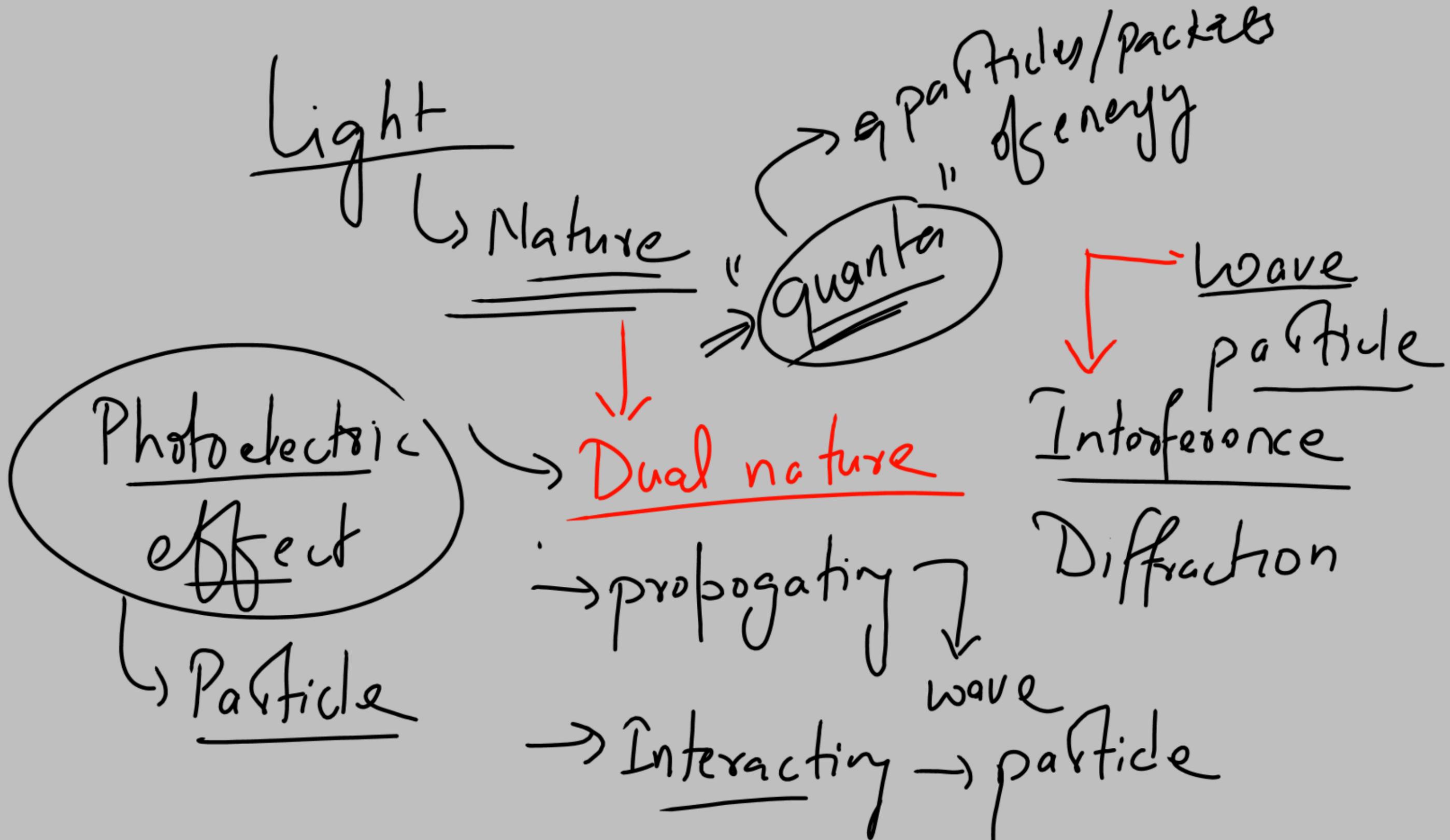




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Light

↳ Nature

" quanta "

