UDAAN 3.0

PHYSICS

ELECTRICITY

ONE SHOT

Lecture No.- 05

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Today's Targets

1 NCERT DISCUSSION

Page No. 200 (INTEXT Q.1)

What does an electric circuit mean?

→ refer Notes

Page No. 200 (INTEXT Q.2)

Define the unit of current.

→ Ampere = $\frac{\text{Coulomb}}{\text{Second}}$

When 1C of charge is transferred in 1 sec
Current is said to be 1A.

Page No. 200 (INTEXT Q.3)

Calculate the number of electrons constituting one coulomb of charge.

n $\qquad$ $Q = 1C$

$$Q = ne$$

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

$$n = \frac{1}{1.6 \times 10^{-19}} = \frac{10 \times 10^{19}}{16} = \frac{625 \times 10^{18}}{100} = 6.25 \times 10^{18}$$

6.25×10^{18} → $1C$

Page No. 202 (INTEXT Q.1)

Name a device that helps to maintain a potential difference across a conductor.

→ Battery

Page No. 202 (INTEXT Q.2)

What is meant by saying that the potential difference between two points is 1 V?

$$V = \frac{W}{Q}$$

$$1V = \frac{1J}{1C}$$

When 1J of work is done on 1C of charge, p.d. is 1V.

Page No. 202 (INTEXT Q.3)

How much energy is given to each coulomb of charge passing through a 6 V battery?

$V = 6V$

$Q = 1C$

$W = E = ?$

$V = \frac{W}{Q}$

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

$W = 6J$ ✓

Page No. 209 (INTEXT Q.1)

On what factors does the resistance of a conductor depend?

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

1) length (l) ↑ R↑

2) Cross-sectional Area (A) ↑ R↓

3) Material ρ↑ R↑

4) Temperature ↑ R↑

Page No. 209 (INTEXT Q.2)

A↑ A↓

Will current flow more easily through a thick wire or a thin wire of the same material, when connected to the same source? Why?

ρ

V

⇒ I↑ $R\downarrow = \rho \frac{\ell}{A\uparrow}$

Thick wire has more cross-sectional Area, its Resistance with the same voltage source is less and current flows more easily

A↑ R↓ V = same I↑

Page No. 209 (INTEXT Q.3)

Let the resistance of an electrical component remains constant while the potential difference across the two ends of the component decreases to half of its former value. What change will occur in the current through it?

R = Constant

$V = V$

$I = I$

$V = IR$

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

$V' = \frac{V}{2}$

$I' = ?$

R = Const.

$V' = I'R$

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

$\frac{V}{2} = I' \frac{V}{I}$

$\frac{I}{2} = I'$ Amp

Page No. 209 (INTEXT Q.4)

Why are coils of electric toasters and electric irons made of an alloy rather than a pure metal?

Homogenous Mixture of Metals & Non-Metals

⇒ Nichrome Alloy

$\rho \uparrow$ $R \uparrow$ $H \uparrow$

Page No. 209 (INTEXT Q.5)

H.W.

Use the data in Table 12.2 to answer the following –

(a) Which among iron and mercury is a better conductor?

