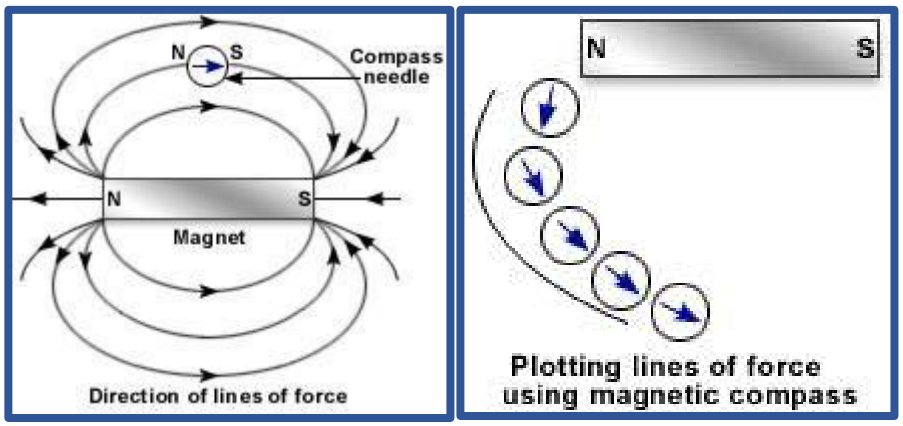
Parul University

Parul Institute of Engineering and Technology (Diploma Studies)

Basic Physics (03692155)

1. State characteristics of magnetic field lines.

- They are said to originate from the north pole and end at the south pole. This is only a convention.
- The lines of forces of a particular magnet do not intersect with each other.
- Tangent to the line of force gives the direction of the magnetic field acting at that point.
- A line of force is continuous: starts from the north pole and ends at the south pole.
- There is no line of force within the magnet.



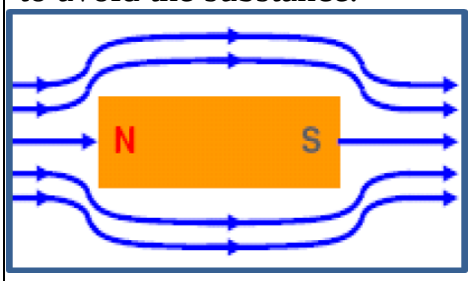
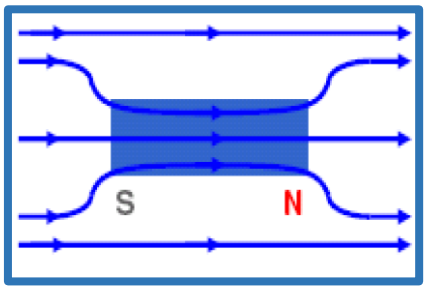
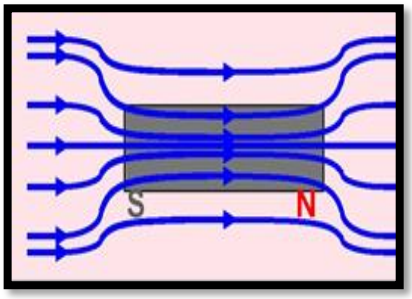
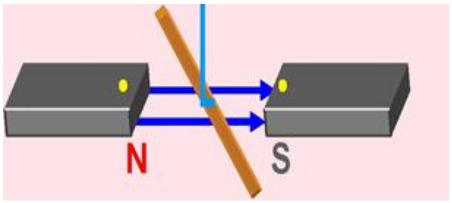
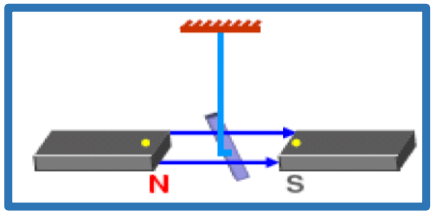
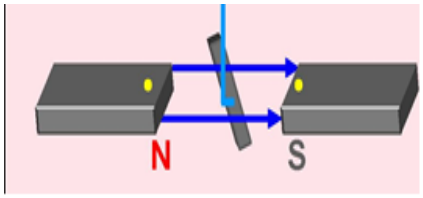
2. Define magnetic field and magnetic field intensity.

