13.13 SOLVED NUMERICALS OF BOOK:

Problem# 13.1: A certain battery is rated at 80 ampere hour. How many coulomb of charges can this battery supply?

Data:

$I = 80\ A$

$t = 1\ hour = 3600\ sec$

$q = ?$

Solution:

$q = It$

$q = 80 \times 3600$

$q = 2.88 \times 10^5\ C$

Self Test# (1):

Q. How much charge pass in 2 minutes through a junction through which a steady current of 5A exists.

Ans. **[q = 600 C]**

Problem# 13.2: A silver wire 2m long is to have a resistance of 0.5Ω. What should its diameter be?

Data:

$L = 2m$

$R = 0.5\Omega$

$\rho = 1.52 \times 10^{-8}\Omega m$

$d = ?$

Solution:

Area of wire:

$R = \frac{\rho L}{A}$

$A = \frac{\rho L}{R}$

$A = \frac{1.52 \times 10^{-8} \times 2}{0.5}$

$\pi r^2 = 6.08 \times 10^{-8}$

$r^2 = \frac{6.08 \times 10^{-8}}{3.14}$

$r^2 = 1.9364 \times 10^{-8}$

$r = \sqrt{1.9364 \times 10^{-8}}$

$r = 1.39 \times 10^{-4} m$

$d = 2 \times 1.39 \times 10^{-4}$

$d = 2.78 \times 10^{-4} m$

Self Test# (2):

Q. A solenoide is constructed from 500m of copper wire having resistance 5.01Ω. Calculate diameter of wire.

Ans. **[D = 1.5mm]**

Problem# 13.3: A current of 6 amp is drawn from a 120Volts line. What power is being developed? How much energy in joule and in kwh is expended if the current is drawn steadily for one week.

Data:

$I = 6A$

$V = 120V$

$P = ?$

E in joule = ?

E in kwh = ?

t = 1 week = 604800 sec

Solution:

$P = VI$

$P = 120 \times 6$

$P = 720\ w$

E in Joule = VIt

$E = 120 \times 6 \times 604800$

$E = 4.35 \times 10^8\ J$

$1kwh = 3.6 \times 10^6\ J$

E in kwh $= \frac{4.35 \times 10^8}{3.6 \times 10^6}$

E = 120.83 kwh

Self Test# (3):

Q. How much heat does a 40W bulb generate in one hour?

Ans. **[E = 144000 J]**

Problem# 13.4: **Current of 3A and 1.5A flow through two wires, at a potential difference of 60 volts and 120 volts respectively. Compare the rate at which energy pass through each wire.**

Data:

$I_1 = 3A$, $V_1 = 60V$

$I_2 = 1.5A$, $V_2 = 120V$

$$\frac{\text{Rate of energy in wire 1}}{\text{Rate of energy in wire 2}} = ?$$

Solution

Rate of energy = Power

Rate of energy = VI

For the first wire

Rate of energy = 60 x 3 = 180W

For the second wire

Rate of energy = 120 x 1.5 = 180W

$$\frac{\text{Rate of energy in wire 1}}{\text{Rate of energy in wire 2}} = \frac{180}{180} = 1$$

Rate of energy in both wires is the same

Problem# 13.5: **A wire carries a current of 1A. How many electrons pass a point in the wire in each second?**

Data:

$I = 1A$

$t = 1$ sec

Number of electrons Passed = ?

Solution:

$q = It$

$q = 1 \times 1$

$q = 1C$

Let 'n' be the number of electrons passing a point in each second.

$q = ne$

$1 = n \times 1.6 \times 10^{-19}$

$$n = \frac{1}{1.6 \times 10^{-19}}$$

$$\boxed{n = 6.3 \times 10^{18} \text{ electrons}}$$

Self Test# (4):

Q. There is a current of 5mA in a wire. How much charge flows through cross-section of the wire is 10S? If the current is due to flow of electrons. How many electrons pass through the wire in 10 second?

Ans. *[$q = 5 \times 10^{-2}$ C $n = 3.125 \times 10^{17}$ electrons]*

Problem# 13.6: **An electric drill rated at 400W is connected to a 240V power line. How much current does it draw?**

Data:

$P = 400\ W$

$V = 240\ V$

$I = ?$

Solution:

$P = VI$

$400 = 240 \times I$

$\boxed{I = 1.67A}$

Problem# 13.7: **Resistors of 20Ω, 40Ω and 50Ω are connected in parallel across 50 volts power source. Find the equivalent resistance of the circuit and the current in each resistor.**

Data:

