CH # 16 ELECTRICITY

Some important formulae:

i) $\Delta V = \frac{W_{AB}}{q}$ $\quad ii) \frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

iii) V = IR iv) $R = R_1 + R_2 + R_3$ v) P = IV

16.1: Calculate the amount of work done in carrying a charge of +2.5μC from A to B, if A is a potential of –60V and B is at +10V.

GIVEN:

Charge = q = +2.5μC = +2.5 x 10^{-6}C

Electric potential at point A = V_A = –60V

Electric potential at point B = V_B = +10V

REQUIRED:

Work done of charge from A to B = W_{AB} = ?

SOLUTION:

$\Delta V = \frac{W_{AB}}{q}$

$W_{AB} = \Delta V \times q$

$W_{AB} = (V_B - V_A) \times q$

$W_{AB} = \{10 - (-60\} \times 2.5 \times 10^{-6}$

$W_{AB} = 70 \times 2.5 \times 10^{-6}$

$W_{AB} = 1.75 \times 10^{-4}$ J

16.2: Find the potential difference between the two ends of the conductor if it offers a resistance of 5Ω. Take the current flowing through the conductor as 5 amperes.

GIVEN:

Resistance = R = 5Ω

Current = I = 5A

REQUIRED:

Potential difference = V = ?

SOLUTION:

According to Ohm's law,

V = IR

V = (5)(5)

V = 25V

16.3: The potential difference applied to the terminals of a portable radio is 9Volts. Find the resistance of the radio if a current of 25mA is flowing through it.

GIVEN:

Potential difference = V = 9V

Current = I = 25mA = 25/1000 = 0.025A

REQUIRED:

Resistance = ?

SOLUTION:

According to Ohm's law,

V = IR

$R = \frac{V}{I}$

$R = \frac{9}{0.025}$

R = 360Ω

16.4: An electric toaster has a resistance of 12Ω. What current will it drawn from a 120V supply?

GIVEN:

Resistance = R = 12Ω

Potential difference = V = 120V

REQUIRED:

Electric current = I = ?

SOLUTION:

According to Ohm's law,

V = IR

$I = \frac{V}{R}$

$I = \frac{120}{12}$

I = 10A

16.5: A series circuit consists of three resistances of 40Ω, 50Ω and 20Ω respectively is connected across a voltage source of 120V as shown in figure. Find the

current in the circuit and potential difference across each resistor.

GIVEN:
Resistance = R_1 = 40Ω
Resistance = R_2 = 50Ω
Resistance = R_3 = 20Ω
Voltage = V = 120V

REQUIRED:
Current in circuit = I = ?
Potential difference across each resistor = V_1,V_2,V_3 = ?

SOLUTION:
Equivalent resistance:
$R = R_1 + R_2 + R_3$
$R = 40 + 50 + 20$
$R = 110\Omega$

Current in circuit:
According to Ohm's law,

$V = IR$

$$I = \frac{V}{R}$$
$$I = \frac{120}{110}$$

$I = 1.09A$

Potential difference across R_1:
$V_1 = IR_1$
$V_1 = (1.09)(40)$
$V_1 = 43.64V$

Potential difference across R_2:
$V_2 = IR_2$
$V_2 = (1.09)(50)$
$V_2 = 54.55V$

Potential difference across R_3:
$V_3 = IR_3$
$V_3 = (1.09)(200)$
$V_3 = 21.82V$

16.6: Resistors of 4Ω, 6Ω and 12Ω are connected in parallel and then joined to an EMF source of 6V. Find the value of:

i) The equivalent resistance of the circuit.

ii) The total current flowing in the circuit.

iii) The current passing through each resistance.

GIVEN:
Resistance = R_1 = 4Ω
Resistance = R_2 = 6Ω
Resistance = R_3 = 12Ω
Voltage = V = 6V

REQUIRED:
i) Equivalent resistance = R = ?
ii) Current in circuit = I = ?
iii) Current flowing through each resistor = I_1,I_2,I_3 = ?

SOLUTION:
Equivalent resistance:
$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R} = \frac{1}{4} + \frac{1}{6} + \frac{1}{12}$$
$$\frac{1}{R} = \frac{3 + 2 + 1}{12}$$
$$\frac{1}{R} = \frac{6}{12}$$
$$\frac{1}{R} = \frac{1}{2}$$
$R = 2\Omega$

Current in circuit:
According to Ohm's law,

$V = IR$

$$I = \frac{V}{R}$$
$$I = \frac{6}{2}$$

$I = 3A$

Current flow through R_1:
$V = I_1R_1$

$$I_1 = \frac{V}{R_1}$$
$$I_1 = \frac{6}{4}$$
I_1 = 1.5A

Current flow through R_2:

$V = I_2R_2$
$$I_2 = \frac{V}{R_2}$$
$$I_2 = \frac{6}{6}$$
I_2 = 1A

Current flow through R_3:

$V = I_3R_3$
$$I_3 = \frac{V}{R_3}$$
$$I_3 = \frac{6}{12}$$
I_3 = 0.5A

16.7: Two light bulbs of 100watt and 60watt both operate in a 220V circuit. Which bulb has the higher resistance and which bulb carries greater current.

GIVEN:
Power = P_1 = 100W
Power = P_2 = 60W
Voltage = 220V

REQUIRED:
Higher resistance = R = ?
Greater current = I = ?

SOLUTION:
For 100Watt bulb:
Current,
P = IV
$$I = \frac{P}{V}$$
$$I = \frac{100}{220}$$
I = 0.4545A

Resistance,
V = IR
$$R = \frac{V}{I}$$
$$R = \frac{220}{0.4545}$$
R = 488.88Ω

For 60Watt bulb:
Current,
P = IV
$$I = \frac{P}{V}$$
$$I = \frac{60}{220}$$
I = 0.2727A

Resistance,
V = IR
$$R = \frac{V}{I}$$
$$R = \frac{220}{0.2727}$$
R = 806.66Ω
By comparing both bulbs,
Higher resistance = 60Watt bulb
Greater current = 100Watt bulb