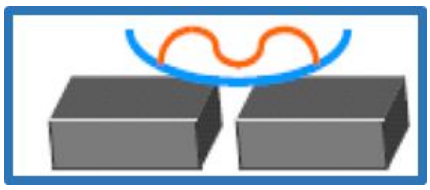
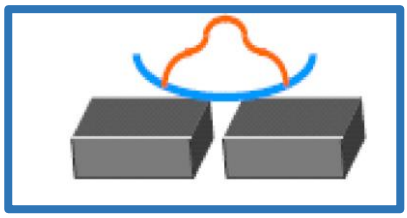
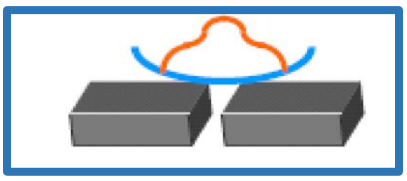
The space around a magnet or the space around a conductor carrying current in which its magnetic influence can be experienced is called a magnetic field.

- The S. I. Unit of magnetic field (B) is $\frac{\mathbf{N}}{\mathbf{Am}}$ or $\mathbf{NA^{-1}m^{-1}}$ or tesla (T) or weber/(meter)^2 i.e. (Web/m^2).

Magnetic intensity: - The degree to which a magnetic field can magnetize a material is represented in terms of magnetizing force or magnetic intensity (H)

3. Explain the difference between diamagnetic, paramagnetic, and ferromagnetic materials.

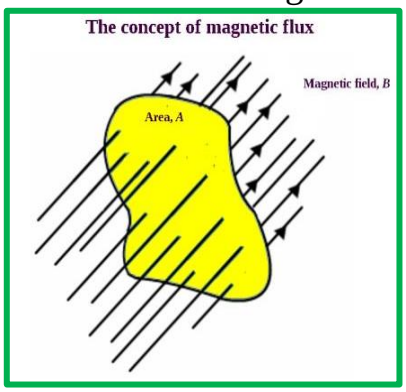
Diamagnetic	Paramagnetic	Ferromagnetic
Diamagnetic substances are those substances that are feebly repelled by a magnet.	Paramagnetic substances are those substances that are feebly attracted by a magnet.	Ferromagnetic substances are those substances that are strongly attracted by a magnet.
When placed in the magnetic field, the lines of force tend to avoid the substance. 	The lines of force prefer to pass through the substance rather than air. 	➢ The lines of force tend to crowd into the specimen. 
When placed in a non-uniform magnetic field, it moves from a stronger to a weaker field (feeble repulsion).	When placed in a nonuniform magnetic field, it moves from a weaker to a stronger field (feeble attraction).	When placed in a nonuniform magnetic field, it moves from a weaker to a stronger field (strong attraction).
When a diamagnetic rod is freely suspended in a uniform magnetic field, it aligns itself in a direction perpendicular to the field. 	When a paramagnetic rod is freely suspended in a uniform magnetic field, it aligns itself in a direction parallel to the field. 	When a ferromagnetic rod is freely suspended in a uniform magnetic field, it aligns itself in a direction parallel to the field very quickly. 

