Unit- 3

Electricity

Concept of Electric Charge

Q.1: Give the concept of electric charge.

Ans: Appliances used in our day to day life are based on the principles of electricity and magnetism. Electricity is one of the most important sources of energy. Lights, fans, motors, radios and television are some common appliances which work on electricity. Historically, it was frictional electricity that was understood first. About 2000 years ago, a Greek philosopher named Thales observed that, a piece of amber rubbed against another material, attracted small objects. The word 'electricity' is derived from the Greek word "electron" meaning amber. The ancient Greeks, however, did not proceed beyond this finding. In 1600 A.D. Dr. Gilbert, a physician showed that besides amber, other substances such as glass and diamond also possessed the same property. But it was the American inventor, Benjamin Franklin (1706 - 1796) who experimented with electricity and made major inroads in understanding the phenomenon.

By the middle of the eighteenth century, there were machines that could generate large electrical charges. Static electricity may produce dramatic effects but it is of very little practical use to us. It is the current electricity that provides us with all our requirements from basic lighting to super computers. The invention of a device for producing current electricity was the result of an accidental discovery by the Italian professor Luigi Galvani. But it was Alessandro Volta who made the first battery in 1800. Today we understand the use of these batteries, which produce chemical, electrical and magnetic effects.

Electric current

Q.2: What is mean by Electric current and how it flows through a circuit? What is the SI unit of electric current and how is it measured?

Ans: **Electric current** is expressed by the amount of charge flowing through a particular area in unit time. In other words, it is the rate of flow of electric charges. In circuits using metallic wires, electrons constitute the flow of charges. Conventionally, in an electric circuit the direction of electric current is taken as opposite to the direction of the flow of electrons, which are negative charges.

If a net charge Q, flows across any cross-section of a conductor in time t, then the current I, through the cross-section is

$I = Q/t$

SI unit of electric charge = coulomb (C)= 6×10^{18} electrons

Electric Current is also showed by Ampere (A)

1 A = 1 C/s or flow of one coulomb charge per second.

Instrument Measuring Electric Current is called Ammeter. It is always connected in series in a circuit

Electric potential and potential difference

Q.3: Define Electric Potential and Potential Difference

Ans: Electric Potential: 'Electrical potential' is a condition, which determines the direction of the flow of charge. Electric potential at a point is work done in moving a unit charge from infinity to that point.

Electric potential = work/charge or $V = W/Q$

S.I. unit of electric potential is 1 volt and is a scalar quantity

When W=1joule. Q=1colomb then V= 1volt [1V=1J/1C]

The work done on the electrical charge in the process of charging gets stored as potential energy of charges. This is known as 'electrostatic potential'.

Potential Difference: The difference in electrical potential between two points is known as potential difference. Electric potential difference between two points in an electric circuit carrying some current as the work done to move a unit charge from one point to the other

Potential difference (V_{AB}) between two points A &B = $V_B - V_A$

The SI unit of electric potential difference is volt (V).

The potential difference is measured by means of an instrument called the voltmeter. The voltmeter is always connected in parallel across the points between which the potential difference is to be measured.

Ohm's law and Experimental verification

Q.4: What is Ohm's Law?

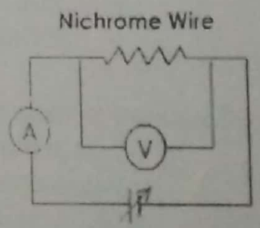
Ans: OHM'S LAW: The electric current flowing through a metallic wire is directly proportional to the potential difference V, across its ends provided its temperature remains the same. This is called Ohm's law. In other words –

$V \propto I$ or V/I = constant = R or $V = IR$

R is a constant for the given metallic wire at a given temperature and is called its resistance. It is the property of a conductor to resist the flow of charges.

Q.5: Explain How Ohm's law is verified in the laboratory?-

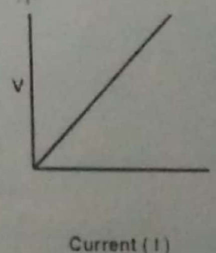
Ans: Verification of Ohm's law: Set up the circuit as shown in the circuit diagram. First use one cell and note the current (I) in the ammeter and the potential difference (V) in the voltmeter across the nichrome wire AB. Repeat by using two cells, three cells and four cells and note the readings in the ammeter and voltmeter. Then plot a graph between the current (I) and potential difference (V). The graph will be a straight line.



This shows that the current flowing through a conductor is directly proportional to the potential difference across its ends.

$I \alpha V$ or $V \alpha I$ or $V/I = R$

where R is a constant called resistance of the conductor.



