****1. Define electric current. Write its formula and SI unit.** ***(ALP)***

The rate of flow of electric charge through any cross-sectional area is called current.

$$Current = \frac{Charge}{Time}$$

$$I = \frac{Q}{t}$$

Unit: In SI the unit of current is Ampere (A).

****2. Define unit of current.** ***(ALP)***

SI the unit of current is Ampere (A).

Ampere: If a charge of one coulomb passes through a cross-sectional area in one second, then current is one ampere. i.e.

$$1A = 1Cs^{-1}$$

Note: Smaller Units of current are milli ampere (mA), micro ampere (μA), which are defined below as:

$$1\ mA = 10^{-3}A$$

$$1\ \mu A = 10^{-6}A$$

****3. What is the difference between electronic current and conventional current?** ***(ALP)***

Electronic Current	Conventional Current
Electronic current flows due to the motion of electrons (negative charges) from negative terminal of the battery to the positive terminal.	Current flowing from positive to negative terminal of a battery due to the flow of positive charges is called conventional current.

4. Why is the charge in the conductors transferred only in the form of free electrons instead of positive charges? ***(ALP)***

The free electrons in the conductors can move easily from one place to another while the positive charges remain stationary in their place. That is why the charge in the conductors moves from one place to another in the form of electrons instead of positive charges.

****5. Write the names of the devices used to measure current. Also define them.** ***(ALP)***

Galvanometer and ammeter are some common current measuring instruments.

Galvanometer: Galvanometer is very sensitive instrument and can detect small current in a circuit. A current of few milliamperes is sufficient to cause full scale deflection in it.

Ammeter: After suitable modification galvanometer can be converted into an ammeter. A large current of the range such as $1\ A$ or $10\ A$ can be measured by means of ammeter.

Note:

- An ideal galvanometer has very small resistance to pass the maximum current in the circuit.
- Like galvanometer, ammeter is also connected in series, so the current flowing in the circuit also passes through the ammeter.

****6. Define potential difference. Also write its SI unit.** ***(ALP)***

Potential difference across the two ends of a conductor causes the dissipation of electrical energy into other forms of energy as the charges flow through the circuit.

SI Unit: SI unit of potential difference is volt.

****7. Define volt.**

A potential difference of 1 V across a bulb means that each coulomb of charge or 1 ampere of current that passes through the bulb consumes 1 joule of energy.

$$1\ V = \frac{1J}{1C}$$

****8. Define electromotive force $(e.m.f)$. Also write its formula and SI unit.** ***(ALP)***

It is the energy supplied by a battery to a unit positive charge when it flows through the closed circuit. **OR**

The energy converted from non-electrical forms to electrical form when one coulomb of positive charge passes through the battery.

$$e.m.f = \frac{Energy}{Charge}$$

For example, cell, battery etc.

SI Unit: SI unit of $e.m.f$ is JC^{-1} which is equal to volt (V).

9. How potential difference is measured?** ***(ALP)

To measure the potential difference across a component (bulb), a voltmeter must be placed in parallel with that component. An ideal voltmeter should have very large value of resistance so that no current passes through it.

10. How $e.m.f$ is measured?** ***(ALP)

In general, $e.m.f$ refers to the potential difference across the terminals of the battery when it is not driving current in the external circuit. So in order to measure $e.m.f$ of the battery we connect voltmeter directly with the terminals of the battery.

11. Why an ammeter is connected in series and voltmeter in parallel?** ***(ALP)

Ammeter is always connected in series so that current flowing in series combination always remains same and the current flowing through the circuit will be equal to current flowing through ammeter. Voltmeter is connected parallel to the circuit so that the voltage in the parallel combination always remains same and

the voltage across the circuit will be equal to voltage of voltmeter.

****12. State ohm's law also write mathematical form.** ***(ALP)***

The amount of current (I) passing through a conductor is directly proportional to the potential difference (V) applied across its ends, provided the temperature and the physical state of the conductor does not change. Mathematically

$$I \propto V$$
$$V \propto I$$
$$V = IR$$

where R is the constant of proportionality, and is the resistance of the conductors.

