[APPLIED PHYSICS]

[SESSIONAL ASSIGNMENT]

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SUBMITTED BY SAAD ALI
[ID NO: 16880]
[BS-SE]
SUBMITTED TO MUHAMMAD KHALID HAMID

SESSIONAL ASSIGNMENT

Q1:

- **a. What is the difference between Reflection and Refraction?**
- **b. What is meant of Critical angle?**
- **c. What is the main function of angle of incidence?**
- **d. What is meant by Index of refraction?**

Q2:

- **a. Explain the difference between Solenoid and toroids?**
- **b. Explain the Magnetic field of solenoids?**
- **c. Explain the Magnetic field of Toroids ?**

Q1:

a. What is the difference between Reflection and Refraction?

ANS: - **REFLECTION: -**

1. When light falls from one medium on the surface of another medium apart from it bounce back in the same medium. This process is called reflection of light.
2. In this process, light bounces back.
3. In this process, light waves bounce off the plane and change direction.
4. In reflection of the light angle of incidence is equal to the angle reflection.
5. The Reflection occurs in mirror.

REFRACTION: -

1. When light falls from one medium on the surface of another medium it changes its direction and speed. This process is called the refraction of light.
2. In this process light change path.
3. In this method, light waves change their direction and speed
4. In refraction angle of the incident is not equal to the angle of refraction.
5. The Refraction occurs in lenses.

b. **What is meant of Critical angle?**

ANS: - CRITICAL ANGLE: -

When the angle of incidence in water reaches a certain critical value, the refracted ray lies along the boundary, having an angle of refraction of 90-degrees. This angle of incidence is known as the critical angle; it is the largest angle of incidence for which refraction can still occur. For any angle of incidence greater than the critical angle, light will undergo total internal reflection.

The Critical Angle Derivation: -

So the critical angle is defined as the angle of incidence that provides an angle of refraction of 90-degrees. Make particular note that the critical angle is an angle of incidence value. For the water-air boundary, the critical angle is 48.6-degrees. For the crown glass-water boundary, the critical angle is 61.0-degrees. The actual value of the critical angle is dependent upon the combination of materials present on each side of the boundary.

Let's consider two different media - creatively named medium i (incident medium) and medium r (refractive medium). The critical angle is the Θ_i that gives a Θ_r value of 90-degrees. If this information is substituted into Snell's Law equation, a generic equation for predicting the critical angle can be derived. The derivation is shown below.

n_i *• sine(Θ_i) = n_r • sine (Θ_r)
n_i • sine(Θ_{crit}) = n_r • sine(90 degrees)

n_i • sine(Θ_{crit}) = n_r

sine(Θ_{crit}) = n_r/n_i

Θ_{crit}= sine^{-1} (n_r/n_i) = invsine (n_r/n_i)

The critical angle can be calculated by taking the inverse-sine of the ratio of the indices of refraction. The ratio of n_r/n_i is a value less than 1.0. In fact, for the equation to even give a correct answer, the ratio of n_r/n_i must be less than 1.0. Since TIR only occurs if the refractive medium is less dense than the incident medium, the value of n_i must be greater than the value of n_r. If at any time the values for the numerator and denominator become accidentally switched, the critical angle value cannot be calculated. Mathematically, this would involve finding the inverse-sine of a number greater than 1.00 - which is not possible. Physically, this would involve finding the critical angle for a situation in which the light is traveling from the less dense medium into the more dense medium - which again, is not possible.

This equation for the critical angle can be used to predict the critical angle for any boundary, provided that the indices of refraction of the two materials on each side of the boundary are known. Examples of its use are shown below:

Example A

Calculate the critical angle for the crown glass-air boundary. Refer to the table of indices of refraction if necessary.
The solution to the problem involves the use of the above equation for the critical angle.

Θcrit = $\sin^{-1}(n_r/n_i)$ = invsine (n_r/n_i)
Θcrit = $\sin^{-1}(1.000/1.52)$ = **41.1 degrees**

Example B

Calculate the critical angle for the diamond-air boundary. Refer to the table of indices of refraction if necessary.

The solution to the problem involves the use of the above equation for the critical angle.

Θcrit = $\sin^{-1}(n_r/n_i)$ = invsine (n_r/n_i)
Θcrit = $\sin^{-1}(1.000/2.42)$ = **24.4 degrees**

c. What is the main function of angle of incidence?

