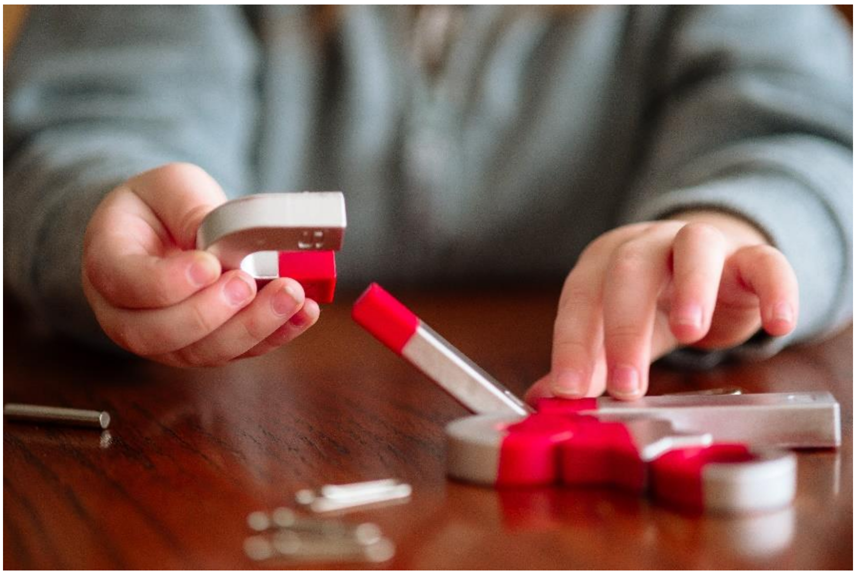
4 Fun with Magnets



"A magnet attracts the magnetic materials like iron. Here, a magnet is attracting balls made of iron."

1. Introduction

It is said that, there was a shepherd named Magnes, who lived in ancient Greece. He used to take his herd of sheep and goats to the nearby mountains for grazing. He would take a stick with him to control his herd. The stick had a small piece of iron attached at one end. One day he was surprised to find that he had to pull hard to free his stick from a rock on the mountainside. It seemed as if the stick was being attracted by the rock.

The rock was a natural magnet and it attracted the iron tip of the shepherd's stick. It is said that this is how natural magnets was discovered. Such rocks were given the name **magnetite**, perhaps after the name of that shepherd. Magnetite contains iron. It is also known as **lodestone**.

Some people believe that magnetite was first discovered at a place called Magnesia. The island of Magnesia is situated in west of present day Turkey. Chinese also used magnetic needles for navigation on ships as early in 400 B.C.

Magnetism is the ability of an object to push or pull another object that has the magnetic property.

SPOT LIGHT

The magnetic effects of certain materials were observed by ancient Greeks as early as 800 BC.

2. What is a magnet ?

You may have played with magnets and watched them snap together or push apart. Magnets can also make some objects move or even fly through the air. A magnet can affect an object without even touching it.

The substances having the property of attracting magnetic materials like iron are now known as **magnets**.

When you bring two magnets close together, they will either repel or attract each other. The force that pushes magnets apart or pulls them together is called **magnetic force**. In other words 'a magnet is any object with magnetic force'.

Natural magnets

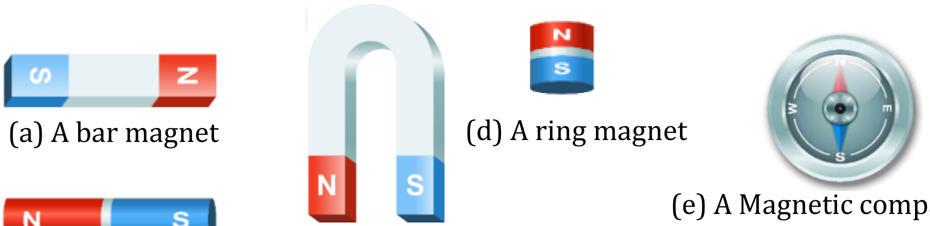
Naturally occurring minerals or ores having magnetic properties are called **'natural magnets'**. Due to their irregular shapes and weak attracting power, natural magnets are rarely used now a days.

