INTERNATIONAL JOURNAL FOR INNOVATIVE RESEARCH IN MULTIDISCIPLINARY FIELD ISSN: 2455-0620 Volume - 7, Issue - 10, Oct – 2021
Monthly, Peer-Reviewed, Refereed, Indexed Journal with IC Value: 86.87 Impact Factor: 6.719
Received Date: 21/09/2021 Acceptance Date: 09/10/2021 Publication Date: 10/10/2021

Chakiya rule for finding the direction of magnetic field lines and magnetic force lines

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Abstract: *In the study of magnetism, we use the right-hand palm rule, Maxwell's right-hand screw rule, and Maxwell's right-hand rule to find the direction of the magnetic field. Similarly, to find the direction of the force acting on a moving charge in a magnetic field or a current-carrying conductor, we apply Fleming's left-hand rule, right hand palm rule and right-hand screw rule. But since there is no clear rule to find the direction of magnetic field lines and magnetic force lines, school children are unable to differentiate between these two, due to which they remain confused. That's why we have introduced the concept of a new rule called 'Chakiya Rule'.*

Key Words: *Chakiya Rule, Magnetism, Field lines, Current, Force lines, Induced.*

1. INTRODUCTION:

In the study of magnetism, various rules have been proposed to find the direction of the magnetic force and the direction of the magnetic field.

1. There are three laws to find the direction of the magnetic field –
    a. Right hand palm rule –
    If we stretch our right hand such that fingers point towards the point. At which magnetic field is required while thumb is in the direction of current then normal to the palm will show the direction of magnetic field.

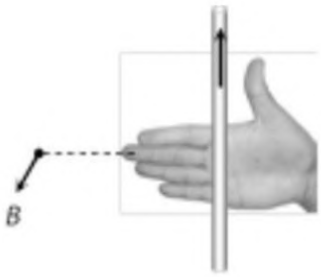

Fig. 1 (a)

    b. Maxwell's right-hand rule –
    Assume that the current carrying conductor is held in the right hand so that the fingers wrap around the conductor and the thumb is stretched (as shown in the figure at left). If the thumb is along the direction of current, wrapped fingers will show the direction of circular magnetic field lines.

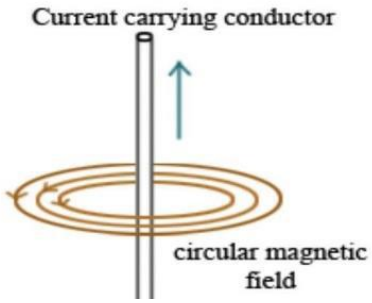

Fig. 1 (b)

c. Maxwell's Right-Hand Screw Rule –
If a right-handed screw is assumed to be held along the conductor, and the screw is rotated such that it moves in the direction of the current, direction of magnetic field is same as that of the rotation of the screw.

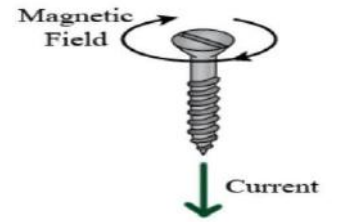

Fig. 1 (c)

2. In the same way, there are three laws to find the direction of the Magnetic Force –
   a. Fleming's Left-hand rule –
   When a current-carrying conductor is placed in an external magnetic field, the conductor experiences a force perpendicular to both the field and to the direction of the current flow. It was invented by John Ambrose Fleming.

   A left hand can be held, as shown in the figure 2 (a), to represent three mutually orthogonal axes on the thumb, forefinger, and middle finger. If we arrange the thumb, the center finger, and the forefinger of the left hand at right angles to each other, then the thumb points towards the direction of the magnetic force, the center finger gives the direction of current and the forefinger points in the direction of a magnetic field.

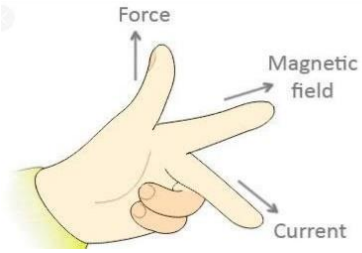

Fig. 2 (a)

   b. Right hand palm rule - To find the direction of the force on the charge, with a flat hand point your thumb in the direction of the velocity of the positive charge and your fingers in the direction of the magnetic field. The direction of the force is out of the palm of your hand. (If the moving charge is negative, point your thumb opposite to its direction of motion.) Mathematically, this force is the cross product of the velocity vector and the magnetic field vector.

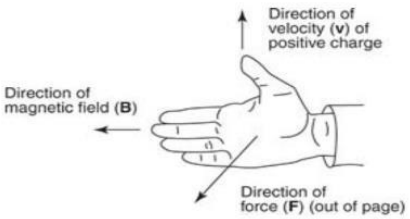

Fig. 2. (b). I

If the velocity of the charged particle is perpendicular to the uniform magnetic field, the force will always be directed toward the center of a circle of radius r, as shown in figure 2. (b). I. (The x symbolizes

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a magnetic field into the plane of the paper, the tail of the arrow and dot symbolizes a vector out of the plane of the paper, the tip of the arrow)

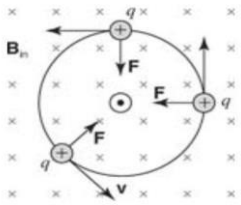

Fig. 2. (b). II

c. Right-Hand Screw Rule –
The right-hand screw rule can be used when a direction must be determined, based upon rotational direction or vice-versa. The axis of the screw is placed as shown in the figure 2 (c). When the screw is moved by a small angle in the direction from A to B, then the direction in which the screw moves forward gives the direction of the resultant vector.

