_1 + R_2 + ... + R_n \qquad (\Omega)$$

$$I_T = I_1 = I_2 = ... + I_n \qquad (A)$$

Resistors in parallel
$$\frac{1}{R_T} = \frac{1}{R_1} + \frac{1}{R_2} + ... + \frac{1}{R_n} \qquad (\Omega)$$

$$I_T = I_1 + I_2 + ... + I_n \qquad (A)$$

Kirchhoff's law (voltage divider)
$$V_T = V_1 + V_2 + ... + V_n \qquad (V)$$

Kirchhoff's Law (current divider)
$$I_T = I_1 + I_2 + ... + I_n \qquad (A)$$

Power
$$P = V \times I \qquad (W)$$

$$\text{Energy} = P \times t \ \text{(kW.h)}$$

Light-emitting diode (LED)
$$R_{series} = \frac{V_T - V_{LED}}{I_{LED}} \qquad (\Omega)$$

POWER SOURCES

Potential difference
$$V = \frac{E}{Q} \qquad (V)$$

Electromotive force (emf)

$V_{emf} = V_{pd} + V_r \quad (V)$

or

$V_{emf} = I(R + r) \quad (V)$

Capacity and power rating

Battery capacity $= I_{charge} \times T_{charge} \quad (A.h)$

ELECTRONIC COMPONENTS

Electrostatic charge

$Q = CV \quad (C)$

Time constant

$\tau = RC \quad (s)$

$T = 5RC \quad (s)$

Charging rate

$V_{capasitor} = V_{supply} \times 0,623 \quad (V)$

$I_{capasitor} = I_{max} \times 0,364 \quad (A)$

Capacitors in series

$$\frac{1}{C_T} = \frac{1}{C_1} + \frac{1}{C_2} + ... + \frac{1}{C_n} \quad (F)$$

Capacitors in parallel

$C_T = C_1 + C_2 + ... + C \quad (F)$

PRINCIPLES OF MAGNETISM

Coils in series

$L_T = L_1 + L_2 + L_3 + ... + L_n \quad (H)$

Coils in parallel

$$\frac{1}{L_T} = \frac{1}{L_1} + \frac{1}{L_2} + \frac{1}{L_3} + ... + \frac{1}{L_n} \quad (H)$$