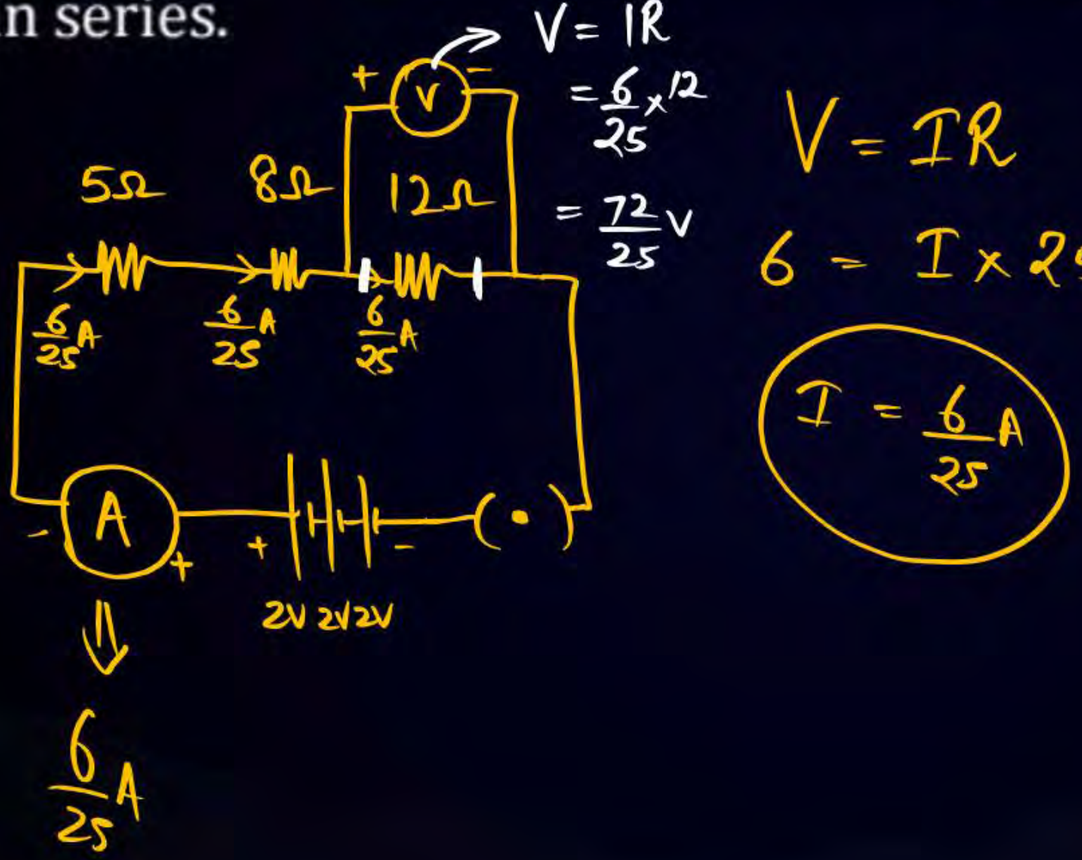
(b) Which material is the best conductor?

$\rho \downarrow$

$\rho \downarrow\downarrow$

Page No. 213 (INTEXT Q.1)

Draw a schematic diagram of a circuit consisting of a battery of three cells of 2 V each, a 5 Ω resistor, an 8 Ω resistor, and a 12 Ω resistor, and a plug key, all connected in series.



$V = IR$

$6 = I \times 25$

$I = \frac{6}{25}\,A$

Page No. 213 (INTEXT Q.2)

Redraw the circuit of Question 1, putting in an ammeter to measure the current through the resistors and a voltmeter to measure the potential difference across the 12 Ω resistor. What would be the readings in the ammeter and the voltmeter?

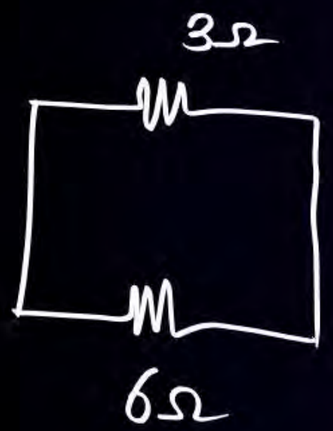
P.T.P.

Page No. 216 (INTEXT Q.1)

Judge the equivalent resistance when the following are connected in parallel –

(a) 1 Ω and 10^6 Ω, (b) 1 Ω and 10^3 Ω, and 10^6 Ω.

≈ 1Ω ≈ 1Ω



≡ 2Ω

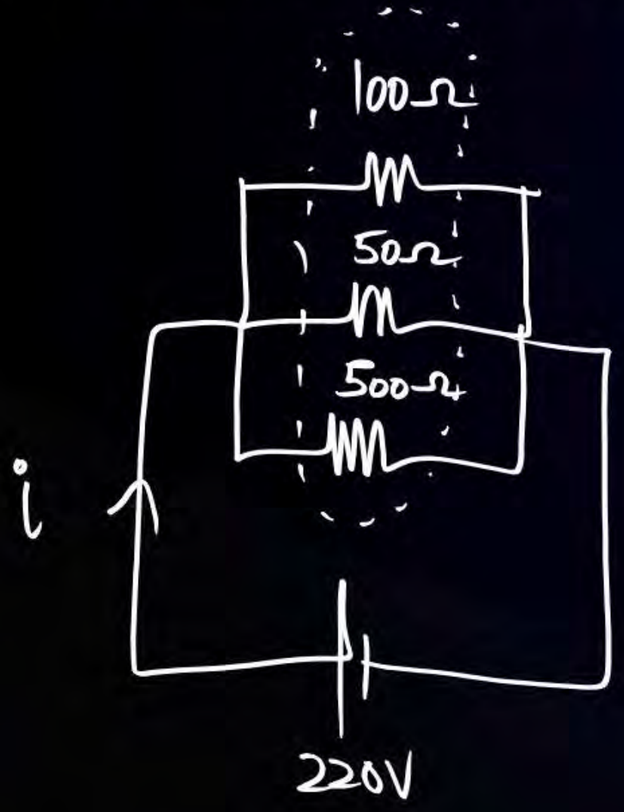
$$\frac{1}{R_t} = \frac{1}{2} + \frac{1}{3} + \frac{1}{6}$$

$$\frac{1}{R_t} = \frac{3+2+1}{6} = \frac{6}{6} \Rightarrow 1$$

$R_t = 1\Omega$

Page No. 216 (INTEXT Q.2)

An electric lamp of 100 Ω, a toaster of resistance 50 Ω, and a water filter of resistance 500 Ω are connected in parallel to a 220 V source. What is the resistance of an electric iron connected to the same source that takes as much current as all three appliances, and what is the current through it?