↳ a particles/packages of energy

↳ wave
particle

Photoelectric effect

↳ Particle

↳ Dual nature

↳ propogating

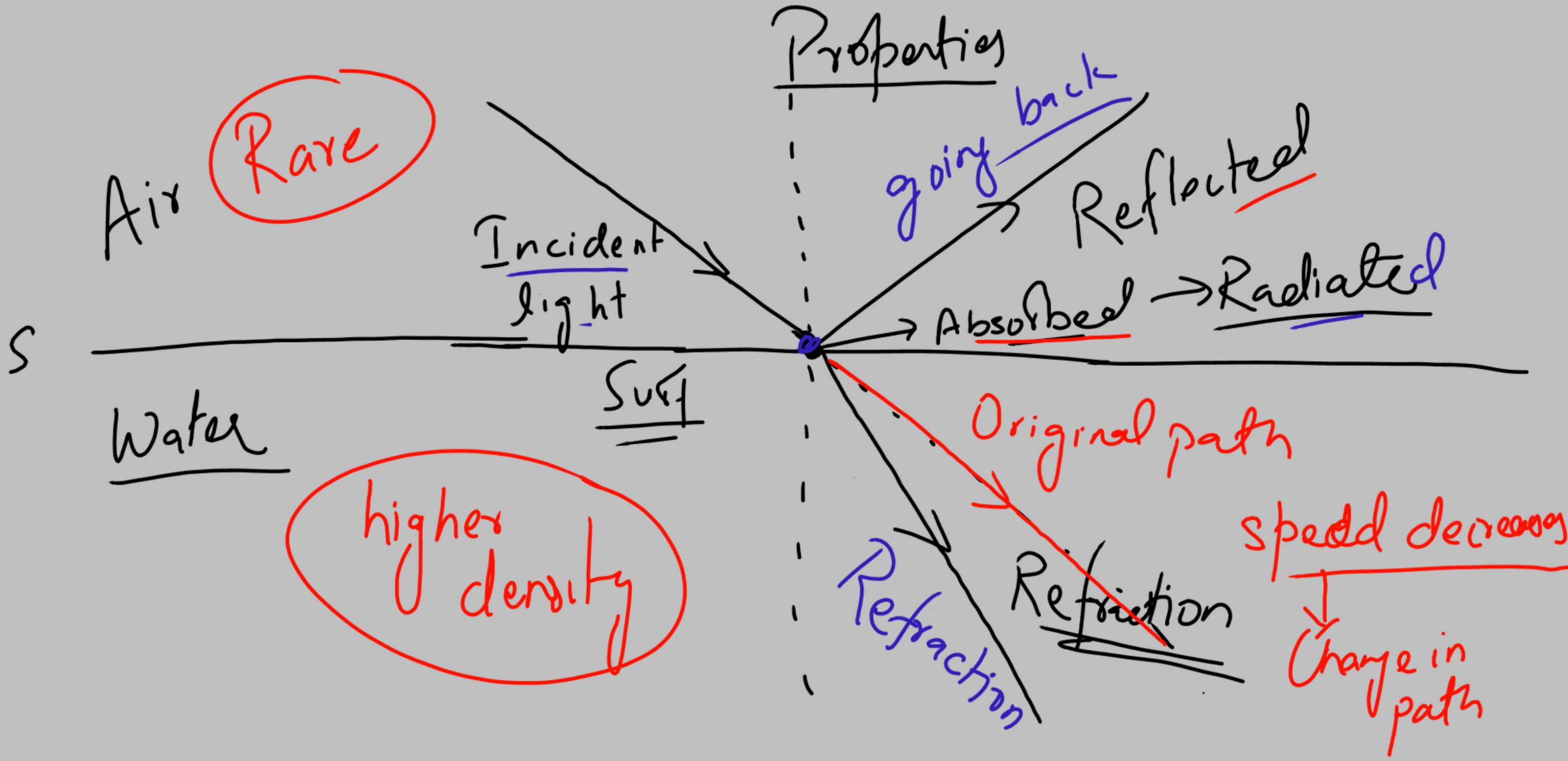
↳ wave

↳ Interacting

↳ particle

Interference

Diffraction

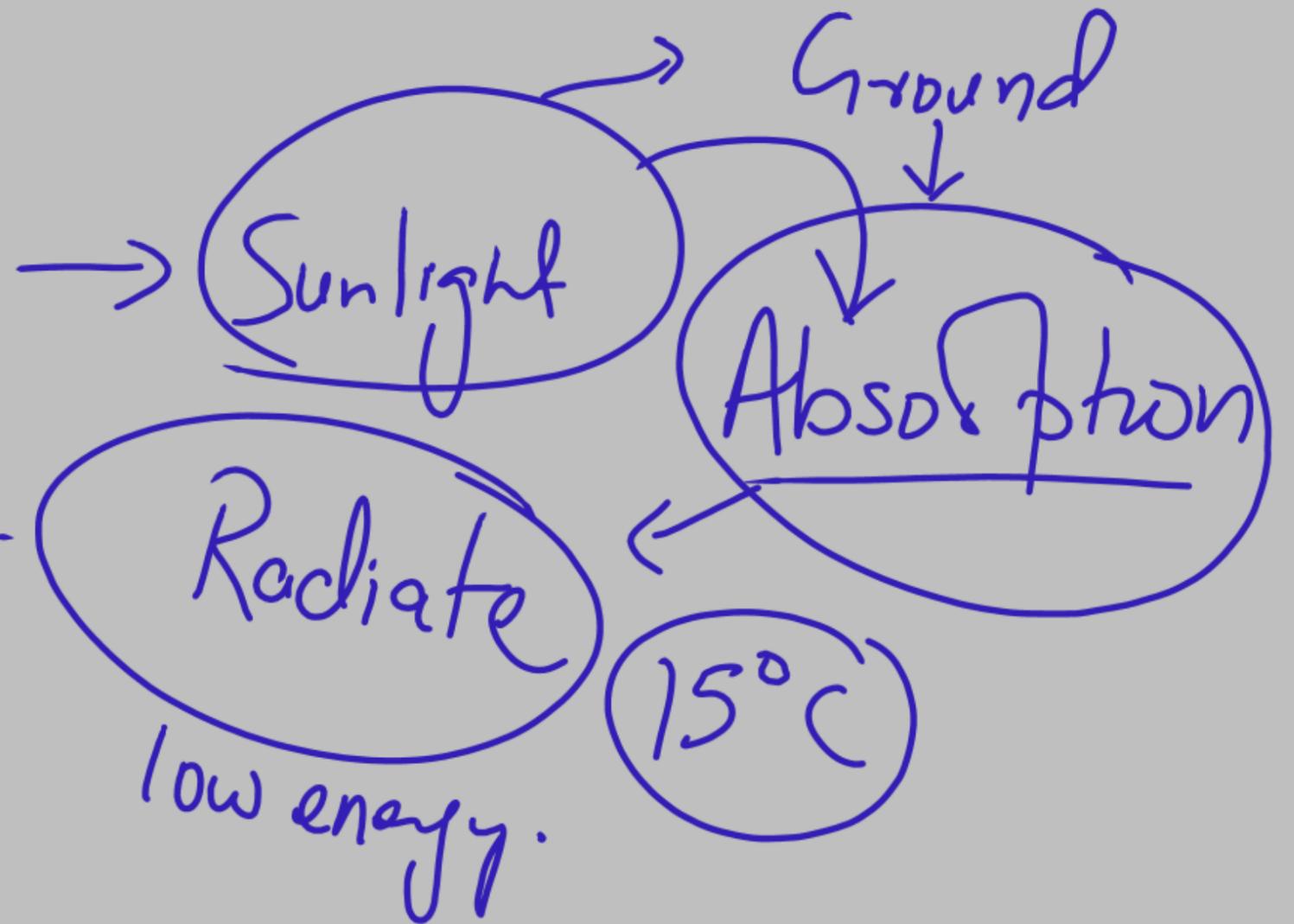


→ Reflection

↳ See

→ Absorption

Absorbed
in atmosphere



Refraction

Why bending

Difference in density of air

horizon

ground

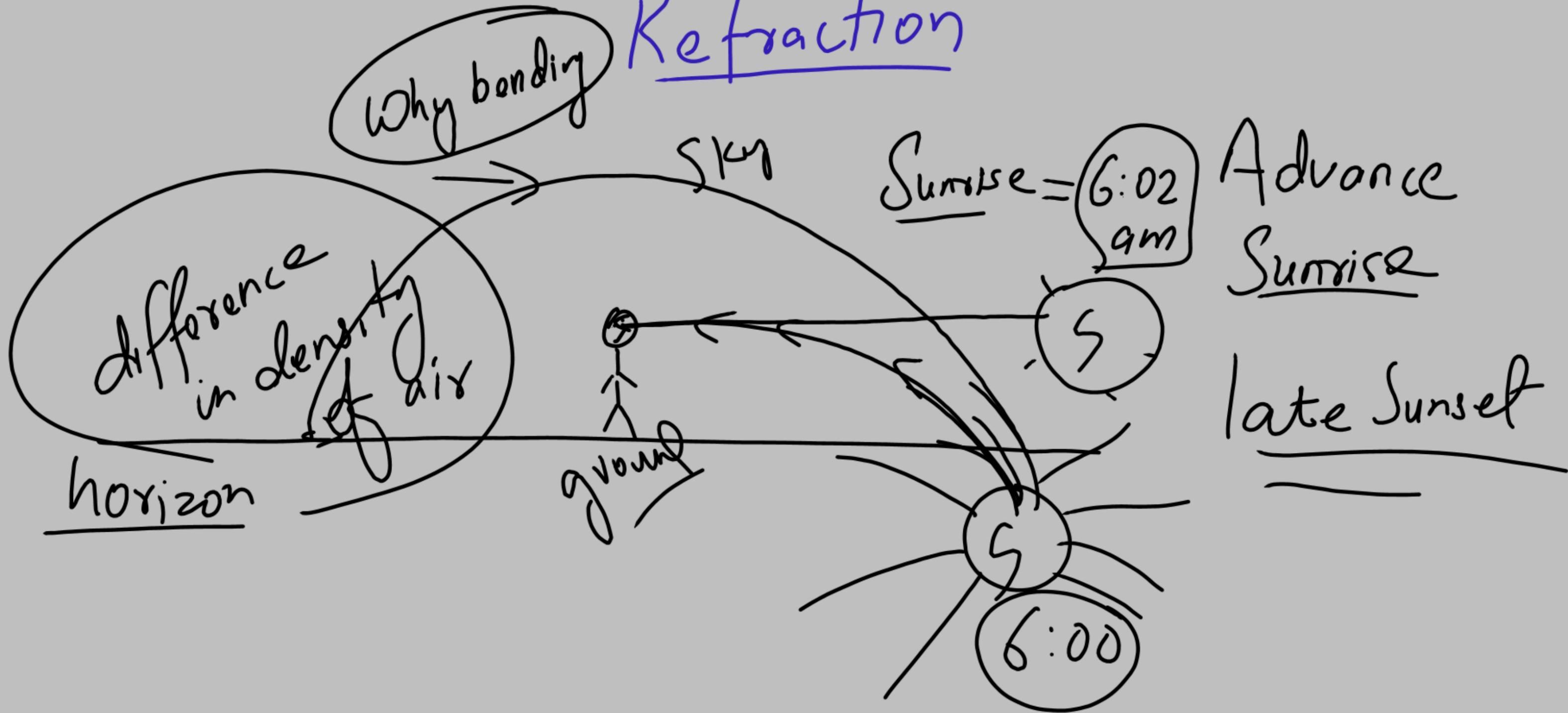
