Numerical Problems

14.1 A current of 3mA is flowing through a wire for 1 minute. What is the charge flowing through the wire?

Answer

Current, I = 3 mA

= 3 x 10-3 A

Time, t = 1 min

= 60 sec.

Charge, Q =?

As we know that,

I = Q/t, or Q = It

Putting the values, we get,

$$Q = 3 \times 10^{-3} \times 60$$

$$\boxed{Q = 180 \times 10^{-3}\ C}$$

14.2 At 100,000 Ωm how much current flows through your body if you touch the terminals of a 12 V battery? If your skin is wet, so that your resistance is only 1000Ω, how much current would you receive from the same battery?

Answer

Resistance. R = 10000 Ω

$= 10^5\ \Omega$

Current. I =?

Voltage, v = 12 V

Resistance of wet skin, R' = 1000 Ω

Current flowing through we skin, I' =?

i) For dry skin

applying ohm's law, we have:

V=IR

Or, I = V/R

Putting the values, we get,

$$I = \frac{12}{10^5}$$

$$\boxed{I = 1.2 \times 10^{-4}\ A}$$

ii) For wet skin

Again, applying ohm's law, we get,

V' = I' R', or I' = V/R'

Putting the values, we get,

I =12/1000

or $\boxed{I' = 1.2 \times 10^{-2}\ A}$

14.3 The resistance of a conductor wire is 10 MΩ. If a potential difference of 100 V applied across its ends, then find the value of current passing through it in mA.

Answer

Resistance, R = 10 M Ω

$= 10 \times 10^6\ \Omega$

Voltage, V = 100V

Current (mA) =I (mA)=?

Applying ohm's law, we get:

$$V = IR$$

$$I = V/R$$

$$\Rightarrow \quad I = 100/10^7$$

$$I = 10^{-5}\ A$$

As we know that, $1A = 10^3 mA$.

$$\boxed{I = 0.01\ mA}$$

14.4, By applying a potential difference of 10 V across a conductor a current of 1.5 A passes through it. How much energy would be obtained from the current in 2 minutes?

Answer

Voltage, V = 10V

Current, I = 1.5 A

Energy obtained =?

Time, t = 2 min

= 120 sec.

As we know according to Joule's law, we get:

$$Energy = VIt$$

Putting the values, we get,

$$Energy = 10 \times 1.5 \times 120$$

$$\boxed{\text{Energy obtained} = 1800\ J}$$

14.5 Two resistance of 2kΩ and 8kΩ are joined in series, if a 10 V battery is connected across the ends of this combination, find the following quantities:

a) The equivalent resistance of the parallel combination.

b) Current passing through each of the resistance.

c) Potential difference across each of the resistance.

Answer

First resistance, R = 2k Ω

= 2000 Ω

Second resistance. R2 = 8 KΩ

= 8000 Ω,

Voltage supplied. V = 12 V

Equivalent resistance. R_{eq}. =?

As the resistance are joined in series,

I_1, = I_2 = I =?

Voltage across R_1. V_1 =?

Voltage across R_2, V_2 =?

We know that:

$$R_{eq} = R_1 + R_2$$

=> = 2KΩ 8kΩ

Also, for current; applying ohm's law;

$$V = IR_{eq}$$

$$I = V/R_{eq}$$

= 12/10,000

I = 0.001 A

$I = ImA$

$I = I_1 = I_2$, So $\boxed{I_2 = I_2 = 1\ mA}$

For voltage, again applying ohm's law,

1) For resistance R1,

=> $V_1 = IR_1$,

$= 0.001 \times 2000$

$\boxed{V_1 = 2V}$

2) for resistance R2,

=> $V_2 = IR_2$,

$= 0.001 \times 8000$

$\boxed{V_2 = 8V}$

14.6 Two resistance of 6Ω and 12 Ω are connected in parallel. A 6V battery is connected across its ends, find the values of the following quantities.

a) Equivalent resistance of the parallel combination.

b) Current passing through each of the resistance.

c) Potential difference across each of the resistance.

Answer

First resistance, $R_1 = 6k\ \Omega$

$= 6000\ \Omega$

Second resistance, $R_2 = 12k\ \Omega$

$= 12000\ \Omega$

Voltage supplied, V = 6V

Equivalent resistance, R_{eq} =?

Current through resistance, R_{eq} =?

Current through resistance, R_1I_1 =?

Current through resistance, R_2I_2 =?

As the combination is parallel, so, $V_1 = V_2 = V$ =?

We know that $1/R_{eq} = 1/R_1 + 1/R_2$

$$= \frac{1}{6k\,\Omega} + \frac{1}{12k\,\Omega}$$

$$= \frac{2k\,\Omega + 1k\,\Omega}{12k\,\Omega}$$

$$\frac{1}{R_{eq}} = \frac{3}{12}k\,\Omega$$

or $\boxed{R_{eq} = 4k\,\Omega}$

As For parallel combination, voltage remains the same, So, $V = V_1 = V_2 = 12$ volts.