ANS: - Angle of Incidence: -

In the event that you have ever taken a gander at a white light being sparkled into a crystal, the primary concern you likely saw is it being transformed into a rainbow. Notwithstanding, did you notice that the light didn't travel straight through the crystal. The light alters course when it enters the crystal, and it changes again when it leaves. This bowing of light isn't something that is interesting to crystals. It's a typical event in translucent and straightforward materials. We have even thought of interesting names for the edges at which the light enters and goes through the material. The point at which the light enters is known as the edge of occurrence. The edge of frequency can be characterized as the point between the approaching beam of light and the typical vector of the outside of the material it is coming into contact with. The ordinary vector is an opposite vector from a plain or surface of an item.

Retention, Reflection and Refraction: -

There are three opportunities for what can befall the light after it comes into contact with an article. The first is retention. In retention, the light beam voyages no further; it is taken into the item and changed into vitality. This frequently appears as warmth. The second is reflection, where the light beam is bobbed off the material rather than retained. The last chance is refraction, in which the light infiltrates the item, however as opposed to being transformed into inward vitality, it alters course and keeps on going through the material as light. Note that light doesn't frequently do only one of those three prospects; rather, it goes in a mix of them. For instance, we see shading since objects mirror the obvious light range of the relating hues we see back to our eyes, however they retain different frequencies of the noticeable light range. Another model would be translucent articles. A translucent material, instead of a straightforward one, just lets a portion of the light travel through it and assimilates and mirrors its remainder.

With ingestion, there are no further relations between the edge of frequency and what befalls the beam of light, however with reflection and refraction, there is a whole other world to learn.

MAIN FUNCTION: -

The connection between the main function beam and the occurrence light beam is represented by the law of reflection. The law of reflection expresses that the point between the reflected beam and the ordinary vector is equivalent to the edge of frequency. Scientifically this is communicated by the accompanying basic connection:

theta = thetaR

theta = angle of incidence

the tar = angle of reflection

So, if you know either the angle of reflection or the angle of incidence, you automatically know the other as well.

Have you at any point been skewer angling, or seen it done on TV? The angler remains in or above shallow water and attempts to skewer the fish as they swim by. On the off chance that they attempt to hit the fish precisely where they see it, they will miss. The fish isn't the place it is by all accounts from over the water. This is an impact of refraction. Light twisting as it enters the water is the thing that makes the fish show up in an alternate spot from where it really is.

Much like with the edge of reflection, there is additionally a connection between the edge of rate and the edge of refraction. At the point when light enters from one medium into another, it can curve somewhat. The computation of what degree the light will twist is known as the law of refraction, or Snell's Law. How much the light twists is reliant on both the rate point entering the subsequent medium and the speed at which the light goes through the two mediums.

The connection between the speed of light and refraction is given in the list of refraction. You should comprehend the record of refraction so as to comprehend Snell's Law.

n = c/v

n = record of refraction

c = speed of light in a vacuum

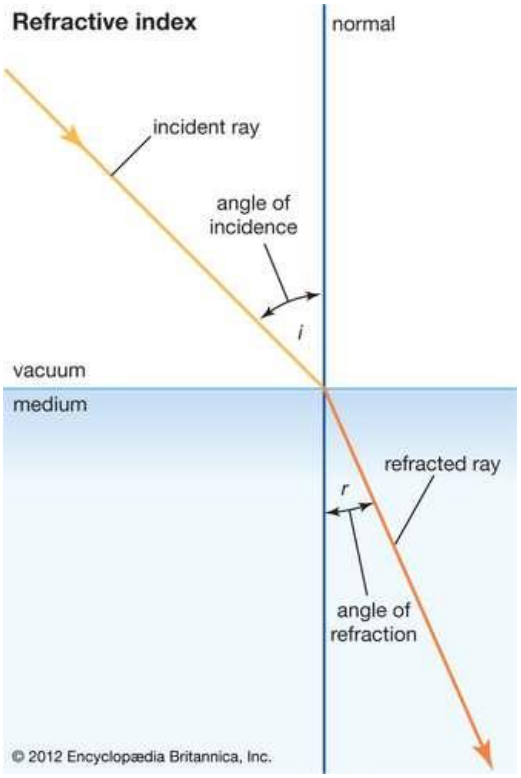
v = normal speed of light in a medium

While the speed of light in a vacuum is consistent, the speed of light in different mediums can shift, and subsequently they have distinctive records of refraction. Some regular models can be found in this table.

d. What is meant by Index of refraction?