sky

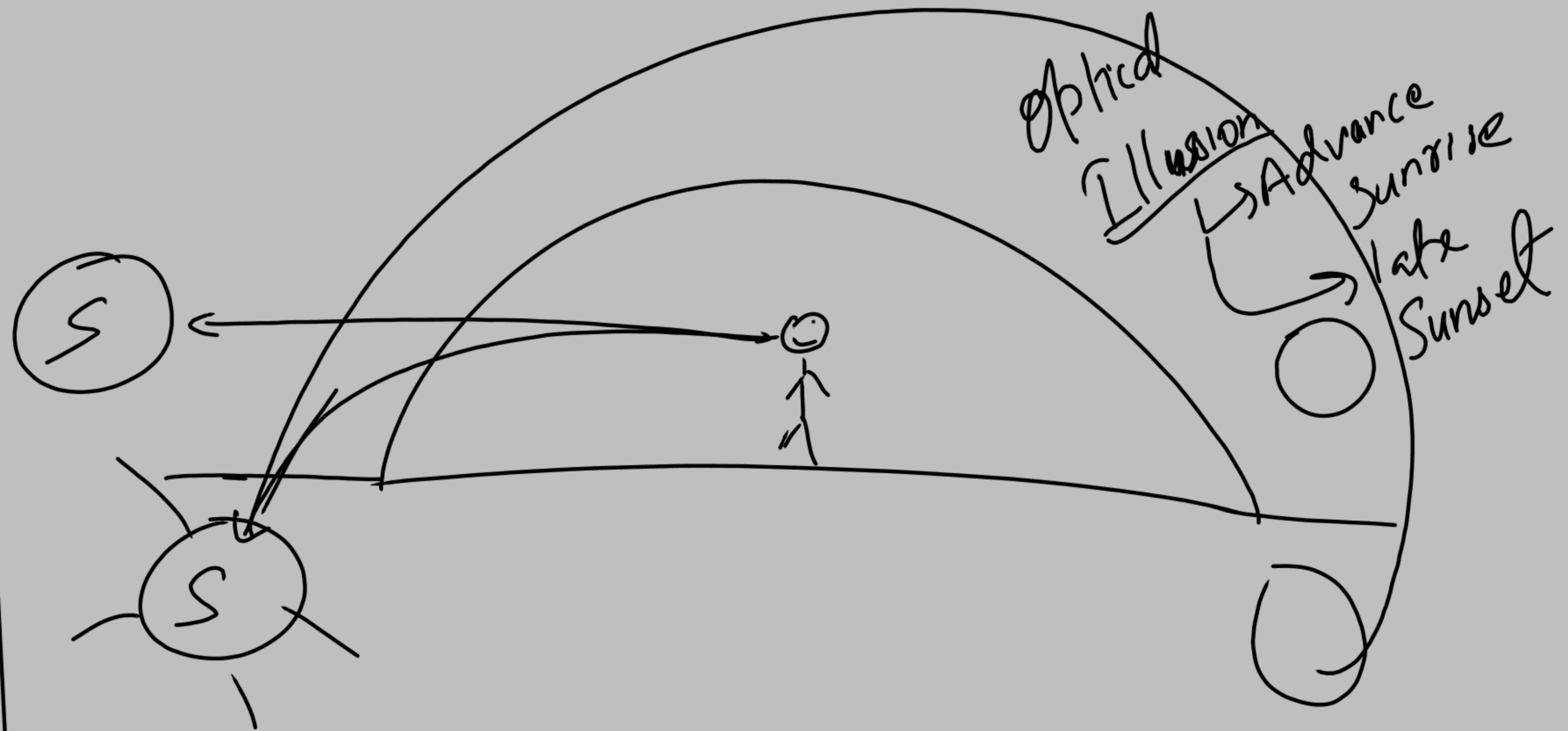
Sunrise = 6:02 am

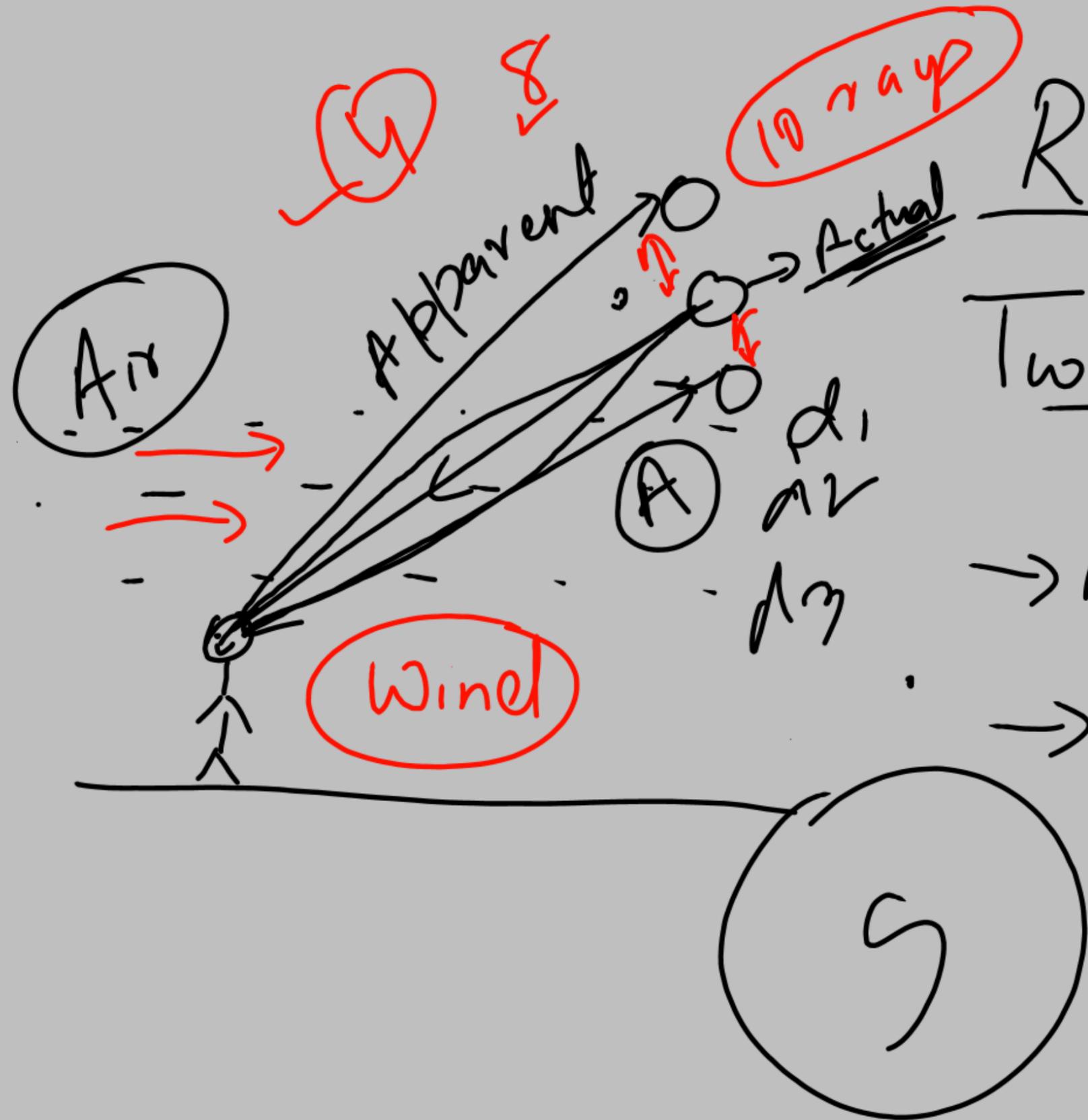
Advance Sunrise

late Sunset

6:00







Refraction

Twinkling of Stars

→ Alternate bright and dimness

→ position seems to be
varying

•
•

Light

What is Light?

Light, or Visible Light, commonly refers to electromagnetic radiation that can be detected by the human eye. Light can also be described in