$R_1 = 20\Omega$

$R_2 = 40\Omega$

$R_3 = 50\Omega$

Joined in parallel

(a) $R = ?$

(b) $I_1 = ?$

$I_2 = ?$

$I_3 = ?$

Solution

(a) $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$

$\frac{1}{R} = \frac{1}{20} + \frac{1}{40} + \frac{1}{50}$

$\frac{1}{R} = \frac{10+5+4}{200} = \frac{19}{200}$

$\boxed{R = 10.52\Omega}$

(b) $I_1 = \frac{V}{R_1} = \frac{50}{20} = 2.5\,A$

$I_2 = \frac{V}{R_2} = \frac{50}{40} = 1.25\,A$

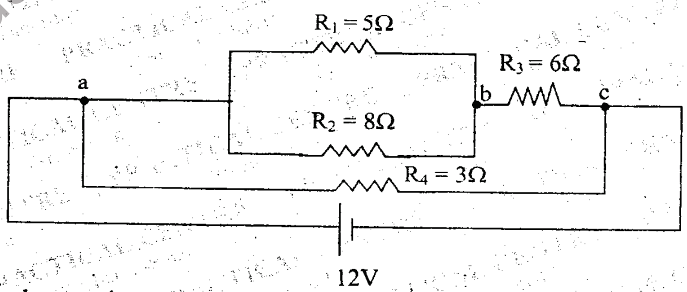
$I_3 = \frac{V}{R_3} = \frac{50}{50} = 1\,A$

Problem# 13.8 **(a) Find the equivalent resistance of the network shown below.**
(b) What is the current in 8Ω resistor if the potential difference of 12v is applied to the network.

Required:

(a) $R = ?$

(b) $I_2 = ?$



Solution:

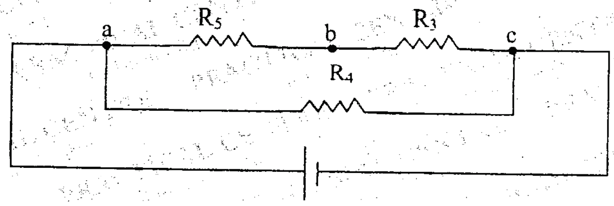
(a) Let R_5 be the equivalent resistance of R_1 and R_2 connected in parallel.

$\frac{1}{R_5} = \frac{1}{R_1} + \frac{1}{R_2}$

$\frac{1}{R_5} = \frac{1}{5} + \frac{1}{8}$

$\frac{1}{R_5} = \frac{13}{40}$

$R_5 = 3.08\Omega$

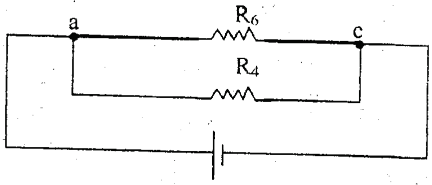


Let R_6 be the equivalent resistance of R_5 and R_3 connected in series.

$R_6 = R_5 + R_3$

$R_6 = 3.08 + 6$

$R_6 = 9.08\Omega$



Let R be the equivalent resistance of R_6 and R_4 connected in parallel.

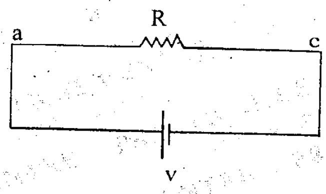
$$\frac{1}{R} = \frac{1}{R_6} + \frac{1}{R_4}$$

$$\frac{1}{R} = \frac{1}{9.08} + \frac{1}{3}$$

$$\frac{1}{R} = \frac{3+9.08}{27.04}$$

$$\frac{1}{R} = \frac{12.08}{27.24}$$

$$R = \frac{27.24}{12.08}$$



$R = 2.25\Omega$

(b) As R is the equivalent resistance of R_6 and R_4 connected in parallel, therefore,

$V_4 = V$

$V_6 = V$

$V_6 = 12V$

$$I_6 = \frac{V_6}{R_6} + \frac{12}{9.08} = 1.32A$$

As R_6 is the equivalent resistance of R_5 and R_3 connected in series therefore,

$I_3 = I_6$

$I_5 = I_6$

$I_5 = 1.32A$

$V_5 = I_5 R_5 = 1.32 \times 3.08 = 4.07V$

As R_5 is the equivalent resistance of R_1 and R_2 connected in parallel, therefore,

$V_1 = V_5$

$V_2 = V_5$

$V_2 = 4.07V$

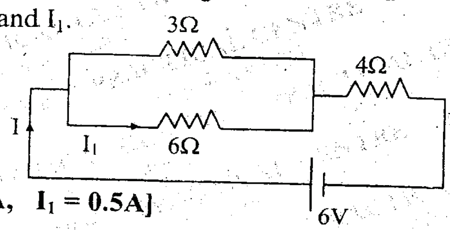
$$I_2 = \frac{V_2}{R_2} = \frac{4.07}{8} \rightarrow \boxed{I_2 = 0.51\ A}$$

Self Test# (5):

Q. Neglecting the internal resistance of D.C. Source find: **(1996)**

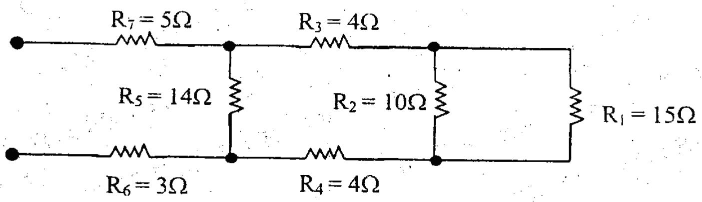
(i) the equivalent resistance of the given circuit and

(ii) the currents I and I_1.



