SCIENCE
WORKSHEET_201125
CHAPTER 11 ELECTRICITY (ANSWERS)

SUBJECT: SCIENCE	**MAX. MARKS : 40**
CLASS : X	**DURATION : 1½ hrs**

General Instructions:
(i).   **All** questions are compulsory.
(ii). This question paper contains 2**0** questions divided into five Sections A, B, C, D and E.
(iii). **Section A** comprises of **10 MCQs** of **1 mark** each. **Section B** comprises of 4 questions of **2 marks** each. **Section C** comprises of 3 questions of **3 marks** each. **Section D** comprises of 1 question of **5 marks** each and **Section E** comprises of 2 Case Study Based Questions of **4 marks** each.
(iv). There is no overall choice.
(v).   Use of Calculators is not permitted
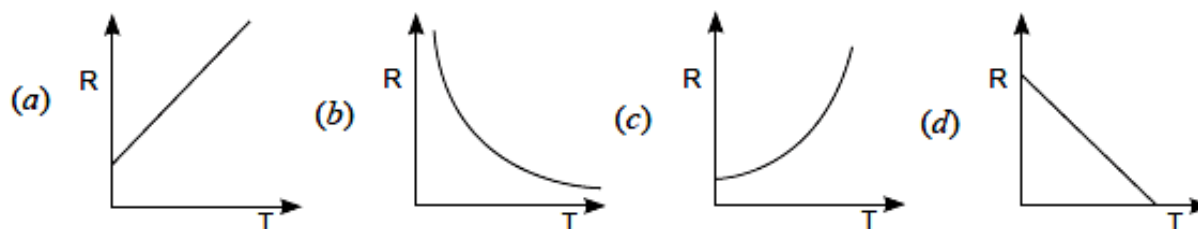
<u>SECTION – A</u>
Questions 1 to 10 carry 1 mark each.

1. A wire of length l, made of material resistivity r is cut into two equal parts. The resistivity of the two parts are equal to,
    (a) ρ (b) $\rho/2$ (c) 2ρ (d) 4ρ
    Ans. (a) ρ
    Resistivity of the material depends only on the nature of material not dimensions.

2. The temperature of a conductor is increased. The graph best showing the variation of its resistance is
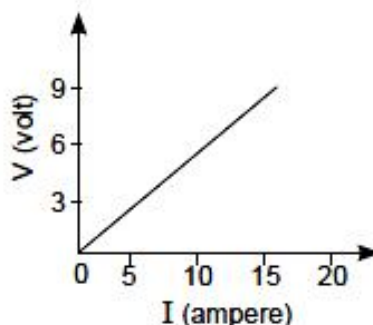

    Ans. (a)
    Resistance is directly proportional to temperature of the conductor.

3. A battery of 10 volt carries 20,000 C of charge through a resistance of 20 Ω. The work done in 10 seconds is
    (a) 2×10^3 joule   (b) 2×10^5 joule   (c) 2×10^4 joule   (d) 2×10^2 joule
    Ans. (b) 2×10^5 joule
    $W = qV = 20000 \times 10 = 2,00,000 = 2 \times 10^5$ J

4. The resistance whose V – I graph is given below is

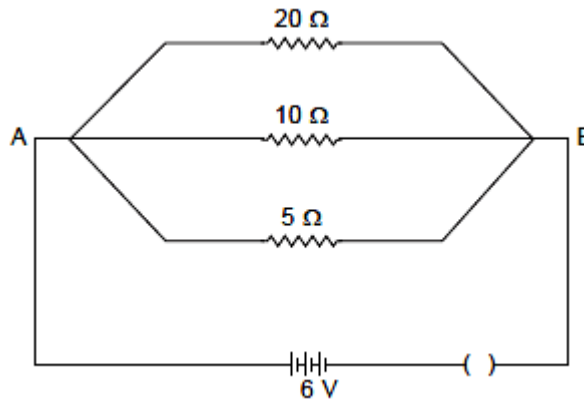(a) $\dfrac{5}{3}\Omega$ (b) $\dfrac{3}{5}\Omega$ (c) $\dfrac{5}{2}\Omega$ (d) $\dfrac{2}{5}\Omega$

