L2

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CLASS X - SCIENCE

ELECTRICITY

PRASHANT KIRAD

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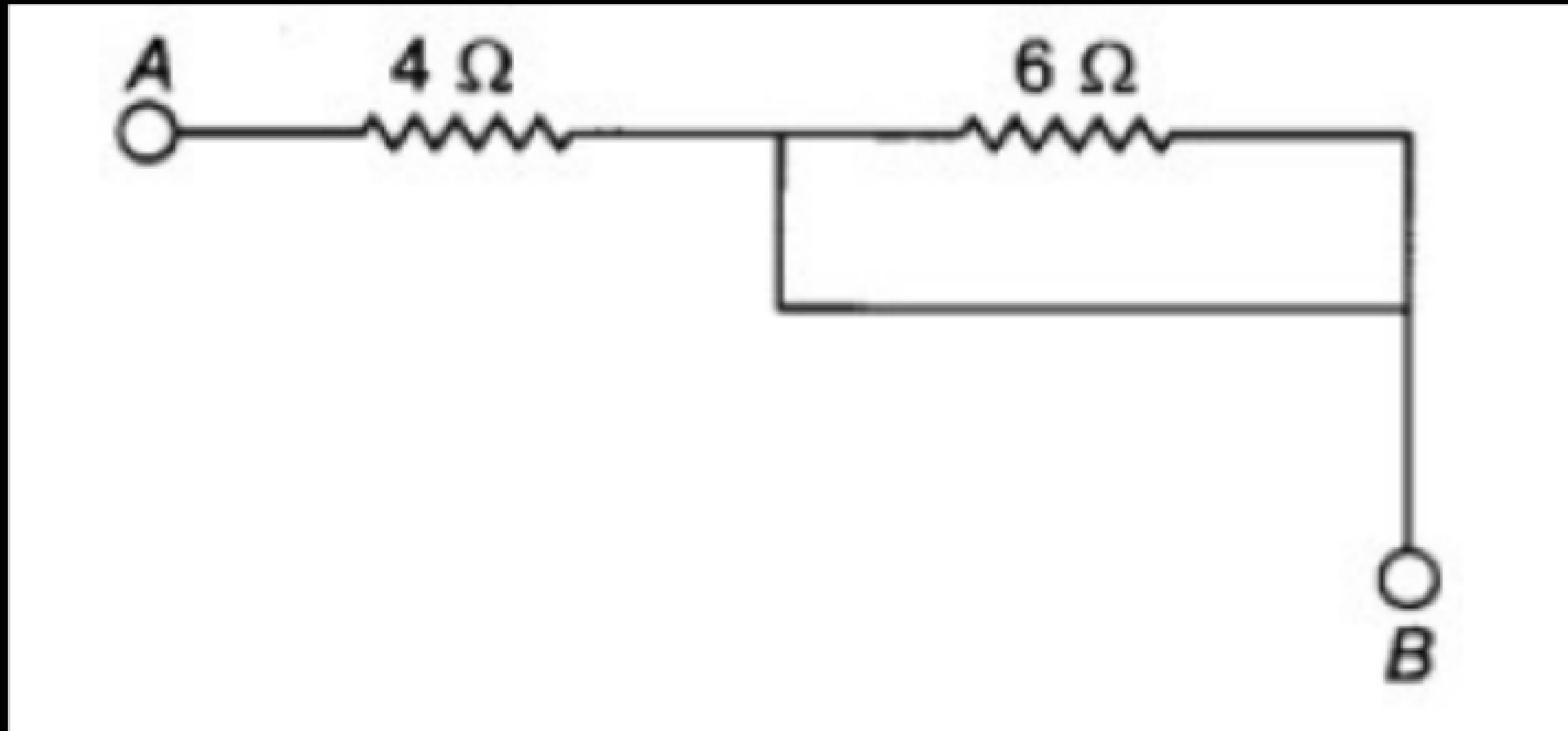
Q.The effective resistance between A and B is



(a) 4 Ω
(b) 6 Ω
(c) May be 10 Ω
(d) Must be 10 Ω

Answer: Option (a)

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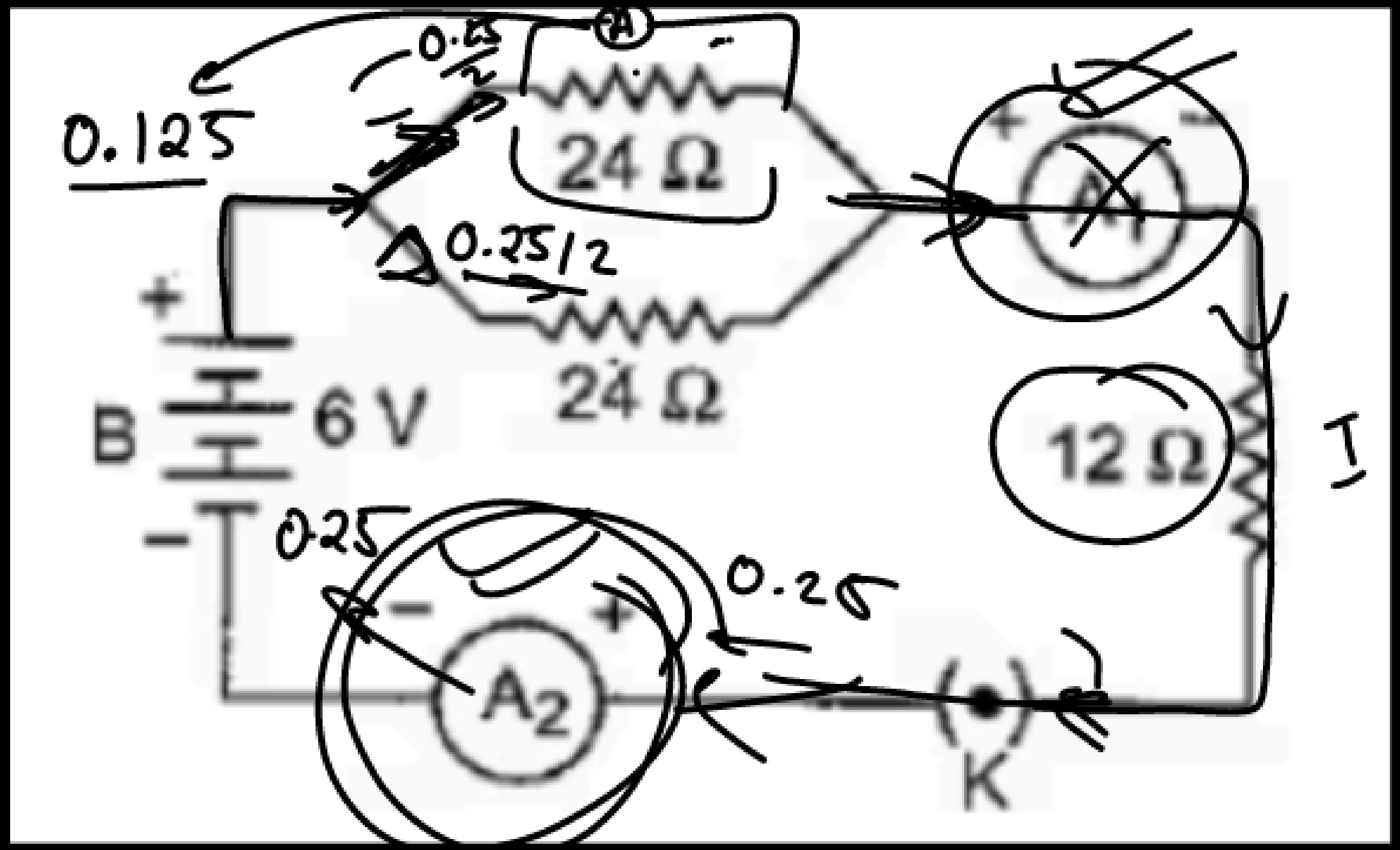
Q. Study the circuit of Fig. and find out:

(i) Current in the 12 Ω resistor

(ii) Difference in the readings of A_1 and A_2, if any. (2019)



① $R_{net} = ?$ $12 + 12 = 24\Omega$

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

Find I

$V = IR$

$6 = I \times 24$

$\frac{6}{24} = I$

$\frac{1}{4} = 0.25A$

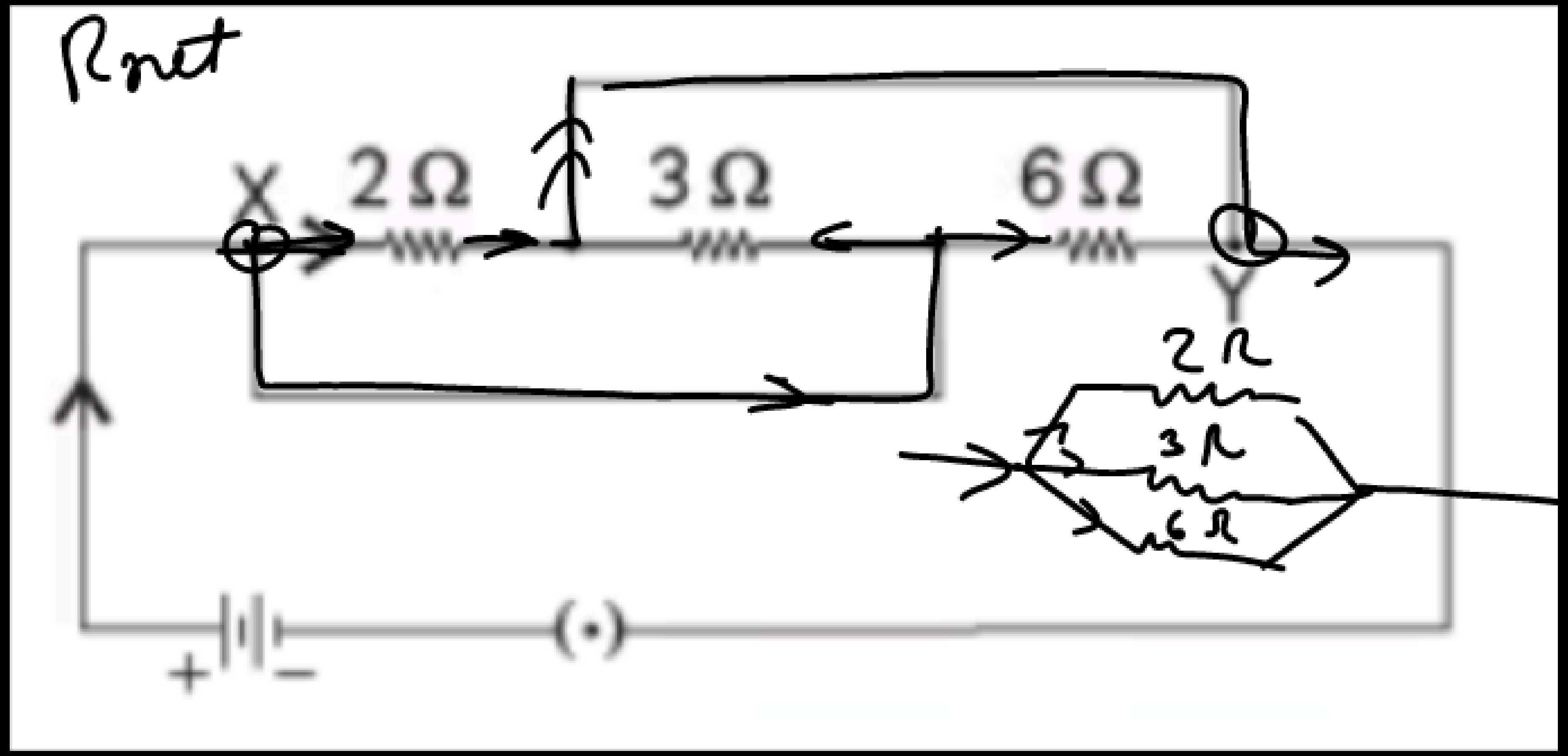
Q. The total resistance between X and Y is:

(a) 12 Ω

(b) 4Ω

(c) 6Ω

(d) 1Ω



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

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(2024)

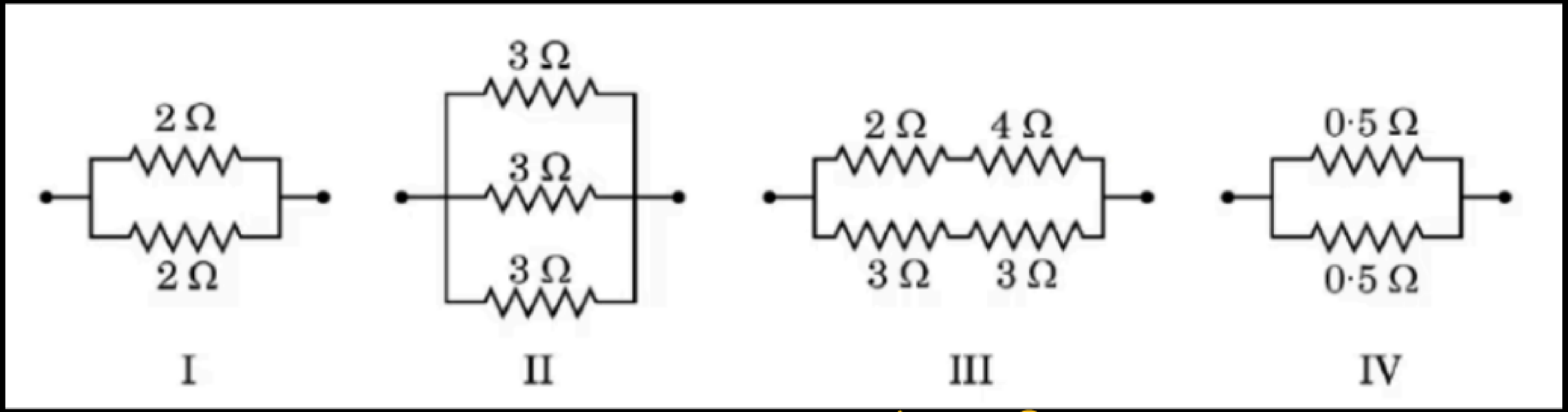
Q. The combinations having equivalent resistance 1 is/are:

