NCERT Class 10 Science - Electricity
Chapter Final Exercise Solutions

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) 25

Explanation:

1. Resistance of a wire is directly proportional to its length. When the wire is cut into 5 equal parts, the resistance of each part becomes R/5.
2. When these 5 parts are connected in parallel, the equivalent resistance R' is calculated as:
   1/R' = 1/(R/5) + 1/(R/5) + 1/(R/5) + 1/(R/5) + 1/(R/5)
   1/R' = 5/R + 5/R + 5/R + 5/R + 5/R
   1/R' = 25/R
3. Rearranging for the ratio:
   R / R' = 25

Question 2
Which of the following terms does not represent electrical power in a circuit?
(a) I^2 * R
(b) I * R^2
(c) V * I
(d) V^2 / R

Answer: (b) I * R^2

Explanation:

1. Electrical power is fundamentally given by P = V * I.
2. According to Ohm's Law, V = I * R. Substituting this into the power formula gives P = (I * R) * I = I^2 * R.
3. Alternatively, substituting I = V / R into the power formula gives P = V * (V / R) = V^2 / R.
4. Therefore, I * R^2 is not a valid representation of electrical power.

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) 100 W

(b) 75 W

(c) 50 W

(d) 25 W

Answer: (d) 25 W

Explanation:

1. Find the resistance (R) of the bulb from its rating using the formula P = V^2 / R:
   R = V^2 / P
   R = (220)^2 / 100
   R = 48400 / 100 = 484 Ohms
2. Calculate the power consumed at 110 V using the same resistance:
   P_new = (V_new)^2 / R
   P_new = (110)^2 / 484
   P_new = 12100 / 484 = 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) 1:4

Explanation:

1. Let the resistance of each wire be R.
2. In series, total resistance (Rs) = R + R = 2R.
3. Heat produced in series (Hs) = (V^2 / Rs) * t = (V^2 / 2R) * t.
4. In parallel, total resistance (Rp) = (R * R) / (R + R) = R / 2.
5. Heat produced in parallel (Hp) = (V^2 / Rp) * t = (V^2 / (R/2)) * t = (2 * V^2 / R) * t.
6. Ratio of heat produced:
   Hs / Hp = [(V^2 / 2R) * t] / [(2 * V^2 / R) * t]
   Hs / Hp = (1 / 2) / 2 = 1 / 4
   Therefore, the ratio is 1:4.

Question 5
How is a voltmeter connected in the circuit to measure the potential difference between two points?

Answer:
A voltmeter is always connected in parallel across the two points where the potential difference is to be measured. It is designed with a very high internal resistance so that it draws negligible current from the main circuit, ensuring an accurate voltage reading.

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 its resistance 10 Ohm? How much does the resistance change if the diameter is doubled?

Answer:
Part 1: Finding the length

- Given:
  Diameter (d) = 0.5 mm = 0.5 x 10^-3 m
  Radius (r) = d / 2 = 0.25 x 10^-3 m
  Resistivity (rho) = 1.6 x 10^-8 Ohm-m
  Resistance (R) = 10 Ohms
- Cross-sectional Area (A) = pi * r^2
  A = 3.14 * (0.25 x 10^-3)^2
  A = 3.14 * 0.0625 x 10^-6 = 1.9625 x 10^-7 m^2
- Formula: R = rho * (l / A)
  l = (R * A) / rho
  l = (10 * 1.9625 x 10^-7) / (1.6 x 10^-8)
  l = 1.9625 x 10^-6 / 1.6 x 10^-8
  l = 122.65 meters

Part 2: If the diameter is doubled

- Resistance is inversely proportional to the square of the diameter (R proportional to 1 / d^2).
- If the diameter is doubled, the cross-sectional area becomes 4 times larger.
- Consequently, the new resistance will become one-fourth of the original resistance:
  New Resistance = R / 4 = 10 / 4 = 2.5 Ohms.

Question 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.

Answer:
Graph Plotting Instructions:
When creating your document, plot 'I' on the X-axis and 'V' on the Y-axis. The data points will form a straight upward-sloping line, demonstrating a linear relationship that verifies Ohm's Law.

Calculation of Resistance:
The resistance (R) corresponds to the slope of the V-I graph.

