States of matter:

Considering all the studies that have been done till today, there are 22 states of matter in total described below:

1. Solid: a solid holds a definite shape and volume without a container and its particles are held very close to each other.
2. Liquid: a liquid is the state of matter which does not have a definite shape but has a definite volume and its volume does not change when pressure is applied to it.
3. Gas: it conforms to the shape of the container as well as it expands to fill it.
4. Plasma: plasma is the state of matter which has free particles that are charged, for example, electrons or any type of ions either positive or negative. They can generate the magnetic or electric field by themselves and thus respond well in the electromagnetic system.
5. Excitonium: this state of matter is made up of particles called excitons, which are formed by the process of quantum mechanical pairing. These are integers which obey Bose statistics in the low-density limit.

6. Electron degenerate matter: these are found in the core of the stars called a
7. white dwarf. In this, the electrons are very strongly bonded to the atoms but are transferable to adjacent atoms.
8. Neutron degenerate matter: in this the fermions i.e., neutrons are found in the neutron stars and by the process of beta decay the electrons are forced to bond with the protons.
9. Strange matter: these are also found in the core of neutron stars. It is one of the forms of quark matter with up, down and strange quarks which are assumed to occur in neutron stars.
10. Photonic matter: inside a quantum nonlinear medium, there are photons which act like they have some mass and interact with one another and result in the formation of photonic molecules.
11. Quantum spin hall state: it is only a theoretical phase of matter derived from the quantum hall state of matter.
12. Bose-Einstein condensate: in this state of matter, there are several bosons which behave like a single wave or particle due to the same and collective quantum state of all the bosons.
13. Fermionic condensate: in this state, any two fermions behave as bosons and then these pairs enter the same quantum state without any kind of restriction.

14. Superconductivity: when certain substances are cooled below a critical temperature, there occurs a state of zero electrical resistance and expulsion of magnetic fields.

15. Superfluid: this is one of the kinds of cryogenic liquid, but at an extreme temperature where they face zero resistance against their flow.

16. Supersolid: it is similar to the superfluid in that it does not have to face any restriction in motion but it retains a rigid shape all the time.

17. Quantum spin liquid: it is a disordered state where quantum spins interact with each other and maintain a disorder to very low temperatures.

18. String net liquid: have closed loops, obeying the branching rules

19. Dropleton: quasiparticles which behave like the liquid.

20. Time crystal: a space-time crystal which changes its structure in space as well as time.
    Rydberg polarons have large atoms at very low temperatures.

21. Quark gluons plasma: high energy state in which quarks are free to move and exist independently.

22. Rydberg matter: exotic phase, which is formed by the Rydberg atoms only.

Note: Solid, liquid, gas and plasma are called the four fundamental states of matter. Superfluid, Bose-Einstein condensate, Fermionic condensate, Rydberg molecule, Quantum Hall state, Photonic matter, Dropleton are called the low-temperature states. Electron degenerate, neutron degenerate, strange matter, quark matter are called high energy states.

Resistance:

Resistance is a measure of the opposition to current flow in an electrical circuit. Resistance is measured in ohms, symbolized by the Greek letter omega (Ω). Ohms are named after Georg Simon Ohm (1784-1854), a German physicist who studied the relationship between voltage, current and resistance
The resistance of a conductor depends upon the resistivity, length and cross-sectional area of the conductor which is given by the relation ($R=\rho Al$). It does also depend on other physical factors like temperature etc. Its SI unit is Ohm (**Ω).**

Ohm's law:

"Current is directly proportional to voltage provided that all the other quantities remains constant"

What is ohm's law?

