CHAPTER

6

Electricity

Electricity

- When two bodies are rubbed together, they acquire the property of attracting light objects like small bits of paper dust particles. The bodies which acquire this property are said to be electrified or charged with electricity.

Charge

- Charge is the basic property associated with matter due to which it produces and experience electrical and magnetic effects.
- Similar charges repel each other and opposite charges attract each other.
- **Conductors** are those substances which allow passage of electrical charges to flow through them and have very low electrical resistance *e.g.*, copper, aluminum, gold, silver etc.
- **Resistors** offer high resistance to flow of current through them *e.g.*, eureka, nichrome etc.
- **Insulators** have infinite resistance and do not allow the passage of current *e.g.*, rubber, glass etc.

Electric Potential

- The electric potential at a point is the work done in bringing a unit positive charge from infinity to that point.
- Electric potential $= \frac{\text{Work done}}{\text{Charge}}$

  Its SI unit is volt (V).
- Potential difference $(V_A - V_B)$ between two points A and B is the work done in bringing a unit charge from point B to point A.
- Potential difference is a scalar quantity and is measured by means of voltmeter (a high resistance device).

Electric Current

- Flow of electric charges is called as electric current. It is measured by ammeter.
- There are two types of electric current (i) Alternating Current (AC) and (ii) Direct current (DC).
- Alternating current is used in houses and factories and its frequency is 50 Hz.
- The direction of positive charges is same as direction of conventional current.

$$\text{Current} = \frac{\text{Charge}}{\text{Time}} \Rightarrow I = \frac{Q}{t}$$

Ohm's law

- According to it, the current flowing through a conductor is directly proportional to the potential difference across it.

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

or $V = IR$, where R is resistance.

Resistance

- The resistance of a conductor is directly proportional to its length and inversely proportional to its cross-sectional area. If l and A are respectively length and cross-sectional area of a conductor and R is its resistance, then

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

Unit of resistance is ohm.

where, ρ is a constant of material of conductor called specific resistance or resistivity. Its SI unit is ohm-metre.

- The reciprocal of resistance of a conductor is called the electrical conductor of the conductor.

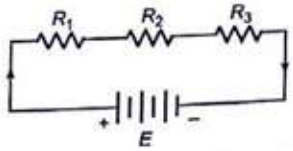
$$\text{Conductance} = \frac{1}{\text{Resistance}}$$

- Unit of conductance is mho or siemen.
- The reciprocal of resistivity of a conductor is called its conductivity. Its SI unit is mho m^{-1} or siemen/metre (Sm^{-1}).
- The specific resistance of the material depends only on the material of conductor and its temperature.

Combination of Resistances

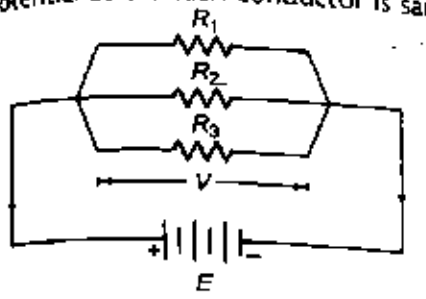
- Series combination : $R = R_1 + R_2 + R_3$

  and here current flows through each conductor is same.



- Parallel combination : $\frac{1}{R}=\frac{1}{R_1}+\frac{1}{R_2}+\frac{1}{R_3}$

- And here potential across each conductor is same.



Electric Power

- Electrical power is the electrical work done per unit time.

$$P=\frac{W}{t}$$

- Its SI unit is watt (W).

$$P=V\times I$$

or

$$P=I^2R \qquad (\because V=IR)$$

or

- 1 kilowatt hour = 3600000 joule; $=3.6\times10^6$ J
- 1 Horse power = 746 watt
- 1 Horse power = 550 foot-pound/second

Heating Effect of Electricity

- Heat is produced when electric current is passed through a conductor.

- Heat produced $=I^2Rt=VIt=\frac{V^2t}{R}$

Important points based on Heating Effect

- In home appliances like as electric iron, electric heater and heating rod, the heating element used is of a nichrome (an alloy of Ni and Ci) wire. Nichrome has high melting point and high resistivity. To avoid the risk of electric shock, the metal body of electrical appliances is earthed.
- A electric fuse is generally prepared from tin-lead alloy (63% tin + 37% lead). It should have high resistance and low melting point. It is connected in the series.
- Filament of electric bulb is made of tungsten has high melting point (3500°C) and high resistivity.
- Tube light contains a long tube of glass which is linked internally with a fluorescent substance. It is filled with an inert gas like argon along with some mercury.