Artificial magnets

Now a days pieces of iron and many other materials of suitable shapes and sizes are made as magnets. Such magnets are called **artificial magnets**. e.g. Bar magnet,

U-shaped magnet (horse-shoe magnet), cylindrical magnet or a ball ended magnet, magnetic compass needle, etc.

> The bar magnets, horseshoe magnets, magnetic compass needle etc, all have magnetism that exists for many years. Thus, they are called permanent magnets.
>
> **SPOT LIGHT**



(a) A bar magnet

(b) A cylindrical magnet

(c) A U shaped magnet or Horse-shoe magnet

(d) A ring magnet

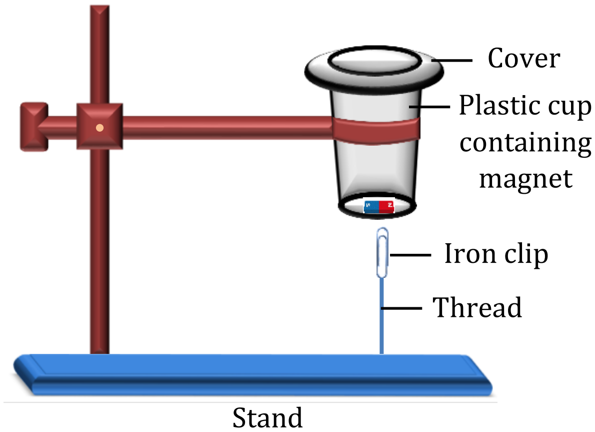
(e) A Magnetic compass needle

Magnets of different shapes

Active Physics 1

1. Take a plastic or a paper cup. Fix it on a stand with the help of a clamp as shown in figure. Place a magnet inside the cup and cover it with a paper so that the magnet is not visible.
2. Attach a thread to a clip made of iron. Fix the other end of the thread at the base of the stand just below the paper cup. Keep the length of the thread sufficiently short.

3. Gradually lower the paper cup. When the cup is quite near to the clip, the clip get raised in air without support, like a kite. This is because the iron clip is attracted towards the magnet present inside the cup.



Active Physics 1

3. Magnetic and non-magnetic materials

The magnet attracts certain materials whereas some do not get attracted towards magnet. The materials which get attracted towards a magnet are called **magnetic materials.** Iron, nickel and cobalt are magnetic in nature.

Iron

Nickel

Cobalt

Magnetic materials

The materials which do not get attracted towards a magnet are called **non-magnetic materials.** Most of the materials we use in our daily life are non-magnetic in nature. Copper, aluminium, silver, wood, plastics, rubber, paper, etc. all are non-magnetic in nature.

Copper

Gold

Wood

Non-magnetic materials

Building Concepts 1

A magnet is kept quite close to a gold ring, but the ring did not get attracted towards the magnet. Try to find out the reason behind it.

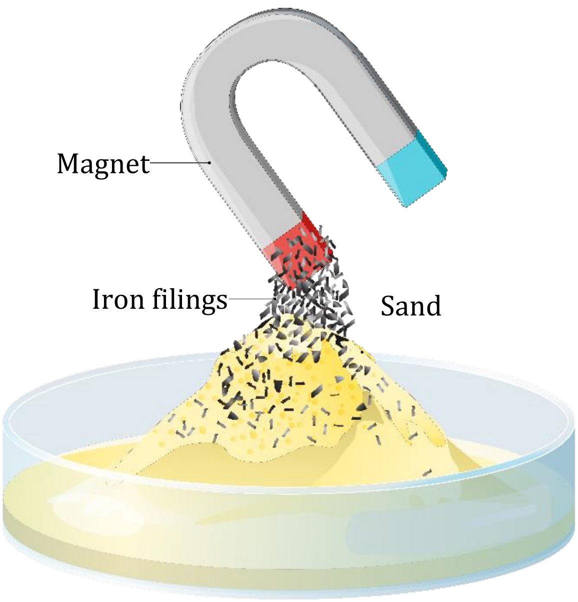
Explanation

First thing that should come in your mind is that 'a magnet always attract a magnetic material, it does not attract a non-magnetic material'. This means gold is a non-magnetic material.