"I" is directly propotional to "V" provided that all the other quantities remains constant.

$$I \propto V$$

$$I = kV \qquad \therefore k = \text{conductivity}$$

$$I = \frac{1}{R}V \qquad k = \frac{1}{R}$$

$$\therefore V = IR$$

	Vector		Scalar
Interaction of two q :	$F = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r^2}$	$\boxed{\Delta U = -\int_a^b F\cdot d}$ $\longleftrightarrow$	$U = \frac{1}{4\pi\varepsilon_0}\frac{q_1q_2}{r}$
	$\boxed{E = \frac{F}{q_0}}$ $\updownarrow$		$\boxed{V = U/q_0}$ $\updownarrow$
At one point :	$E = \frac{1}{4\pi\varepsilon_0}\frac{q}{r^2}$	$\longleftrightarrow$ $\boxed{V = Ed}$	$V = \frac{1}{4\pi\varepsilon_0}\frac{q}{r}$

Resistivity:

resistivity, electrical resistance of a conductor of unit cross-sectional area and unit length. A characteristic property of each material, resistivity is useful in comparing various materials on the basis of their ability to conduct electric currents

High resistivity designates poor conductors.

ρ, is quantitatively equal to th.e resistance R of a specimen such as a wire, multiplied by its cross-sectional area A, and divided by its length l; ρ = RA/l. The unit of resistance is the ohm

What is super conductor?

Materials that exhibit no resistance to the flow of electrical current.

How does superconductivity work?

First superconductors discovered were found to be superconducting only at extremely low temperatures, such that electrons inside them are cooled down so much that they don’t behave as electrons at room temperature. They form a completely new state of matter, a superconducting state

Why Are Superconductors Still Not Used in Everyday Life?

At a sufficiently low temperature, the resistivity in them falls down exactly to zero, below the limits of even the most precise measuring devices!

The only problem is that the conditions for superconductivity to occur are still quite extreme. So far, superconductivity can only occur at very low temperatures or under extremely high pressures. Additionally, some compounds are difficult to be produced, they are brittle and chemically unstable

What is Resistor?

Resistors are fundamental components in electrical and electronic circuits used to control voltage and current values in circuits. They are basically energy-consuming elements that limit the flow of current to have the right amount of current and voltage that you want precisely in your circuits. A resistor is used where more current is required to be impeded so that the desired amount of current is achieved without any resistance. They are passive two-terminal components that implement resistance to reduce the flow of current to a safe value. They convert electrical energy into heat, which is then dissipated into the air. Resistors are generally classified into two types: fixed and variable. Resistance is measured in “Ohm”.

Difference between Capacitor and Resistor

1. Basics of Capacitor and Resistor:

Capacitor and resistor are the two most common basic components used in electronic circuits with each can be described in terms of the relationship between the current flow and the voltage across the component. Both are energy storage components, but they differ in the way they store energy. A resistor is an electronic component used to resist the flow of current in a circuit. It’s more like a friction which restricts energy. A capacitor, on the other hand, is an electronic component used to store electrical charge. It generally opposes changes in current in electrical and electronic circuits.

2. Working of Capacitor and Resistor:

A resistor is a passive two-terminal electrical component that implements controlled amounts of resistance into electrical circuits meaning it restricts the amount of current flowing through a device. It doesn’t do anything actively to any electronic circuit; in fact, it’s simply hooked into a circuit to have the currents and voltages that you want precisely in your circuit. A capacitor, on the other hand, stores potential energy in an electric field and gives it back to the circuit when required. Simply put, it charges and discharges the electric charge stored in the circuit.

3. Function of Capacitor and Resistor:

A resistor is a little resistance package which controls the flow of current to other components in an electrical circuit. It’s not only used to amplify signals but to limit the flow of current, adjust signal levels, terminate transmission lines, etc. It limits the current flow to a safe value. A capacitor consists of two or more parallel conductor plates with an insulator between them. The function of a capacitor is to keep the positive and negative charges separated from each other. The effect of a capacitor is known as capacitance.

4. Measurement for Capacitor and Resistor

Resistance is the measure of the opposition to the flow of current in an electrical circuit and the unit of electrical resistance is “ohm” and is represented by Ω. It is defined by Ohm’s Law and is given as R = V/I, where V is the voltage drop measured in “volts” and I is the current flow of the resistor measured in “ampere”. Capacitance is the ability to store electrical energy which is defined as C = q/V, where q is the charges measures in “coulombs”, and V is the voltage measured in “volts”.

What would happen when 3 capacitors are connected in series?