Ans. [$R = 6\Omega$, $I = 1.5A$, $I_1 = 0.5A$]

Problem# 13.9: A 60V potential difference is applied to the circuit shown below. Find the current in 10 Ω resistance.



Required:

$I_2 = ?$

Solution:

Let R_8 be the equivalent resistance of R_1 and R_2 connected in parallel.

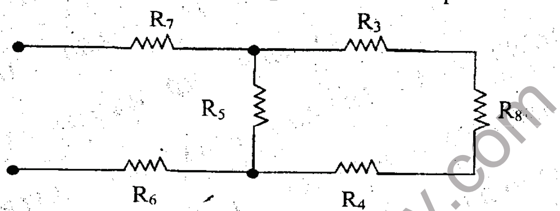
$$\frac{1}{R_8} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{R_8} = \frac{1}{15} + \frac{1}{10}$$

$$\frac{1}{R_8} = \frac{2+3}{30}$$

$$\frac{1}{R_8} = \frac{30}{5}$$

$$\boxed{R_8 = 6\Omega}$$

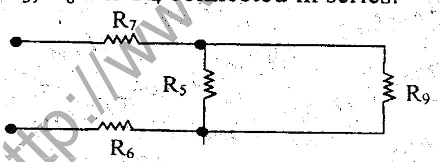


Let R_9 be the equivalent resistance of R_3, R_8 and R_4 connected in series.

$$R_9 = R_3 + R_8 + R_4$$

$$R_9 = 4 + 6 + 4$$

$$\boxed{R_9 = 14\Omega}$$



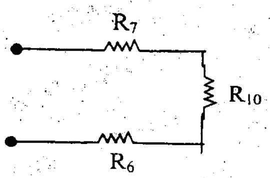
Let R_{10} be the equivalent resistance of R_5 and R_4 connected in parallel.

$$\frac{1}{R_{10}} = \frac{1}{R_5} + \frac{1}{R_9}$$

$$\frac{1}{R_{10}} = \frac{1}{14} + \frac{1}{14}$$

$$\frac{1}{R_{10}} = \frac{2}{14}$$

$$\boxed{R_{10} = 7\Omega}$$

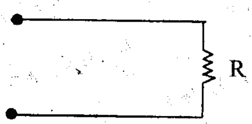


Let R be the equivalent resistance of R_7, R_{10} and R_6 connected in series.

$$R = R_7 + R_{10} + R_6$$

$$R = 5 + 7 + 3$$

$$\boxed{R = 15\Omega}$$



$$I = \frac{V}{R} = \frac{60}{15} = 4A$$

As R is the equivalent resistance of R_7, R_{10} and R_6 connected in series, therefore,

$$I_{10} = I = 4A$$

$$V_{10} = I_{10} R_{10} = 4 \times 7 = 28V$$

As R_{10} is the equivalent resistance of R_9 and R_5 connected in parallel, therefore,

$$V_9 = V_{10}$$
$$V_9 = 28V$$
$$I_9 = \frac{V_9}{R_9} = \frac{28}{14} = 2A$$

As R_9 is the equivalent resistance of R_3, R_8 and R_4 connected in series, therefore,

$$I_8 = I_9 = 2A$$
$$V_8 = I_8R_8 = 2 \times 6 = 12V$$

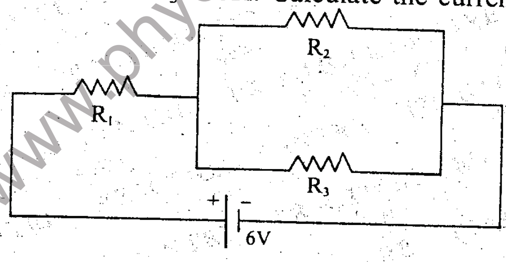
As R_8 is the equivalent resistance of R_1 and R_2, connected in parallel, therefore,

$$V_2, = V_8 = 12V$$
$$I_2 = \frac{V_8}{R_8} = \frac{12}{10}$$
$$\boxed{I_2 = 1.2\,A}$$

Self Test# (6):

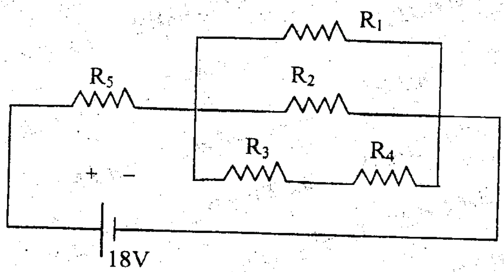
Q.1 In the given diagram $R_1 = R_2 = 4\Omega$ and $R_3 = 6\Omega$. Calculate the current the 6Ω resistor. **(2009)**

Ans. **[$I_3 = 0.37A$]**



Q.2 Find the equivalent resistance and the current through R_3 and R_4. **(2001)**

$R_1 = 20\Omega$
$R_2 = 30\Omega$
$R_3 = 20\Omega$
$R_4 = 40\Omega$
$R_5 = 10\Omega$



Ans. **[$R = 20\Omega$, $I_3 = 0.15A$, $I_6 = 0.15A$]**

Problem# 13.10: A source of what potential difference is needed to charge a battery of 20V e.m.f and internal resistance of 0.1Ω at the rate of 70A.