Active Physics 2

1. Take a magnet and put it in the sand. Move the magnet in the sand for few seconds. Now, pull out the magnet from the sand.
2. Some particles of sand or soil may stick to the magnet. Now, gently shake the magnet to remove the particles of sand. But some particles may continue to stick to the magnet. These particles are surely magnetic in nature and usually they are small pieces of iron (iron filings) present in the sand.

> Magnetic separation is used to separate magnetic ores like magnetite from non-magnetic impurities.
>
> **SPOT LIGHT**



Active Physics 2

3. Through this activity, we can find out whether the soil or sand from a given place contains particles that have iron. Also, we can conclude that **'magnetic particles can be separated from non-magnetic particles using magnets'**.

Quick Tips

★ If an object attracts to both poles a magnet, it is surely a magnetic material.

4. Magnetic poles

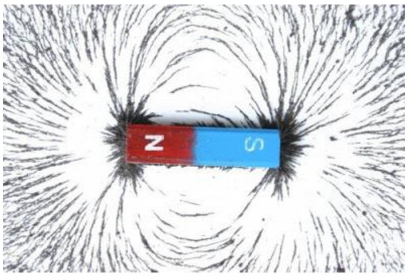
The parts of a magnet where the magnetic force is strongest are called the **magnetic poles**. All known magnets have two poles, a north pole and a south pole.

Active Physics 3

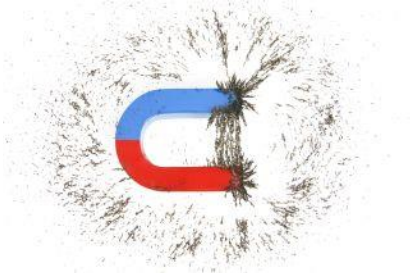
1. Put some iron filings on a sheet of paper. Roll a bar magnet in the filings and then lift it up. You will observe that most of the iron filings stick to the magnets at the ends [see figure (a)]. There are fewer iron filings in between and almost none at the middle of the bar magnet. This means the iron filings do not stick to the magnet uniformly along its length. They stick more to certain portions of the magnet.

2. Now, repeat this activity with a horseshoe magnet. Again, you will observe that most of the iron fillings stick to the two ends of the horseshoe magnet [see figure (b)].

3. From this activity, we can conclude that 'in a bar magnet or a horseshoe magnet, the regions of strongest magnetism are near their ends. These ends are called **magnetic poles**.



(a) Bar magnet



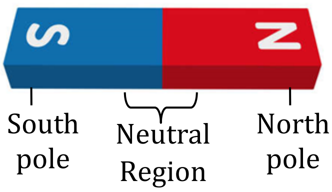
(b) Horseshoe magnet

Active Physics 3

5. Properties of a magnet

Attractive nature

When iron filings are put near a bar magnet, the magnet attracts iron filings towards it. The attracting power is maximum (see figure) near the ends (poles) and minimum at the middle (neutral region).



A magnet has two poles

Directive property

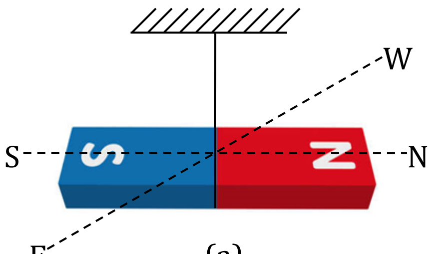
When a magnet is suspended freely, it aligns itself to north-south direction. The pole of the bar magnet pointing towards north direction when suspended freely is called '**north pole** (or north seeking pole)'. The pole of the bar magnet pointing towards south direction when suspended freely is called '**south pole** (or south seeking pole)'.

Do You Remember ?

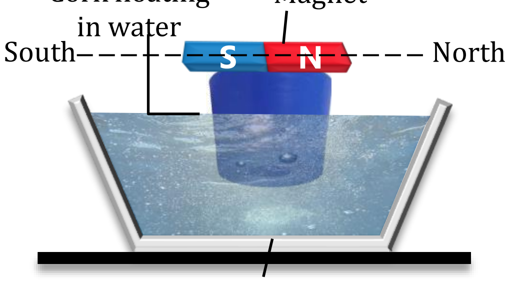
★ To find directions using a magnet you should have knowledge about the properties of magnet like magnet aligns itself in north south direction when suspended freely.

