Magnetism and magnetic effects of electric current

Notes and Key Points

- Many birds and animals have magnetic sense in their eyes using Earth's magnetic field for navigation.
- Magnetic sensing in eyes - for Zebra finches bird, due to protein crypto chromes Cry4 present in retina, it uses Earth magnetic field for navigation.
- The branch of physics which deals with the Earth's magnetic field is called Geomagnetism or Terrestrial magnetism.
- The angle between magnetic meridian at a point and geographical meridian is called the declination or magnetic declination (D).
- The angle subtended by the Earth's total magnetic field $\vec{B}$ with the horizontal direction in the magnetic meridian is called dip or magnetic inclination (I) at that point.
- The component of Earth's magnetic field along the horizontal direction in the magnetic meridian is called horizontal component of Earth's magnetic field, denoted by B_H.
- The magnetic dipole moment is defined as the product of its pole strength and magnetic length.

- Aurora Borealis and Aurora Australis People living at high latitude regions (near Arctic or Antarctic) might experience dazzling coloured natural lights across the night sky. This ethereal display on the sky is known as aurora borealis (northern lights) or aurora australis (southern lights).
- These lights are often called as polar lights. The lights are seen above the magnetic poles of the northern and southern hemispheres. They are called as “Aurora borealis” in the north and “Aurora australis” in the south. This occurs as a result of interaction between the gaseous particles in the Earth’s atmosphere with highly charged particles released from the Sun’s atmosphere through solar wind. These particles emit light due to collision and variations in colour are due to the type of the gas particles that take part in the collisions.
- A pale yellowish – green colour is produced when the ionized oxygen takes part in the collision and a blue or purplish – red aurora is produced due to ionized nitrogen molecules.
- Pole strength is a scalar quantity with dimension $[M^0LT^0A]$. Its SI unit is N T^{-1} (newton per tesla) or A m (ampere-metre).
- Like positive and negative charges in electrostatics, north pole of a magnet experiences a force in the direction of magnetic field while south pole of a magnet experiences force opposite to the magnetic field.

- Pole strength depends on the nature of materials of the magnet, area of cross- section and the state of magnetization.
- If a magnet is cut into two equal halves along the length then pole strength is reduced to half.
- If a magnet is cut into two equal halves perpendicular to the length, then pole strength remains same.
- If a magnet is cut into two pieces, we will not get separate north and south poles. Instead, we get two magnets. In other words, isolated monopole does not exist in nature.
- The magnetic flux density can also be defined as the number of magnetic field lines crossing unit area kept normal to the direction of line of force.
- The number of magnetic field lines crossing per unit area is called magnetic flux ΦB.
- The magnetic flux density can also be defined as the number of magnetic field lines crossing unit area kept normal to the direction of line of force.
- Magnetic field is said to be uniform if it has same magnitude and direction at all the points in a given region. Example, locally Earth’s magnetic field is uniform.
- Magnetic field is said to be non-uniform if the magnitude or direction or both varies at all its points.

- The force of attraction or repulsion between two magnetic poles is directly proportional to the product of their pole strengths and inversely proportional to the square of the distance between them.
- Why a freely suspended bar magnet in your laboratory experiences only torque (rotational motion) but not any translatory motion even though Earth has non-uniform magnetic field?

  It is because Earth's magnetic field is locally(physics laboratory)uniform.
- Suppose we keep a freely suspended bar magnet in a non-uniform magnetic field. What will happen?

  It will undergo translatory motion (net force) and rotational motion (torque).
- When a magnetic needle or magnet is freely suspended in two mutually perpendicular uniform magnetic fields, it will come to rest in the direction of the resultant of the two fields.
- The magnetic field which is used to magnetize a sample or specimen is called the magnetising field.
- The measure of ability of the material to allow the passage of magnetic field lines through it or measure of the capacity of the substance to take magnetisation or the degree of penetration of magnetic field through the substance.

- Superconductors are perfect diamagnetic materials. The expulsion of magnetic flux from a superconductor during its transition to the superconducting state is known as Meissner effect.
- The magnitude of the reverse magnetising field for which the residual magnetism of the material vanishes is called its coercivity.
- If we hold the current carrying conductor in our right hand such that the thumb points in the direction of current flow, then the fingers encircling the wire points in the direction of the magnetic field lines produced.
- Mnemonic means that it is a special word or a collection of words used to help a person to remember something.
- Electric current is not a vector quantity. It is a scalar quantity. But electric current in a conductor has direction of flow. Therefore, the electric current flowing in a small elemental conductor can be taken as vector quantity i.e. $Id\vec{l}$.
- The magnetic dipole moment of any current loop is equal to the product of the current and area of the loop.
- If we curl the fingers of right hand in the direction of current in the loop, then the stretched thumb gives the direction of the magnetic moment associated with the loop.

- Solenoid can be used as electromagnets. It produces strong magnetic field that can be turned ON or OFF. This is not possible in case of permanent magnet. Further the strength of the magnetic field can be increased by keeping iron bar inside the solenoid. This is because the magnetic field of the solenoid magnetizes the iron bar and hence the net magnetic field is the sum of magnetic field of the solenoid and magnetic field of magnetised iron. Because of these properties, solenoids are useful in designing variety of electrical appliances.
- MRI is Magnetic Resonance Imaging which helps the physicians to diagonise or monitor treatment for a variety of abnormal conditions happening within the head, chest, abdomen and pelvis. It is a non invasive medical test. The patient is placed in a circular opening (actually interior of a solenoid which is made up of superconducting wire) and large current is sent through the superconducting wire to produce a strong magnetic field. So, it uses more powerful magnet, radio frequency pulses and a computer to produce pictures of organs which helps the physicians to examine various parts of the body.
- The principle used in Bainbridge mass spectrograph to separate the isotopes.
- Deutrons (bundles of one proton and one neutron) can be accelerated because it has same charge as that of proton. But neutron (electrically neutral

particle) cannot be accelerated by the cyclotron. When a deutron is bombarded with a beryllium target, a beam of high energy neutrons are produced. These high-energy neutrons are sent into the patient's cancerous region to break the bonds in the DNA of the cancer cells (killing the cells). This is used in treatment of fast-neutron cancer therapy.

- Figure of merit of a galvanometer it is defined as the current which produces a deflection of one scale division in the galvanometer.
- Current sensitivity: It is defined as the deflection produced per unit current flowing through it.
- Voltage sensitivity: It is defined as the deflection produced per unit voltage applied across it.