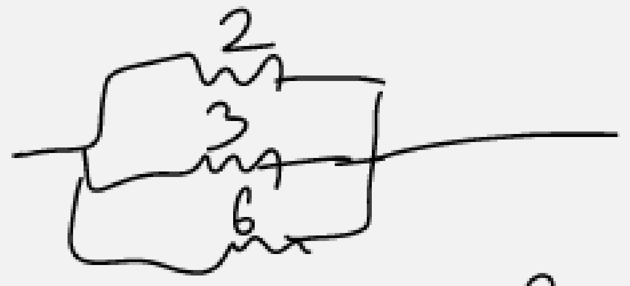
(a) I and IV

(b) Only IV

(c) I and II

(d) I, II, and III



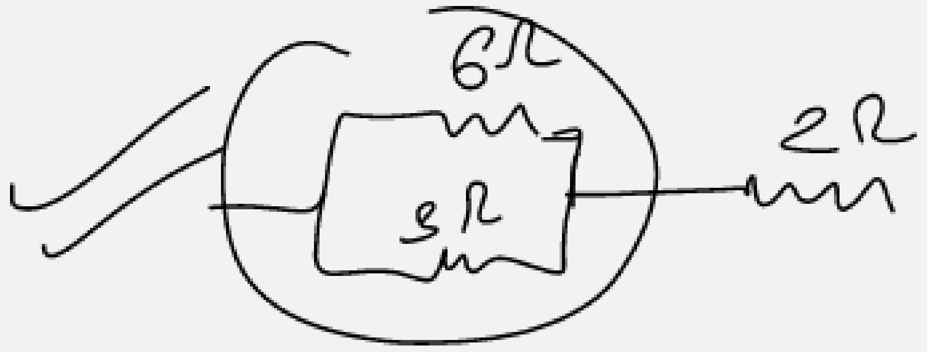


2 Ω 3 Ω 6 Ω

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

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

4, 1 Ω



$\frac{1}{6}+\frac{1}{3} = \frac{2+1}{6} = \frac{3}{6} = \frac{1}{2} \rightarrow 2\Omega$

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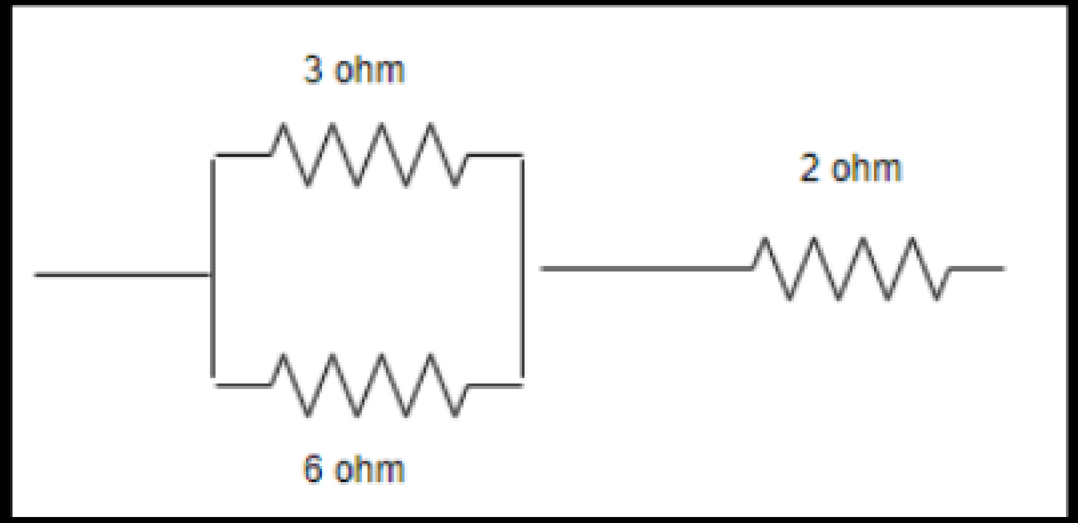
Q.How can three resistors of resistances 2 Ω, 3 Ω and 6Ω be connected to give a total resistance of

(a) 4 Ω,

(b) 1 Ω?

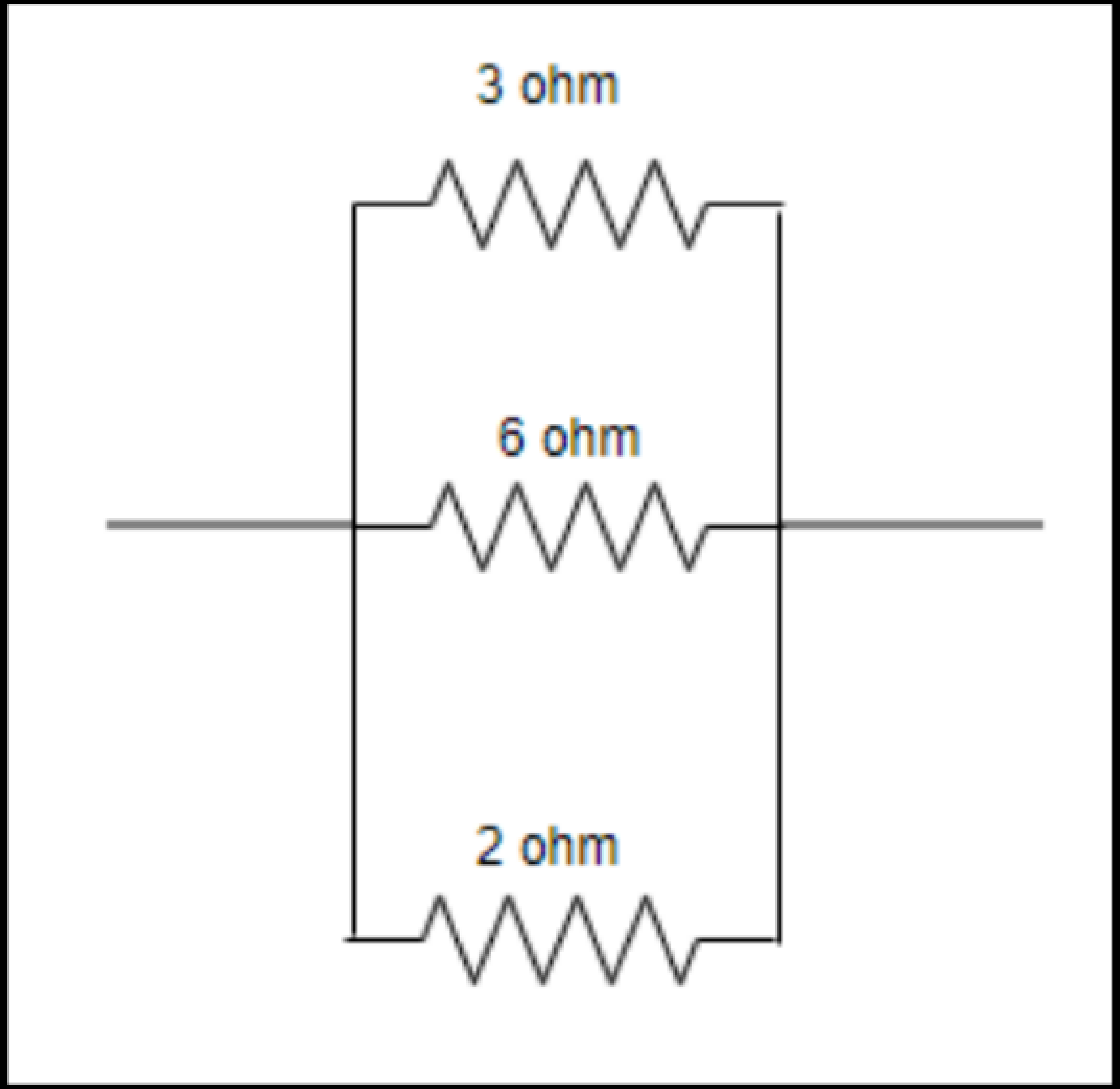
(a) for 4 Ω reistance:

3Ω and 6 Ω resistances are connected in parallel and this combination is connected in series to 2 Ω resistor.