Active Physics 4

1. Take a bar magnet and suspend it using a thread [see figure (a)]. Another method is to place the magnet on a cork and float the cork in a vessel containing water [see figure. (b)]. There should not be a magnet or magnetic material present near the suspended bar magnet so that it does not disturb the suspended bar magnet.



(a)



(b)

Active Physics 4

2. You will observe that the freely suspended bar magnet always comes to rest in the north-south direction. One end of the magnet points towards the north. This pole is called the north pole of the magnet. The other end which points towards the south is called the south pole of the magnet.

Building Concepts 2

A freely suspended magnet aligns in a north-south direction. Why ?

Explanation

Earth has its own magnetism, similar to the magnetism of a bar magnet. The poles of the giant imaginary magnet inside the Earth are located near, but not exactly at, Earth's geographic poles. This is why, a freely suspended magnet align itself to Earth's magnetic north and south poles. Actually, a freely suspended magnet aligns approximately not exactly in the geographic north-south direction.

Poles exist in pairs

In a bar magnet, there are always two poles which are equal in strength and opposite in nature. In other words, 'a magnet is always a dipole'.

Quick Tips

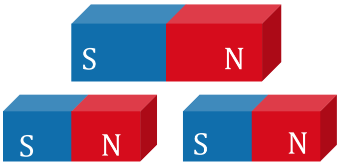
★ Repulsion is a sure test to find a magnet.

Building Concepts 3

Can we separate the north pole of a magnet from its south pole by breaking it from the middle ?

Explanation

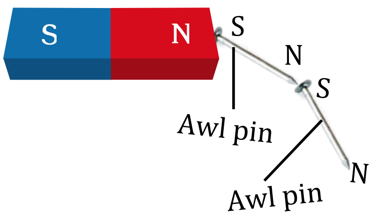
If we break a magnet into two parts from the middle, we cannot isolate the north and the south poles. Instead we will get with two separate magnets, each with its own north and south poles. If we further cut these two magnets, we would get four separate magnets, each with its own north and south poles (see figure). This means, poles always exist in pairs, and we can never have an isolated north pole or south pole.



A magnet always have two poles

Inductive nature

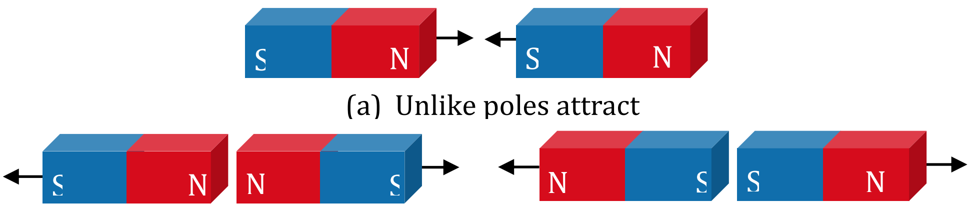
When certain substances like iron, steel, cobalt, nickel are placed near a bar magnet, they acquire magnetisation called 'induced magnetisation'. The phenomenon is called **'magnetic induction'**. It involves inducing opposite pole in a magnetic material like iron on the side facing the magnetic pole (see figure).



Magnetic induction

Forces between the poles of two magnets

When two magnets are brought together, a north pole and a south pole attract each other i.e., unlike poles attract each other [see figure (a)]. Like poles (north-north or south-south) repel each other [see figure (b)].



Forces between the poles of two magnets

Quick Tips

★ Hammering or heating a magnet will cause it to loose its magnetism as by this the molecules lose their north south alignment and get arrange in random direction.

Check your Concepts 1

1. A tailor was stitching buttons on his shirt. The needle has slipped from his hand on to the floor. Can you help the tailor to find the needle ?
2. If you put a magnet in a heap of iron filings, which part of magnet attracts them the least ?
3. You are given two identical bars which look as if they might be made of iron. One of them is a magnet, while the other is a simple iron bar. How will you find out, which one is a magnet ?