if a watch glass containing a small quantity of diamagnetic liquid is placed on two dissimilar magnetic poles, the liquid shows depression in the middle. 	if a watch glass containing a small quantity of paramagnetic liquid is placed on two dissimilar magnetic poles, the liquid shows an elevation in the middle. 	if a watch glass containing a small quantity of ferromagnetic liquid is placed on two dissimilar magnetic poles, the liquid shows an elevation in the middle. 
When a diamagnetic substance is placed in a magnetic field, it is weakly magnetized in the direction opposite to the inducing field.	When a paramagnetic substance is placed in a magnetic field, it is weakly magnetized in the direction of the inducing field.	When a ferromagnetic substance is placed in a magnetic field, it is strongly magnetized in the direction of the inducing field.
On removal of the external magnetic field, diamagnetic substances lose their magnetism.	On removal of the external magnetic field, paramagnetic substances lose their magnetism.	On removal of the external magnetic field, ferromagnetic substances do not lose their magnetism. i.e., they are permanent magnets.
The relative magnetic permeability of diamagnetic substances is always less than unity. $\mu_r < 1$	The relative magnetic permeability of a paramagnetic substance is always greater than unity. $\mu_r > 1$	The relative Magnetic permeability of a ferromagnetic substance is large i.e. much more than unity. $\mu_r > 1$

From the relation $\mu_r = 1 + \chi_m$, as $\mu_r < 1$, χ_m is negative. Hence susceptibility of diamagnetic substances is negative.	From the relation $\mu_r = 1 + \chi_m$, as $\mu_r > 1$ therefore, χ_m must be positive. Hence susceptibility of paramagnetic substances is positive and has a small value.	From the relation $\mu_r = 1 + \chi_m$, as $\mu_r > 1$ therefore, χ_m mustvbe positive. Hence susceptibility of ferromagnetic substances is positive and has a large value.
The susceptibility of diamagnetic does not change with temperature.	Susceptibility of paramagnetic substances varies inversely as the temperature of the substance $i.e\ x_m \propto \frac{1}{T}$ $i.e$ they lose their magnetic character with the rise in temperature.	With the rise in temperature, the susceptibility of ferromagnetic materials decreases. At a certain temperature, ferromagnetic passes over to paramagnetic.

4. Define magnetic flux.

- Magnetic flux is defined in the same way as electric flux is defined**.**
- Magnetic Flux: - The magnetic flux linked through any surface placed in a magnetic field is the number of magnetic field lines crossing this surface normally.

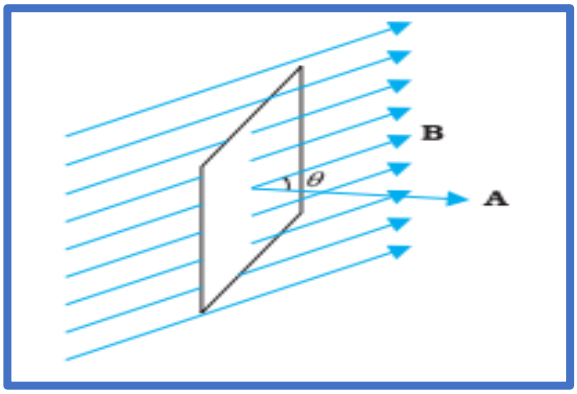


- Magnetic Flux is a scalar quantity and is denoted by $\boldsymbol{\phi}$.
- Magnetic flux through a plane of area A placed in a uniform magnetic field B can be written as,

$$\phi = \vec{B} \cdot \vec{A}$$

$$\phi = BA\cos\theta$$

- Where θ = Angle between B and A.



- The notion of the area as a vector.
- The SI unit of magnetic flux is weber (Wb) or tesla meter square (Tm^2).

5. **State the full form of the laser.**

Laser is the acronym for,
L-Light
A-Amplification by
S-Stimulated
E-Emission of
R-Radiation

6. **State properties of lasers.**

Laser light has three unique characteristics that make it different than "ordinary" light, which is as follows,

- It is highly monochromatic means that it consists of one single color or wavelength. Even though some lasers can generate more than one wavelength, the light is extremely pure and consists of a very narrow spectral range.
- It is highly directional means that the beam is well collimated (very parallel) and travels over long distances with very little spread.
- It is highly coherent means that all the individual waves of light are moving precisely together through time and space, i.e., they are in phase.

7. **State applications of lasers.**

Lasers are now widely used in various fields.
1. In Industry
- for welding, melting, etching, surface hardening, and surface processing.
- For cutting and drilling holes in materials.
- For testing the quality of the material.
- For the annealing (heating and cooling) process of the material.