Ans. (b) $\dfrac{3}{5}\Omega$

Resistance = slope line of V-I graph = $\dfrac{9-0}{15-0} = \dfrac{9}{15} = \dfrac{3}{5}\Omega$

5. Calculate the current flows through the 10 Ω resistor in the following circuit.

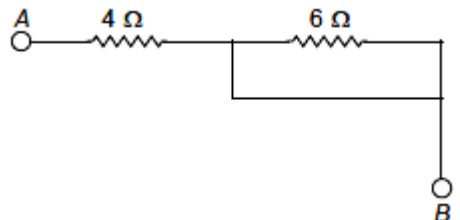(a) 1.2 A   (b) 0.6 A   (c) 0.2 A   (d) 2.0 A

Ans. (b) 0.6 A

In parallel, potential difference across each resistor will remain same. So, current through 10 Ω resistor

$I = \dfrac{V}{R} = \dfrac{6}{10} = 0.6A$

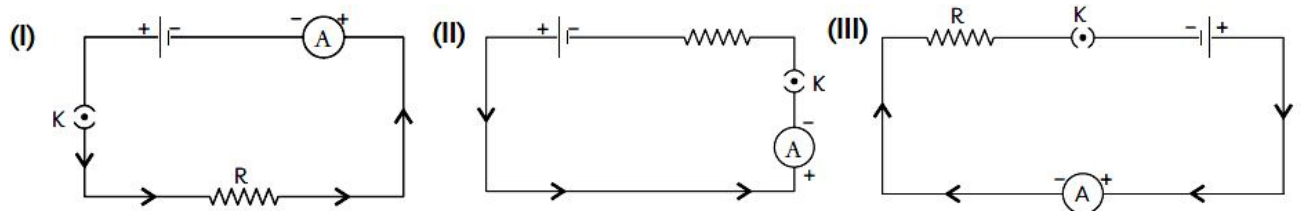6. The effective resistance between A and B is

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

Ans. (a) 4 Ω

6 Ω is shorted so effective resistance is 4 Ω.

7. A cell, a resistor, a key and an ammeter are arranged as shown in the circuit diagrams. The current recorded in the ammeter will be

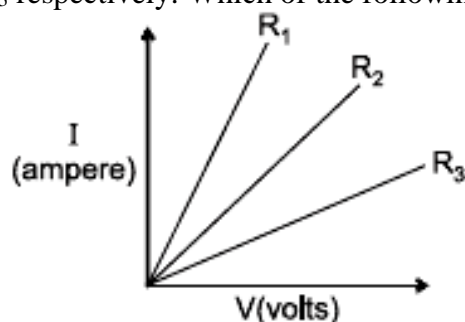(a) maximum in (I)   (b) maximum in (II)   (c) maximum in (III)   (d) same in all the cases

Ans. (d) same in all the cases

Ammeter is always connected in series with in the circuit. The reading is independent from its location.

8. A student carries out an experiment and plots the V-I graph of three samples of nichrome wire with resistances R_1, R_2 and R_3 respectively. Which of the following is true?

(a) $R_1 = R_2 = R_3$ (b) $R_1 > R_2 > R_3$ (c) $R_3 > R_2 > R_1$ (d) $R_2 > R_3 > R_1$

Ans. (c) $R_3 > R_2 > R_1$

Current is inversely proportional to the resistance for the same potential. So higher resistance would allow less current to pass through its which is shown by R_3, as $I_3 < I_2 < I_1$.

∴ $R_3 > R_2 > R_1$

In the following questions 9 and 10, a statement of assertion (A) is followed by a statement of reason (R). Mark the correct choice as:

(a) Both assertion (A) and reason (R) are true and reason (R) is the correct explanation of assertion (A).

(b) Both assertion (A) and reason (R) are true but reason (R) is not the correct explanation of assertion (A).

(c) Assertion (A) is true but reason (R) is false.

(d) Assertion (A) is false but reason (R) is true.

9. **Assertion (A):** One circuit with 15 A current rating is used for appliances such as geysers and air coolers.

Reason (R): Appliances with metallic body are connected to an earth wire with low resistance.

Ans. (b) Both A and R are true, and R is not the correct explanation of A.