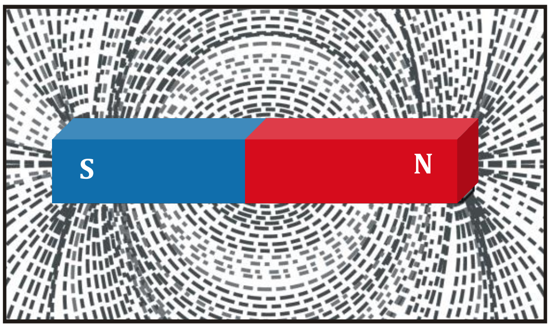
☞ Magnets that are far apart do not pull or push enough to move each other. The magnetic force between two magnets is weak when magnets are far apart. The magnetic force gets stronger as the magnets are brought closer together.

6. Magnetic field

A region of influence surrounding a magnet, in which other magnets or materials like iron are affected by magnetic forces is called '**magnetic field**'.

Active Physics 5

1. Fix a sheet of white paper on a drawing board using some adhesive material. Place a bar magnet in the centre of it. Sprinkle some iron filings uniformly around the bar magnet. You can use salt-sprinkler for this purpose.
2. Now tap the board gently. You will observe that iron filings align themselves in a specific curved manner around the magnet. This pattern of curve lines is the magnetic field of the bar magnet.



Active physics 5

7. Finding direction using magnets

The chariot with direction finding statue

Magnets were known to people from ancient times. Many properties of the magnets were also known to them. It is said that an emperor in China named Hoang Ti had a chariot with a statue of a lady that could rotate in any direction. It had an extended arm as if it was showing the way (see figure). The statue had an interesting property. It would rest in such a position that its extended arm always pointed towards South.

By looking at the extended arm of the statue, the Emperor was able to locate directions when he went to new places on his chariot. The property of magnet that was used in statue of the lady is that, 'a freely suspended magnet always keeps itself in north-south direction'.

Quick Tips

★ Earth's magnetic field is 1000 times weaker than a typical bar magnet.

Magnetic compass needle (or compass)

Pretend you are on a boat at night. No land is in sight. The sky is cloudy. Ancient sailors could become lost on such nights until the compass was invented.

☞ A magnetic compass needle or simply 'compass' is an instrument that uses Earth's magnetic field to help people find directions (see figure). A compass needle is actually a thin magnet. The needle points in north direction because it aligns in the direction of Earth's magnetic field. Since a compass needle points north, the compass can be used to tell north, east, south, and west, and other directions in between.

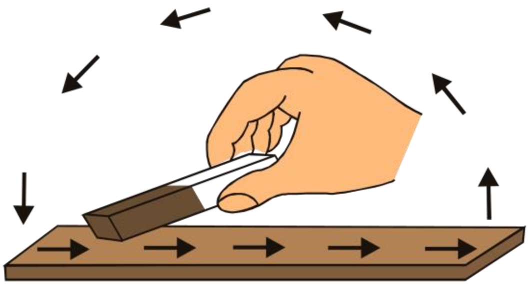
A magnetic compass needle

Do You Remember ?

★ A magnetic compass needle approximately point toward Earth's north pole. The geographic north pole and the magnetic north pole are in slightly different places.

Active Physics 6

1. Take a rectangular piece of iron. Place it on the table. Now take a bar magnet and place one of its poles near one edge of the bar of iron. Without lifting the bar magnet, move it along the length of the iron bar till you reach the other end.
2. Now, lift the magnet and bring the pole (the same pole you started with) to the same point of the iron bar from which you began (see figure). Move the magnet again along the iron bar in the same direction as you did before. Repeat this process about 50-60 times.
3. Now bring a awl pin near the iron bar. If iron bar attracts the pin, it means it has become a magnet. If not, continue the process for some more time. Remember that the pole of the magnet and the direction of its movement should remains the same. Try this activity on iron nail, a needle or a blade and convert them into a magnet.

