PHYS 1200 Physics of Everyday Experience

Review questions and exercises for Lecture 27 (E&M-5)

1. What are the two types of magnets?
2. What is the general direction and shape of magnetic fields?
3. What contributions to magnetism were made by (a) Oersted, and (b) Ampere?
4. What type of materials are permanent magnets made from?
5. (a) What is the shape of the earth's magnetic field? (b) Why does a compass point north?
6. What are the van Allen radiation belts?
7. What is the effect of a magnetic field on a charged particle?
8. What role do magnetic forces play in an electric motor?
9. What is the shape of the magnetic field produced by a current in a long straight wire?
10. Why do magnets "stick" to certain materials which are not magnets?
11. What is the ultimate source of magnetism in electromagnets and permanent magnets?
12. Are neutral particles affected by magnetic fields?

Answers:

1. The two types of magnets are permanent magnets and electromagnets (currents in wires).
2. Magnets always have a north and a south pole and the magnetic field points from the North Pole to the South Pole. Magnetic field lines always form closed loops.
3. (a) Oersted first observed that a compass needle was deflected by a current in a wire. (b) Ampere discovered the mathematical formula that relates the current in a wire to the magnetic field that it produces.
4. Permanent magnets are formed from a class of materials known as ferromagnetic.
5. (a) The earth's magnetic field points in the direction from the south geographic pole to the north geographic pole. Thus in the northern hemisphere the earth's magnetic field points downward and at an angle to the ground. (b) The north pole of the compass points to the earths geographic north because the geographic north pole of the earth is the south magnetic pole.
6. The van Allen radiation belts are two regions surrounding the earth containing a large accumulation of charged particles. These particles come to the earth from the sun and get trapped by the earth's magnetic field.
7. A magnetic field produces a deflection on a moving charged particle. Charged particles revolve around magnetic field lines in spiral orbits.
8. An electric motor consists of a coil of wire located inside a permanent magnet. When current flows in the coil the magnetic forces on the current produce a net torque that cause the coil to rotate – this rotation is the mechanical action of a motor.
9. The magnetic field lines of the current in a long straight wire are a series of concentric circles surrounding the wire. The magnetic field is stronger near the wire.
10. Permanent magnets can stick to materials that have properties that allow them to be magnetized when a permanent magnet is brought close to them. These materials have internal microscopic magnets that are usually not aligned to form a permanent magnetic field. However, when a magnetic field is present, the microscopic magnets are temporarily aligned and thus exhibit overall magnetic properties. Thus magnets stick to objects made of steel (like refrigerators). Some materials like copper, aluminum and non-conductors are not magnetized when a permanent magnet is brought close to them.
11. The ultimate source of the magnetic field is current. When these currents flow in wires and coils they are called electromagnets. The origin of permanent magnetism is atomic currents due to electron spin and orbital motion in certain materials.

12. Only moving charged particles can experience magnetic forces. Neutral particles are not affected by magnetic fields whether they are moving or at rest.