The assertion (A) that one circuit with a 15 A current rating is used for appliances like geysers and air coolers is valid based on the anticipated power requirements of these devices. However, the reason (R) provided, stating that appliances with metallic bodies are connected to an earth wire with low resistance, does not directly explain the specific choice of a 15 A current rating for the circuit. The connection to an earth wire is generally a safety measure to dissipate fault currents, but it doesn't inherently determine the precise current rating chosen for the circuit. Therefore, both statements (A and R) are correct, but the reason (R) is not the correct explanation for assertion (A).

10. **Assertion (A):** At high temperatures, metal wires have a greater chance of short circuiting.

Reason (R): Both resistance and resistivity of a material vary with temperature.

Ans. (b) Both (A) and (R) are true, and (A) is not the correct explanation of (A).

At high temperatures, the free electrons start moving at a greater speed and more heat is evolved. The increased amount of heat melts the insulation of wires and wires have greater chance of short circuiting. Sometimes the short circuit may even melt the wire and it may cause fire. Both resistance and resistivity vary with temperature. When the temperature is increased, the random motion of electrons increases. As a result the number of collision increases between atoms and electrons.
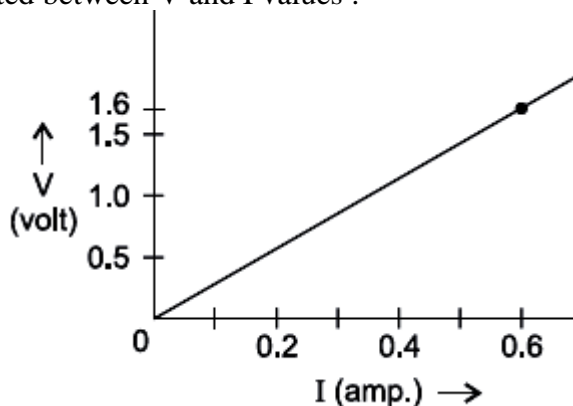
SECTION – B
Questions 11 to 14 carry 2 marks each.

11. Define 1 volt. Express it in terms of SI unit of work and charge. Calculate the amount of energy consumed in carrying a charge of 1 coulomb through a battery of 3 V.

Ans. When 1 joule of work is done in carrying 1 coulomb of charge, from infinity to a point in the electric field, then potential at that point is called 1 volt. Potential difference between two points is $V = \dfrac{W}{Q}$

$\Rightarrow W = Q \times V = 1 \times 3 = 3$ J

12. Following graph was plotted between V and I values :

What would be the values of V /I ratios when the potential difference is 0.8 V, 1.2 V and 1.6 V respectively? What conclusion do you draw from these values?

Ans. From the graph, when p.d is 1.6 volt and 0.6 A current the ratio of $\dfrac{V}{I} = \dfrac{1.6}{0.6} = 2.67\Omega$

Therefore, straight line nature of graph shows that the value of ratio $\dfrac{V}{I}$ for all potential difference of 0.8 V, 1.2 V and 1.6 volt will be same and is equal to 2.67 Ω. We conclude that at the given temperature, the resistance of wire is constant and is equal to 2.67 Ω.

13. List the factors on which the resistance of a conductor in the shape of a wire depends.
Ans. The factors on which the resistance of a conductor in the shape of wire depends
(i) Length of the conductor: Resistance is directly proportional to length of the conductor.
(ii) Area of cross section of the wire: The resistance is inversely proportional to area of cross section of the wire.
(iii) The resistance of the conductor depends on the nature of its material.
(iv) Temperature of the conductor: Resistance is directly proportional to the temperature of the conductor.

14. (a) Why are metals good conductors of electricity whereas glass is a bad conductor of electricity? Give reason.
(b) Why are alloys commonly used in electrical heating devices? Give reason.
Ans. (a) Metals are good conductor of electricity as they have free electrons to conduct whereas glass is a bad conductor of electricity as it does not allow electric current to pass through it due to non-availability of free electrons.
(b) The alloys are commonly used in electric heating device. This is because
(i) Alloy are combination of two or more metals.
(ii) Its resistivity is higher than that of its constituent metals.
(iii) It neither gets oxidised nor burn easily at high temperature.
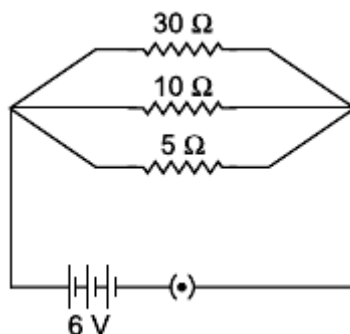(iv) It shows less rapid variations of resistivity due to change in temperature.