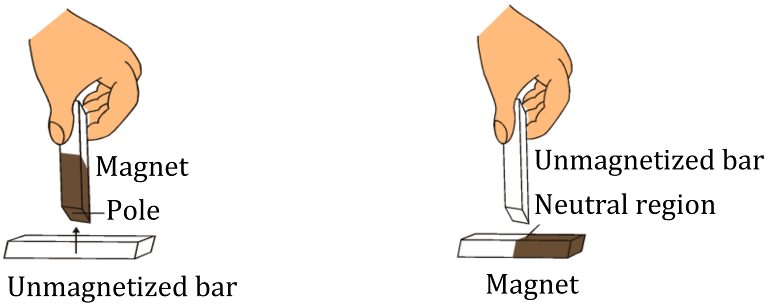


Active Physics 6 : Making your own magnet

Check your Answers 1

1. By using a magnet, we can help the tailor in finding the iron needle. When we move magnet on the floor, the iron needle will get attracted towards it as iron is a magnetic material. In this way we can find the lost needle.
2. If a magnet is put in a heap of iron filings, the middle region of the magnet will attract them the least because the magnetic force is weakest at the center and strongest at the poles.
3. First, we will take one of the bar in our hand and touch its end with the center of the other bar. If there is a significant attraction between them, then the bar in hand is magnetized. If there is a negligible attraction between the two bars, then the bar in hand is unmagnetized, this means the other one is magnetized.

This is because the central part of a magnet is its neutral region (the region where the attractive power is minimum). If the magnetized bar is in our hand, this means we are touching its pole to the unmagnetized bar, there will be a significant attraction between the two bars. If the unmagnetized bar is in our hand, this means we are touching its end with the neutral region of the magnetized bar, thus, the attraction between them will be negligible.



(a) Significant attraction (b) Negligible attraction

Check your answers 1 (3)

Be Alert !

★ If any strong magnetic field is near a compass, its's needle will align along its magnetic field and not the earth's magnetic field.

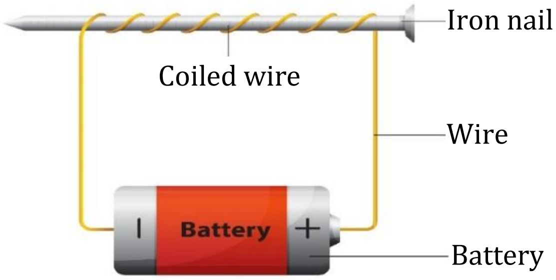
8. Electromagnets

In the 1820s and 1830s, scientists such as Michael Faraday and Joseph Henry made some amazing discoveries about electric currents and magnets. They found that electric currents make magnetic fields and that magnets could generate, or make an electric current. When an electric current flows through a wire, it creates a magnetic field around the wire. Increasing the current makes the magnetic field stronger. You can also make the magnetic field stronger by winding the wire into a long coil. Each loop of wire is like a little magnet that has its own magnetic force. All loops together produce a strong magnetic field.

Strength of an electromagnet increases with the increase in current. The more tightly the turns are wound stronger will be the electromagnet.

SPOT LIGHT

An **electromagnet** is a coil of wire wrapped around an iron core. When an electric current flows through the coil, it creates a magnetic field. This produces temporary magnetism in the iron core. Thus, magnetism of current carrying coil and iron core together produces a strong magnetic field. When the current stops, the iron core is no longer magnetised and there is no magnetic field due to the coil.



An electromagnet

Advantage of electromagnet over permanent magnet

(i) An electromagnet can produce a strong magnetic field as compared to a permanent magnet.

(ii) The strength of a magnetic field of an electromagnet can be changed easily by changing the current or the number of turns in the coil.

(iii) The polarity (north pole or south pole) of the electromagnet can be changed by reversing the direction of the current.

(iv) An electromagnet can be easily magnetised or demagnetised as per the requirement.

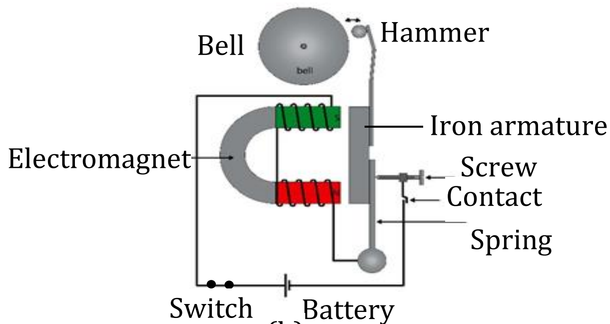
An electromagnet can be switched on and off by turning the electric current on and off. Also, by changing the current, the magnetic field can be made stronger or weaker.
SPOT LIGHT

Electric bell

In an electric bell, a small hammer is attached to the iron strip called armature. The armature is vibrated back and forth several times a second, striking a metal bell (or gong). Figure shows the circuit that causes the armature to move. When a button is pushed, the switch is closed.