(b) For 1 Ω resistance:

All these three resistances are connected in parallel to get equivalent resistance of 1 Ω



QThree resistors of 3 Ω each are connected to a battery of 3 V as shown. Calculate the current drawn from the battery.

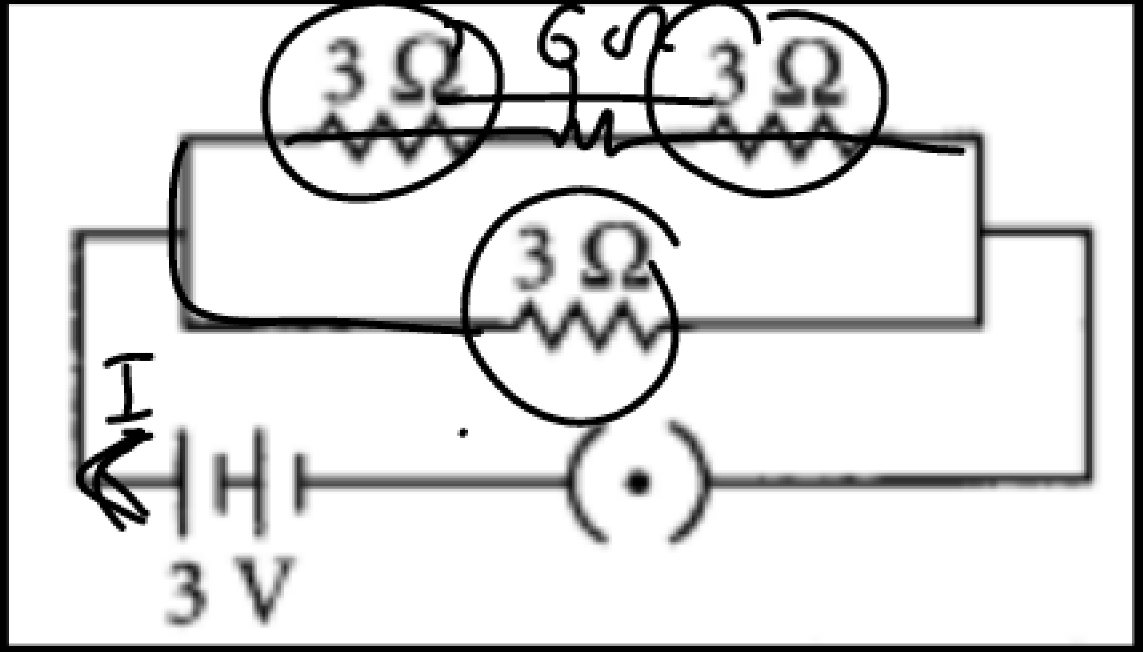
$\frac{1}{6}+\frac{1}{3}=\frac{2+1}{6}=\frac{3}{6}=\frac{1}{2}$, 2Ω

V=3V

V=IR

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

$\frac{3}{2}=I$



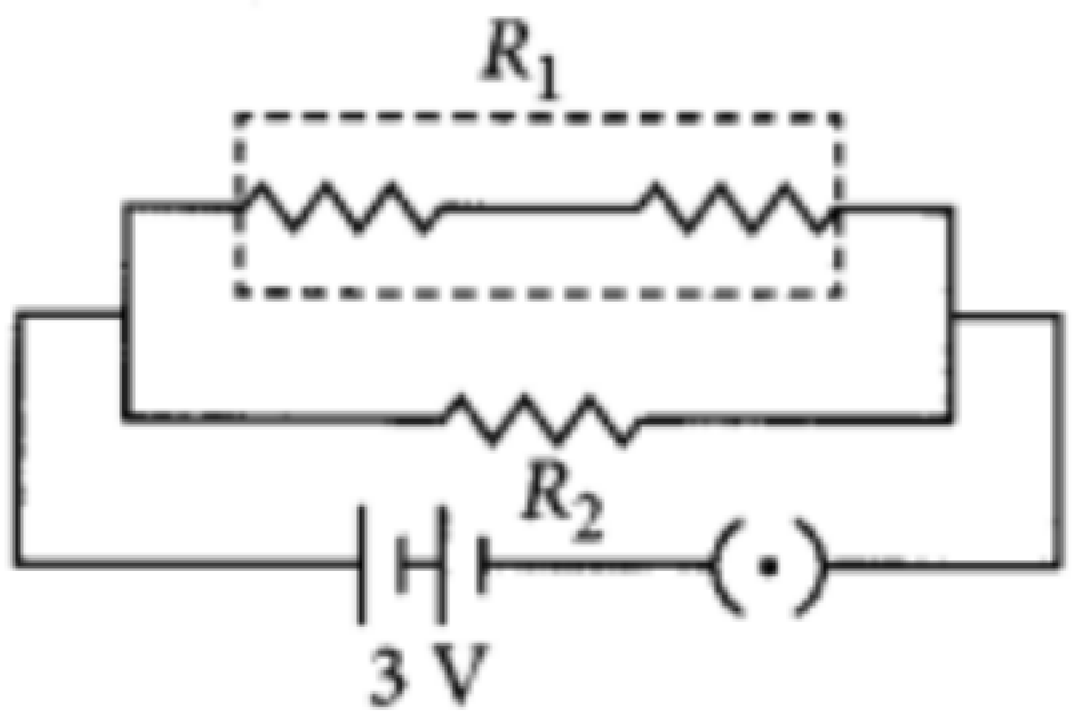
As given in circuit diagram, two 3 Ω resistors are connected in series to form R1; so R1 = 3 Ω + 3 Ω = 6 Ω

And, R1 and R2 are in parallel combination,

Hence, equivalent resistance of circuit (Req) given by

$$\frac{1}{R_{eq}}=\frac{1}{R_1}+\frac{1}{R_2}$$

$$\therefore \quad \frac{1}{R_{eq}}=\frac{1}{6}+\frac{1}{3}=\frac{1+2}{6}=\frac{3}{6}=\frac{1}{2}$$



Req = 2 Ω

Using Ohm's law, V = IR

We get,

3 V = I × 2 Ω

or I = 3/2 A = 1.5 A

Current drawn from the battery is 1.5 A.

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JOULE'S LAW OF HEATING

If an electric circuit is purely resistive, the source of energy continually get dissipated entirely in form of heat. This is known as **heating effect of electric current.**

$H \propto I^2$ $H \propto t$

$H \propto R$

$$H = I^2 R t$$

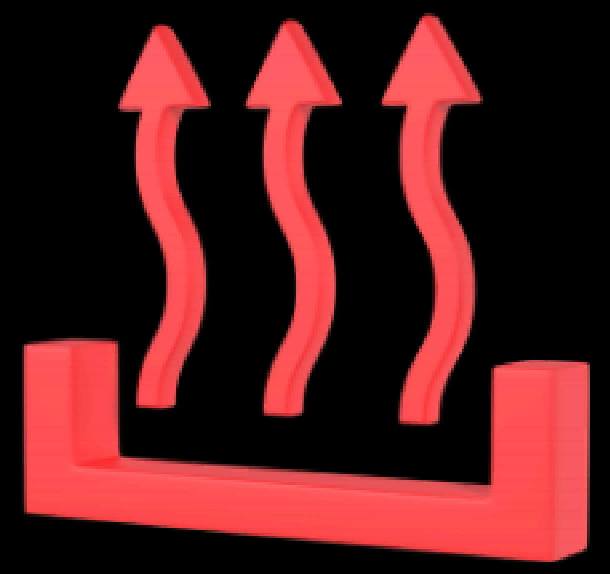
Joule's Law of Heating

It states that the heat produced in a resistor is :

(i) directly proportional to square of the current (I)

(ii) directly proportional to resistance (R) for given current

(iii) directly proportional to time (t) for which current flow through resistor.