Or $V_1 = V_2 = 12$ volts

For current applying ohm's law;

1) For resistance R_1:

$V = I_1R_1$

$I1 = V/R_1$

or $= 6/6000$

$I_1 = 10^{-3}A$

or $\boxed{I_1 = 1mA}$

2) For resistance R_2:

$V = I_2R_2$

$I_2 = V/R_2$

or $= 6/12000$

$I_2 = 5 \times 10^{-4}$ A

or $\boxed{I_2 = 0.5 \text{ mA}}$

14.7 An electric bulb is marked with 220Vf IOOW. Find the resistance of the filament of the bulb. If the bulb is used 5 hours daily, find the energy in kilowatt-hour consumed by the bulb in one month (30 days).

Answer

Voltage, V = 220 V

Power, P = 100W

Resistance, R =?

Time, t = 5 × 30

= 150 hrs.

Energy (kwh) =?

We know that.

$P = V^2/R$

or $R = V^2/P$

Putting the values, we get:

$R = (220)^2/110$

or $R = 484\ \Omega$

Also, we know that

$$\text{Energy (KWh)} = \frac{\text{Watt} \times \text{time (hours)}}{1000}$$

$$= \frac{100 \times 150}{1000}$$

Energy consumed in KWh = 15 KWh

14.8 An incandescent light bulb with an operating resistance of 95 Ω is labelled "150 W". Is this bulb designed for use in a 120V circuit or a 220V circuit?

Answer

Resistance, R = 95 Ω

Power, P = 150 W

Voltage, V =?

We know that:

$P = V^2/R$

or $V^2 = P \times R$

$V2 = 150 \times 95$

$V = 119.3$ V

V= 120 V

∴ (It has been designed for 120 V)

14.9 A house is installed with:

a)10 bulbs of 50 W each of which are used 5 hours daily.

b) 4 fans of 75 W each of which run 10 hours daily.

c) One T.V of 250W which is used for 2 hours daily.

d) One electric iron of 1000 W which is used for 2 hours daily.

If the cost of one unit of electricity is Rs. 4. Find the monthly expenditure of electricity (one month = 30 days)

Answer.

a) Energy consumed by bulb (KWh) $= \frac{(10 \times 60) \times (5 \times 30) \text{ hours}}{1000}$

$= \frac{600 \text{ W} \times 150 \text{ hrs}}{1000}$

$= 90$ KWh

b) Energy consumed by fans (KWh) $= \frac{(4 \times 75) \times (10 \times 30) \text{ hours}}{1000}$

$= \frac{300 \text{ W} \times 300 \text{ hrs}}{1000}$

$= 90$ KWh

c) Energy consumed by T.V (KWh) $= \frac{(1 \times 250) \times (2 \times 30) \text{ hours}}{1000}$

$= \frac{250 \text{ W} \times 60 \text{ hrs}}{1000}$

$= 15$ KWh

d) Energy consumed by electric iron (KWh) $= \frac{(1 \times 1000) \times (2 \times 30) \text{ hours}}{1000}$

$= \frac{1000 \text{ W} \times 60 \text{ hrs}}{1000}$

$= 60$ KWh

Total energy consumed = (90 + 90 + 15 + 60)

= 255 KWh

Monthly expenditure of electricity = Total energy consumed x cost per unit.

= 225 × 4

= Rs. 1020/-

14.10 A 100 W lamp bulb and a 4kW water heater are connected to a 250 V supply. Calculate (a) the current which flows in each appliance (b) the resistance of each appliance when is use.

Answer

Power of bulb, $P_1 = 100$ W

Power of water heater, $P_2 = 4$ KW

$= 4000$ W

Voltage, V = 250 V

Current through bulb, I_1 =?

Current through water heater, I2=?

Resistance of bulb, R_1=?

Resistance of water heater; R2=?

I) For bulb; we have, $P_1 = VI_1$,

$= I_1 = P_1/V$

or $I_1 = 100/250$

$\boxed{I_1 = 0.4 \text{ A}}$

For resistance, we apply ohm's law

$= V = I_1R$

or $R_1 = \frac{V}{I_1}$

$R_1 = \frac{250}{0.4}$

$\boxed{R_1 = 625\ \Omega}$

2) For water heater; we have;

$P_2 = VI_2$

Or $I_2 = P_2/V$

$= 4000/250$

$\boxed{I_2 = 16 \text{ A}}$

And, $V = I_2R_2$

$R_2 = V/I_2$

$= 250/16$

$\boxed{R_2 = 15.6\ \Omega}$

14.11 A resistor of resistance 5.6Ω is connected across a battery of 3.0 V by means of wire of negligible resistance. A current of 0.5 A passes through the resistor. Calculate

a) power dissipated in the resistor

b) total power produced by the battery

c) Give the reason of difference between these two quantities

Answer

Resistance of resistor, $R = 5.6\ \Omega$

Voltage across battery, $V = 3\ V$

Current through resistor, $I = 0.5\ A$

Power dissipated in resistor, $P = ?$

Total power produced by battery, $P' = ?$

1) For Resistor R:

We know that, $P = I^2R$

$= (0.5)^2 \times 5.6$

$\therefore \quad \boxed{P = 1.4\ W}$

2) For battery:

As the internal resistance of battery is not known so,

$V = IR'$

$$R' = V/I$$

Or $$R' = 3/0.5$$

$$R' = 6\Omega$$

It means that battery has resistance = R' - R = 6 - 5.6

$$= 0.4\ \Omega$$

So, power produced by the battery;

$$P' = I^2 R'$$

$$= (0.5)^2 x\ 6$$

$$\boxed{P' = 1.5\ W}$$