****13. What are the limitations of ohm's law?** ***(ALP)***

Limitations of Ohm's law:

- **(i)** Ohm's law is applicable when temperature of conductor is keep constant.
- **(ii)** Conductors obey Ohm's law as long as the electric current through them is not very large.
- **(iii)** The physical state of the conductor also remains same.
- **(iv)** Ohm's law is applicable in metallic conductor only.

****14. Define resistance also define its SI unit.** ***(ALP)***

Resistance: The property of a substance which offers opposition to the flow of current through it is called its resistance. Mathematically

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

Unit of Resistance $(\boldsymbol{ohm})$**:** The SI unit of resistance R is ohm. If we put $V = 1\,V$, and $I = 1\,A$, the value of R will be 1Ω.

$$1\Omega = \frac{1\,V}{1\,A}$$

Ohm: When a potential difference of one volt is applied across the ends of a conductor and one ampere of current passes through it, then its resistance will be one ohm.

***15. What are the factors upon which the resistance of conductor depends?**

resistance of conductor depends upon following factors:

- Length of conductor (L)
- Area of cross section (A)
- Temperature
- Nature of conductor

Mathematically, $R = \rho\frac{L}{A}$

****16. Define specific resistance/resistivity and write the formula.**

We know that

$$R = \rho\frac{L}{A}$$

If $L = 1\,m$, and $A = 1\,m^2$, then $R = \rho$, i.e., the resistance of one meter cube of a substance is equal to its specific resistance. The unit of 'ρ' is ohm-metre (Ωm).

****17. What is the difference between conductors and insulators?**

Conductors	Insulators
The substances through which heat and electric current can pass easily called conductors.	The substances through which heat and electric current cannot pass easily are called insulators
Metals like silver, copper etc. are good conductor of electricity.	Plastic, fur, wood etc. are non-conductors or insulators.
More free electrons are available for the conduction of electric current.	No free electrons are available for the conduction of electric current.
Conductors have very low value of resistance	Insulators have very high value of resistance.

****18. What is the difference between a cell and a battery?** ***(ALP)***

A battery is the agency which provides the potential difference for the steady flow of current in a wire.

Difference: A battery can be a single cell or multiple cells connected together in series or parallel to make the voltage rating as required while a cell is a single unit at the base voltage.

OR

Cell	Battery
A cell consists of two metal electrodes dipped into an electrolyte. It is a device which converts chemical energy into electrical.	Battery is the group of large number of cells. Batteries store larger energy as compared to cell.

****19. What is difference between ohmic and non ohmic conductors (matrerials).** ***(ALP)***

Ohmic: Materials that obey Ohm's law, and hence have a constant resistance over a wide range of voltages, are said to be ohmic.

Non Ohmic: Materials that do not obey Ohm's law and do not have a constant resistance over a wide range of voltage are called non-ohmic conductors.

20. What is thermistor? Write its one use.** ***(ALP)

A thermistor is a temperature dependent resistor and its resistance decreases as temperature rises. Thermistor is used in a circuit that senses temperature change.

21. Write formula of equivalent resistance of series and parallel combination of resistors.

Equivalent Resistance of Series Circuit:

$$R_e = R_1 + R_2 + R_3 + \cdots + R_n$$

Equivalent Resistance of Parallel Circuit:

$$\frac{1}{R_e} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3} + \cdots + \frac{1}{R_n}$$

****22. Define Joule's law.** ***(ALP)***

The amount of heat generated in a resistance due to flow of charges is equal to the product of square of current I, resistance R and the time duration t. The energy supplied by Q charge is

$$W = I^2Rt$$

23. Prove $W = I^2Rt$. ***(ALP)***

$$\begin{aligned} \text{Electrical energy supplied by Q charge} &= W = QV \text{ joules} \\ \text{Energy supplied by Q charge in t seconds} &= W = (It)V \\ W &= VIt \\ W &= (IR)It \\ W &= I^2Rt \end{aligned}$$

