

1. EFFECTS OF ELECTRIC CURRENT

CLASS.4

Electric Power

The amount of energy consumed/released by an electrical appliance in unit time (in one second) is its power. The unit of power is joule/second and is called '**watt**'.

$$\text{Power } P = H/t = I^2Rt/t = I^2R$$

But using the relations $I = V/R$ & $R = V/I$, power can also be expressed as

$$P = V^2/R = VI$$

Note: i) If voltage is constant, power is inversely proportional to the resistance.

That is, $P \propto (1/R)$

ii) If current is constant, power is directly proportional to the resistance. That is, $P \propto R$

? An electric heater of power 460 W is worked at the voltage 230V.

a. What is its amperage? b. Find the resistance of the heating coil.

Ans.a. Amperage, $I = P/V = 460/230 = 2 \text{ A}$

b. Resistance $R = V^2/P = 230 \times 230 / 460 = 115 \Omega$

Lighting Effect of electric current.

Incandescent lamp(Filament lamp): Incandescent lamp works on lighting effect of electric current. In this, a filament is supported by two copper wires. The filament is made of a pure metal **tungsten** that can become white hot and emit white light when current is passed through it. In order to **avoid oxidation of the filament, the bulb is evacuated. And it is filled with inert gas or nitrogen gas for preventing vaporisation of the filament.**

Note: The word 'incandescent' means *glowing with heat*.

Features of tungsten as a filament.

* Emit white light when it is being heated* High melting point * High resistivity

* High ductility.

Merits and demerits of Incandescent lamps.

Merits: Low cost, It doesn't make pollution.

Demerit: Major part of (above 60%) electric energy given to the lamp is lost as heat.

Discharge lamps: In discharge lamps light is produced as a result of discharge of electricity through gases filled in a tube at low pressure. Discharge lamps are more efficient than incandescent lamp. Sodium vapour lamp, fluorescent lamp, CFL, Arc lamp etc are discharge lamps.

When voltage is applied between the electrodes of these lamps, the atoms of the gas inside the tube gets excited. When the excited atom comes back to the original state, light will be radiated.

Energy loss in most of the discharge lamps is very small. That is why we widely use discharge lamps like fluorescent lamp, CFL etc.

LED Lamps: The full form of LED is Light Emitting Diode. It is an **electronic device** which converts electric energy into light energy by consuming low power. LED lamps are more efficient than any other lamps.

Advantages of LED Lamps: i) Work at low power. ii) No energy loss in the form of heat as there is no filament. (high efficiency) iii) High longevity iv) Not harmful to environment

As LED lamps are more efficient, its production and use are to be encouraged.

PRACTICE QUESTIONS & ANSWERS

1. When 1.5V is applied to a piece of tungsten filament, it burns into ashes. But it doesn't happen so even at 230V, when the filament is inside the bulb. Why?

Answer: Tungsten is a metal than can oxidise at high temperature. That is why filament burns away even when a small voltage is applied in the presence of air. But there is no oxygen inside the bulb and hence the filament doesn't oxidise even at high voltage.

2. Gas atoms in the discharge lamps are excited to high energy level. Why do the excited atoms give out energy?

Answer: For coming back to their original state to attain stability.

3. "The use of LED lamps are to be encouraged" Why?

Ans. i. Its efficiency is high. ii. It doesn't make environmental pollution.

4. Ramesh got a bulb of broken filament. He gently joined the ends of the filament and worked it. Then it is seen that its power is increased. Can you explain why?

Answer: When filament was rejoined, its length would have been reduced. It may leads to reduce the resistance of the filament. As power is inversely proportional to resistance at constant voltage, power is increased.

5. What happens to the power of a device/conductor due to the change in applied voltage.

Answer: We have $P = V^2/R$. So, power is directly proportional to square of the voltage. That is, if voltage is doubled, power will be quadrupled. Or If voltage is halved, power will be one fourth.

6. It is marked as 100W,220V in an electric appliance. What will be its power if the applied voltage is 110V.

Answer: Resistance of the appliance $R = V^2/P = 220 \times 220 / 100 \approx 484 \Omega$.

Then the power at 110V $= V^2/R = 110 \times 110 / 484 = 25 \text{ W}$

Another method: Power is directly proportional to square of the voltage. Here voltage is halved. So power will be $\frac{1}{4}$ th of the marked power. That is, new power = $100/4 = 25 \text{ W}$

7. Two bulbs are marked as 40W,240V and 100W,240V. Which one has greater resistance?

Answer: Resistance of 40W bulb, $R_{40} = V^2/P = 240 \times 240 / 40 = 1440 \Omega$.

Resistance of 100W bulb, $R_{100} = V^2/P = 240 \times 240 / 100 = 576 \Omega$.

8. Two bulbs are connected in series as shown in the figure.

a. Find resistance of each bulb.

b. If current passes through the bulb L_1 is 0.45A, what will be the current through the bulb L_2 .

c. Of these which will show more brightness?

d. Why does this bulb emit more light?

e. If they were connected parallel, which bulb would give more light. Why?