Data:

$V = P$
$E = 20V$
$R = 0.1\Omega$
$I = 70\ A$

Solution:

$$V = E + Ir$$
$$V = 20 + 70 \times 0.1$$
$$V = 20 + 7$$
$$\boxed{V = 27V}$$

Problem# 13.11: A battery of e.m.f 24v is connected to 10Ω load and a current of 2.2 amp flows in it. Find the internal resistance of the battery and its terminal voltage.

Data:

$E = 24V$

$R = 10\Omega$

$I = 2.2A$

$R = ?$

$V = ?$

Solution:

$V = IR$

$V = 2.2 \times 10$

$V = 22V$

$E = V + Ir$

$Ir = E - V$

$r = \frac{E - V}{I}$

$r = \frac{24 - 22}{2.2}$

$r = \frac{2}{2.2}$

$r = 0.9\Omega$

Self Test# (7):

Q. A battery of 24V is connected to a 10Ω load and current of 2.2A is drawn. Find the internal resistance of the battery and its terminal voltage. **(2002 P.M)**

Ans. [V = 22V, r = 0.9Ω]

Problem# 13.12: A 40 Ω resistor is to be wound with platinum wire 0.1mm in diameter. How much wire is needed?

Data:

$R = 40\Omega$

$d = 0.1mm = 1 \times 10^{-4}m$

$\rho = 11 \times 10^{-8}\Omega m$

$L = ?$

Solution:

$R = \frac{\rho L}{A}$

OR $L = \frac{RA}{\rho}$

$L = \frac{R\pi r^2}{\rho}$

$L = \frac{40 \times 3.14 \times (5 \times 10^{-5})^2}{11 \times 10^{-8}}$

$\boxed{L = 2.85m}$

Self Test# (8):

Q.1 A 50 ohm resistor is required from a copper wire, 0.2mm in diameter. What is the length of the wire needed? ($\rho = 1.6 \times 10^{-8}\ \Omega$–m). **(2006)**

Ans. [L = 98.125m]

Q.2 A 50Ω resistor is to be wound with platinum wire 0.1mm in diameter. How much wire is needed. ($\rho = 11 \times 10^{-8} \Omega m$). **(2003 P.E)**

Ans. [L = 3.6m]

Q.3 A platinum wire of diameter 0.2mm is wound to make a resistor of 40Ω. How long a wire is needed for this purpose? ($\rho = 11 \times 10^{-8}\ \Omega m$) **(1995)**

Ans. [L = 11.4m]

Problem# 13.13: The battery of a Pocket calculator supplies 0.35A at a p.d of 6 volts. What is the power of the calculator?

Data:

I = 0.35A
V = 6V
P = ?

Solution:

P = VI
P = 6 x 0.35
P = 2.1W

Problem# 13.14: A current of 5A through a battery is maintained for 30 sec and in this time 600 J of chemical energy is transferred into electrical energy.

(a) What is the e.m.f of the battery?

(b) How much electrical power is available for heating and other uses?

Data:

I = 5A
t = 30 sec
E = 600J
(a) e.m.f = ?
(b) p = ?

Solution:

(a) If internal resistance of circuit is ignored, then

e.m.f = V

E = VIt

OR $V = \frac{E}{It}$

OR $e.m.f = \frac{E}{It}$

$e.m.f = \frac{600}{5 \times 30}$

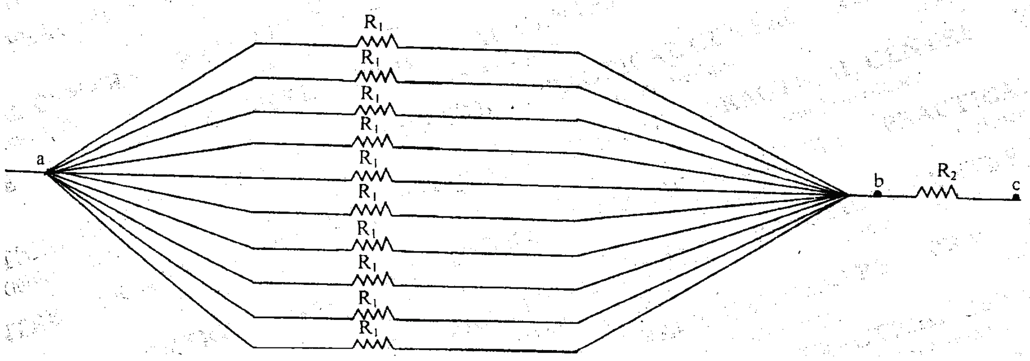
e.m.f = 4V

p = VI

p = 4 x 5

P = 20W

Problem# 13.15 A resistor of 12Ω is connected in series with a parallel combination of 10 resistors, each of 200Ω. What is the net resistance of the circuit?