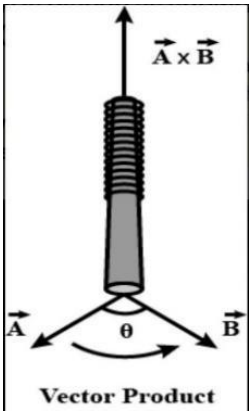

Fig. 2 (c)

There are many misconceptions among school children in understanding and implementing the above rules. Due to which they are unable to differentiate between magnetic field lines and magnetic force lines. Therefore, it has become necessary that such a rule should be given to them which is related to their everyday life and there is no inconvenience in understanding this rule at all. Keeping this in mind, we have given a simple and very useful rule to find the direction of magnetic field lines and magnetic force lines, which is named “Chakiya rule”.

Fig. 3

According to this rule, 'If the axis of rotation of the Chakiya wheel represents the direction of the current (moving positive charge) in the conductor, then the direction of rotation of the Chakiya wheel, while rotating with the handle will be the direction of the magnetic field lines. Whereas the direction of the magnetic force lines will be towards the center in the direction of the centripetal force acting on the handle.

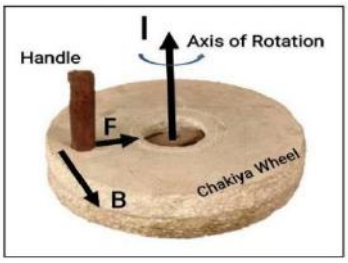

Fig. 4

2. LITERATURE REVIEW:

This chakiya rule is very simple, convenient and informative to understand and express the direction of magnetic field lines and magnetic force lines.

3. MATERIALS:

We used hand operated chakiya for grinding flour, pulses, porridge etc at our homes. So first we have to understand the working process of that chakiya.

Fig. 5

4. METHOD:

When we put the grains of grain in the pit made around its axis of rotation ("keeli") in the wheel and then holding the handle at one end in its upper wheel and rotating it Anti clockwise, then the grain is grinded. Due to such motion of the Chakiya wheel, we have made a simple and convenient rule to find the direction of magnetic field lines and magnetic force lines, which is called Chakiya rule.

According to this rule, "If the axis of rotation of the Chakiya wheel represents the direction of the current (moving positive charge) in the conductor, then the direction of rotation of the Chakiya wheel, while rotating with the handle will be the direction of the magnetic field lines. Whereas the direction of the magnetic force lines will be towards the center in the direction of the centripetal force acting on the handle".

By Chakiya rule we can easily find the direction of magnetic field lines and magnetic force lines. With this we can also find the direction of the magnetic field and the direction of the magnetic force.

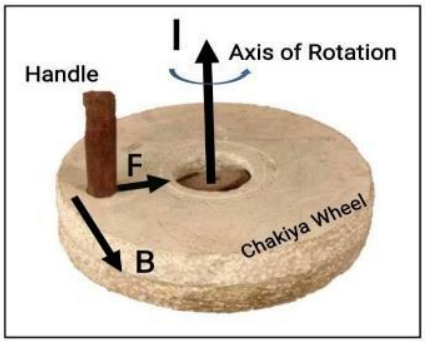

Fig. 6

5. DISCUSSION:

In this way, among some people who believe that magnetic field lines and magnetic force lines are one and the same, we can make a clear distinction between magnetic force lines and magnetic field lines by this rule.

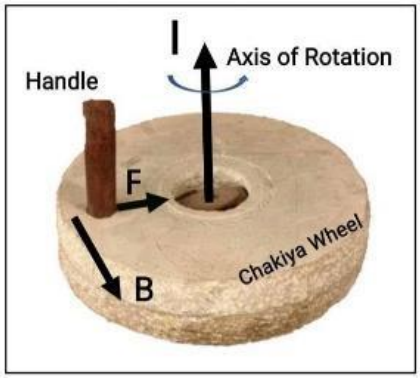

Fig. 7

This Chakiya law proves to be very simple and convenient as well as very useful in the study of magnetism. Chakiya as our cultural heritage is still used in homes as per the requirement. By using this rule, our chakiya will also maintain its place in the scientific world forever.

6. ANALYSIS:

To find and understand the direction of magnetic field lines and magnetic force lines, it is very easy to use the rule made on the basis of the wheel used in every household. This rule is very helpful for clearing the confusion created in children as it clearly explains the direction of the magnetic force lines and the direction of the magnetic field lines and states that the directions of these two are mutually perpendicular.

7. RESULT:

In this way, we can easily understand magnetic field lines and magnetic force lines by chakiya rule and can also explain it to students.

8. RECOMMENDATIONS:

"In this way, we can easily understand magnetic field lines and magnetic force lines by Chakiya Rule and can also explain it to children". - Mr. Manish Kumar, National Awardee, Coordinator, District Science Club (Auraiya)

9. CONCLUSION / SUMMARY:

In magnetism, to find the direction of the magnetic field we apply three rules :

1. Right-Hand Thumb Rule
2. Maxwell Right-Hand Screw Rule
3. Maxwell's Right-Hand Rule

Similarly, to find the direction of the force acting on a moving charge or a current-carrying conductor in a magnetic field, we also apply three rules:

1. Fleming's Right-Hand Rule
2. Right-Hand Thumb Rule
3. Right-Hand Screw Rule

Despite this, students studying magnetism have a lot of confusion about the direction of magnetic field lines and the direction of magnetic force lines. Most children use both in the same sense. Even in their reference book, they remain confused as there is no clear distinction written. But this rule of ours is successful in making a clear distinction between the direction of the magnetic force, the direction of the magnetic field, the direction of the magnetic force lines and the direction of the magnetic field lines.

In this way, this chakiya rule will prove to be a milestone for the scientific world along with keeping the cultural heritage alive forever among the people.

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