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

$$\frac{1}{R} = \frac{1}{50} + \frac{1}{100} + \frac{1}{500}$$

$$= \frac{10 + 5 + 1}{500} = \frac{16}{500}$$

$R_t = \frac{500}{16}\ \Omega \Rightarrow I_{\text{iron}}$

Page No. 216 (INTEXT Q.3)

What are the advantages of connecting electrical devices in parallel with the battery instead of connecting them in series?

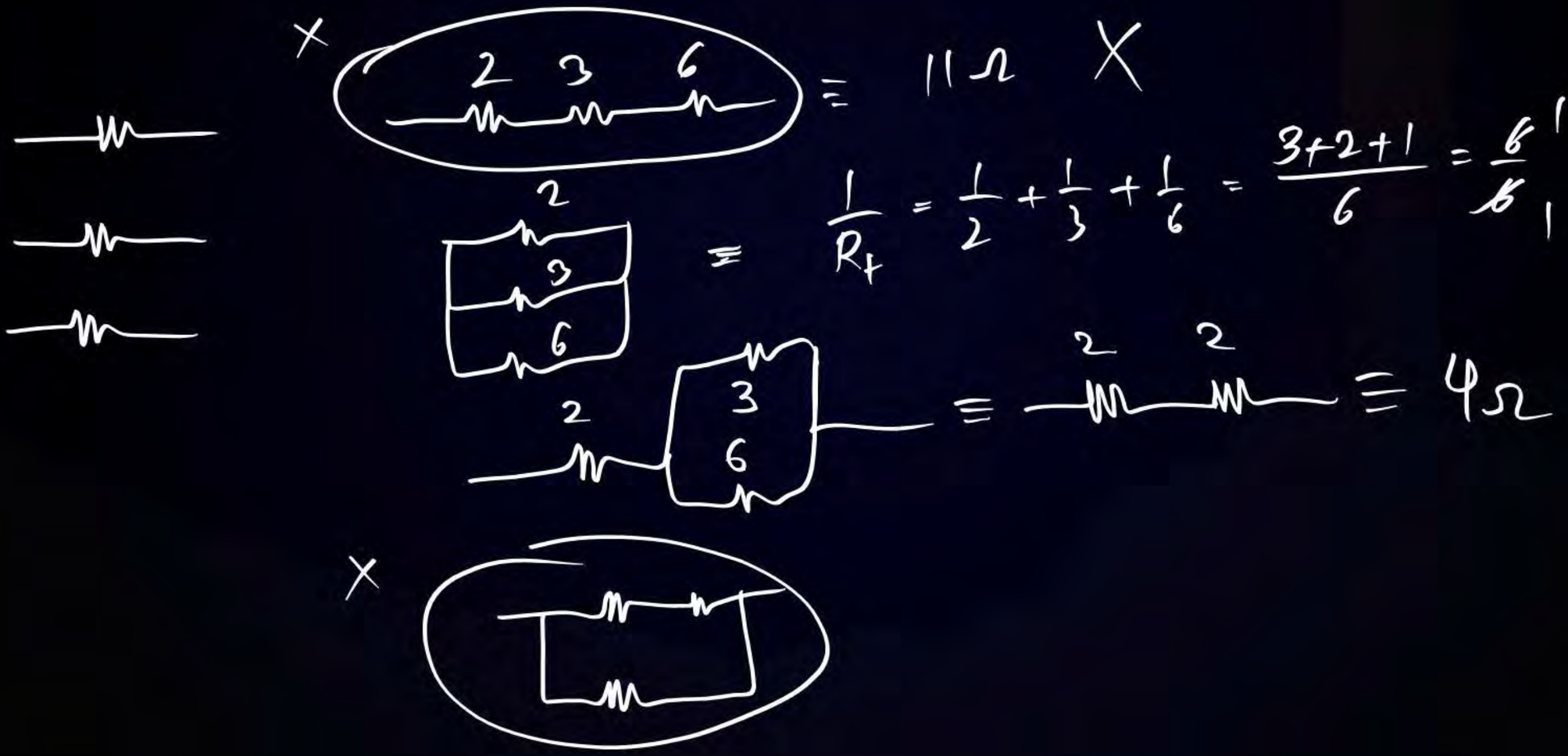
1) Voltage remains same, each appliance works on full efficiency.