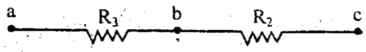
Data:

Resistance of each of parallel resistor, $R_1 = 200\Omega$
Number of parallel resistors, $n = 10$
Resistance of series resistor, $R_2 = 12\Omega$
Equivalent resistance, $R = ?$

Solution:

Let R_3 be the equivalent resistance of 10 parallel resistors

$$\frac{1}{R_3} = 10\frac{1}{R_1}$$



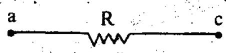
$$\frac{1}{R_3} = 10 \times \frac{1}{200}$$

$$R_3 = 20\Omega$$

Let R be the equivalent resistance of R_3 and R_2 connected in series.

$$R_1 = R_3 + R_2$$

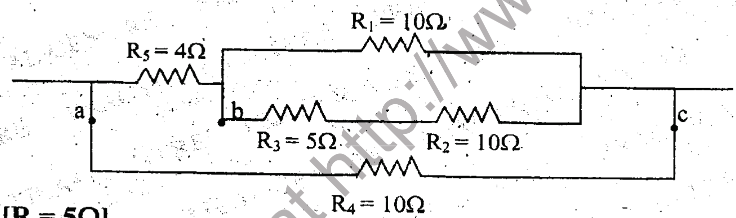
$$R = 20 + 12$$



$$\boxed{R = 32\Omega}$$

Self Test# (9):

Q. Calculate the equivalent resistance of the given circuit. **(1993)**



Ans. **[$R = 5\Omega$]**

Problem# 13.16: Three equal resistance each of 12Ω can be connected in four different ways. What is the equivalent resistance of each combination?

Solution:

(i) When all are in series combination.

$$R = R_1 + R_2 + R_3$$

$$R = 12 + 12 + 12$$

$$\boxed{R = 36\Omega}$$

(ii) When all are in parallel combination.

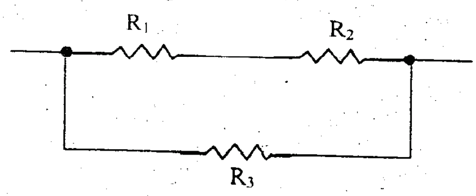
$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R} = \frac{1}{12} + \frac{1}{12} + \frac{1}{12}$$

$$\frac{1}{R} = \frac{3}{12}$$

$$\boxed{R = 4\Omega}$$

(iii) When two in series and one in parallel

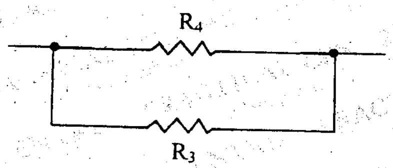


Let R_4 be the equivalent resistance of R_1 and R_2 connected in series.

$R_4 = R_1 + R_2$

$R_4 = 12 + 12$

$R_4 = 24\Omega$



Let R be the equivalent resistance of R_4 and R_3 connected in parallel.

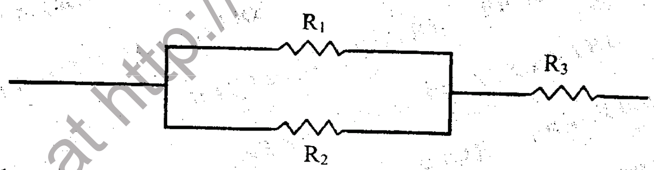
$$\frac{1}{R} = \frac{1}{R_4} + \frac{1}{R_3}$$

$$\frac{1}{R} = \frac{1}{24} + \frac{1}{12}$$

$$\frac{1}{R} = \frac{3}{24}$$

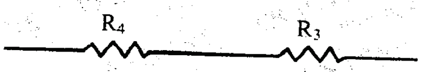
$$\boxed{R = 8\Omega}$$

(iv) When two in parallel and one in series.



Let R_4 be the equivalent resistance of R_1 and R_2 connected in parallel.

$$\frac{1}{R_4} = \frac{1}{R_1} + \frac{1}{R_2}$$



$$\frac{1}{R_4} = \frac{1}{12} + \frac{1}{12}$$

$$R_4 = \frac{2}{12}$$

$R_4 = 6\Omega$

Let R be the equivalent resistance of R_4 and R_3 connected in series.

$R = R_4 + R_3$

$R_1 = 6 + 12$

$$\boxed{R = 18\Omega}$$

Problem# 13-17 **Find the resistance at 50°C of a copper wire 2mm in diameter and 3m long.**

Data:

$R_T = ?$

$T = 50^\circ C$

$d = 2mm = 2 \times 10^{-3} m$

$L = 3m$

$\rho = 1.6 \times 10^{-8} \Omega m$

$\alpha = 0.0039\ (^\circ C)^{-1}$

Solution:

$$R_o = \frac{\rho L}{A}$$

$$R_o = \frac{\rho L}{\pi r^2}$$

$$R_o = \frac{1.6 \times 10^{-8} \times 3}{3.14 \times (1 \times 10^{-3})^2}$$

$R_o = 0.0153\Omega$

Determination of R_T

$R_T = R_o \{1 + \alpha\Delta T\}$

$\Delta T\ 50^\circ C = 50K$

$R_T = 0.0153\ \{1 + 0.0039 \times 50\}$

$R_T = 0.0153\ \{1 + 0.195\}$

$\boxed{R_T = 0.0183\Omega}$

Self Test# (10):