SECTION – C
Questions 15 to 17 carry 3 marks each.

15. For the electric circuit given below calculate:
(i) Current in each resistor,

(ii) Total current drawn from the battery, and
(iii) Equivalent resistance of the circuit.

30 Ω
10 Ω
5 Ω
6 V

(i) Current through each resistor

$$I_1 = \frac{V}{R_1} = \frac{6}{5} = 1.2 \text{ A}$$

$$I_2 = \frac{V}{R_2} = \frac{6}{10} = 0.6 \text{ A}$$

$$I_3 = \frac{V}{R_3} = \frac{6}{30} = 0.2 \text{ A}$$

Current in 5 Ω, 10 Ω and 30 Ω are therefore, 1.2 A, 0.6 A and 0.2 A respectively.
(ii) Total current drawn from the battery

$$I = I_1 + I_2 + I_3 = 1.2 + 0.6 + 0.2 = 2.0 \text{ A}$$

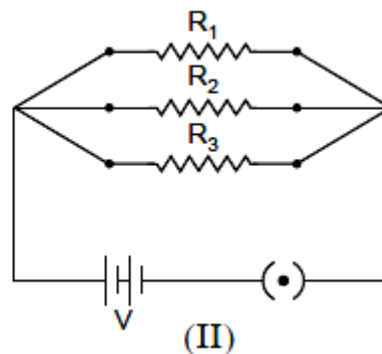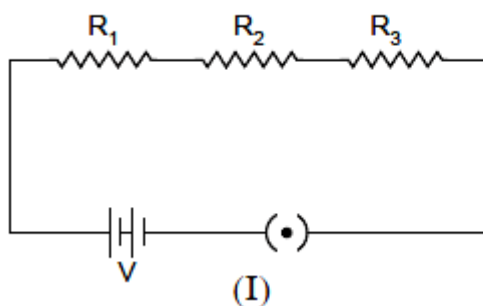(iii) $R_1 = 5 \text{ Ω}, R_2 = 10 \text{ Ω}$ and $R_3 = 30 \text{ Ω}$ are connected in parallel.

So their equivalent resistance

$$\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} = \frac{1}{5} + \frac{1}{10} + \frac{1}{30} = \frac{1}{3}$$

$$R = 3 \text{ Ω}$$

16. Two electric circuits I and II are shown below

R_1 R_2 R_3

V

(I)

R_1
R_2
R_3

V

(II)

(i) Which of the two circuits has more resistance?
(ii) Through which circuit more current passes?
(iii) In which circuit, the potential difference across each resistor is equal?
Ans. (i) Equivalent resistance of a series combination is more that of a their parallel combination. Hence, circuit 'I' has more resistance.
(ii) From Ohm's Law, for the same applied potential difference, current is inversely proportional to equivalent resistance of the combination, i.e. $I \propto \dfrac{1}{R}$

Therefore, in parallel combination, circuit II, has less resistance, hence, more current will pass through it.
(iii) Parallel combination, the potential difference across each resistance is equal to the applied potential difference.

17. A current of 1 A is drawn by a filament of an electric bulb. Calculate the number of electrons passing through the cross-section of the filament in 30 minutes.

Ans. Given: I = 1 A, t = 30 min = 30 × 60 = 1800 sec

Using, Q = It = 1 × 1800 = 1800 C

Now, Q = ne ⇒

$1800 = n \times 1.6 \times 10^{-19}$

$\Rightarrow n = \dfrac{1800}{1.6 \times 10^{-19}} = 1125 \times 10^{19}$

$\Rightarrow n = 1.125 \times 1022$

Hence, number of electrons passing through the filament in 30 minutes = 1.125×10^{22} electrons.

$\simeq 10^{22}$ electrons

SECTION – D
Questions 18 carry 5 marks.

18. (a) Define electric power. Express it in terms of potential difference V and resistance R.

(b) An electrical fuse is rated at 2A. What is meant by this statement?

(c) An electric iron of 1 kW is operated at 220 V. Find which of the following fuses that respectively rated at 1 A, 3 A and 5 A can be used in it.