24. Prove $W = \frac{V^2t}{R}$** ***(ALP)

$$\begin{aligned} \text{Electrical energy supplied by Q charge} &= W = QV \text{ joules} \\ \text{Energy supplied by Q charge in t seconds} &= W = (It)V \\ W &= VIt \\ W &= V\left(\frac{V}{R}\right)t \\ W &= \frac{V^2t}{R} \end{aligned}$$

****25. Define electric power. Also write SI unit.** ***(ALP)***

The amount of energy supplied by current in unit time is known as electric power.

$$Electrric\ Power = \frac{electrical\ energy}{time}$$

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

SI Unit: The unit of electric power is *watt* which is equal to one joule per second (Js^{-1}). It is represented by the symbol W.

****26. Define unit of power.** ***(ALP)***

SI unit of power is watt (W).

Watt: If one joule energy is supplied by electric current in one second, then its power is called one watt. Mathematically

$$watt = \frac{J}{s} = Js^{-1}$$

27. Prove $P = \frac{V^2}{R}$ ***(ALP)***

We know that

$$Electrric\ Power = \frac{electrical\ energy}{time}$$

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

$$P = \frac{QV}{t} \qquad \because W = QV$$

$$P = \left(\frac{Q}{t}\right)V$$

$$P = IV \qquad \because I = \frac{Q}{t}$$

$$P = \left(\frac{V}{R}\right)V \qquad \because I = \frac{V}{R}$$

$$P = \frac{V^2}{R}$$

28. Prove that $P = I^2R$ ***(ALP)***

We know that

$$Electrric\ Power = \frac{electrical\ energy}{time}$$

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

$$P = \frac{QV}{t} \qquad \because W = QV$$

$$P = \left(\frac{Q}{t}\right)V$$

$$P = IV \qquad \because I = \frac{Q}{t}$$

$$P = I(IR) \qquad \because V = IR$$

$$P = I^2R$$

****29. Define kilowatt-hour.** ***(ALP)***

The amount of energy delivered by a power of one kilowatt in one hour is called kilowatt-hour.

$$1\ kWh = 3.6\ MJ$$

30. Convert 1 kWh into Joules.** ***(ALP)

$$\begin{aligned} 1\ kWh &= 1000\ Wh \\ 1\ kWh &= (1000W)(3600\ s) \\ 1\ kWh &= 3600000\ J \\ 1\ kWh &= 3.6 \times 10^6\ J \\ 1\ kWh &= 3.6\ MJ \end{aligned}$$

31. How many watt-hours are there in 1000 joules? ***(ALP)***

$$\begin{aligned} 3.6\ MJ &= 1\ kWh \\ 3.6 \times 10^6\ J &= 1\ kWh \\ 1\ J &= \frac{1\ kWh}{3.6 \times 10^6} \\ 1000\ J &= 1000 \times \frac{1000\ Wh}{3.6 \times 10^6} \\ 1000\ J &= 0.27\ Wh \end{aligned}$$

32. How can energy obtained in kilowatt-hour?** ***(ALP)

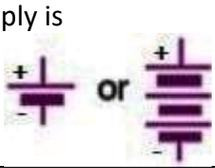
$$The\ amount\ of\ energy\ (kWh) = \frac{Power(W) \times time\ (h)}{1000}$$

33. How can calculate the amount of monthly electricity bill? ***(ALP)***

$$Monthly\ bill = \frac{Power(W) \times time\ (h) \times (unit\ price) \times 30}{1000}$$

****34. What is difference between D.C and A.C?**

Direct Current $(D.C)$	Alternating Current $(A.C)$
The current that does not change its direction of flow and is unidirectional is known as direct current.	The current that changes its direction after equal interval of time is called alternating current.

The current derived from cell or a battery is direct current.	The current supplied to home by the power companies is alternating current.
The symbol used for D.C supply is 	The symbol used for A.C supply is 
Direct current has fix polarity. It means positive and negative terminals of $\boldsymbol{D.C}$ source are fixed.	In alternating current source, its polarity changes in regular intervals of time.