Q. A resistor is made by using a 50 metre nichrome wire of diameter 0.8mm at 0°C. Calculate its resistance at 50°C. (Given: Resistivity $\rho = 1.1 \times 10^{-6}\ \Omega - m$ and $\alpha = 0.0002^\circ C^{-1}$ at 0°C) **(2009)**

Ans. **[$R_{50} = 109.9\Omega$]**

Problem# 13.18: **The resistance of a tungsten wire used in the filament of a 60W bulb is 240Ω when the bulb is hot at a temperature of 2020°C. What would you estimate its resistance at 20°C?**

Data:

at $T = 2020^\circ C$

$R = 240\Omega$

at $T = 20^\circ C$

$R = ?$

$\alpha = 0.0046\ ^\circ C^{-1}$

Solution:

Determination of R_o from resistance of 2020°C.

$\Delta T = 2020\ ^\circ C = 2020\ K$

$R_T = R_o \{1 + \alpha\Delta T\}$

$$Ro = \frac{R_T}{1 + \alpha\Delta T}$$

$$Ro = \frac{240}{1 + 0.0046 \times 2020}$$

$R_o = 23.32\Omega$

Determination resistance at 20°C from R_o.

$\Delta T = 20\ ^\circ C = 20\ K$

$R_T = R_o \{1 + \alpha\Delta T\}$

$R_T = 23.32\ \{1 + 0.0046 \times 20\}$

$\boxed{R_T = 25.5\Omega}$

Problem# 13.19: **A water heater that will deliver 1kg of water per minute is required. The water is supplied at 20°C and an output temperature of 80°C is desired. What should be the resistance of the heating element in the water if the line voltage is 220 volts.**

Data:

$m = 1\ kg$
$t = 1\ min = 60\ sec$
$T = 20°C$
$T_2 = 80°C$
$V = 220V$
$R = ?$
$C = 4200 J/kg\text{-}k$

Solution:

$$\Delta T = 80 - 20$$

$$\Delta T = 60°C = 60K$$

According to the law of conservation of energy.
Electrical energy = specific heat capacity of water

$$\frac{V^2 t}{R} = mc\Delta T$$

$$R = \frac{V^2 t}{mc\Delta T}$$

$$R = \frac{(220)^2 x\, 60}{1 x\, 4200 x\, 60}$$

$$\boxed{R = 11.5\Omega}$$

Problem# 13.20: **Prove that the rate of heat production in each of the two resistors connected in parallel is inversely proportional to the resistances.**

Required:

$$P \propto \frac{1}{R}$$

Proof:

Let us consider two resistors of resistance R_1 and R_2 are connected in parallel with a source of voltage V.

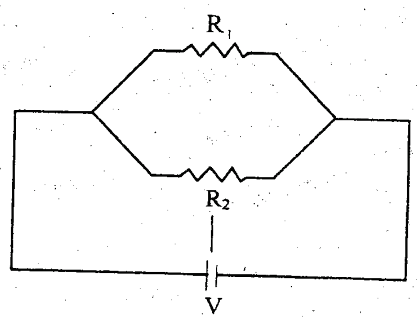
Rate of heat produced in $R_1 = P_1 = \frac{V^2}{R_1}$ -------------- (1)

Rate of heat produced in $R_2 = P_2 = \frac{V^2}{R_2}$ -------------- (2)

By dividing eq (1) with eq (2), we get

$$\frac{P_1}{P_2} = \frac{\frac{V^2}{R_1}}{\frac{V^2}{R_2}}$$

$$\frac{P_1}{P_2} = \frac{R_2}{R_1} \implies P \propto \frac{1}{R}$$



Problem# 13.21: **A 240V cloth dryer draws a current of 15amp. How much energy in kwh and joule does it use in 45 minutes operation. How much will be the cost if the rate per unit is Rs. 1.45.**

Data:

V = 240V
I = 15A
t = 45 min
E in Joule = ?
E in kwh = ?
Rate per unit = Rs 1.45
Cost = ?

Solution:

Energy in Joule = VIt
E = 240 x 15 x 45 x 60
$\boxed{E = 9.72 \times 10^6 J}$
As 1 kwh = 3.6 x 10^6J

$$\text{Energy in kwh} = \frac{\text{Energy in Joule}}{3.6 \times 10^6}$$

$$E = \frac{9.72 \times 10^6}{3.6 \times 10^6}$$

$\boxed{E = 2.7 \text{ kwh}}$
Cost of energy = 2.7 x 1.45
$\boxed{\text{Cost of energy = Rs 3.91}}$

Self Test# (11):

Q. If the electrical energy cast Rs. 1.50 per unit (KWh) how much does it cast to operate 500 watt electrical kettle for 30 minutes?