2. In Medicine
- To perform bloodless and microsurgery.
- To treat retinal detachment problems.
- To treat diseases like cancers and tumors.
- To drill microscopic holes in cell walls without damaging them.

3. A powerful laser torch can be used to destroy airplanes, missiles, etc.
4. It is also used to determine precisely the location and motion as well as size of distant objects, which is done by the beam reflected from the object. This is known as LIDAR.
5.In Science and Engineering
- It is used in fiber optics communication.

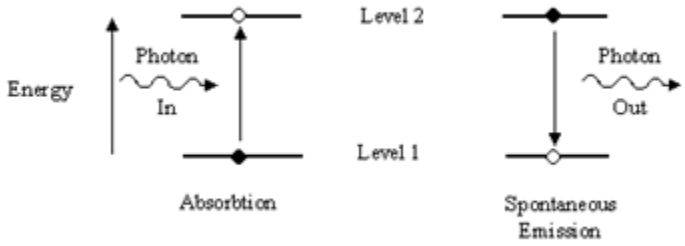
- It is used in holography.
- It is used to accelerate some chemical reactions.
- It is used in the nuclear fusion process.

8. Difference between spontaneous and stimulated emission.

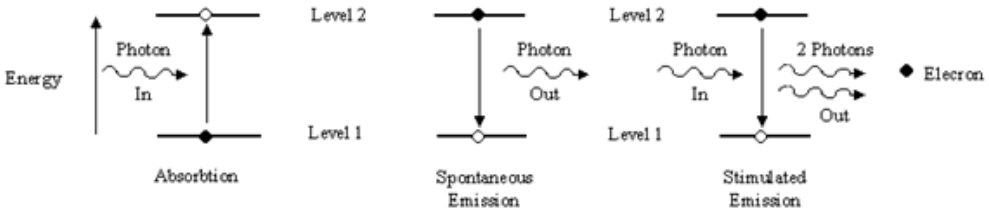
Spontaneous Emission

A particle from a higher energy state passes to a lower energy state spontaneously emitting a photon hυ.

This emission depends on the type of particle and type of transition. It is not caused by extraneous effects and is a random process. The radiations emitted are mixture of quanta having various wavelengths. Thus, radiations are incoherent and has broad spectrum.



A particle can pass from an excited state to normal state emitting quanta (photons) not only spontaneously but also when forced to it, under the effect of another external quantum.

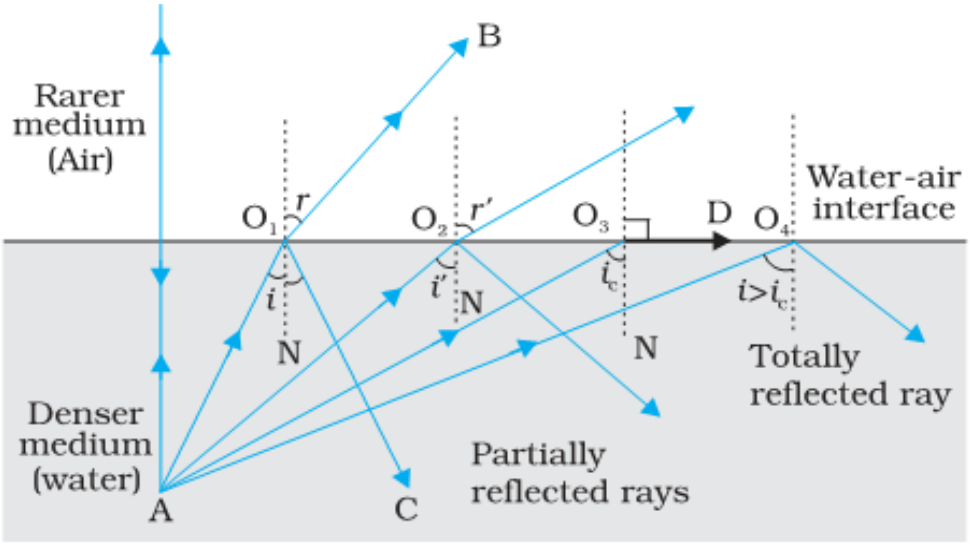


According to Einstein, an interaction between the excited atom and a photon can trigger the excited atom to make a transition to the ground state. Therefore, the transition generated a second photon which is identical to the triggering photon. The radiations are thus coherent with the stimulating incident radiation.