2) Each appliance gets a separate switch.

3) If one appliance gets damaged, other works properly.

Page No. 216 (INTEXT Q.4)

How can three resistors of resistances 2 Ω, 3 Ω, and 6 Ω be connected to give a total resistance of (a) 4 Ω, (b) 1 Ω?



Page No. 216 (INTEXT Q.5)

What is (a) the highest, (b) the lowest total resistance that can be secured by combinations of four coils of resistance 4 Ω, 8 Ω, 12 Ω, 24 Ω?

a) $4\Omega + 8\Omega + 12\Omega + 24\Omega = 48\Omega$

Note :-

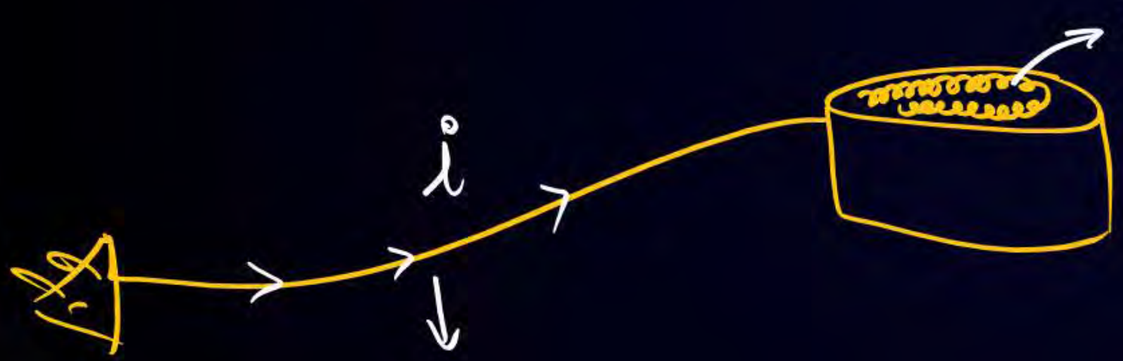
b) $$\frac{1}{R_p} = \frac{1}{4} + \frac{1}{8} + \frac{1}{12} + \frac{1}{24} = \frac{6+3+2+1}{24} = \frac{12}{24}\Omega$$

$$R_p = 2\Omega$$

Page No. 218 (INTEXT Q.1)

Why does the cord of an electric heater not glow while the ~~heating element~~ coil does?

Wire



Coil ⇒ Alloy (Nichrome)

⇓

$\rho \uparrow$ $R \uparrow$ $H \uparrow$

Pure metal ⇒ Cu $\rho \downarrow$ $R \downarrow$ $H \downarrow$

Page No. 218 (INTEXT Q.2)

Compute the heat generated while transferring 96000 coulomb of charge in one hour through a potential difference of 50 V.

$V = 50\,V$

$Q = 96000\,C$

$t = 1\,h$

$H = I^2Rt$

$H = \frac{V^2}{R}t$

$H = VIt$

$V = \frac{W}{Q}$

$W = QV$

$= 96000 \times 50$

$= \square\,J$

Page No. 218 (INTEXT Q.3)

M.W.

An electric iron of resistance 20 Ω takes a current of 5 A. Calculate the heat developed in 30 s.

Page No. 220 (INTEXT Q.1)

What determines the rate at which energy is delivered by a current?

'Electric Power'

Page No. 220 (INTEXT Q.2)

An electric motor takes 5 A from a 220 V line. Determine the power of the motor and the energy consumed in 2 h.

$I = 5A$

$V = 220V$

$P = ?$

$E = ?$

$t = 2h$

$P = VI$

$= 220 \times 5$

$P = 1100\ W$

$E = P \times t$

$= \frac{1100}{1000} \times 2h$

$= 1.1\ KW \times 2h$

$E = 2.2\ KWh$ Ans

Page No. 221 (INTEXT Q.1)

H.W. Notes

A piece of wire of resistance R is cut into five equal parts. These parts are then connected in parallel. If the equivalent resistance of this combination is R', then the ratio R/R' is –

(a) 1/25
(b) 1/5
(c) 5
(d) 25

Page No. 221 (INTEXT Q.2)

Which of the following terms does not represent electrical power in a circuit?

(a) I^2R

(b) IR^2

(c) VI

(d) V^2/R

$P = VI$

$P = I^2R$

$P = \frac{V^2}{R}$

Page No. 221 (INTEXT Q.3)

Imp.