An electric current flows through the contact and the spring attached to the coil, and the iron core become magnetised. The core attracts the iron armature, which moves toward the electromagnet, causing the hammer to strike the bell. As the hammer strikes the bell, the movement of the armature opens the contact. The electric current stops flowing to the coil and the soft iron core becomes demagnetised, releasing the armature. A spring pulls the armature back to re-establish contact, thereby completing the circuit, and the entire cycle begins again.

(a)



(b)

Electric bell

Uses of magnets and electromagnets

(1) They are used in radio and stereo speakers.

(2) They are used in almirah and refrigerator doors to keep them in closed position.

(3) They are used on video and audio cassette tapes.

(4) They are used on the hard discs and floppies for computers.

> Keep magnets away from cassettes, mobiles, television, music system, compact disks (CDs) and the computer.
>
> **SPOT LIGHT**

(5) They are used in different children's toys.

(6) In medicine, they are used in Magnetic Resonance Imaging (MRI) scanners to examine the inner body parts of human beings.

(7) Electromagnets are frequently used now a days for various purposes. e.g. lifting heavy iron pieces, electric doorbells, telephones, miniature circuit breakers (MCB), electric guitars, vacuum cleaners, etc.

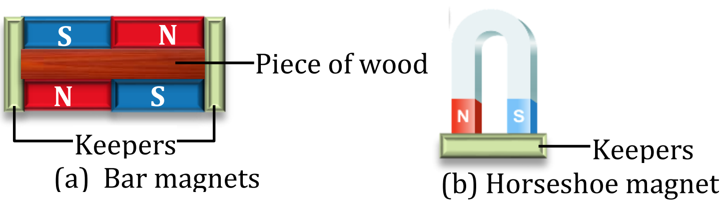
(8) Magnetic compass needle is used to find the approximate north-south direction.

9. Safety measures for magnets

(i) Magnets should not be heated at high temperatures, repeatedly hammered or dropped from some height. This is because by doing so, they loose their magnetism.