terms of a stream of photons, massless packets of energy, each travelling with wavelike properties at the speed of light. A photon is the smallest quantity (quantum) of energy which can be transported, and it was the realization that light travelled in discrete quanta that was the origins of Quantum Theory.

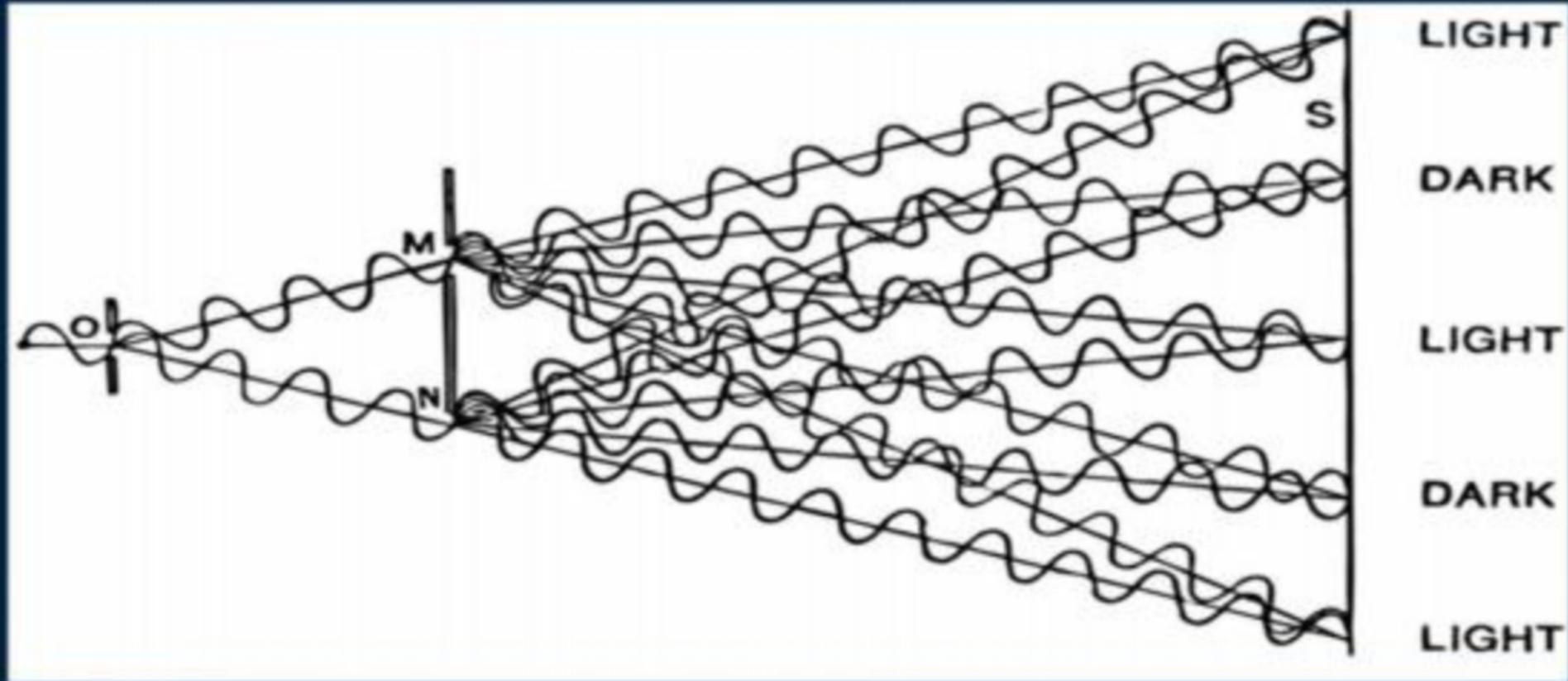
Visible light is not inherently different from the other parts of the electromagnetic spectrum, with the exception that the human eye can detect visible waves. This in fact corresponds to only a very narrow window of the electromagnetic spectrum, ranging from about 400nm for violet light through to 700nm for red light. Radiation lower than 400nm is referred to as Ultra-Violet (UV) and radiation longer than 700nm is referred to as Infra-Red (IR), neither of which can be detected by the human eye