Ans. **[Cast = Rs. 0.37 = 37 Paisas]**

Problem# 13.22: **A resistance is made by winding on a spool 40m length of constantan wire of diameter 0.8mm. Calculate the resistance of the wire at (i) 0°C (ii) 50°C.**

Data:

L = 40m
d = 0.8mm = 8 x 10^{-4}m
(i) R_o = ?
(ii) T = 50°C
R_T = ?
α = 0.00001 $°C^{-1}$
ρ = 49x10^{-8} Ω m

Solution

$$R_o = \frac{\rho L}{A}$$

$$R_o = \frac{\rho L}{\pi r^2}$$

$$R_o = \frac{49 \times 10^{-8} \times 40}{3.14 \times (4 \times 10^{-4})^2}$$

$\boxed{R_o\ 39.01\Omega}$

(ii) $R_T = R_o = \{1 + \alpha\Delta T\}$
ΔT = 50°C = 50 k

(ii) $R_o = \frac{\rho L}{A}$

$$R_o = \frac{\rho L}{\pi r^2}$$

R_T = 39.01 {1 + 0.00001 x 50}
R_T = 39.01 { 1 + 0.0005 }
$\boxed{R_T = 39.03\Omega}$

Self Test# (12):

Q. A rectangular bar of iron 2cm x 2cm in cross-section and 20cm long what is the resistance of the bar at 500°C if ρ = 11 x 10^{-8} Ω and α = 0.0025K^{-1}. **(2011)**

Ans. **[R_o = 5.5 x 10^{-5} Ω, R_{500} = 1.2375 x 10^{-4} Ω]**

13.14 EXTRA NUMERICALS:

Two resistors of 5Ω and 2Ω are connected in parallel combination with a 9VoH battery. Calculate the current and power dissipated in each resistance. **(2008)**

DATA:

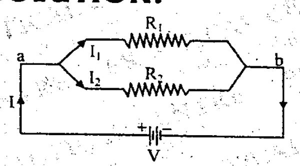
$R_1 = 5\Omega \quad R_2 = 2\Omega$

$V = 9VoH$

(a) $I_1 = ?$ $\quad I_2 = ?$

(b) $P_1 = ?$ $\quad P_2 = ?$

SOLUTION:



Using:

$V = IR$

$\therefore \quad I = \frac{V}{R}$ ——(1)

Since combination is parallel

$V_1 = V_2 = V$

Now

$I_1 = \frac{V}{R_1} = \frac{9}{5}$

$\boxed{I_1 = \frac{9}{5}\text{amp} = 1.8\text{amp}}$

Also

$I_2 = \frac{V}{R_2} = \frac{9}{2}$

$\boxed{I_2 = 4.5\text{amp}}$

As $P = VI$

$P_1 = VI_1$

$P_1 = 9 \times \frac{9}{5}$

$\boxed{P_1 = \frac{81}{5}\text{watt}}$

OR $\boxed{P_1 = 16.2 \text{ watt}}$

Also $P_2 = VI_2$

$P_2 = 9 \times 4.5$

$\boxed{P_2 = 40.5 \text{ watt}}$

Q.1) A rectangular block of Iron has the dimension 1.2cm x 1.2cm x 15cm. **(2008)**

(i) What is the resistance of the opposing square ends?

(ii) What is the resistance between two of the rectangular faces?

(Resistivity for Iron $\rho = 9.6 \times 10^{-8}\ \Omega m$)

DATA:

Dimension of rectangular block = 1.2cm x 1.2cm x 15cm

= 0.012m x 0.012m x 0.15m

Resistivity of Iron = $\rho = 9.6 \times 10^{-8}\ \Omega m$

(i) Resistance between square ends $= R_1 = ?$

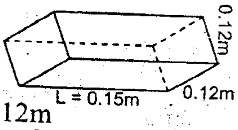
(ii) Resistance between rectacgular face $= R_2 = ?$

SOLUTION:

As we know that

$$R = \rho \frac{L}{A} \quad \text{———} (1)$$

(i) For "R_1"



$L = 0.15m$

$A = 0.012 \times 0.012m$

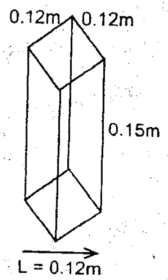
$= 1.44 \times 10^{-4}\ m^2$

$$\therefore (1) \Rightarrow R_1 = 9.6 \times 10^{-8} \frac{0.15}{1.44 \times 10^{-4}}$$

$$R_1 = \frac{1.44 \times 10^{-8}}{1.44 \times 10^{-4}}$$

$$\boxed{R_1 = 1 \times 10^{-4}\ \Omega = 100\ \mu\Omega}$$

(ii) For "R_2"



$L = 0.012m$

$A = 0.012m \times 0.15m$

$= 1.8 \times 10^{-3}\ m^2$

$$\therefore (1) \Rightarrow R_2 = 9.6 \times 10^{-8} \frac{0.012}{1.8 \times 10^{-3}}$$

$$R_2 = \frac{1.152 \times 10^{-9}}{1.8 \times 10^{-3}}$$

$$\boxed{R_2 = 6.4 \times 10^{-7}\ \Omega = 0.64\ \Omega}$$

Q.2 Two resistance of 10Ω and 50Ω are connected in series with a 6 Volt battery. Calculate **(2005)**

(i) The charge drawn from the battery per minute.

(ii) The power dissipate in 10Ω resistance.