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JOULE'S LAW OF HEATING

Derivativation of Joule's Law

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

Or $W = VQ$

So, $W = VIt$ $\quad (I = \frac{Q}{T}$, so $Q = It)$

This work done gets converted into heat energy.

Therefore, $H = VIt$ ________(1)

Acc to Ohm's law, $V = IR$ Substituting in (i)

$$H = I^2Rt$$

$$H = I^2Rt$$

APPLICATION OF HEATING EFFECT OF ELECTRIC CURRENT

Electric Fuse

In any electrical instrument, due to sudden rise of current, the instrument gets burnt down which sometimes results in fire. A conducting wire with low melting point is connected in series with the circuit to avoid this type of accident. When the current rises, the wire melts due to excessive heating, thus breaking the electrical circuit.

Electric Bulb

Electric bulb contains a thick metallic wire made up of tungsten metal. The metal is kept in an inert environment with a neutral gas or vacuum. When current flows through the tungsten wire, it becomes heated and emits light. Most of the electric power drawn in the circuit from the electrical source is dissipated in the form of heat and the rest is emitted in the form of light energy

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Electric Heater/ Heating element

High R ↑ H ↑

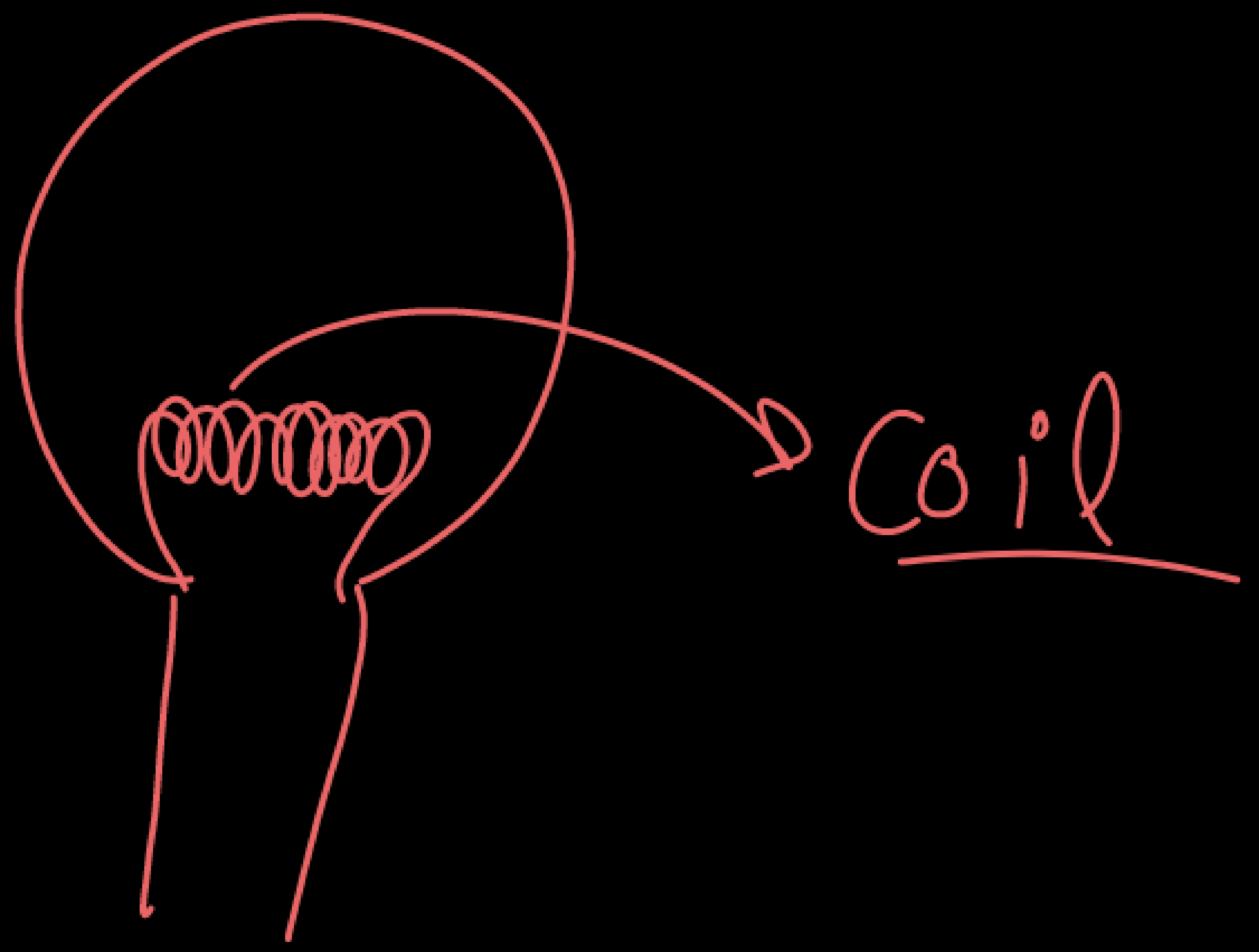
In an electric heater, high resistance nichrome wire is used as a coil. The coil is wound on grooves made up in ceramic material or china clay. When the current flows in the coil, it becomes heated, which is then used to heat cooking vessels

↳ does not get oxidized

Elements used :

- Filament of the bulb - Tungsten
- Connecting wires - Copper
- Heating Elements - Nichrome
- Fuse wire - Sn - Pb alloy

H↑ R↑



R↑ L↑

ELECTRICAL POWER

The rate at which electric energy is consumed or dissipated in an electric circuit.

It is denoted by P.