Magnets

- Magnet is a piece of iron or other materials that can attract iron containing objects.
- The magnets which do not lose their magnetism with normal treatment are called permanent magnets.
- The permanent magnets are made of certain alloys of nickel, cobalt and alloys of iron with some carbon.
- Permanent magnets are made of steel, cobalt-steel, ticonal, alcomax and alnico.
- The materials which retain their magnetism for a long time are called hard magnetic materials.
- In bar, rod and horse-shoe magnets, north or south poles are either indicated by the letter *N* or *S*.
- When poles of two magnets are brought close together, they exert force on each other. This force is called intersection between the poles.
- If we cut a magnet in two parts, then each separate part will behave as a magnet

Magnetic Field

- The space in the surrounding of a magnet or a current carrying conductor in which its magnetic effect can be experience is called magnetic field.

Magnetic Flux

- The magnetic flux linked with a surface is equal to the total number of magnetic lines of force passing through that surface normally. Its unit is weber.

Electromagnetic Induction

- When a change occurs in the magnetic flux lined with the coil, an emf is induced in the coil. The phenomenon is called electromagnetic induction.
- The phenomenon of production of induced emf in a circuit due to change in magnetic flux in its neighbouring circuit is called mutual induction.

Points to be Remember

- An electromagnet is the magnet formed [illegible] due to the magnetic field of a current.
- Transformer is a device which raises or lowers the voltage in AC circuits through mutual induction.
- Transformer works on AC only and [illegible]
- The cores of electromagnets are made of [illegible] material like soft iron.
- An electromagnet is utilized in eclectic bell, telegraph, telephone, diapharm, transformer, dynamo etc.
- An electric motor converts electrical energy into [illegible] energy.
- An electric generator coverts mechanical energy into [illegible] energy. It works on the principle of electromagnetic induction.
- In house, all electrical appliances are connected in [illegible] the line wire.
- The polarity of electromagnet can be changed by changing the direction of the current

Exercise

1. Galvanized iron is coated with a thin coating of
   (a) tin (b) zinc
   (c) aluminium (d) copper

2. The total resistance of 3 resistors, each of 3 ohms, connected in parallel, is
   (a) 3 ohm (b) 2 ohm
   (c) 1 ohm (d) 9 ohm

3. Farad is the unit of
   (a) field intensity (b) potential difference
   (c) capacity (d) power

4. A DC voltmeter is capable of measuring a maximum of 300 volts. If it is used to measure the voltage across a device operating at 220 volt AC supply, the reading of the voltmeter will be
   (a) 0 volt (b) 110 volt
   (c) 220 volt (d) 300 volt

5. An electric generator converts
   (a) electric energy into sound energy
   (b) electric energy into light energy
   (c) electric energy into mechanical energy
   (d) mechanical energy into electric energy

6. AC cannot be used in
   (a) amplifier (b) voltmeter
   (c) transformer (d) galvanometer

7. The tape of a tape recorder is coated with
   (a) zinc oxide (b) mica
   (c) copper sulphate (d) ferromagnetic powder

8. The wire used in the filaments of household bulbs has
   (a) high resistance, high melting point
   (b) high resistance, low melting point
   (c) low resistance, high melting point
   (d) low resistance, low melting point

9. A bird sitting on a high power line
   (a) gets a fatal shock (b) gets a mild shock
   (c) gets killed instantly (d) is not affected practically

10. The device that changes the voltage of an electric power supply is
    (a) potentiometer (b) transformer
    (c) voltmeter (d) battery

11. The heating element in an electric iron is made of
    (a) iron (b) tungsten
    (c) nichrome (d) copper

12. hich of the following is a good conductor of heat but bad conductor of electricity?
    (a) Mica (b) Aluminium
    (c) Mercury (d) Platinum

13. Safety fuses are integral part of electric installations and instruments. This is so because safety fuses
    (a) block the passage of current due to increase in their resistance and saves it
    (b) switch off the service of electric supply through relay action
    (c) provide alternative path to excess current as does a shunt
    (d) switch off the supply if current beyond a certain limit flows through the circuit

14. The rod in a dry cell which acts as positive terminal is made of
    (a) brass (b) zinc
    (c) copper-carbon (d) paper