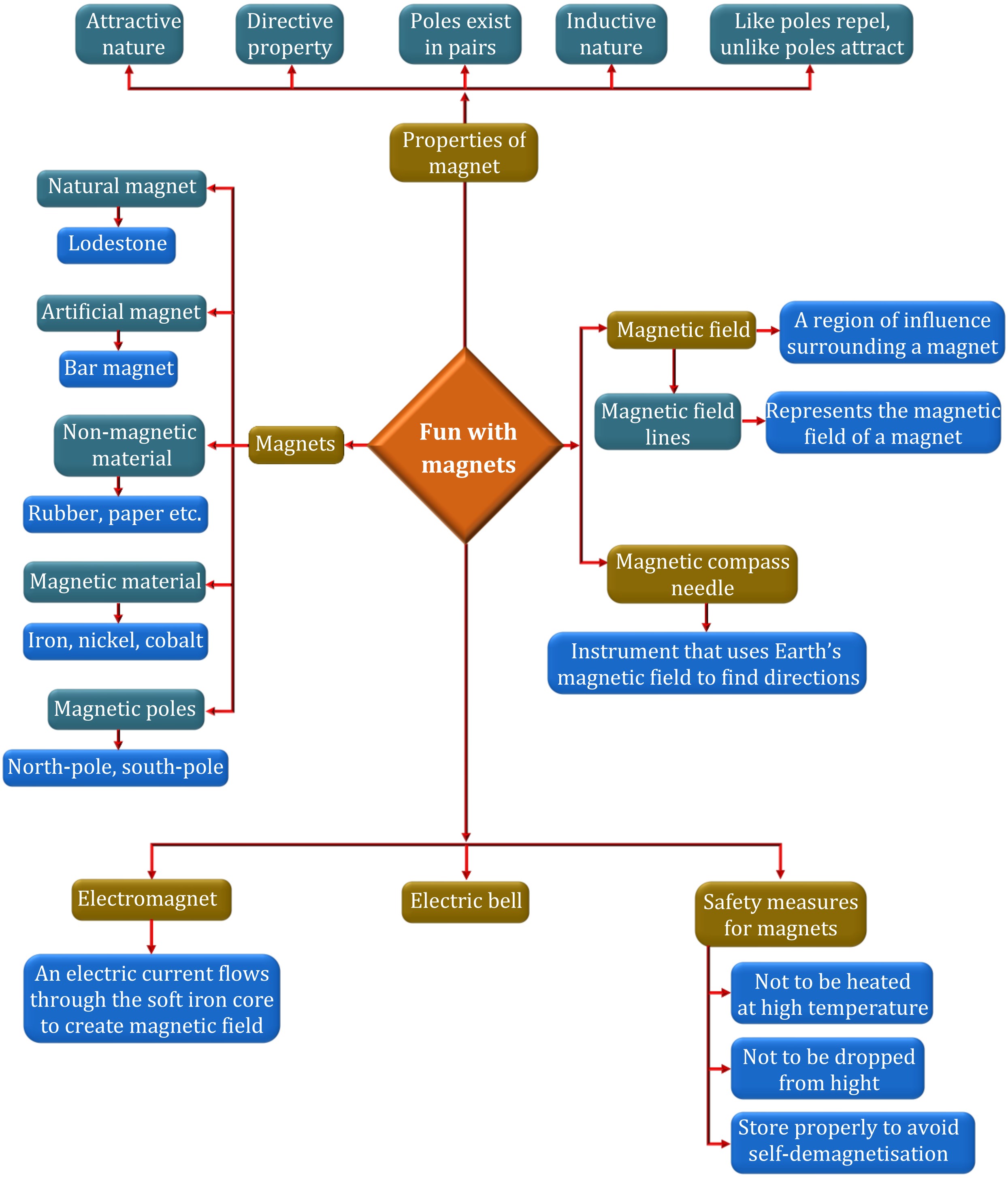
(ii) Keep magnets away from the cassettes, mobiles, television, music system, compact disks (CDs) and the computer.

(iii) Magnets become weak if they are not stored properly. Magnets tend to become weaker after some time if their poles are left free. This is called **self demagnetisation**. To avoid this, bar magnets are kept in pairs separated by a piece of wood, with unlike poles on the same side. Pieces of iron, called **magnetic keepers** or simply **keepers**, are placed across both the ends. A horseshoe magnet needs only one keeper across its poles.



Keeping magnets safely

Concept Map


Attractive nature
Directive property
Poles exist in pairs
Inductive nature
Like poles repel, unlike poles attract
Properties of magnet
Natural magnet
Lodestone
Artificial magnet
Bar magnet
Non-magnetic material
Rubber, paper etc.
Magnetic material
Iron, nickel, cobalt
Magnetic poles
North-pole, south-pole
Magnets
Fun with magnets
Magnetic field
A region of influence surrounding a magnet
Magnetic field lines
Represents the magnetic field of a magnet
Magnetic compass needle
Instrument that uses Earth's magnetic field to find directions
Electromagnet
An electric current flows through the soft iron core to create magnetic field
Electric bell
Safety measures for magnets
Not to be heated at high temperature
Not to be dropped from hight
Store properly to avoid self-demagnetisation

Some basic terms

1. Suspended – supported by attachment from above.
2. Align – Place or arrange in a straight line.
3. **Grazing** - to feed on growing grass or to eat grass.
4. **Ores**- a naturally occurring mineral containing a valuable constituent (such as metal) for which it is mined and worked.
5. **Impurities** - substances that are present in small quantities in another substance and make it dirty or of an unacceptable quality.
6. **Chariot** - a small carriage pulled by horses.
7. **Coil** - consists of a core and a wire wound around the core.
8. **Gong** - a large, flat, circular piece of metal that you hit with a hammer to make a sound like a loud bell.
9. **Armature** - a piece of soft iron or steel that connects the poles of a magnet or of adjacent magnets.
10. **Keepers** - a piece of wood or soft iron which is used in storing magnets because bar magnets get demagnetised.