Answer: a. Resistance of $L_1, R_1 = V^2/P = 200 \times 200 / 40 = 1000 \Omega$

Resistance of $L_2, R_2 = V^2/P = 200 \times 200 / 50 = 800 \Omega$

b. As the bulbs are connected in series, current will be same through both bulbs. That is, 0.45 A itself through the bulb L_2 .

c. L_1 will glow brighter. d. Because resistance of L_1 is greater than that of L_2 .

e. The bulb L_2 will give more light. Because when they are connected parallel, more current will pass through low resistance.

9. Filaments lamps are also called incandescent lamps. a. What is the meaning of the word "incandescent"

b. Name the substance used for making filament?

c. What are the features of this substance?

d. What are the advantages of filling the bulbs with nitrogen after removing air from them?

e. What is the major limitation of filament lamp?

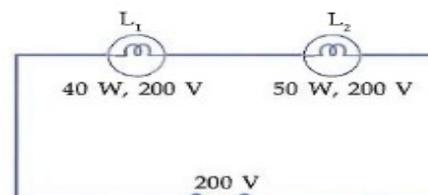
f. Name three light source that can be used as substitute for incandescent lamp.

Answer: a. glowing with heat. b. Tungsten c. ability to emit white light on being heated, high melting point, high resistivity, high ductility.

d. prevent oxidation and vapourisation of filament.

e. Major portion (above 60%) of electrical energy consumed is lost in the form of heat.

f. discharge lamp, fluorescent lamp, CF lamp, LED lamp.



10. What is your opinion about making filament using nichrome?

Answer: It is doesn't work. Because i) Nichrome cannot emit white light when it gets heated.
ii) Nichrome almost completely converts the consumed electric energy into heat energy.

1. A bulb was designed to get a specific power when it works on 250V. When this bulb is worked at 100V, its power is 16W. Then what was its desired power?

Answer: We have $P = V^2/R$ Then the resistance of the bulb, $R = V^2/P = 100 \times 100 / 16 = 625 \Omega$
So the desired power of the bulb $P^1 = V^2/R = 250 \times 250 / 625 = 100W$.

12. Power of an electric Iron is 1000W. When it works at its marked power what will be heat energy released per second?

Ans.Power is the energy consumed or released per second. So this iron box will release 1000 J of heat energy in one second.

13. An electric appliance designed to work at 230V has 690Ω resistance. Find its power.

Answer: Power $P = V^2/R = 230 \times 230 / 690 = 76.7 W$

14. Whether 1kW heater or 100W bulb which work on 230V posses more resistance? Why?

Answer: We have $P = V^2/R$ Or $R = V^2/P$

Resistance of heater $R_H = 230 \times 230 / 1000 = 52.9 \Omega$

Resistance of bulb $R_B = 230 \times 230 / 100 = 529 \Omega$

a. What are indicated in it? b. Calculate the energy produced if it works at 230V for 5 minutes.

Answer: a. 750 W is its power and 230 V is required voltage to consume this power.

b. Heat produced in 5 minutes = power x time = $750 \times 5 \times 60 = 225000 J$.

15. A 40 W fluorescent lamp and 40 W incandescent lamp are used in a house.

Which is the lamp that consumes more current?

Answer: a. As the power of both lamps are same, same current will be drawn by each.

16. A wire AB of 20Ω resistance is included in a circuit as shown in the figure.

a. Find the current in the circuit.

b. If the wire is folded into half and included in the same circuit, what will be the current ?

c. Calculate the heat produced in the circuit in one second then.

d. What is the power then?

Answer: a. $R = 20 \Omega$ $V = 10V$ $I = V/R = 10/20 = 0.5A$

b. When it is folded, length is halved and thickness is doubled. So resistance becomes $\frac{1}{4}$ of the previous value.

Therefore new resistance $R^1 = 20/4 = 5 \Omega$. Then current $I^1 = V/R^1 = 10/5 = 2A$.

c. Heat produced in one second, $H = VIt = 10 \times 2 \times 1 = 20J$.

d. Power is the energy released or consumed per second. So power of the wire is 20W.

17. is an electronic device works on lighting effect of current. **Answer:** LED Lamp.

18. Which of the following is not expressing power.

a. I^2Rt . b. V^2/R c. I^2R . d. VI **Answer:** a. I^2Rt .

19. The marking on an electrical appliance is 800W,200V.

a. If it works on 100 V, what will be the consumed power?

b. What is the power when it works on 50V?

Answer: a. Resistance of the appliance, $R = V^2/P = 200 \times 200 / 800 = 50 \Omega$

Power when it is worked on 100V, $P = V^2/R = 100 \times 100 / 50 = 200W$.

b. Power when it is worked on 50V, $P = V^2/R = 50 \times 50 / 50 = 50W$