ANS: - INDEX OF REFRACTION: -

Refractive index, also called **index of refraction**, measure of the bending of a ray of light when passing from one medium into another. If i is the angle of incidence of a ray in vacuum (angle between the incoming ray and the perpendicular to the surface of a medium, called the normal) and r is the angle of refraction (angle between the ray in the medium and the normal), the refractive index n is defined as the ratio of the sine of the angle of incidence to the sine of the angle of refraction; i.e., $n = \sin i / \sin r$. Refractive index is also equal to the velocity of light c of a given wavelength in empty space divided by its velocity v in a substance, or $n = c/v$.



refractive index

Diagram of a light ray being refracted.

Some typical refractive indices for yellow light (wavelength equal to 589 nanometres [10^{-9} metre]) are the following: air, 1.0003; water, 1.333; crown glass, 1.517; dense flint glass, 1.655; and diamond, 2.417. The variation of refractive index with wavelength is the source of chromatic aberration in lenses. The refractive index of X-rays is slightly less than 1.0, which means that an X-ray entering a piece of glass from air will be bent away from the normal, unlike a ray of light, which will be bent toward the normal. The equation $n = c/v$ in this case indicates, correctly, that the velocity of X-rays in glass and in other materials is greater than its velocity in empty space.

Q2:

a. Explain the difference between Solenoid and toroids?

ANS: - SOLENOID: -

1. Cylindrical in shape.
2. Magnetic field is created outside
3. Has uniform magnetic field inside it.
4. Magnetic field due to solenoid is (B) = Uo.ni

TOROIDS: -

1. Circular in shape.
2. Magnetic field is created within.
3. It does not have a uniform magnetic field inside it.
4. Magnetic feild Outside :- magnetic field (B) = 0
5. Magnetic feild Inside:- Magnetic field (B) = 0
6. Magnetic feild Within the toroid:- Magnetic field (B) = Uo.ni

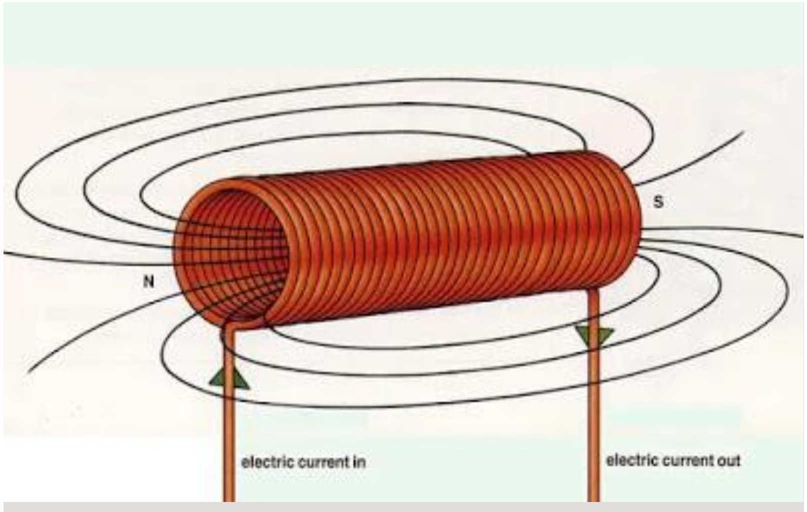
Similarities between solenoid and toroid: -

1. Both works on the principle of Electromagnetism.
2. When current is passed through them, they both act like an electromagnet.
3. Magnetic field due to the solenoid and within the toroid is the same. B = Uo.ni.

What are toroid and solenoid?