Resistance and its dependence

MULTIPLE CHOICE ITEMS

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1. **Electricity constituted by electric charges at rest on the surface of a conductor is called**
   (a) Electricity
   (b) Potential difference
   (c) Current electricity
   (d) Static electricity

2. **The closed path between two points at different potentials, to make the electric current flow is called**
   (a) Electric circuit
   (b) Electric current
   (c) Electric potential
   (d) Electric cell.

3. **Direction of conventional current is taken from**
   (a) Negative to positive
   (b) Positive to negative
   (c) It could be from positive to negative or negative to positive
   (d) None of these.

4. **With increase in temperature, resistance of a conductor**
   (a) Decreases
   (b) Increases
   (c). May decreases or increases depending on temperature
   (d) It does not depend on temperature.

5. **In series combination, resistance increases due to increase in**
   (a) Temperature
   (b) Humidity
   (c) Length
   (d) Area of cross-section.

6. **In parallel combination, resistance decreases due to increase in**
   (a) Temperature
   (b) Humidity
   (c) Area of cross-section
   (d) Length.

7. **The rate at which electricity is dissipated or consumed by an appliance is called electrical**
   (a) current
   (b) Power
   (c) Potential
   (d) Energy.

8. **The unit of electrical power is**
   (a) watt
   (b) ampere
   (c) joule
   (d) ohm.

9. **In series combination of electrical appliances, total electrical power**
   (a) Increases
   (b) Decreases
   (c) May increases or decreases
   (d) Does not changes.

10. **In parallel combination of electrical appliances, total electrical power**
    (a) Increases
    (b) Decreases
    (c) Does not change
    (d) Remain same.

11. **The total work done by an electrical appliance during its operation, is called electrical**
    (a) Current
    (b) Power
    (c) Energy
    (d) Potential

12. **The number of joules in 1kWh is**
    (a) 3.6×10^7
    (b) 3.6×10^6
    (c) 3.6×10^5
    (d) 3.6×10^4

13. **When electric current flows through a conductor, it**
    (a) Gains electrons
    (b) Loose electrons
    (c) Becomes hot
    (d) No change is observed

14. **Heating of a current carrying conductor is due to**
    (a) Loss of kinetic energy by atoms

(b) Loss of kinetic energy by electrons
(c) Attraction between electrons
(d) Repulsion between electrons & protons

15. The correct relation between heat produced & electric current flowing
(a) H∝ I
(b) H∝I^2
(c) H∝I /I
(d) H∝I/I^2

16. The relation between H&I is called
(a) Newton's law
(b) Faraday's law
(c) Joule's law
(d) Ohm's law

17. In electric heating appliances, the material of heating element is
(a) Brass
(b) Nichrome
(c) Silver
(d) Copper

18. Formula for electric power is
(a) P= V^2I
(b) P=V I
(c) P=I/V
(d) P=V/I.

19. In a circuit containing two unequal resistors connected in parallel
(a) The current is same in both resistors
(b) The current is large in the resistance having more value
(c) The voltage is same across both the resistors
(d) The voltage drops is larger across both the resistors.

20. The equivalent resistance in series combination is
(a) Smaller than the resistance having high value
(b) Larger than the largest resistance
(c) Smaller than the smallest resistance
(d) Larger than the smallest resistance.

21. Lamps of 40 watt & 60 watt are connected in parallel, the total power of combination is
(a) 40 watt
(b) 60 watt
(c) 24 watt
(d) 100 watt

22. A fuse wire is always inserted in the
(a) Live wire
(b) In the neutral wire
(c) In the earth wire
(d) May be connected in any line.

23. Two bulbs in a house, one glow brighter than the other. The bulb with large resistance is
(a) Dim bulb
(b) The brighter bulb
(c) Both has same resistance
(d) None of these.

24. The characteristics of fuse wire is
(a) High melting point
(b) Low melting point
(c) Low resistivity & high melting point
(d) High resistivity & low melting point

25. The unit of specific resistance is
(a) Ohm/m^2
(b) Ohm-m
(c) Ohm m^3
(d) Ohm/m^3

26. In series combination total resistance:
(a) Decreases
(b) Increases
(c) May decrease or increase according to the situation
(d) No particular observation

27. Two resistors r_1 and r_2 are connected in parallel, such that the equivalent resistance is R. The mathematical express for equivalent resistance of R is:
(a) r_1r_2/r_1+r_2
(b) $(r_1+r_2)/r_1r_2$
(c) $(1+1)/r_1r_2$
(d) $1(r_1+r_2)/r_2$