For capacitors in series, the total capacitance can be found by adding the reciprocals of the individual capacitances, and taking the reciprocal of the sum. Therefore, the total capacitance will be lower than the capacitance of any single capacitor in the circuit.

Advantages of Parallel Circuit

- Each connected electrical device and appliance are independent from others. This way, switching ON / OFF a device won't affect the other appliances and their operation.
- In case of break in the cable or removal of any lamp will not break the all circuits and connected loads, in other words, other lights/lamps and electrical appliances will still work smoothly.
- If more lamps are added in the parallel lighting circuits, they will not be reduced in brightness (as it happens only in series lightning circuits). Because voltage is same at each point in a parallel circuit. In short, they get the same voltage as the source voltage.
- It is possible to add more light fixture and load points in parallel circuits according to future need as far as the circuit is not overloaded.
- Adding additional devices and components wont increase the resistance but will decrease the overall resistance of the circuit especially when high current rating devices are used such as air conditioner and electric heaters.
- parallel wiring is more reliable, safe and simple to use.

Why do we use combination or Resistors and Capacitor?

- Mainly in case of electronic circuits we use resistors where current reduction is required or voltage division is needed.
- Sometimes variable resistances are used to set the sensitivity of a circuit to a certain level.
- Mainly dc circuits are being used where fix volteges are needed sometimes where capacitors are useful.
- And in case of filter circuits , resonating circuits we require the combination of r, l and c .

- **Combination of Resistances:**
- **Uses of combination resistances:**
- In practical electrical circuits, we generally need to control current and voltage (potential difference). Different components in an electrical appliance often need different voltages and currents. To obtain the required values of the currents and voltages in any electrical circuit, a certain combination of resistances is used.
- **Ways for Combination of resistances that can be used in a circuit:**
- The need of using a combination of resistances is to obtain a desired value of current in an electrical circuit, it can be done in two ways, they are

- i) series combination, ii) parallel combination.
- **Equivalent Resistance:**
- Equivalent resistance: If a single resistance can replace the combination of resistances in such a manner that the current in the circuit remains unchanged, then that single resistance is called the equivalent resistance

What is an Alternating Current (AC)?

In alternating current, the electric charge flow changes its direction periodically. AC is the most commonly used and most-preferred electric power for household equipment, office, buildings, etc. It was first tested based on the principles of Michael Faraday in 1832 using a Dynamo Electric Generator. Alternating current can be identified in a waveform called a sine wave. In other words, it can be referred to as a curved line. These curved lines represent electric cycles and are measured per second. The measurement is read as Hertz (Hz). AC is used in powerhouses and buildings because generating and transporting AC across long distances is relatively easy. AC is capable of powering electric motors which are used in refrigerators, washing machines, etc.

What is Direct Current (DC)?

Unlike alternating current, the flow of direct current does not change periodically. The current electricity flows in a single direction in a steady voltage. The major use of DC is to supply power to electrical devices and also to charge batteries. Example: mobile phone batteries, flashlights, flat-screen television and electric vehicles. DC has the combination of a plus and a minus sign, a dotted line or a straight line.
Everything that runs on a battery and uses an AC adapter while plugging into a wall or uses a USB cable for power relies on DC. Examples would be cellphones, electric vehicles, flashlights, flat-screen TVs (AC goes into the TV and is converted into DC)

What is difference between AC & DC current?

Electric current flows in two ways as an alternating current (AC) or direct current (DC). The main difference between AC and DC lies in the direction in which the electrons flow. In DC, the electrons flow steadily in a single direction, while electrons keep switching directions, going forward and then backwards in AC

Alternating Current	Direct Current
AC is easy to be transferred over longer distances – even between two cities – without much energy loss.	DC cannot be transferred over a very long distance. It loses electric power.
The rotating magnets cause the change in direction of electric flow.	The steady magnetism makes DC flow in a single direction.
The frequency of AC is dependent upon the country. But, generally, the frequency is 50 Hz or 60 Hz.	DC has no frequency or zero frequency.
In AC the flow of current changes its direction forward and backward periodically.	It flows in a single direction steadily.
Electrons in AC keep changing their directions – backward and forward.	Electrons only move in one direction – forward.