These are devices used as an electromagnet when current is passed through them

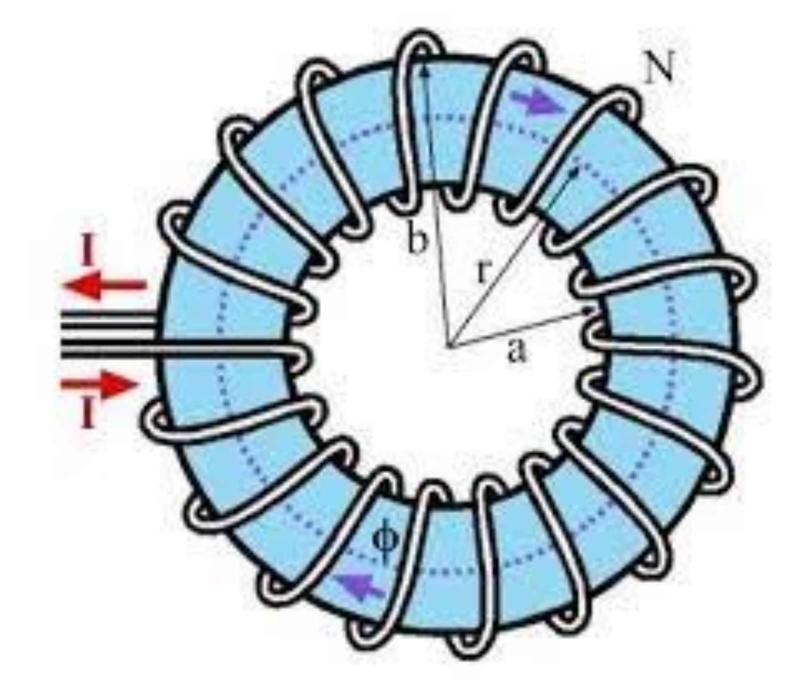
SOLENOID: -



Current passing through a solenoid

A long wire wrapped around in helical shape is known as **Solenoid**. They are cylindrical in shape as you can see in the image above. A solenoid is used in experiments and research field regarding the magnetic field.

TOROID: -



Current passing through a toroid

Unlike solenoid, the shape of the toroid is circular in shape and coil wrapped around toroid is circular in shape. You can use toroid in electric devices with low frequency.

Conclusion:

Solenoid and toroid both work on the principle of electromagnetism and both behave like an electromagnet when current is passed. The magnetic field produces by them is **B = Uo.ni.** Even after having so many similarities solenoid and toroid differs in property such as shape:

1. A solenoid is cylindrical in shape whereas toroid is circular.

2. Magnetic field is produced outside in solenoid whereas magnetic filed outside of toroid is zero and the magnetic field is produced within.

3. The solenoid has a uniform magnetic field whereas toroid does not have a uniform magnetic field within.

b. Explain the Magnetic field of solenoids?

ANS: - Magnetic Field of a Solenoid: -

A solenoid is a tightly wound helical coil of wire whose diameter is small compared to its length. The magnetic field generated in the centre, or *core*, of a current carrying solenoid is essentially *uniform*, and is directed along the axis of the solenoid. Outside the solenoid, the magnetic field is far weaker. Figure 27 shows (rather schematically) the magnetic field generated by a typical solenoid. The solenoid is wound from a single helical wire which carries a current I. The winding is sufficiently tight that each turn of the solenoid is well approximated as a circular wire loop, lying in the plane perpendicular to the axis of the solenoid, which carries a current I. Suppose that there are n such turns per unit axial length of the solenoid. What is the magnitude of the magnetic field in the core of the solenoid?