DATA:

$R_1 = 10\Omega$

$R_2 = 50\Omega$

$V = 6$ Volt

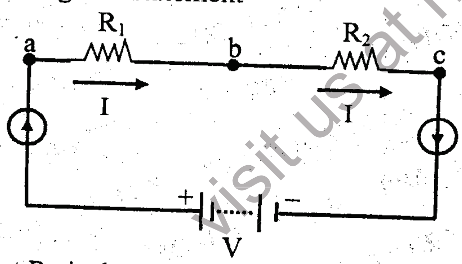
(i) $t = 1$ minute $= 60$ sec

$q = ?$

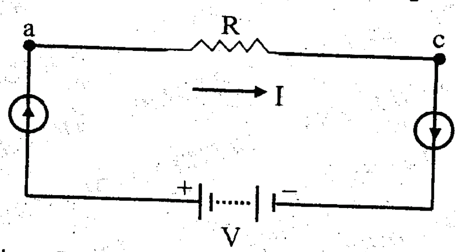
(ii) Power dissipation in $10\Omega = P_1 = ?$

SOLUTION:

From given statement



Let Re is the equivalent of R_1 and R_2



Since R_1 and R_2 are in series

$R = R_1 + R_2$

$R = 10 + 50$

$R = 60\Omega$ ———(1)

Using Ohm's Law

$V = IR$

$$I = \frac{V}{R} = \frac{6}{60}$$

$I = 0.1$ Amp ——— (2)

(i) **For "q"**

As we know that

$q = I\,t$

$q = 0.1 \times 60$

$\boxed{q = 6\ \text{Coul/min}}$

(ii) **For Power dissipation**

Since R_1 and R_2 both are in series therefore current in R_1 and R_2 is similar i.e.

$I_1 = I_2 = I = 0.1$ Amp.

Using

$P = I^2R$

OR $P_1 = I_1^2 R_1 = (0.1)^2 \times 10$

$P_1 = 0.01 \times 10$

$\boxed{P_1 = 0.1\ \text{Watt}}$

Q.3 You are given three resistors each of 2 ohms. How would you arrange these resistors to obtain the equivalent resistances of (i) 0.67Ω (ii) 3Ω (iii) 6Ω? Also provide the result mathematically. **(2004)**

SOLUTION:

(i) When all are connected in parallel.

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

$$\frac{1}{R} = \frac{1}{2} + \frac{1}{2} + \frac{1}{2}$$

$$\frac{1}{R} = \frac{3}{2}$$

$$\boxed{R = 0.67\Omega}$$

(ii) When two are connected in parallel and third in series.

$$\frac{1}{R_4} = \frac{1}{R_1} + \frac{1}{R_2}$$

$$\frac{1}{R_4} = \frac{1}{2} + \frac{1}{2}$$

$$R_4 = 1\Omega$$

$$R = R_4 + R_3$$

$$R = 1 + 2$$

$$\boxed{R = 3\Omega}$$

(iii) When all are connected in series

$$R = R_1 + R_2 + R_3$$

$$R = 2 + 2 + 2$$

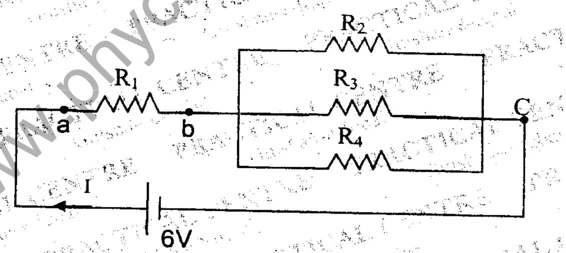
$$\boxed{R = 6\Omega}$$

Q.4 Find the equivalent resistance in the given circuit, current I and potential difference between a and b. **(2003 P.M)**

DATA:

$R_1 = 5\Omega$, $R_2 = 2\Omega$

$R_3 = 3\Omega$, $R_4 = 6\Omega$



SOLUTION:

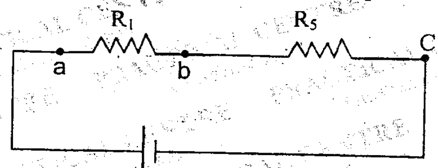
Let R_5 be the equivalent resistance of R_2, R_3 and R_4 connected in parallel.

$$\frac{1}{R_5} = \frac{1}{R_2} + \frac{1}{R_3} + \frac{1}{R_4}$$

$$\frac{1}{R_5} = \frac{1}{2} + \frac{1}{3} + \frac{1}{6}$$

$$\frac{1}{R_5} = \frac{6}{6}$$

$$R_5 = 1\Omega$$

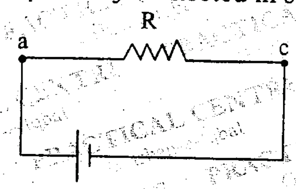


Let R be the equivalent resistance of R_1 and R_5 connected in series.

$$R = R_1 + R_5$$

$$R = 5 + 1$$

$$\boxed{R = 6\Omega}$$



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

$$\boxed{I = 1A}$$

$$V_{ab} = V_1 = I_1R_1$$

$$V_{ab} = 1x5$$

$$\boxed{V_{ab} = 5V}$$