9. State the principle of fiber optic cables.

Total Internal Reflection: -

When the light passes through an interface between two media, it gets partly reflected and partly refracted in the following figure, consider the case, where 'A' is a point-like source in the denser medium having higher refractive index, and emitting light rays in all directions. Suppose the denser medium is glass. Now, whenever a ray of light passes from an optically denser medium to a rarer medium, the refracted ray is bent away from the normal i.e., the angle of refraction is greater than the angle of incidence.



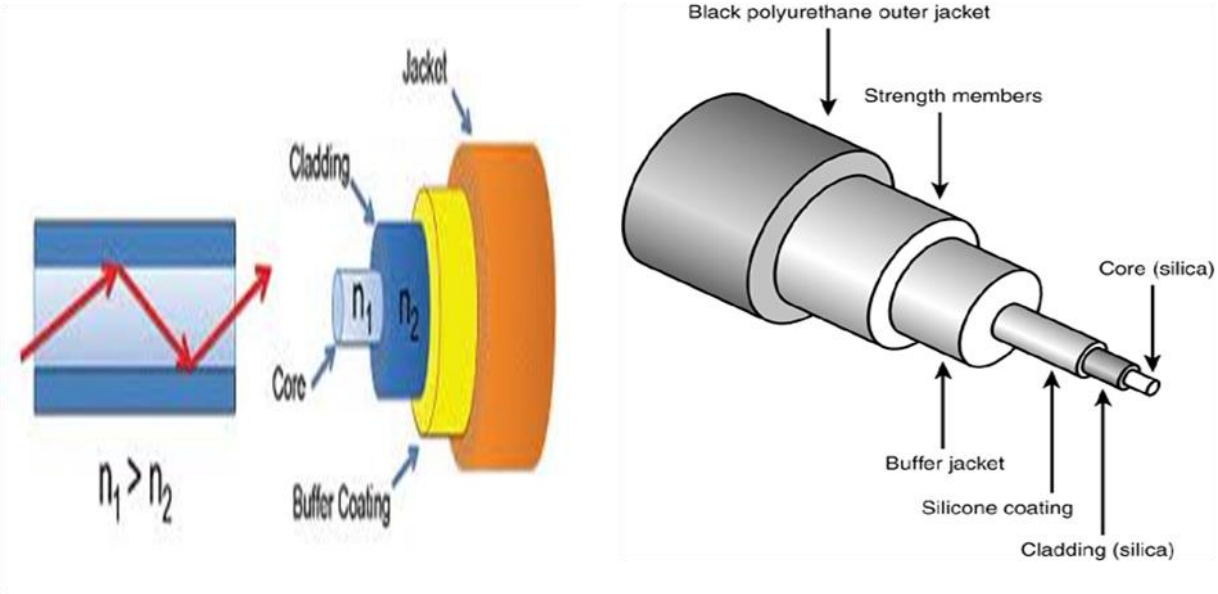
First of all, consider a ray AB striking the interface at an angle i and is refracted at an angle r, for that $\angle r > \angle i$. As the angle of incidence increases the angle of refraction also increases. But for a particular value of angle of incidence, the refracted ray emerges along the surface of separation. This particular angle is known as the **"Critical Angle"** as shown in the figure.

The angle of incidence for which the angle of refraction is 90° is called the critical angle 'C' of the denser medium with respect to the rarer medium.