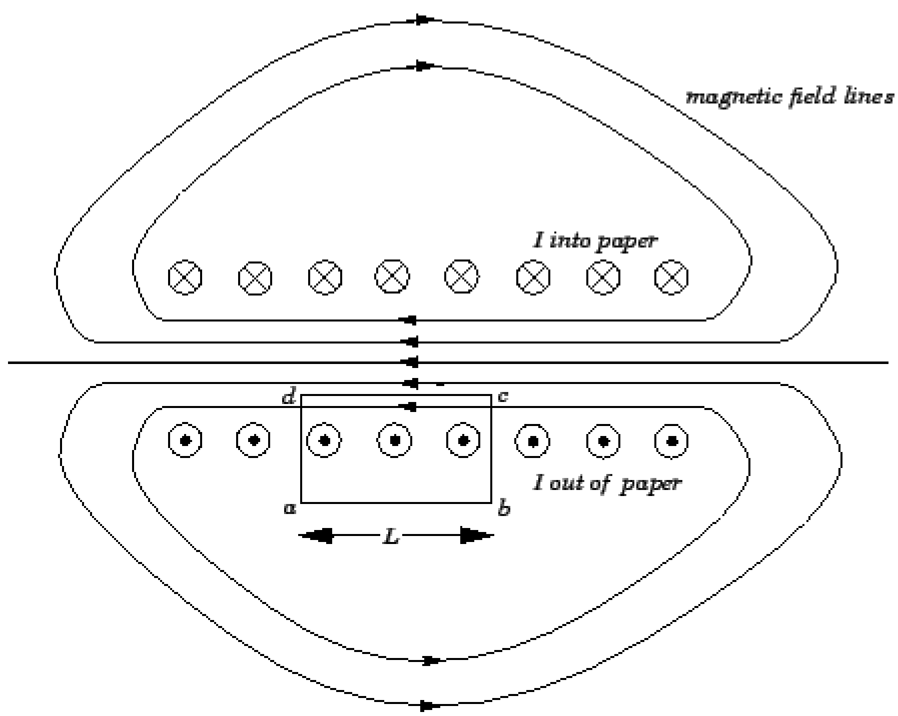


Figure 27: *A solenoid.*

In order to answer this question, let us apply Ampère's circuital law to the rectangular loop abcd. We must first find the line integral of the magnetic field around abcd. Along bc and da the magnetic field is essentially perpendicular to the loop, so there is no contribution to the line integral from these sections of the loop. Along cd the magnetic field is approximately uniform, of magnitude B, say, and is directed parallel to the loop. Thus, the contribution to the line integral from this section of the loop is B L , where L is the length of cd. Along ab the magnetic field-strength is essentially negligible, so this section of the loop makes no contribution to the line integral. It follows that the line integral of the magnetic field around abcd is simply

$$w = B\,L.$$

By Ampère's circuital law, this line integral is equal to μ_0 times the algebraic sum of the currents which flow through the loop $abcd$. Since the length of the loop along the axis of the solenoid is L, the loop intersects $n\,L$ turns of the solenoid, each carrying a current I. Thus, the total current which flows through the loop is $n\,L\,I$. This current counts as a positive current since if we look against the direction of the currents flowing in each turn (*i.e.*, into the page in the figure), the loop $abcd$ circulates these currents in an anti-clockwise direction. Ampère's circuital law yields

$$B\,L = \mu_0\,n\,L\,I,$$

which reduces to

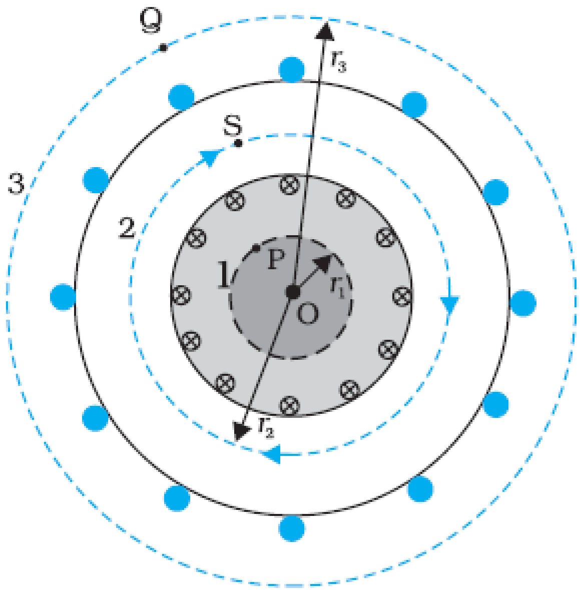
$$B = \mu_0\,n\,I.$$

Thus, the magnetic field in the core of a solenoid is directly proportional to the product of the current flowing around the solenoid and the number of turns per unit length of the solenoid. This, result is *exact* in the limit in which the length of the solenoid is very much greater than its diameter.

c. Explain the Magnetic field of Toroids?

ANS: - MAGNETIC FIELD DUE TO A TOROID: -

EXAMPLE:



The magnetic field in the open space inside (point P) and exterior to the toroid (point Q) is zero. The field B inside the toroid is constant in magnitude for the ideal toroid of closely wound turns.The direction of the magnetic field inside is clockwise as per the right-hand thumb rule for circular loops. Three circular Amperian loops 1, 2 and 3 are shown by dashed lines. By symmetry, the magnetic field should be tangential to each of them and constant in magnitude for a given loop.

Example:The number of turns per unit length in a toroid is 103 and current flowing in it is $4\pi 1$ ampere, then the magnetic induction produced in it, is :

