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Question 1. What determines the rate at which energy is delivered by a current?
Answer:
The rate of consumption of electric energy in an electric appliance is called electric power. Hence, the rate at which energy is delivered by a current is the power of the appliance.

Question 2. An electric motor takes 5 A from a 220 V une. Determine the power of the motor and the energy consumed in 2 h.
Answer:
Power (P) is given by the expression,

$$P = VI$$

Where,

Voltage, $V = 220$ V

Current, $I = 5$ A

$$P = 220 \times 5 = 1100 \text{ W}$$

Energy consumed by the motor = Pt

Where,

Time, $t = 2\ h = 2 \times 60 \times 60 = 7200$ s

$\therefore\ P = 1100 \times 7200 = 7.92 \times 10^6$ J

Therefore, power of the motor = 1100 W

Energy consumed by the motor = 7.92×10^6 J

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Question 1. 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
Answer:
(d) Resistance of a piece of wire is proportional to its length. A piece of wire has a resistance R. The wire ¡s cut into five equal parts.
Therefore, resistance of each part = R/5
All the five parts are connected in parallel. Hence. equivalent resistance (R’) is given as

$$\frac{1}{R'} = \frac{5}{R} + \frac{5}{R} + \frac{5}{R} + \frac{5}{R} + \frac{5}{R} = \frac{5+5+5+5+5}{R}$$

$$\frac{1}{R'} = \frac{25}{R}$$

$$\frac{R}{R'} = 25$$

Therefore, the ratio $\frac{R}{R'}$ is 25.

Question 2. Which of the following terms does not represent electrical power in a circuit?

(a) I^2R

(b) IR^2

(c) VI

(d) $\frac{V^2}{R}$

Answer:

(b) Electrical power is given by the expression, $P = VI$ ... (i)

According to Ohm's law, $V = IR$ ... (ii)

Where,

V = Potential difference

I = Current

R = Resistance

$\therefore P = VI$

From equation (i), it can be written

$P = (IR) \times I$

$\therefore P = I^2R$

From equation (ii), it can be written

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

$\therefore P = V \times \frac{V}{R}$

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

$\therefore P = VI = I^2R = \frac{V^2}{R}$

Power P cannot be expressed as IR^2.

Question 3. An electric bulb is rated 220 V and 100 W. When it is operated on 110 V, the power consumed will be
(a) 100W
(b) 75 W
(c) 50 W
(d) 25 W
Answer:
(d) Energy consumed by an appliance ¡s given by the expression.

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

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

Where,

Power rating, $P = 100$ W

Voltage, $V = 220$ V

Resistance, $R = \frac{(220)^2}{100} = 484\ \Omega$

The resistance of the bulb remains constant if the supply voltage is reduced to 110 V If the bulb is operated on 110V, then the energy consumed by it is given by the expression for power as

$$\therefore P' = \frac{(V')^2}{R} = \frac{(110)^2}{484} = 25 \text{ W}$$

Therefore, the power consumed will be 25 W.

Question 4. 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
Answer:
(c) The Joule heating is given by, $H = i^2Rt$
Let. R be the resistance of the two wires.
The equivalent resistance of the series connection is $R_S = R + R = 2R$
If V is the applied potential difference, then it is the voltage across the equivalent resistance.

$$V = i_s \times 2R$$

$$\Rightarrow i_s = \frac{V}{2R}$$

The heat dissipated in time *t* is,

$$H_s = i_s^2 \times 2R \times t = \left(\frac{V}{2R}\right)^2 \times 2R \times t$$

$$\Rightarrow H_s = \frac{V^2 t}{2R}$$

The equivalent resistance of the parallel connection is

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

V is the applied potential difference across this R_p.

$$V = i_p \times \frac{R}{2}$$

$$\Rightarrow i_p = \frac{2V}{R}$$

The heat dissipated in time t is,

$$H_p = i_p^2 \times \frac{R}{2} \times t = \left(\frac{2V}{R}\right)^2 \times \frac{R}{2} \times t$$

$$\Rightarrow H_p = \frac{2V^2 t}{R}$$

So, the ratio of heat produced is,

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

Note: $H \propto R$ also $H \propto i^2$ and $H \propto t$. In this question, t is same for both the circuit. But the current through the equivalent resistance of both the circuit is different. We could have solved the question directly using $H \propto R$ if in case the current was also same. As we know the voltage and resistance of the circuits, we have calculated i in terms of voltage and resistance and used in the equation $H = i^2Rt$ to find the ratio.

Question 5. How is a volmeter connected bi the cicult to measure the potential dIfference between two pobits?
Answer:
To measure the potential dIfference between two points, a voltmeter should be connected bi parallel to the points.

Question 6:
A copper wire has diameter 0.5 mm and resistivity of 1 6 x 10^{-8} ohm m. What will be the length of this wire to make ¡ts resistance 10 ohm How much does the resistance change if the diameter is doubled?
Answer:
Resistance (R) of a copper wire of length l and cross-section A is given by the expression.

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

Where,

Resistivity of copper, $\rho = 1.6 \times 10^{-8}\ \Omega\,\text{m}$

Area of cross-section of the wire, $A = \pi\left(\frac{\text{Diameter}}{2}\right)^2$

Diameter= 0.5 mm = 0.0005 m

Resistance, R = 10 Ω

Hence, length of the wire, $l = \frac{RA}{\rho} = \frac{10 \times 3.14 \times \left(\frac{0.0005}{2}\right)^2}{1.6 \times 10^{-8}} = \frac{10 \times 3.14 \times 25}{4 \times 1.6} = 122.72\ \text{m}$

If the diameter of the wire is doubled, new diameter $= 2 \times 0.5 = 1\ \text{mm} = 0.001\ \text{m}$

Therefore, resistance R'

$$R' = \rho \frac{l}{A} = \frac{1.6 \times 10^{-8} \times 122.72}{\pi\left(\frac{1}{2} \times 10^{-3}\right)^2}$$

$$= \frac{1.6 \times 10^{-8} \times 122.72 \times 4}{3.14 \times 10^{-6}} = 250.2 \times 10^{-2} = 2.5\ \Omega$$

Therefore, the length of the wire is 122.7 m and the new resistance is $2.5\ \Omega$.

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