An electric bulb is rated 220 V and 100 W. When it is operated on 110 V, the power consumed will be –

(a) 100 Ω
(b) 75 Ω
(c) 50 Ω
(d) 25 W

$P = 100W$

$V = 220V$

$P = \frac{V^2}{R}$

$R = \frac{V^2}{P} = \frac{(220)^2}{100}\Omega$

$P' = ?$

$V = 110V$

$R = \frac{(220)^2}{100}\Omega$

$P' = \frac{V^2}{R} = \frac{(110)^2}{\frac{(220)^2}{100}} = \frac{110 \times 110 \times 100}{220 \times 220} = 25W$

$P = VI$ ×

$P = \frac{V^2}{R}$ ✓

$P = I^2R$ ×

Page No. 221 (INTEXT Q.4)

H.W.

Two conducting wires of the same material and of equal lengths and equal diameters are first connected in series and then parallel in a circuit across the same potential difference. The ratio of heat produced in series and parallel combinations would be –

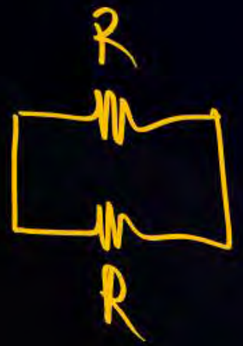
(a) 1 : 2

(b) 2 : 1

(c) 1 : 4

(d) 4 : 1

$\equiv 2R, V$



$\equiv \frac{R}{2}, V$

$H = I^2 R t$ X

$H = \frac{V^2}{R} t$

$H = VIt$ X

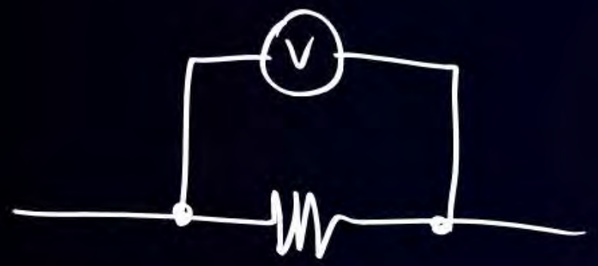
$\frac{H_s}{H_p} = \frac{\frac{V^2}{2R} \times t}{\frac{V^2}{\frac{R}{2}} \times t} = \frac{1}{2 \times 2} = \frac{1}{4}$

$H_s : H_p = 1 : 4$

Page No. 221 (INTEXT Q.5)

How is a voltmeter connected in the circuit to measure the potential difference between two points?

→ 'Parallel'



Page No. 221 (INTEXT Q.6)

$d \to 2d,\ r \to 2r,\ A \to 4A,\ R \Rightarrow \frac{R}{4}$

A copper wire has diameter 0.5 mm and resistivity of $1.6 \times 10^{-8}\ \Omega$ m. What will be the length of this wire to make its resistance 10 Ω? How much does the resistance change if the diameter is doubled?

$\to R = 10\Omega$

$d = 0.5\text{mm} \times 10^{-3}$

$r = \frac{0.5}{2} \times 10^{-3}\ m$

$A = \pi r^2$

$\to A = 3.14 \times \frac{0.5}{2} \times \frac{0.5}{2} \times 10^{-6}\ m^2$

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

$\to l = ?$

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

$\frac{RA}{\rho} = l$

$l = \frac{RA}{\rho} = \frac{16 \times 3.14 \times 0.5 \times 0.5 \times 10^{-6}}{16 \times 10^{-8}}$

$= \frac{12.5}{2} \times \frac{10^{-6}}{10^{-8}}$

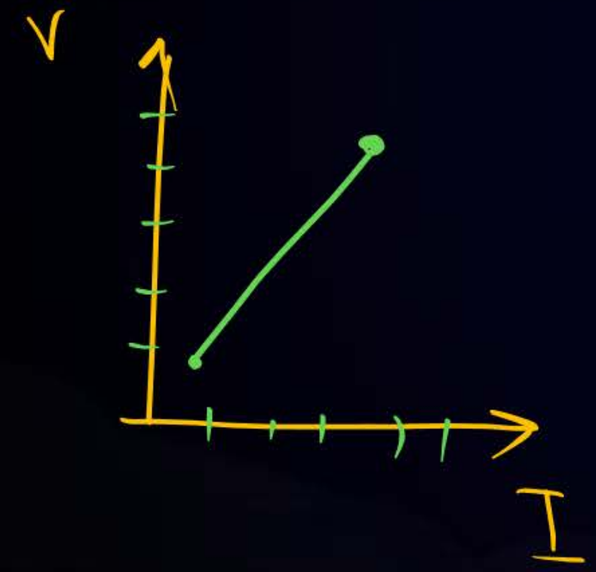
$= 12.5 \times 10^2 = 1250\text{m}$ ✓

Page No. 221 (INTEXT Q.7)

