• Electricity

1. (a) Prove that the equivalent resistance of three resistors R1, R2 and R3 in series is R1 + R2 + R3.
(b) You have four resistors of 8 each. Show how would you connect these resistors to have effective resistance of 8Ω ?
(2013, 2015, 2016)

2. State Ohm's law. Draw a labelled circuit diagram to verify this law in the laboratory. If you draw a graph between the potential difference and current flowing through a metallic conductor, what kind of curve will you get? Explain how would you use this graph to determine the resistance of the conductor. (2014, 2015, 2016)

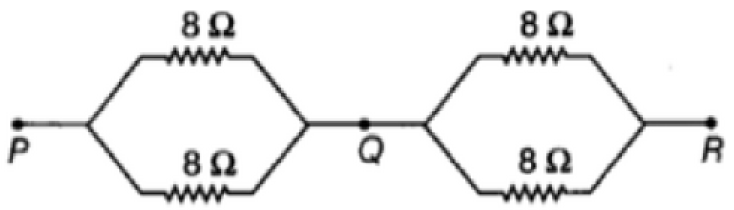
3.(i)State one difference between kilowatt and kilowatt hour. Express 1 kWh in joules.
(ii) A bulb is rated 5V; 500 mA. Calculate the rated power and resistance of the bulb when it glows.
(2013, 2016)

4. Two lamps, one rated 100 W; 220 V, and the other 60 W; 220 V, are connected in parallel to electric mains supply. Find the current drawn by two bulbs from the line, if the supply voltage is 220 V.
(2018. 2014)

5.Draw a schematic diagram of a circuit consisting of a battery of 3 cells of 2 V each, a combination of three resistors of 10Ω, 20Ω and 30Ω connected in parallel, a plug key and an ammeter, all connected in series. Use this circuit to find the value of the following:
(a) Current through each resistor
(b) Total current in the circuit
(c) Total effective resistance of the circuit. (2020)

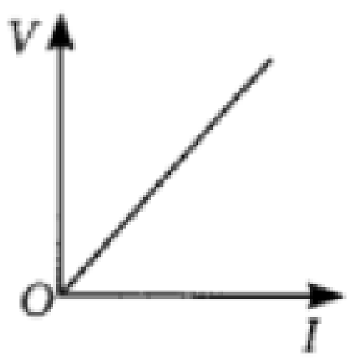
Solutions

1. The total potential difference across a combination of resistors in series is equal to the sum of a potential difference across the individual resistors. $V=V_1+V_2+V_3$
Let I be the current in the circuit. The current through each resistor is also I. It is possible to replace the three resistors joined in series by an equivalent resistor of resistance R.
Applying Ohm's law, $V=IR$
$V_1= IR_1$
$V_2= IR_2$
$V_3= IR_3$
$V=V_1+V_2 + V_3$
$IR= IR_1+ IR_2 + IR_3$
$R=R_1+ R_2+R_3$



Two parallel combinations must be connected in series with each other to get the effective resistance of 8Ω. The effective resistance of each of the parallel combination is 4Ω resistors are added together to get 8Ω effective resistance.

2. It states that the potential difference V, across the ends of a given metallic wire in an electric circuit is directly proportional to the current flowing through it, provided its temperature remains the same. Mathematically,
$V \propto I$
$V = RI$
where R is resistance of the conductor.
or $R = V/I$
So the slope of V-I graph at any point represents the resistance of the given conductor.



3. Kilowatt (kW) - a large unit of electric power Kilowatt hour (kWh) - a commercial unit of energy.

1 kWh = -3.6×10^6 Joules.

Potential difference = 5V, Current = 500 mA = 500×10^{-3} A

P = VI

= $5V \times 500 \times 10^{-3} = 2.5W$

R = V/I

= $5/500 \times 10^{-3} \times 10\Omega$

= 100Ω

4. Since both the bulbs are connected in parallel and to a 220 V supply, the voltage across each bulb is 220 V. Then

Current drawn by 100 W bulb,

I1 = power/voltage = 100W/220V = 0.454A

Current drawn by 60 W bulb,

I2 = 60W/220V = 0.273 A

Total current drawn from the supply line,

I = I1 + I2 = 0.454 A + 0.273 A = 0.727 A = 0.73 A

5. (a) Given, voltage = 2V + 2V + 2V = 6V

Current through 10Ω resistance,

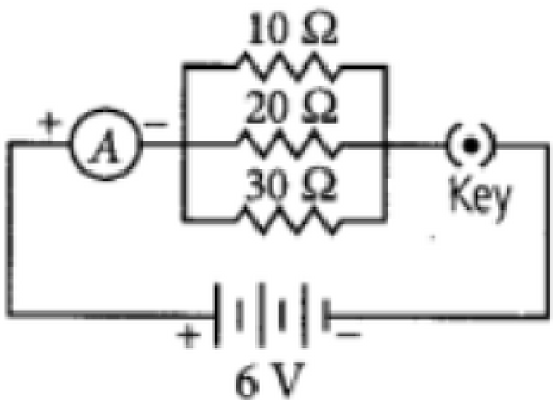
I(10) = V/R=6/10 = 0.6 A

Current through 20Ω resistance,

I(20) = V/R =6/20 = 0.3 A

Current through 30Ω resistance,

I(30) = V/R=6/30 = 0.2 A



(b) Total current in the circuit, I = I(10) + I(20) + I(30)

= 0.6+0.3 +0.2 = 1.1 A

(c) Total resistance of the circuit,

1/Rp=1/10+1/20+1/30=11/60