Its S.I. unit is Watt (W) or J/s.

$$P = \frac{W}{t} = \frac{\Delta E}{t}$$

P = Power (watt)

W = Work done (J)

ΔE = Energy transformed

t = time(s)

$$P = \frac{W}{t}$$

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

$$V \times Q = W$$

$$P = \frac{V \times Q}{t} \quad I$$

$$P = VI$$

$$V = IR$$

$$P = I^2 R$$

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

$$V^2/R$$

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Q. An electric lamp of resistance 20 Ω and a conductor of resistance 4 Ω are connected to a 6 V battery as shown in the circuit. Calculate:

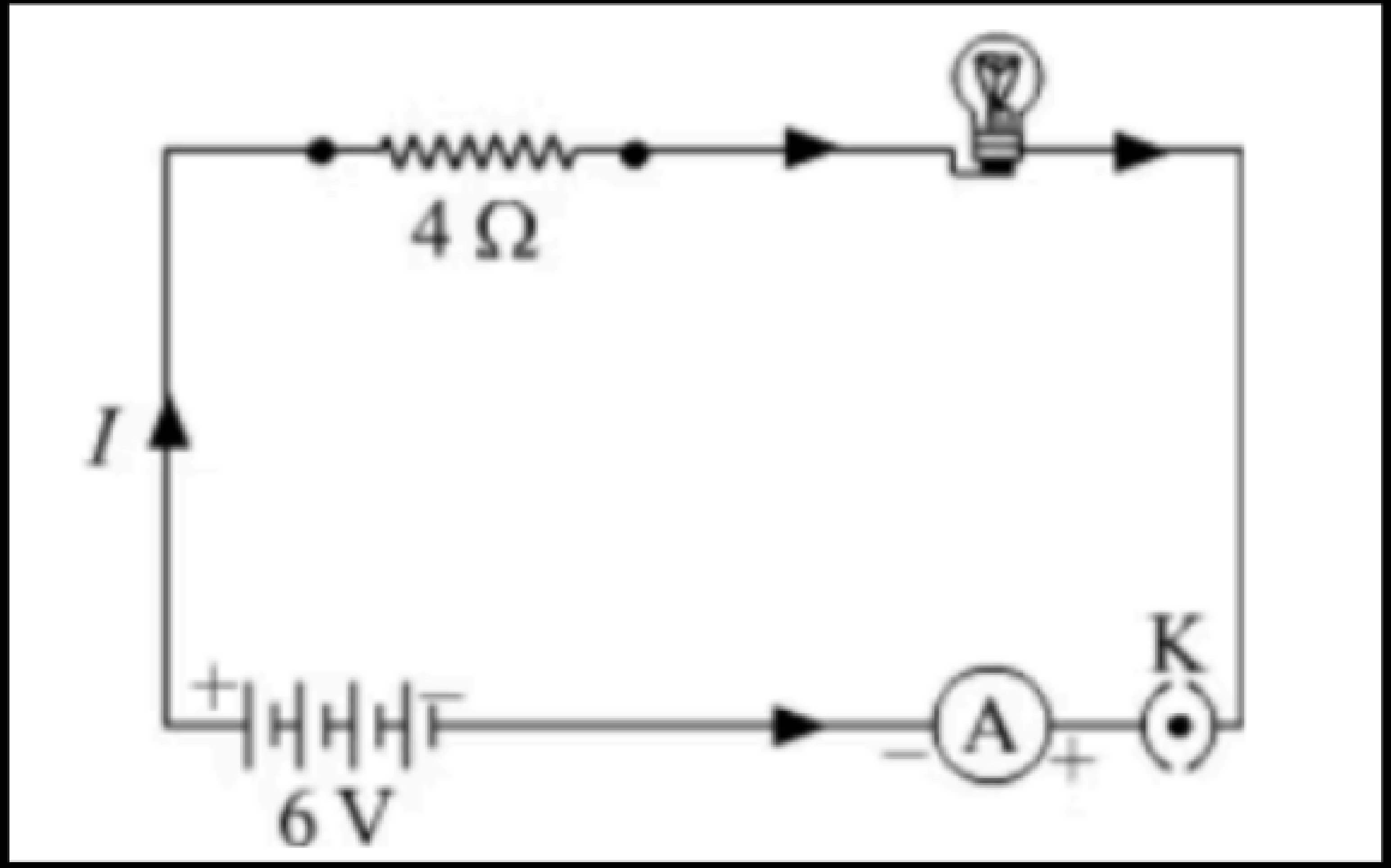
(a) The total resistance of the circuit,

(b) The current through the circuit,

(c) The potential difference across the (i) electric lamp and (ii) conductor, and

(d) The power of the lamp.

(2019)



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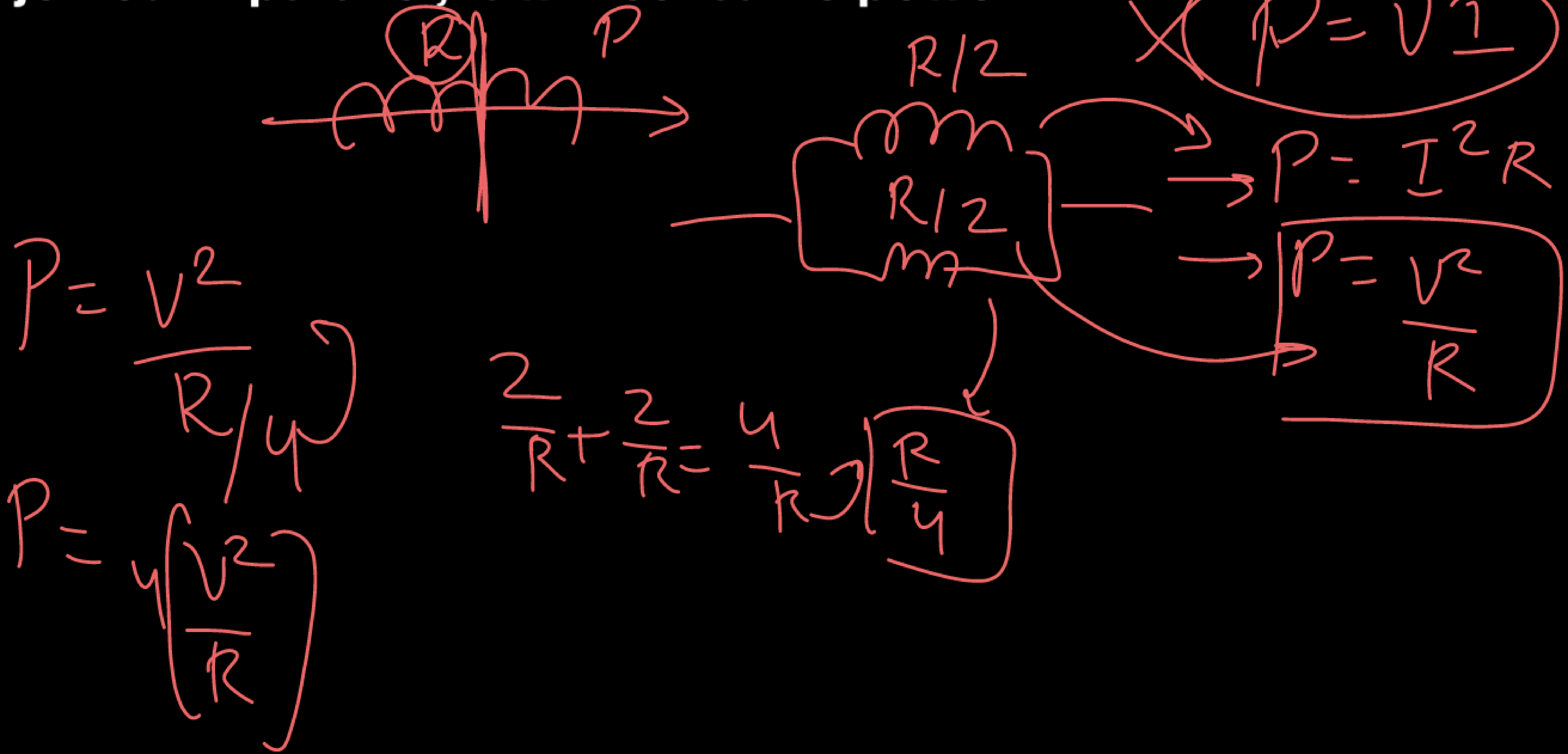
Q.A coil in the heater consumes power P on passing current. If it is cut into halves and joined in parallel, it will consume power