The values of current I flowing in a given resistor for the corresponding values of potential difference V across the resistor are given below –

I (amperes)	0.5	1.0	2.0	3.0	4.0
V (volts)	1.6	3.4	6.7	10.2	13.2

Plot a graph between V and I and calculate the resistance of that resistor.



$$\text{Slope } (V-I) = \frac{\Delta y}{\Delta x} = \frac{\Delta V}{\Delta I} = \frac{V_2 - V_1}{I_2 - I_1} = \frac{13.2 - 1.6}{4 - 0.5}$$

$$= (\quad)\ \Omega$$

Page No. 221 (INTEXT Q.8)

When a 12 V battery is connected across an unknown resistor, there is a current of 2.5 mA in the circuit. Find the value of the resistance of the resistor.

$V = 12\,V$

$I = 2.5\,mA = 2.5 \times 10^{-3}\,A$

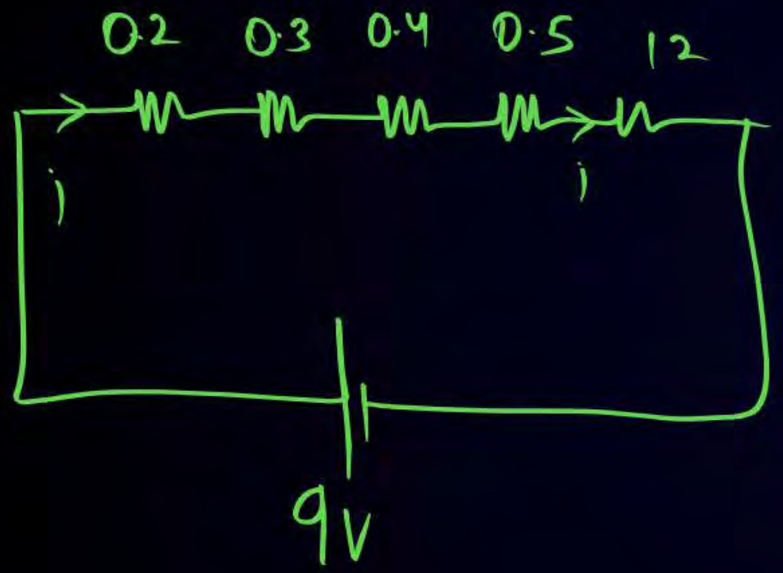
$R = ?$

$$R = \frac{V}{I} = \frac{12}{2.5 \times 10^{-3}} = \frac{12 \times 10^{3} \times 10}{25}$$

$$= \frac{12 \times 4 \times 100 \times 100}{25} = 4800\ \Omega$$

Page No. 221 (INTEXT Q.9)

A battery of 9 V is connected in series with resistors of 0.2 Ω, 0.3 Ω, 0.4 Ω, 0.5 Ω and 12 Ω, respectively. How much current would flow through the 12 Ω resistor?



$R_t = 13.4\ \Omega$

$V = 9V$

$i = \frac{V}{R} = \frac{9}{13.4}\ A$

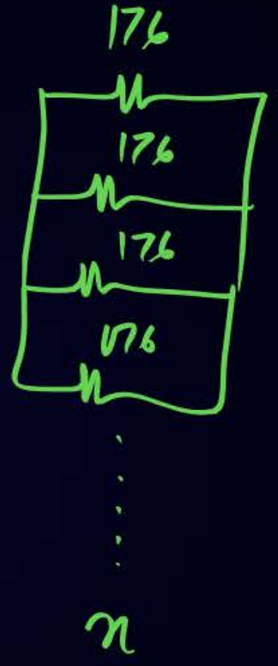
Page No. 221 (INTEXT Q.10)

How many 176 Ω resistors (in parallel) are required to carry 5 A on a 220 V line?

$V = 220V$

$i = 5A$

$R_t = \frac{V}{i} = \frac{220}{5} = 44\Omega$



$\frac{1}{R_t} = \frac{1}{176} + \frac{1}{176} + \frac{1}{176} \ldots n$

$\frac{1}{44} = \frac{n}{176}$

$\frac{176}{44} = n$

$n = 4$ Ans

Page No. 221 (INTEXT Q.11)

H.W.

Show how you would connect three resistors, each of resistance 6 Ω, so that the combination has a resistance of (i) 9 Ω, (ii) 4 Ω.