35. What is the frequency of AC supply in Pakistan?
In Pakistan, alternating current oscillates 50 times every second. Thus, its frequency is $50\ Hz$.

***36. How many wires are generally used in house wiring?**
The electric power enters our house through three wires.

- **(i)** Earth Wire
- **(ii)** Neutral Wire
- **(iii)** Live Wire

Earth Wire: First wire is called earth wire or ground wire (E). This carries no electricity. The earth-wire is connected to a large metal plate buried deep in the ground near the house.

Neutral Wire: Second wire is maintained at zero potential by connecting it to the Earth at the power station itself and is called neutral-wire (N). This wire provides the return path for the current.

Live Wire: The third wire is at a high potential and is called live-wire (L). The potential difference between the livewire and the neutral wire is $220\ V$.

***37. What are hazards of electricity? What are two major hazards (dangers) of electricity?**
Dangers of electricity are called electricity hazards. Care should be taken to save ourselves from hazardous effects.

- Voltage of 50 V and current of 50 mA can be fatal.
- Major dangers of electricity are electric shock and fire.

38. What is meant by insulation damage?
Insulation Damage: All electrical wires are well insulated with some plastic cover for the purpose of safety. But when electrical current exceeds the rated current carrying capacity of the conductor, it can produce excess current that can damage insulation due to overheating of cables. This results into a short circuit which can severely damage electrical devices or persons.

****39. What is meant by damped conditions?**
Damp Conditions: Dry human skin has a resistance of $100000\ ohms$ or more. But under damp conditions (wet environment) resistance of human skin is reduced drastically to few hundred ohms.

Therefore, never operate any electrical appliance with wet hands. Also keep switches, plugs, sockets and wires dry.

40. What is a fuse and its function.
A fuse is a safety device. It is short and thin piece of metal wire that melts when large current passes through it.
Function: If a large, unsafe current passes through the circuit, the fuse melts and breaks the circuit before the wires become very hot and cause fire.

41. What is circuit breaker? Also write its principle.
The circuit breaker acts as a safety device in the same way as a fuse. It disconnects the supply automatically if current exceeds the normal value.

Principle: A circuit breaker consists of an electromagnet, an iron strip and a spring. When large current flows through live wire, the electromagnet attracts the iron strip and separates the contact and breaks the circuit.

42. How jewelers can tell if a diamond is real or fake one?
Diamond does not conduct electricity, because it has no free electrons. However, it is very good at conducting heat because its particles are very firmly bonded together. Jewellers can tell if a diamond is a real diamond or a fake one made from glass, by holding it to their lips. A real diamond feels very cold due to good ability of transferring heat four or five times better than copper.

43. Write two advantages of parallel circuit.

- **(i)** In parallel combination each appliance gets the full voltage.
- **(ii)** If one appliance is switched on, others are not affected.

****44. What is impotence of circuit diagram and electric symbols?**
A circuit diagram is a symbolic method of describing a real circuit. The electric symbols used in circuit diagrams are standard, so anyone familiar with electricity can interpret a circuit diagram.

Important Long Questions

(1) Differentiate between electromotive force ($e.m.f$) and potential difference.

(2) What is meant by term $e.f.m$? write its formula and unit. Is it really force? Explain it.

(3) State Ohm's law and what are its limitations?

(4) State Ohm's law and also explain V-I characteristics of Ohmic and Non-ohmic.

(5) Write a note on specific resistance.

(6) Determine the equivalent resistance of series combination of resistors.

(7) Determine the equivalent resistance of parallel combination of resistors.

(8) What is difference between conductors and insulators?

(9) Explain energy dissipation in resistance. Also state Joule's law.

(10) Define electric power and drive its equation and define unit of power.

(11) What do you mean by electricity hazards? What are their types?

(12) Describe four safety measures that should be taken in connection with household circuit.

(13) What is meant by fuse? Explain its uses and safety measure.