- Let us pick two points from the data set:
  Point 1: I1 = 1.0 A, V1 = 3.4 V
  Point 2: I2 = 3.0 A, V2 = 10.2 V
- Slope (R) = (V2 - V1) / (I2 - I1)
  R = (10.2 - 3.4) / (3.0 - 1.0)
  R = 6.8 / 2 = 3.4 Ohms

The average resistance of the resistor is 3.4 Ohms.

Question 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.

Answer:

- Given:
  Voltage (V) = 12 V
  Current (I) = 2.5 mA = 2.5 x 10^-3 A
- Using Ohm's Law (R = V / I):
  R = 12 / (2.5 x 10^-3)
  R = (12 * 1000) / 2.5
  R = 12000 / 2.5 = 4800 Ohms (or 4.8 kOhms)

The resistance of the unknown resistor is 4800 Ohms.

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

Answer:

- Given resistances in series:
  R1 = 0.2 Ohm, R2 = 0.3 Ohm, R3 = 0.4 Ohm, R4 = 0.5 Ohm, R5 = 12 Ohm
  Voltage (V) = 9 V
- Total Equivalent Resistance (Rs) = R1 + R2 + R3 + R4 + R5
  Rs = 0.2 + 0.3 + 0.4 + 0.5 + 12 = 13.4 Ohms
- Total current in the circuit (I) = V / Rs
  I = 9 / 13.4 = 0.67 A
- In a series circuit, the current remains identical through all components.
- Therefore, the current flowing through the 12 Ohm resistor is 0.67 A.

Question 10
How many 176 Ohm resistors (in parallel) are required to carry 5 A on a 220 V line?

Answer:

- Given:
  Resistance of one individual resistor (R) = 176 Ohms
  Total Current (I) = 5 A
  Total Voltage (V) = 220 V
- Let 'n' be the number of required resistors.
- Total required target resistance (Rp) = V / I
  Rp = 220 / 5 = 44 Ohms

- For 'n' identical resistors connected in parallel:
  Rp = R / n
  44 = 176 / n
  n = 176 / 44
  n = 4

Exactly 4 resistors connected in parallel are required.

Question 11
Show how you would connect three resistors, each of resistance 6 Ohm, so that the combination has a resistance of (i) 9 Ohm, (ii) 4 Ohm.

Answer:
Case (i) To get 9 Ohms:

- Connect two 6 Ohm resistors in parallel, and then connect this pair in series with the third 6 Ohm resistor.
- Equivalent resistance of the parallel pair (Rp) = (6 * 6) / (6 + 6) = 36 / 12 = 3 Ohms.
- Total Resistance (R_total) = Rp + 6 = 3 + 6 = 9 Ohms.

Case (ii) To get 4 Ohms:

- Connect two 6 Ohm resistors in series, and then connect this entire branch in parallel with the third 6 Ohm resistor.
- Equivalent resistance of the series branch (Rs) = 6 + 6 = 12 Ohms.
- Total Resistance (R_total) = (Rs * 6) / (Rs + 6) = (12 * 6) / (12 + 6) = 72 / 18 = 4 Ohms.

Question 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?

Answer:

- Given:
  Power of one bulb (P) = 10 W
  Voltage (V) = 220 V
  Maximum allowable current (I) = 5 A
- Resistance of one bulb (R) = V^2 / P
  R = (220 * 220) / 10 = 48400 / 10 = 4840 Ohms
- Total target resistance allowed for the circuit (Rp) = V / I
  Rp = 220 / 5 = 44 Ohms
- For 'n' identical bulbs in parallel:
  Rp = R / n
  44 = 4840 / n
  n = 4840 / 44
  n = 110

A maximum of 110 lamps can be connected in parallel.

Question 13
A hot plate of an electric oven connected to a 220 V line has two resistance coils A and B, each of 24 Ohm resistance, which may be used separately, in series, or in parallel. What are the currents in the three cases?