Ans.

(a) Electric power: It is the rate of doing work by an energy source or the rate at which the electrical energy is dissipated or consumed per unit time in the electric circuit is called electric power.

So, Power $P = \dfrac{\text{Work done }(W)}{\text{Time }(t)} = \dfrac{\text{Electrical energy dissipated}}{\text{Time }(t)} = \dfrac{VIt}{t} = VI = \dfrac{V^2}{R}$

(b) It means, the maximum current will flow through it is only 2 A. Fuse wire will melt if the current exceeds 2 A value through it.
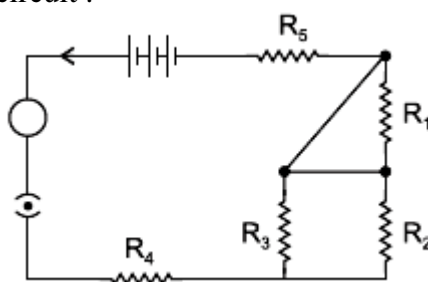
(c) Given: $P = 1$ kW = 1000 W, $V = 220$ V

Current drawn, $I = \dfrac{P}{V} = \dfrac{1000}{220} = \dfrac{50}{11} = 4.54$ A

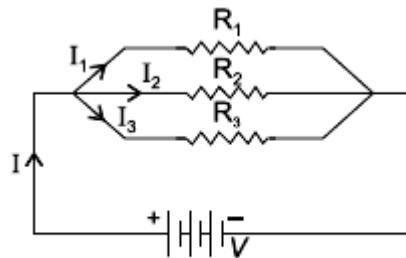To run electric iron of 1 kW, rated fuse of 5 A should be used.

OR

Deduce the expression for the equivalent resistance of the parallel combination of three resistors R_1, R_2 and R_3.

Consider the following electric circuit :

(a) Which two resistors are connected in series?

(b) Which two resistors are connected in parallel?

(c) If every resistor of the circuit is of 2 Ω, what current will flow in the circuit?

Ans. Consider the following parallel circuit shown below :

[Parallel circuit]

Let I_1, I_2 and I_3 be the current flow through the resistor R_1, R_2 and R_3 connected in parallel. Using Ohm's law, current through each resistor is

$$I_1 = \frac{V}{R_1}, I_2 = \frac{V}{R_2} \text{ and } I_3 = \frac{V}{R_3}$$

Let their equivalent resistance be R_P then

$$V = IR_P \Rightarrow I = \frac{V}{R_P}$$

Total current through the circuit is $I = I_1 + I_2 + I_3$

or

$$\frac{V}{R_P} = \frac{V}{R_1} + \frac{V}{R_2} + \frac{V}{R_3}$$

or

$$\frac{V}{R_P} = V\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)$$

or

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

For the given circuit

(a) R_5 and R_4 with Parallel combination of R_2 and R_3 are in series

(b) R_2 and R_3 are in parallel.

(c) R_2 and R_3 in parallel gives $R_p = 1\ \Omega$

R_p, R_5 and R_4 are in series. So, $R_{eq} = 5\ \Omega$

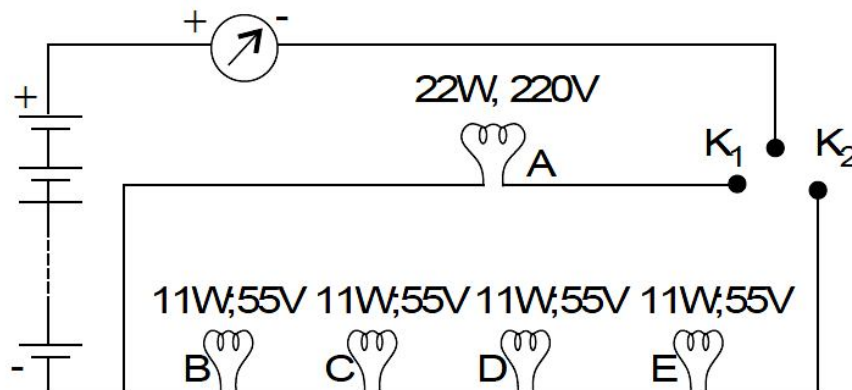R_1 is not to be taken as it is shorted.