28. Two resistors of 2Ω and 4Ω are connected in parallel circuit. If the magnitude of current in 2Ω resistor is I then magnitude of current in 4Ω resistor is:
(a) I
(b) I/2
(c) 2I
(d) I/4

29. Two resistors of 3Ω and 6Ω are connected in parallel, such that p.d. across their ends is 0.6V. The magnitude of current flowing through 3Ω resistor is:
(a) 0.3A
(b) 0.6A
(c) 0.2A
(d) 0.9A

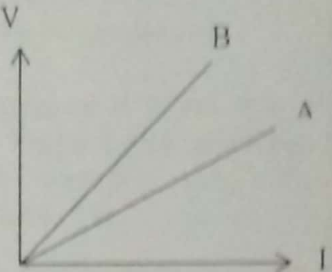
30. A resistor of 5Ω is connected to a cell when the magnitude of current is 1.5 A. If another resistor of 5Ω is connected to first resistors in parallel, the magnitude of current will be:
(a) 1.5 A
(b) more than 1.5 A
(c) less than 1.5 A
(d) none of these

31. The instrument used for measuring electric current is :
(a) ammeter
(b) galvanometer
(c) voltmeter
(d) potentiometer

32. The resistance 2 Ω, 4 Ω, and 8 Ω are connected in parallel. Their equivalent resistance is:
(a) 10 Ω
(b) 14 Ω
(c) 8/7Ω
(d) between 2Ω & 8Ω

33. A wire of resistance 1Ω is divided into two halves and both are connected in parallel. The new resistance will be:
(a) 1Ω
(b) 2Ω
(c) 0.5Ω
(d) 0.25Ω

34. The V-I graphs of parallel and series combinations of two metallic resistors are shown in the figure. The graph that represents parallel combination is:
(a) A
(b) B
(c) both
(d) none



35. The following apparatus is available in a laboratory:
Battery :adjustable from 0 to 6V
Resistors : 3 Ω and 6 Ω
Ammeters : A_1 of range 0 to 5A; least count 0.25A
A_2 of range 0 to 3A; least count 0.1A
Voltmeters: V_1 of range 0 to 10V; least count 0.5V
V_2 of range 0 to 5V; least count 0.1V
To find the equivalent resistance of the parallel combination of the two given resistors, the best choice would be:
(a) ammeter A_1 and voltmeter V_1
(b) ammeter A_1 and voltmeter V_2
(c) ammeter A_2 and voltmeter V_1
(d) ammeter A_2 and voltmeter V_2

36. Charge per unit time is called:
(a) power
(b) current
(c) potential difference
(d) coulomb

37. Device which is always connected in parallel in the electric circuit is:
(a) resistance
(b) voltmeter
(c) ammeter
(d) battery

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38. If two equal resistors of RΩ connected in parallel. The total resistance will be:
(a) 2R
(b) R/4
(c) R/2
(d) 4R

39. If a graph between V& I is a straight line .We conclude:
(a) Resistors obey ohm's law
(b) resistors don't obey Ω law
(c) Current flowing through the resistance is proportional to the P.D. across the end of a conductor.
(d) both (a) & (c) are correct

40. To determine resistance of a given conductor:
(a) Ammeter should be joined in parallel &voltmeter should be joined in series
(b) Ammeter should be joined in series & voltmeter should be joined in parallel
(c) Ammeter & voltmeter should be in series
(d) Ammeter & voltmeter should be in parallel.

41. The resistance 4 ohm, 8 ohm, & 16 ohm are connected in parallel. The equivalent resistance is
(a) 28Ω
(b) 20Ω
(c) 16/7Ω
(d) between 4Ω and 6Ω

42. To get minimum resistance from the given resistors we should connect
(a) All the resistors in series
(b) All the resistors in parallel
(c) Half in series &half in parallel
(d) More in series less in parallel.

43. A wire of resistance R is cut into n equal parts. These parts are then connected in parallel then the equivalent resistance is
(a) R/n
(b) R/n^2
(c) n^2R
(d) n^2/R

44. A technician has only two resistance coils. By using these singly, in series or in parallel he is able to obtain the resistances of 3Ω, 4Ω, 12Ω and 16Ω. Then the resistance of the two coils are
(a) 6 and 10 ohm
(b) 4 and 12 ohm
(c) 7 and 9 ohm
(d) 4 and 16 ohm

45. The resultant value of n resistances, each of value rΩ when connected in parallel is x. when these resistances are connected in series the resultant resistance is
(a) nx
(b) n^2x
(c) x/n
(d) x/n^2