(a) P

(b) P/2

(c) 2 P

(d) 4 P



Answer: Option (d)

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$V = 200V \quad P = 100W$

Q. (a) An electric bulb is rated at 200 V, 100W. What is its resistance?

(b) Calculate the energy consumed by 3 such bulbs if they glow continuously for 10 hours for complete month of november. (2020)

$30 \times 10 = 300\ hr$

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

$100 = \frac{(200)^2}{R}$

$R = \frac{40000}{100}$

$R = 400\Omega$

$P = \frac{E}{t}$

$P \times t = E$

$P_{net} = 300W$

$= \frac{300}{1000}$

$300 \times 300 = 90000\ W\,hr$

$= 90\ kW\,hr$

KWhr

W $\rightarrow$ KW

1000

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Q. An electric bulb draws a current of 8 A and works on 250 V on the average 8 hours a day.

a. Find the power consumed by the bulb

b. If the electric distribution company changes Rs 5 for 6 KWH, what is the monthly bill for 60 days

Charges

5 → per Unit

$V = 250\,V$

$I = 8\,A$

$P = VI$

$P = 8 \times 250$

$= 2000\,W$

$= 2\,KW$

$E = P \times t$

$t = 8 \times 60$

$= 480$ hours

$E = 480 \times 2$

$= 960$ KWh

Bill $= 960 \times 5$

$= 4800$ Rs

(5) Mark 0.75 KW

P = 750 V = 200

Q. An electric iron has a rating of 750 W; 200 V. Calculate:

(i) the current required.

(ii) the resistance of its heating element.

(iii) energy consumed by the iron in 2 hours.

$V = 200\,V$

$I = \frac{75}{20}$ Amp

$E = 0.75 \times 2$

$= 1.5$ KWh

$P = V \times I$

$750 = 200 \times I$

$\frac{75}{20} = I$

$V = IR$

$200 = \frac{75}{20} \times R$

$\frac{160}{3} = \frac{4 \times 40}{3} = R$

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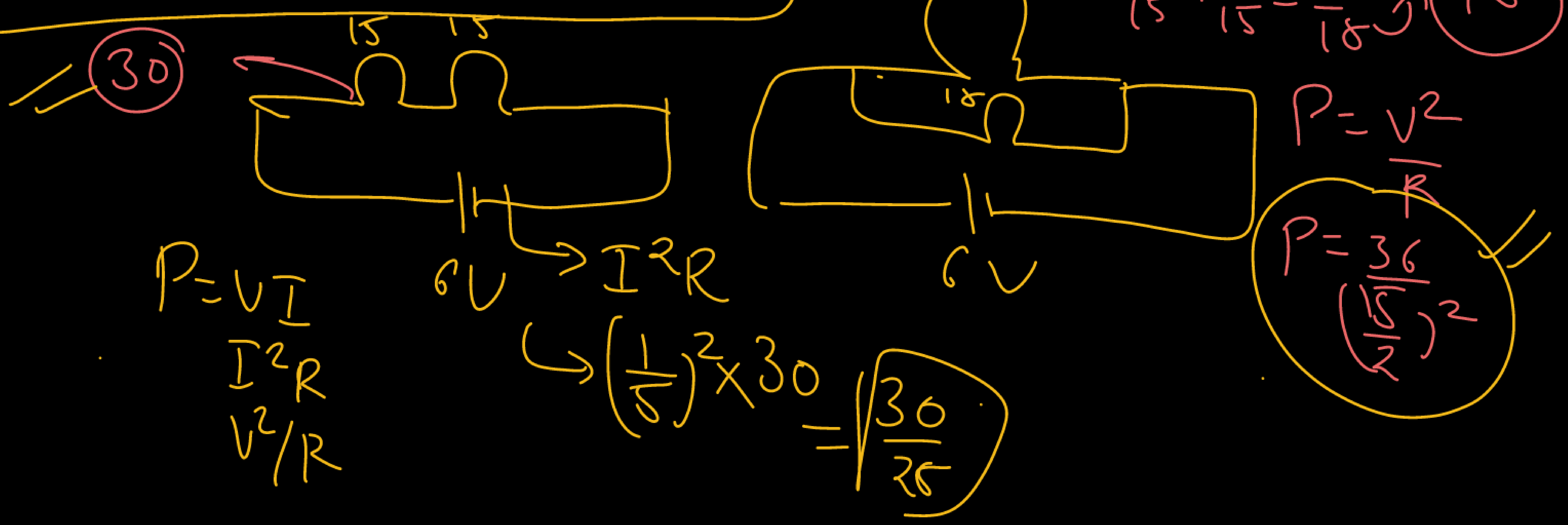
Q. Two identical resistors, each of resistance 15 Ω, are connected in

(i) series, and

(ii) parallel,

in turn to a battery of 6 V. Calculate the ratio of the power consumed in the combination of resistors in each case.



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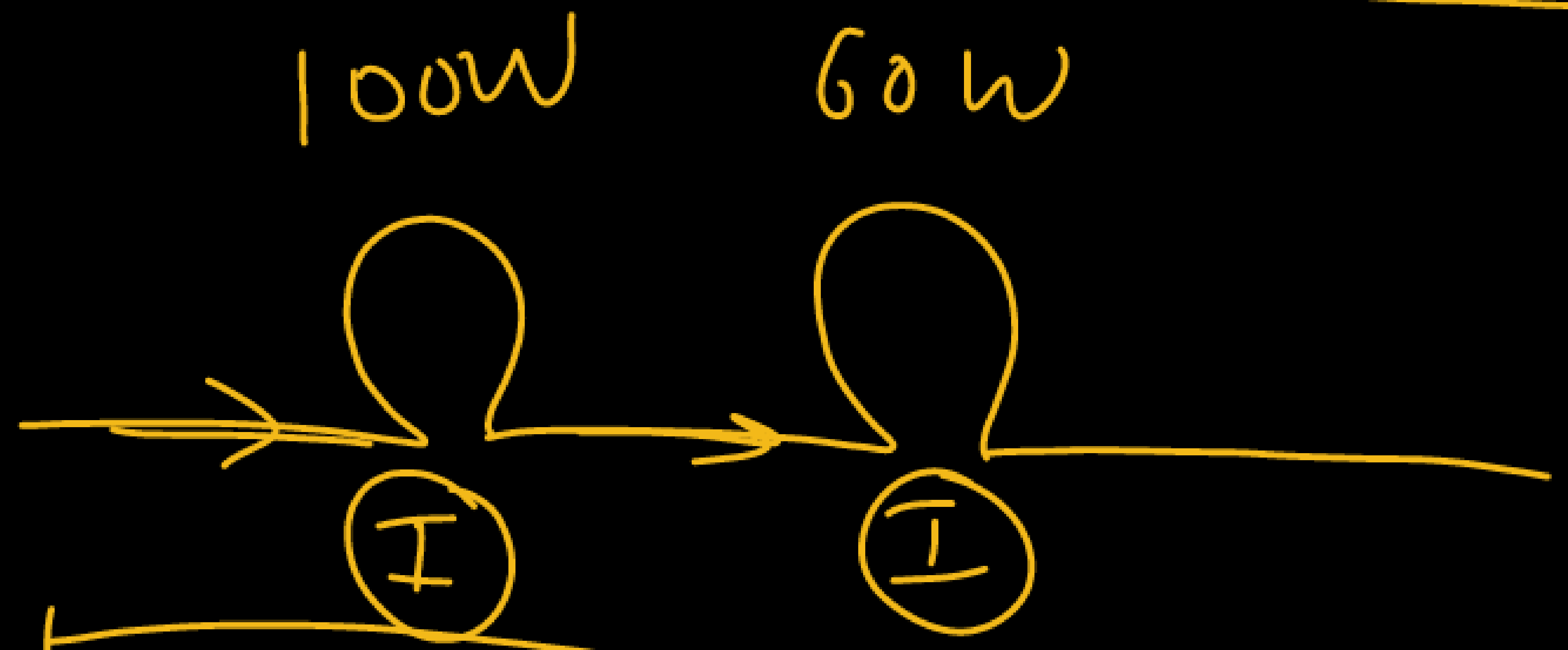
$$P = \frac{V^2}{R}$$