Light

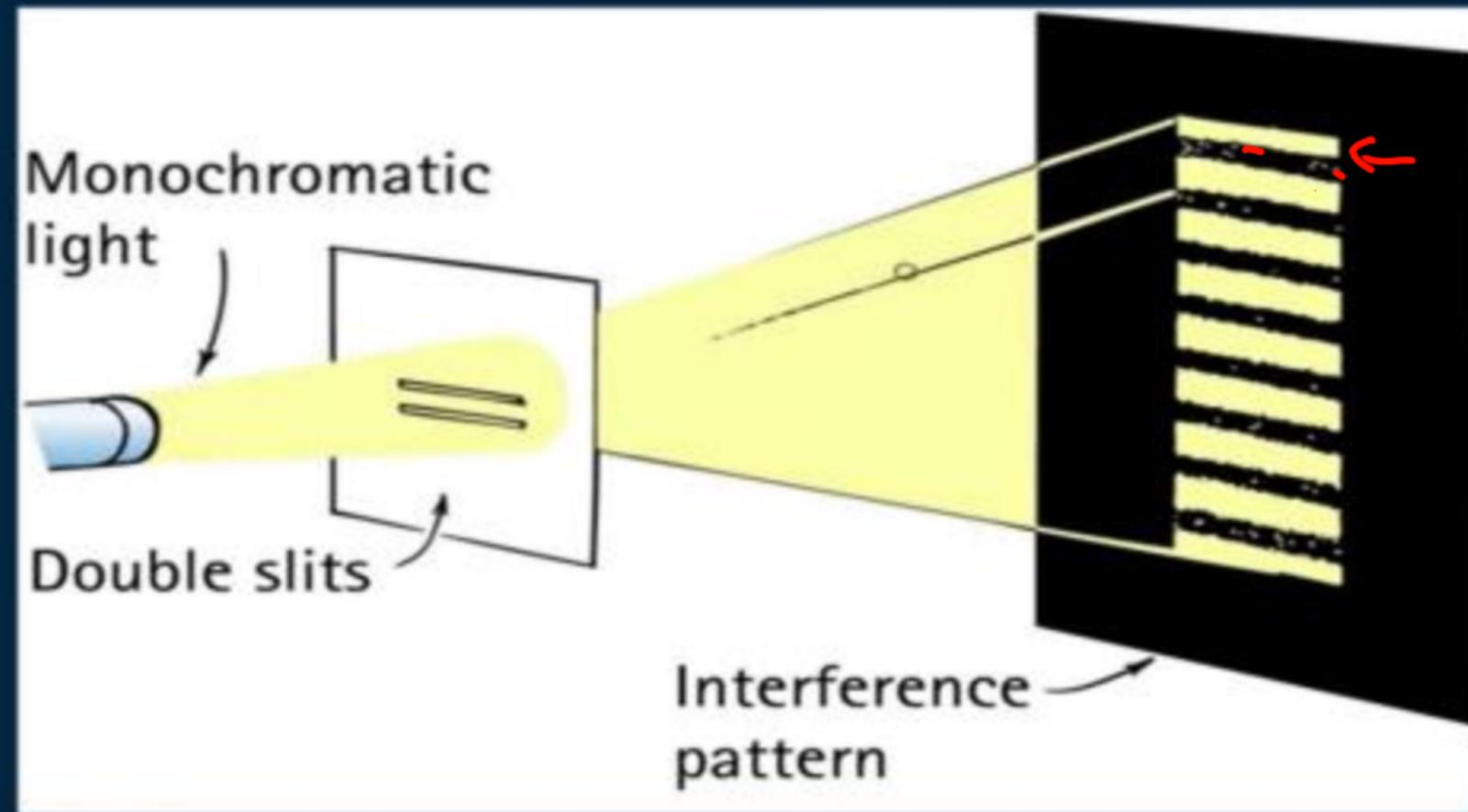
Nature of Light:

Many scientists had some experimental evidence (diffraction and interference) that indicated light was a wave and other experimental evidence (black body radiation and the photoelectric effect) that indicated light was a particle. The solution to this problem was to develop a concept known as the wave-particle duality of light. The point of this concept is that light travels as a wave and interacts with matter like a particle. Thus when light is traveling through space, air, or other media, we speak of its wavelength and frequency, and when the light interacts with matter, we switch to the characteristics of a particle (quantum).