Answer:

- Given:
  Voltage (V) = 220 V
  Resistance of individual coils, Ra = Rb = 24 Ohms
- Case 1: Coils used separately
  Current (I) = V / Ra = 220 / 24 = 9.17 A
- Case 2: Coils used in series
  Total Resistance (Rs) = 24 + 24 = 48 Ohms
  Current (I) = V / Rs = 220 / 48 = 4.58 A

- Case 3: Coils used in parallel
  Total Resistance (Rp) = 24 / 2 = 12 Ohms
  Current (I) = V / Rp = 220 / 12 = 18.33 A

Question 14
Compare the power used in the 2 Ohm resistor in each of the following circuits:
(i) A 6 V battery in series with 1 Ohm and 2 Ohm resistors, and
(ii) A 4 V battery in parallel with 12 Ohm and 2 Ohm resistors.

Answer:

- Circuit (i): 6 V battery in series with 1 Ohm and 2 Ohm resistors
  Total resistance (Rs) = 1 + 2 = 3 Ohms
  Circuit current (I) = V / Rs = 6 / 3 = 2 A
  Since it is a series connection, the current through the 2 Ohm resistor is 2 A.
  Power used in the 2 Ohm resistor = I^2 * R = (2)^2 * 2 = 4 * 2 = 8 W
- Circuit (ii): 4 V battery in parallel with 12 Ohm and 2 Ohm resistors
  In a parallel circuit, the voltage across each parallel branch matches the battery voltage.
  Voltage across the 2 Ohm resistor = 4 V
  Power used in the 2 Ohm resistor = V^2 / R = (4)^2 / 2 = 16 / 2 = 8 W

Comparison: The power consumed by the 2 Ohm resistor is exactly the same (8 W) in both electrical configurations.

Question 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?

Answer:

- Given:
  Power of lamp 1 (P1) = 100 W
  Power of lamp 2 (P2) = 60 W
  Voltage (V) = 220 V
- Because the elements are arranged in parallel, total power is the sum of individual powers:
  Total Power (P_total) = P1 + P2 = 100 + 60 = 160 W
- Formula for total current: P_total = V * I
  I = P_total / V
  I = 160 / 220 = 8 / 11 = 0.73 A

The total current drawn from the line is 0.73 A.

Question 16
Which uses more energy, a 250 W TV set in 1 hr, or a 1200 W toaster in 10 minutes?

Answer:

- Energy consumption formula: E = Power * Time
- For the TV set:
  Power = 250 W = 0.25 kW
  Time = 1 hour
  Energy (E_tv) = 0.25 kW * 1 h = 0.25 kWh
- For the Toaster:
  Power = 1200 W = 1.2 kW
  Time = 10 minutes = 10 / 60 hours = 1 / 6 hours
  Energy (E_toaster) = 1.2 kW * (1 / 6) h = 0.2 kWh

Conclusion: Comparing 0.25 kWh to 0.2 kWh shows that the TV set uses more energy.

Question 17
An electric heater of resistance 8 Ohm draws 15 A from the service mains 2 hours. Calculate the rate at which heat is developed in the heater.

Answer:

- Given:
  Resistance (R) = 8 Ohms
  Current (I) = 15 A
  Time (t) = 2 hours (Note: The term "rate at which heat is developed" refers directly to Electrical Power, making time an extra piece of information).
- Rate of heat development (Power, P) = I^2 * R
  P = (15)^2 * 8
  P = 225 * 8 = 1800 W (or 1800 Joules per second)

The rate at which heat develops is 1800 W.

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

Answer:
(a) Tungsten has an exceptionally high melting point (approx. 3380 degrees Celsius) and high resistivity. This prevents it from melting or oxidizing easily even when glowing at white-hot temperatures inside a lightbulb.
(b) Alloys have higher resistivity than their constituent pure metals and possess a significantly higher melting point. They also do not undergo oxidation (burn up) at high operating temperatures.
(c) In a series circuit, if one appliance fails or is turned off, the entire circuit

breaks, causing all other connected devices to turn off. Additionally, appliances cannot get a uniform voltage line supply in series.

(d) The resistance of a uniform wire is inversely proportional to its cross-sectional area (R proportional to 1/A). Doubling the thickness decreases the resistance to one-fourth.

(e) Copper and aluminium are excellent electrical conductors with very low values of resistivity. They allow current to pass easily through them while minimizing energy loss as heat during transmission.