Page No. 221 (INTEXT Q.12)

Several electric bulbs designed to be used on a 220 V electric supply line, are rated 10 W. How many lamps can be connected in parallel with each other across the two wires of 220 V line if the maximum allowable current is 5 A?

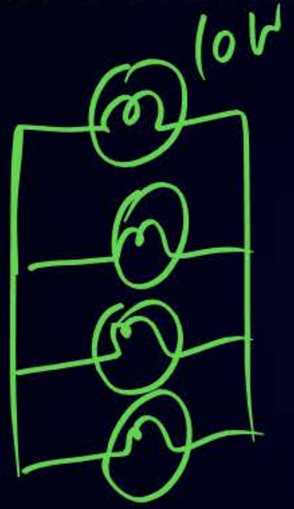
$V = 220V$

$i = 5A$

$P_t = Vi$

$= 220 \times 5$

$= 1100\ W$



$P_t = P + P + P \ldots n$

$1100 = 10 + 10 + 10 \ldots n$

$1100 = 10n$

$n = 110$ bulbs

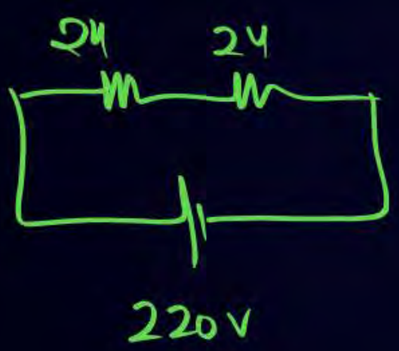
Page No. 221 (INTEXT Q.13)

A hot plate of an electric oven connected to a 220 V line has two resistance coils A and B, each of 24 Ω resistance, which may be used separately, in series, or in parallel. What are the currents in the three cases?

Case I

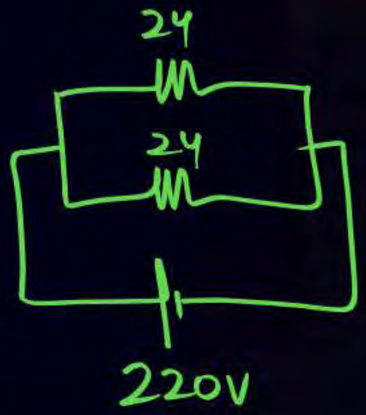
$$i = \frac{V}{R} = \frac{220}{24}\ A$$

Case II



$$i = \frac{220}{48}\ A$$

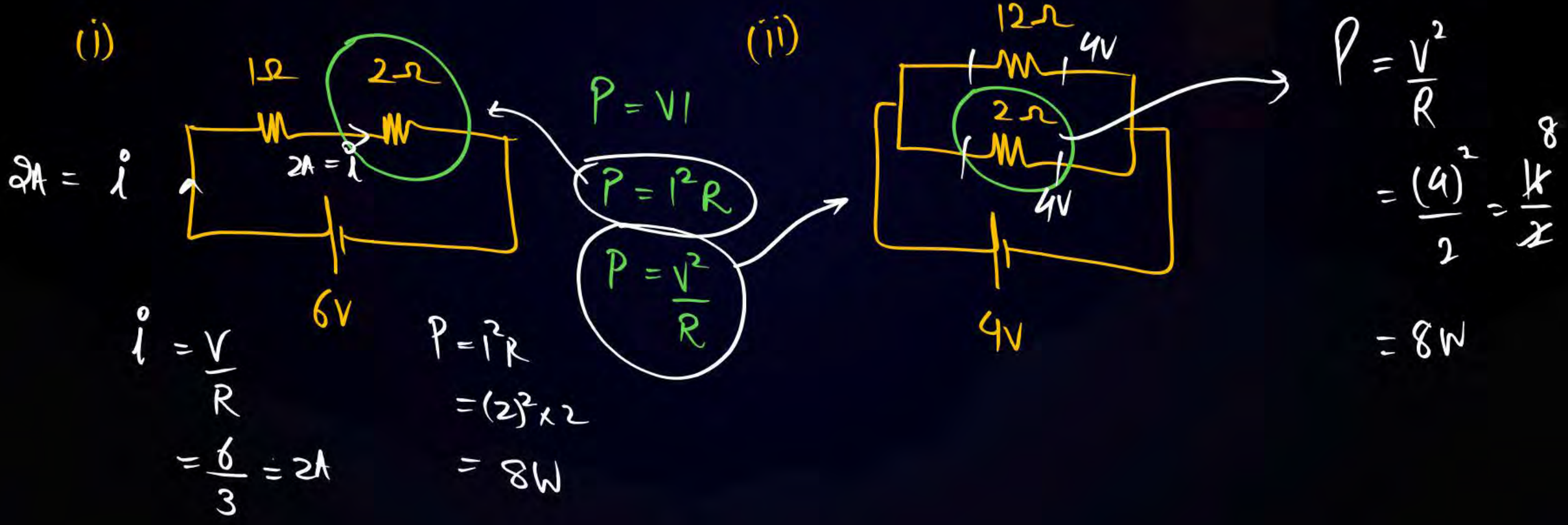
Case III



$$i = \frac{V}{R} = \frac{220}{12}\ A$$

Page No. 221 (INTEXT Q.14)