INTERFERENCE of LIGHT

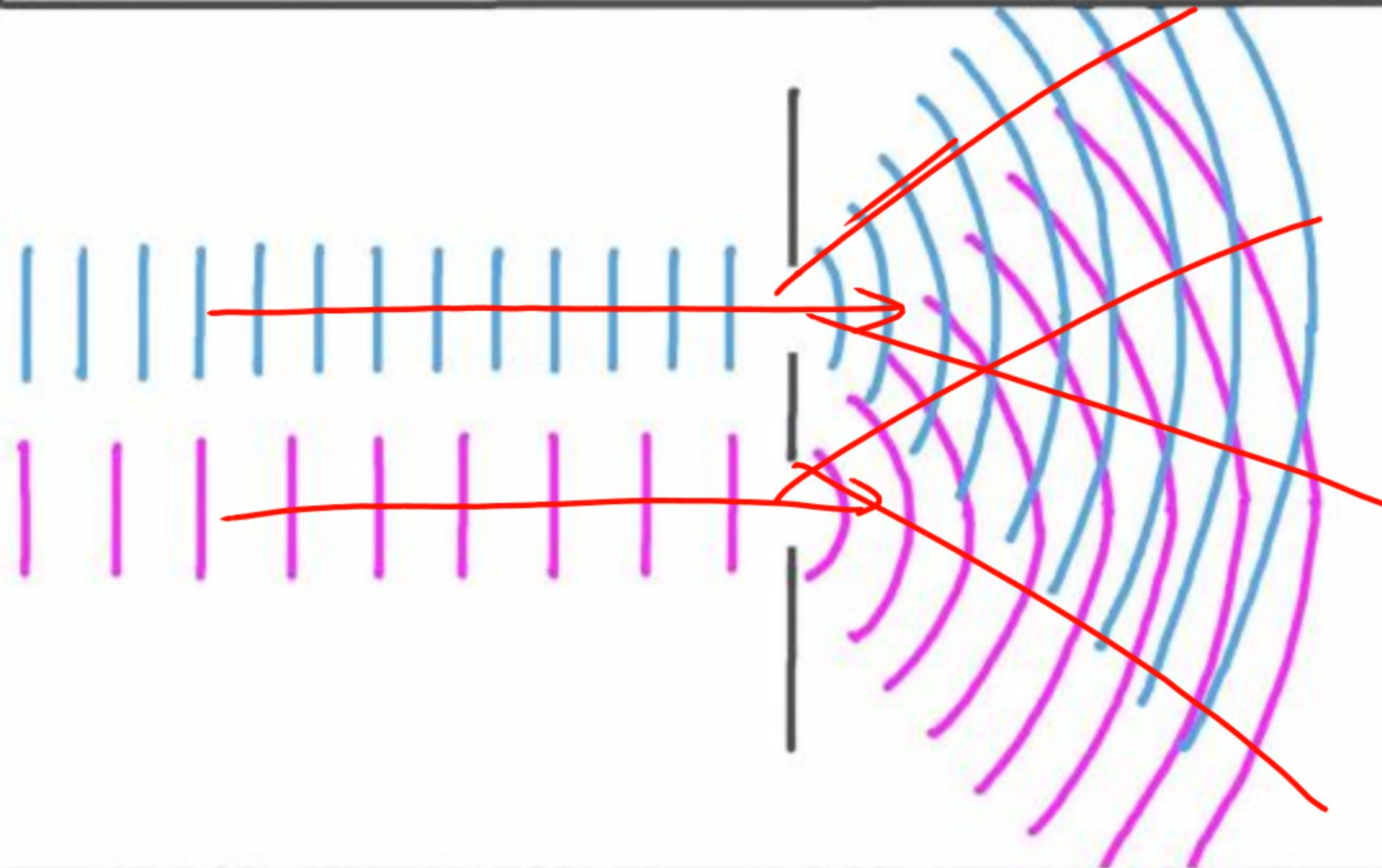


INTERFERENCE of LIGHT



Wave nature

DIFFRACTION OF LIGHT WAVES



bending
of light
around the
corner

Light

Refraction of Light:

When light passes from denser medium to rarer medium it bends away from the normal. When it passes from rarer medium to denser medium it bends towards the normal. This phenomenon of bending of light is called refraction of light.

When light travels from one medium to another its speed changes. A ray of light from a rarer medium to a denser medium slows down and bends towards the normal. On the other hand the ray of light going from a denser medium to a rarer medium is speeded up and bends away from the normal. It shows that the speed of light in different medium varies. Different medium have different abilities to bend or refract light.

Light

Twinkling of stars: The twinkling of a star is due to atmospheric refraction of starlight. The starlight, on entering the earth's atmosphere, undergoes refraction continuously before it reaches the earth. The atmospheric refraction occurs in a medium of gradually changing refractive index. Since the atmosphere bends starlight towards the normal, the apparent position of the star is slightly different from its actual position. The star appears slightly higher (above) than its actual position when viewed near the horizon.