Magnetic field in a toroid $B=\mu 0ni$

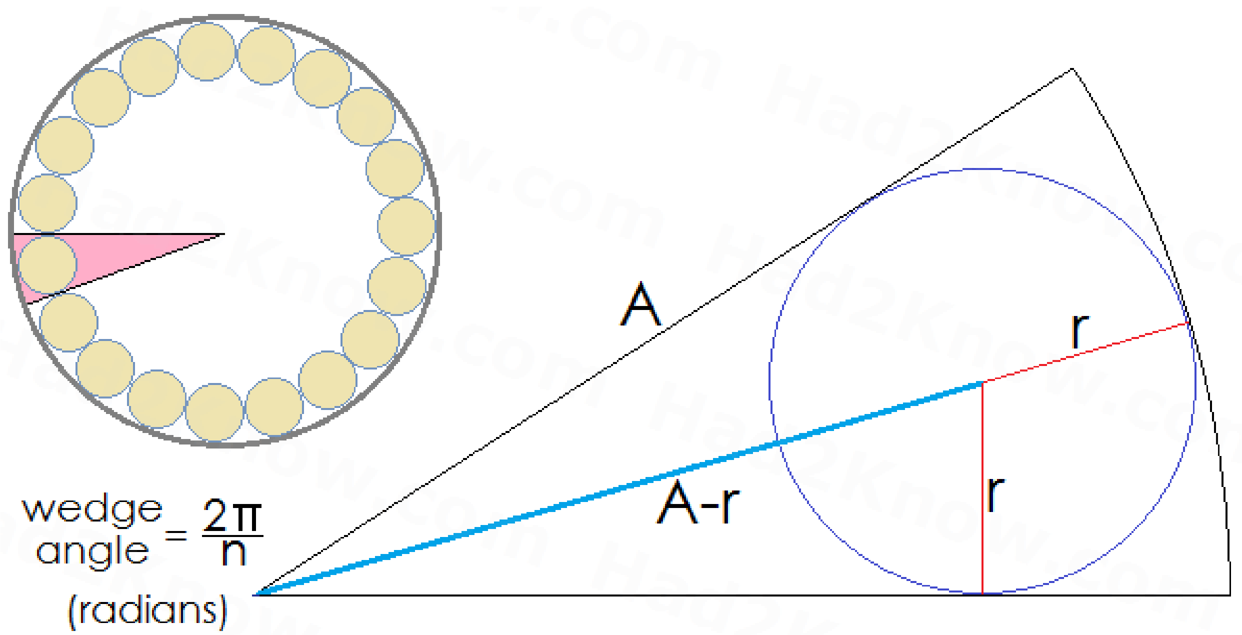
Given $n=103$ and $i=4\pi 1A$

We know that $\mu 0=4\pi\times 10-7T/A$

$B=4\pi\times 10-7\times 103\times 4\pi 1=10-4T$

NUMBER OF TURNS IN A TOROIDAL COIL: -

FORMULA:



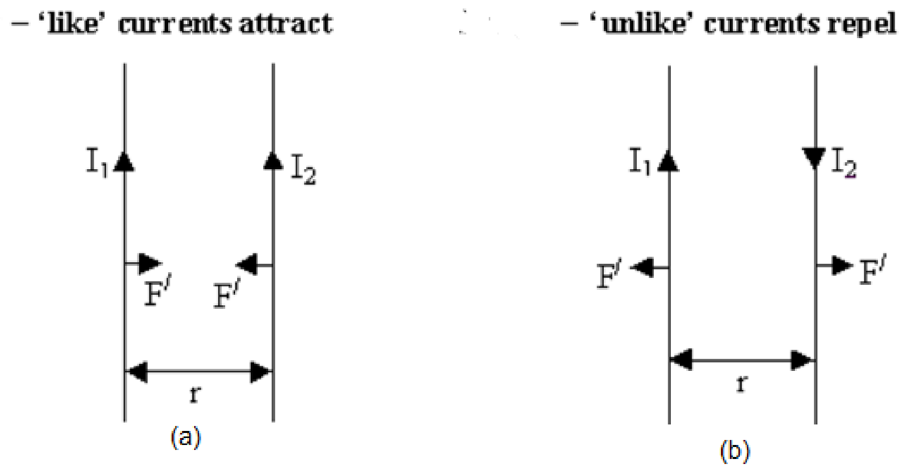
The figure below shows a cross-sectional view of the inner radius of a toroid inductor and wire. The inner radius of the torus is **A**, the radius of the wire is **r**, and the maximum number of loops is **n.**

The equation that relates **A**, **r**, and **n** is: $sin(n\pi)=A-rr$ in radians

$n=\text{arcsin}A-rr\pi$

OBSERVE THAT PARALLEL CURRENTS REPEL IN A SOLENOID AND TOROID: -

DEFINITION:



Two parallel wires carrying currents will either attract or repel each other. Consider diagram (a):
Apply the right-hand grip rule to the left-hand conductor - this indicates that the magnetic field at the right-hand conductor due to the current in the left-hand conductor is into the paper. Now apply Flemings left hand rule to the right-hand conductor - this indicates that the field produces a force on the right-hand conductor to the left, as shown.
The directions of all the forces can be determined in a similar way.
The flux density $B1$ produced by the left-hand conductor at the right-hand conductor is given by: $B1=2\pi r\mu 0I1$