Q. Two bulbs, one rated 100 W at 220 V and the other 60 W at 220 V, are connected in series.

(a) Calculate the resistance of each bulb.

(b) Which bulb will glow brighter when connected in series? Why?

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



$$P = I^2 R \uparrow$$

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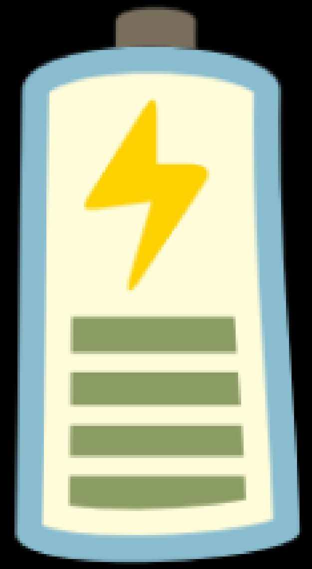
COMMERCIAL UNIT OF ENERGY

Commercial unit of electrical energy is **kWh (kilowatt-hour).**
It is defined as energy consumed by an appliance of 1kW when it is used for one hour.



$$E = P \times t$$
$$\text{Joule} = \text{Watt} \times \text{Second}$$
$$J = Ws$$
$$E = \text{Kilowatt hour}$$

$$1kWh = 1000Wh$$
$$= 1000 \times 3600Ws$$
$$= 1kWh = 3.6 \times 10^{6} J$$

1 KWhr → Seconds

1000 × 60 × 60

=

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Q.Two bulbs are rated 40W, 220V and 60W, 220V. The ratio of their resistances will be

(a) 4:3

(b) 3:4

(c) 2:3

(d) 3:2

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

$R_1 = \frac{V^2}{P}$

$R_1 = \frac{(220)^2}{40}$

$R_2 = \frac{(220)^2}{60}$

$= \frac{60}{40} = 6:4$

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Q.A fuse wire repeatedly gets burnt when used with a good heater. It is advised to use a fuse wire of

(a) More length

(b) Less radius

(c) Less length

(d) More radius

R ↑ H ↑

R ↓ L ↓ A ↑

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Q.Unit of electric power may also be expressed as

(a) Volt-ampere

(b) Kilowatt-hour

(c) Watt second

(d) Joule second

$P = VI$

$P = \frac{W}{t}$

$= J/s$

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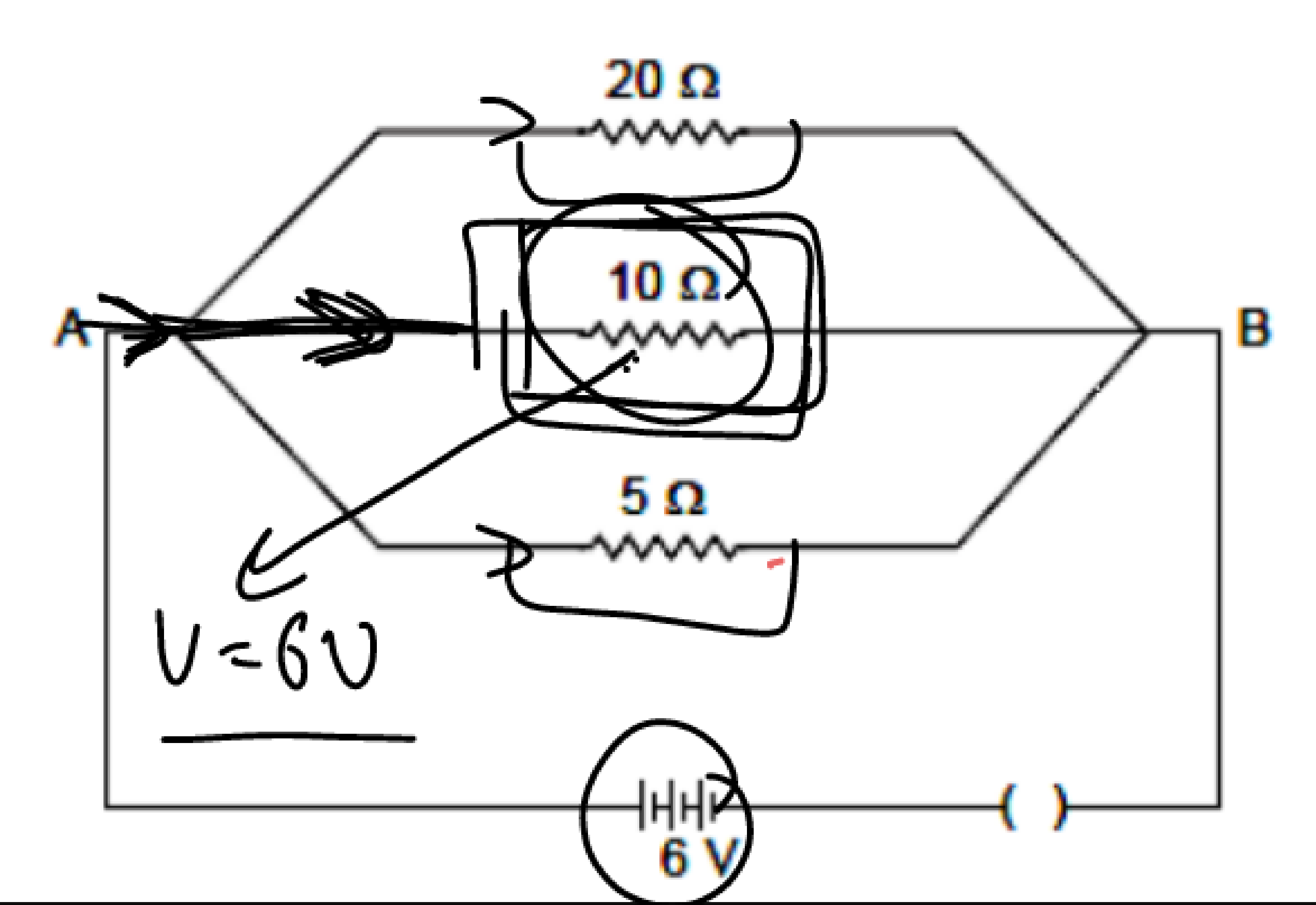
Q.Calculate the current flow through the 10 Ω resistor in the following circuit.



(a) 1.2 A
(b) 0.6 A
(c) 0.2 A
(d) 2.0 A

Answer: Option (b)

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