Current flowing $= I = \dfrac{V}{R_{eq}} = \dfrac{5}{5} = 1A$

SECTION – E (Case Study Based Questions)

Questions 19 to 20 carry 4 marks each.

19. **Read the given passage and answer the questions based on passage and related studied concepts.**

In a domestic circuit, five LED bulbs are arranged as shown. The source voltage is 220 V and the power rating of each bulb is marked in the circuit diagram.

Based on the above circuit diagram, answer the following questions:

(a) State what happens when

(i) key K_1 is closed.
(ii) key K_2 is closed.
(b) Find the current drawn by the bulb B when it glows.
(c) Calculate
(i) the resistance of bulb B, and
(ii) total resistance of the combination of four bulbs B, C, D and E.

OR

What would happen to the glow of all the bulbs in the circuit when keys 1 and K_2 both are closed and the bulb C suddenly get fused? Give reason to justify your answer

Ans. (a) (i) Only bulb A will glow.
(ii) Bulbs B, C, D and E will glow.
(b) Let current drawn by bulb B = I
We know that, P = VI

$$\Rightarrow I = \frac{P}{V} = \frac{11}{55} = \frac{1}{5}A = 0.2A$$
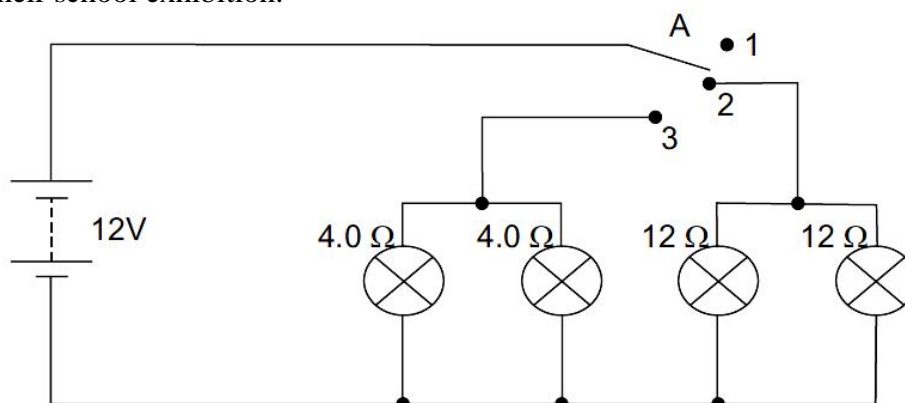
(c) (i) Using Ohm's law, V = IR

$$\Rightarrow R_B = \frac{V_B}{I} = \frac{55}{1/5} = 275\Omega$$

(ii) Total resistance = $4 \times 275 = 1100\Omega$

OR

Only bulb A will glow. Bulbs B, D and E will not glow because in a series circuit when one bulb fuses, the entire circuit breaks and none of the bulb glows up.

20. Vinita and Ahmed demonstrated a circuit that operates the two headlights and the two sidelights of a car, in their school exhibition.

Based on their demonstrated circuit, answer the following questions:
(a) State what happens when switch A is connected to
(i) Position 2 (ii) Position 3
(b) Find the potential difference across each lamp when lit.
(c) Calculate the current:
(i) In each 12 Ω lamp when lit.
(ii) In each 4 Ω lamp when lit.

OR

Show, with calculations, which type of lamp, 4.0 Ω or 12 Ω, has the higher power.
Ans. (a) (i) Only 12 Ω lamps will light up.
(ii) Only 4 Ω lamps will light up.
(b) 12 V for both sets of lamps as all of them are in parallel.
(c) (i) Voltage across both 12 Ω lamps = 12 V.
Using Ohm's law, V = IR

$$\Rightarrow I = \frac{V}{R} = \frac{12}{12} = 1A$$

(ii) Voltage across both 4 Ω lamps = 12 V.

Using Ohm's law, V = IR

$$\Rightarrow I = \frac{V}{R} = \frac{12}{4} = 3A$$

OR

All lamps are in parallel and hence same V for all lamps.

Using, P = V²/R

For 4 Ω lamps, $P = \frac{12 \times 12}{4} = 36W$

For 12 Ω lamps, $P = \frac{12 \times 12}{12} = 12W$

Hence, 4 Ω lamps will have higher power.