15. The core of a transformer is laminated so that
    (a) ratio of the voltages across the secondary and primary is doubled
    (b) the weight of the transformer can be kept low
    (c) the rusting of the core is prevented
    (d) energy loss due to eddy currents is minimised

16. A tube light works on the principle of
    (a) chemical effect of current
    (b) magnetic effect of current
    (c) heating effect of current
    (d) discharge of electrons through gases

17. The work done in moving a unit positive charge across two points in an electric circuit is a measure of
    (a) potential difference (b) electrostatic force
    (c) current (d) power

18. Potential difference between two points of a wire carrying 2 ampere current is 0.1 volt. The resistance of the wire is
    (a) 0.05Ω (b) 0.5Ω
    (c) 5Ω (d) 0.25Ω

19. An electric bulb is marked as 240V, 60W. The resistance of its filament is
    (a) 940 Ω (b) 245 Ω
    (c) 950 Ω (d) 960 Ω

20. The circuit element where the impressed voltage is always in phase with the resulting current is
    (a) an ideal resistor (b) an ideal coil
    (c) an ideal capacitor (d) an ideal transformer

21. The device used to convert alternating current into direct current is
    (a) potentiometer (b) rectifier
    (c) galvanometer (d) voltmeter

22. Which one of the following is not correctly matched?
    (a) Voltameter – Potential difference
    (b) Potentiometer – EMF
    (c) Ammeter – Electric current
    (d) Metre bridge – Electrical resistance

23. A wire of resistance 20 Ω is drawn out so that its length is increased to twice its original length. Then, its new resistance is
    (a) 88 Ω (b) 84 Ω (c) 80 Ω (d) 40 Ω

24. Two resistances when connected in parallel give the resultant value of 2 ohm; when connected in series the value becomes 9 ohm. The value of each resistance is
    (a) 1 Ω and 8 Ω (b) 2 Ω and 7 Ω
    (c) 3 Ω and 3 Ω (d) 3 Ω and 6 Ω

25. Permanent magnets can be made from
    (a) cobalt (b) zinc
    (c) aluminium (d) lead

26. In storage batteries, which of the following is used?
(a) Lead (b) Copper
(c) Zinc (d) Tin

27. Match List I with List II and select the answer using the codes below the lists.

List I	List II
A. Electrical force between two charged particle	1. Volt
B. Electric charge	2. Newton
C. Electric potential	3. Farad
D. Electrical capacity	4. Coulomb

Codes

	A	B	C	D		A	B	C	D
(a)	2	4	1	3	(b)	2	4	3	1
(c)	1	2	3	4	(d)	2	1	3	4

28. Core of a transformer is made up of
(a) soft iron (b) steel
(c) copper (d) aluminium

29. Transformer is a kind of appliance that can **(CDS 2011 II)**
1. increase power
2. increase voltage
3. decrease voltage
4. measure current and voltage

Select the correct answer using the code given below
(a) 1 and 4 (b) 4 only
(c) 2 and 3 only (d) 2, 3 and 4

30. When you pull out the plug connected to an electrical appliance, you often observe a spark. To which property of the appliance is this related? **(CDS 2011 II)**
(a) Resistance (b) Inductance
(c) Capacitance (d) Wattage

31. Why are inner lining of hot water geysers made up of copper? **(CDS 2010 II)**
(a) Copper has low heat capacity
(b) Copper has high electrical conductivity
(c) Copper does not react with steam
(d) Copper is good conductor of both heat and electricity

32. Which one of the following common devices works on the basis of the principle of mutual induction?
(a) Tubelight (b) Transformer **(CDS 2008 II)**
(c) Photodiode (d) LED

33. In electric supply lines in India, which parameter is kept constant? **(CDS 2007 I)**
(a) Voltage (b) Current (c) Frequency (d) Power

Answers

1. (b)	2. (c)	3. (c)	4. (a)	5. (d)	6. (d)	7. (d)	8. (b)	9. (d)	10. (b)
11. (c)	12. (a)	13. (d)	14. (c)	15. (d)	16. (d)	17. (a)	18. (a)	19. (d)	20. (a)
21. (b)	22. (a)	23. (c)	24. (d)	25. (a)	26. (a)	27. (a)	28. (a)	29. (c)	30. (a)
31. (d)	32. (b)	33. (c)							