Now consider the rays, which are incident at an angle greater than the critical angle i.e. no refraction occur means the angle of refraction is greater than 90° and thus the angle of the incident ray is reflected in the same medium means the 100% reflection will take place. This phenomenon is called Total Internal Reflection.

10. Explain the structure of fiber optic cable.

- There are many different cable designs available today. Depending on the configuration, the cable may include a core, a cladding, a protective tube, a polyurethane compound, and one or more protective jackets.
- The fiber cable consists of a core at the center and cladding outside the core. The core is generally a cylindrical dielectric glass with a refractive index of n1 and the cladding is the second stealth or cover made of glass with a lower refractive index of n2 than the core refractive index, figure. The cladding in turn covered by a buffer jacket. This buffer jacket provides protection for the fiber from the external mechanical influence that could cause fiber breakage or excessive optical attenuation.
- Surrounding the buffer jacket there is a layer of strength members called Kevlar (a yarn-type material) which increases the tensile strength of the cable. Again, an outer protective tube is filled which polyurethane, which prevents moisture from coming into contact with the fiber.
- When light propagate through the fiber, the light is transmitted within the core. The cladding keeps the light waves within the core because. The refractive index of the cladding material is less than that of core.
- The type of cable construction used to depend on performance requirements of the system and both the economic and environmental constructions.



11. State applications of fiber optic cables.

The application and uses of optical fiber can be seen in:
Medical Industry
Communication
Defense
Industries
Broadcasting
Lighting and Decorations
Mechanical Inspections
Optical Fibers uses in the medical industry
Because of its extremely thin and flexible nature, it is used in various instruments to view internal body parts by inserting them into hollow spaces in the body. It is used as a laser during surgeries, endoscopy, microscopy, and biomedical research.

Optical Fibers used in Communication
In the communication system, telecommunication has major uses of optical fiber cables for transmitting and receiving purposes. It is used in various networking fields and even increases the speed and accuracy of the transmission data. Compared to copper wires, fiber optics cables are lighter, more flexible, and carry more data.

Optical Fibers used in Defense Purpose
Fiber optics are used for data transmission in high-level data security fields of military and aerospace applications. These are used in wirings in aircraft, hydrophones for SONARs, and seismic applications.

Optical Fibers are used in Industries
These fibers are used for imaging in hard-to-reach places such as they are used for safety measures and lighting purposes in automobiles both in the interior and exterior. They transmit information at lightning speed and are used in airbags and traction control. They are also used for research and testing purposes in industries.

Optical Fibers used for Broadcasting

These cables are used to transmit high-definition television signals which have greater bandwidth and speed. Optical Fiber is cheaper compared to the same quantity of copper wires. Broadcasting companies use optical fibers for wiring HDTV, CATV, video-on-demand, and many applications.

Uses of Optical Fiber for Lightening and Decorations

By now, we got a fair idea of what is optical fiber and it also gives an attractive, economical and easy way to illuminate the area and that is why it is widely used in decorations and Christmas trees.

Optical Fibers Used in Mechanical Inspections

On-site inspection engineers use optical fibers to detect damages and faults which are at hard-to-reach places. Even plumbers use optical fibers for the inspection of pipes.

12. State types of fiber optic cables

The optical fiber cable is classified based on three factors – the refractive index, the materials used, and the mode of propagation of light.

The basis of the refractive index OFC is of two types:

Step Index Fibers: It comprises a core enclosed by the cladding, which has a single uniform index of refraction.

Graded Index Fibers: The refractive index of the optical fiber decreases as the radial distance from the fiber axis increases.

Based on materials, OFC is of two types:

Plastic Optical Fibers: The poly (methyl methacrylate) is used as a core material for the transmission of light.

Glass Fibers: This fiber cable consists of extremely fine glass fibers.

Based on the mode of propagation of light, OFC is divided into:

Single-Mode Fibers: Used for long-distance transmission of signals.

Multimode Fibers: Used for short-distance transmission of signals.