Compare the power used in the 2 Ω resistor in each of the following circuits: (i) a 6 V battery in series with 1 Ω and 2 Ω resistors, and (ii) a 4 V battery in parallel with 12 Ω and 2 Ω resistors.



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

$= \frac{6}{3} = 2A$

$P = I^2R$

$= (2)^2 \times 2$

$= 8W$

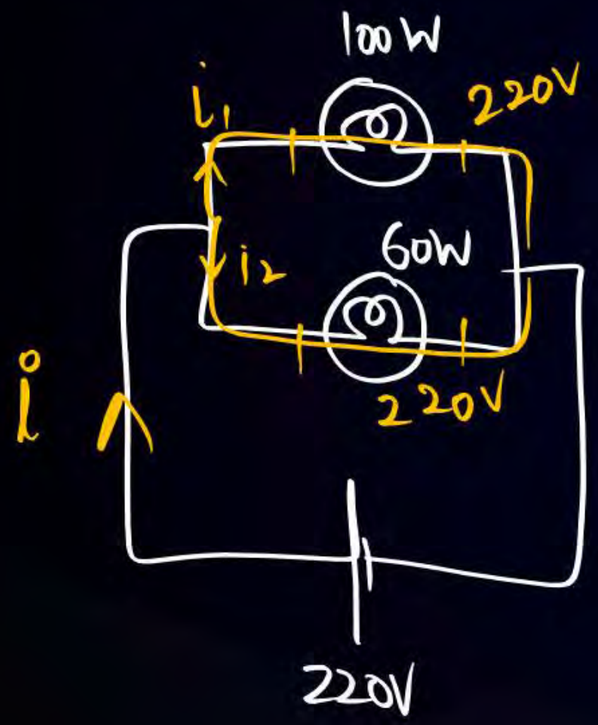
$P = \frac{V^2}{R}$

$= \frac{(4)^2}{2} = \frac{16}{2}$

$= 8W$

Page No. 221 (INTEXT Q.15)

Two lamps, one rated 100 W at 220 V, and the other 60 W at 220 V, are connected in parallel to electric mains supply. What current is drawn from the line if the supply voltage is 220 V?



$P = Vi_1$

$100 = 220 \times i_1 \rightarrow i_1 = \frac{100}{220} A$

$P = Vi_2$

$60 = 220 \times i_2 \rightarrow i_2 = \frac{60}{220} A$

$i = i_1 + i_2$

$= \frac{100}{220} + \frac{60}{220}$

$i_1 = \frac{8}{11} A$

$i_1 = \frac{\frac{160}{220}}{11} = \frac{8}{11} A$

Page No. 221 (INTEXT Q.16)

Which uses more energy, a 250 W TV set in 1 hr, or a 1200 W toaster in 10 minutes?

TV

$P = 250\ W$

$t = 1\ h$

$E = P \times t$

$= \frac{250}{1000} \times 1$

$= 0.25\ kWh$

Toaster

$P = 1200\ W$

$t = \frac{10\ min}{60} = \frac{10}{60}\ h$

$E = P \times t$

$= \frac{1200}{1000} \times \frac{10}{60}$

$= 0.2\ kWh$

$0.25\ kWh > 0.2\ kWh$

Page No. 221 (INTEXT Q.17)

An electric heater of resistance 8 Ω draws 15 A from the service mains 2 hours. Calculate the rate at which heat is developed in the heater.

- $R = 8\Omega$
- $i = 15A$
- $t = 2h$

$$P = i^2 R$$

$$= (15)^2 \times 8$$

$$= 225 \times 8 \text{ Watt}$$

Page No. 221 (INTEXT Q.18)

Explain the following.

(a) Why is the tungsten used almost exclusively for filament of electric lamps?

(b) Why are the conductors of electric heating devices, such as bread-toasters and electric irons, made of an alloy rather than a pure metal?

(c) Why is the series arrangement not used for domestic circuits?

(d) How does the resistance of a wire vary with its area of cross-section?

$R \propto \frac{1}{A}$ ↑

(e) Why are copper and aluminium wires usually employed for electricity transmission?

↓

light weight


Thank
You