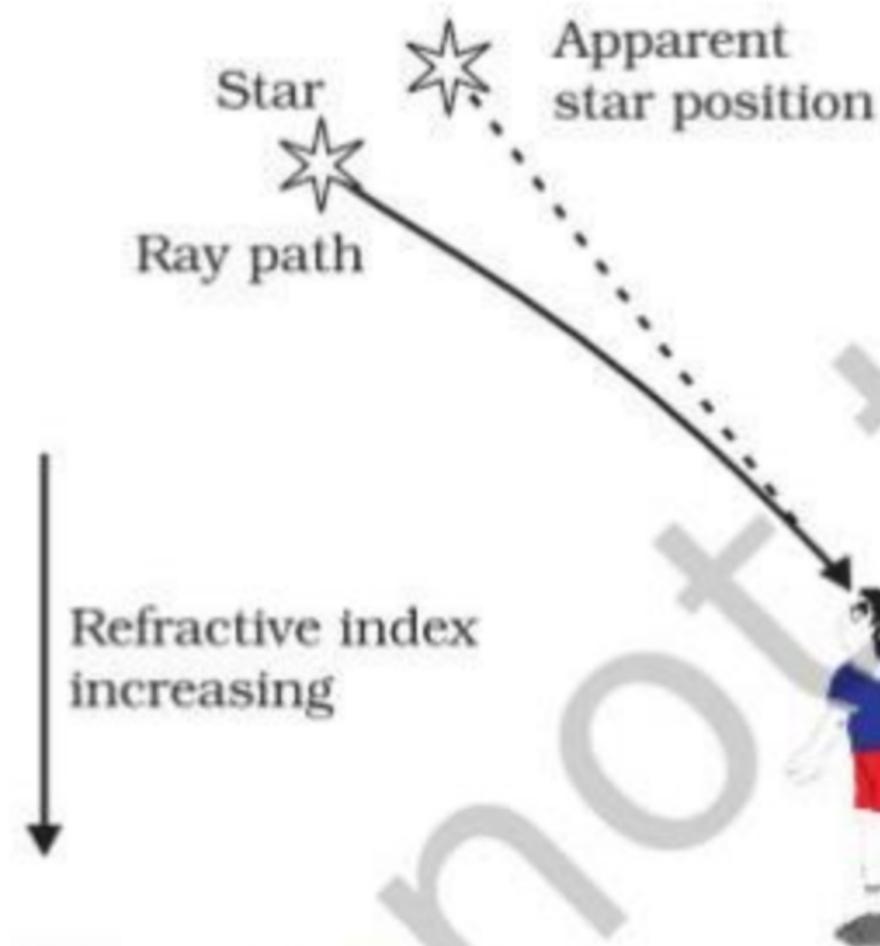


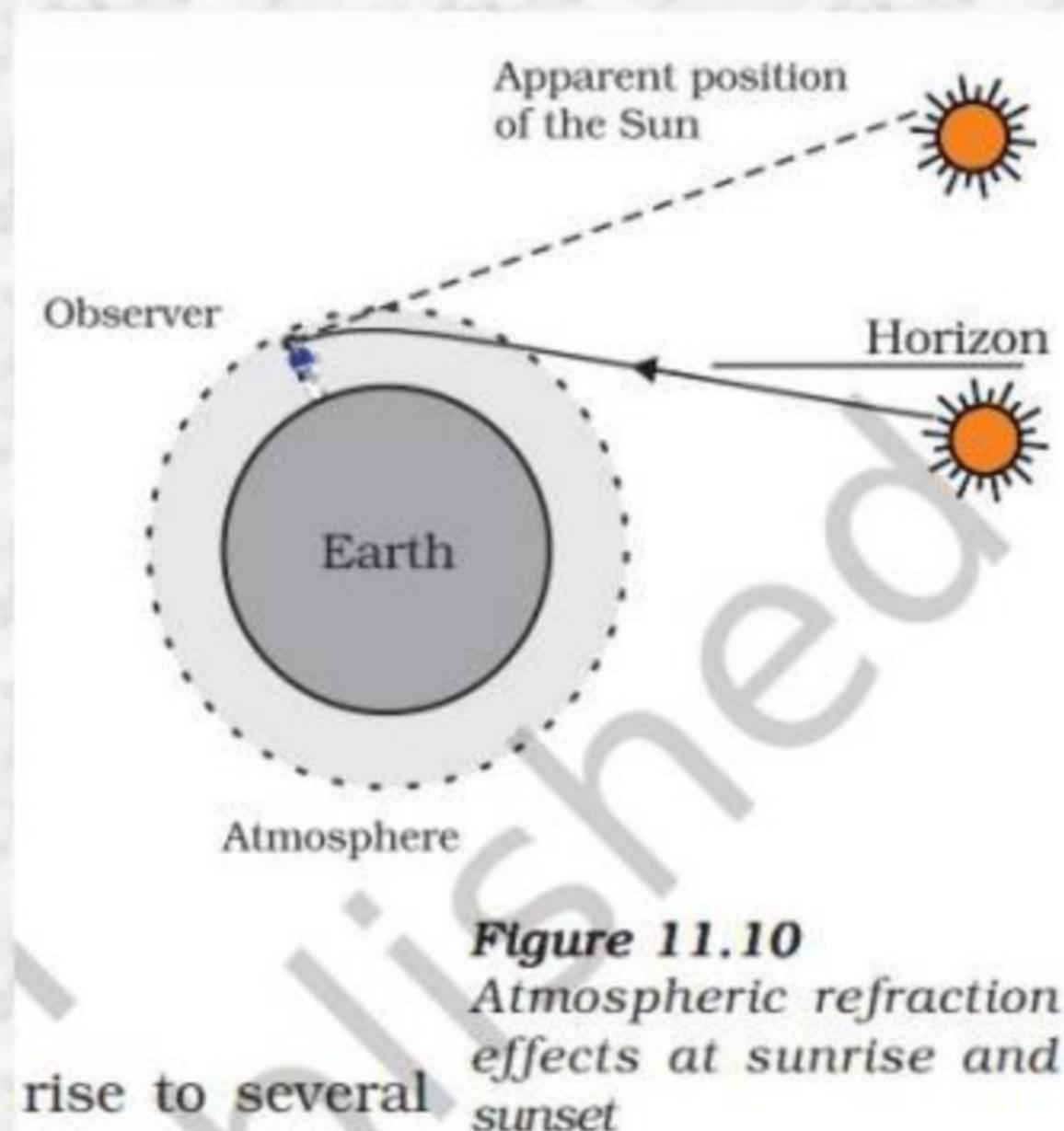
Figure 11.9
Apparent star position due to atmospheric refraction

Light

Further, this apparent position of the star is not stationary, but keeps on changing slightly, since the physical conditions of the earth's atmosphere are not stationary, as was the case in the previous paragraph. Since the stars are very distant, they approximate point-sized sources of light. As the path of rays of light coming from the star goes on varying slightly, the apparent position of the star fluctuates and the amount of starlight entering the eye flickers – the star sometimes appears brighter, and at some other time, fainter, which is the twinkling effect.

Light

Advance sunrise and delayed sunset: The Sun is visible to us about 2 minutes before the actual sunrise, and about 2 minutes after the actual sunset because of atmospheric refraction. By actual sunrise, we mean the actual crossing of the horizon by the Sun. The following shows the actual and apparent positions of the Sun with respect to the horizon. The time difference between actual sunset and the apparent sunset is about 2 minutes. The apparent flattening of the Sun's disc at sunrise and sunset is also due to the same phenomenon.

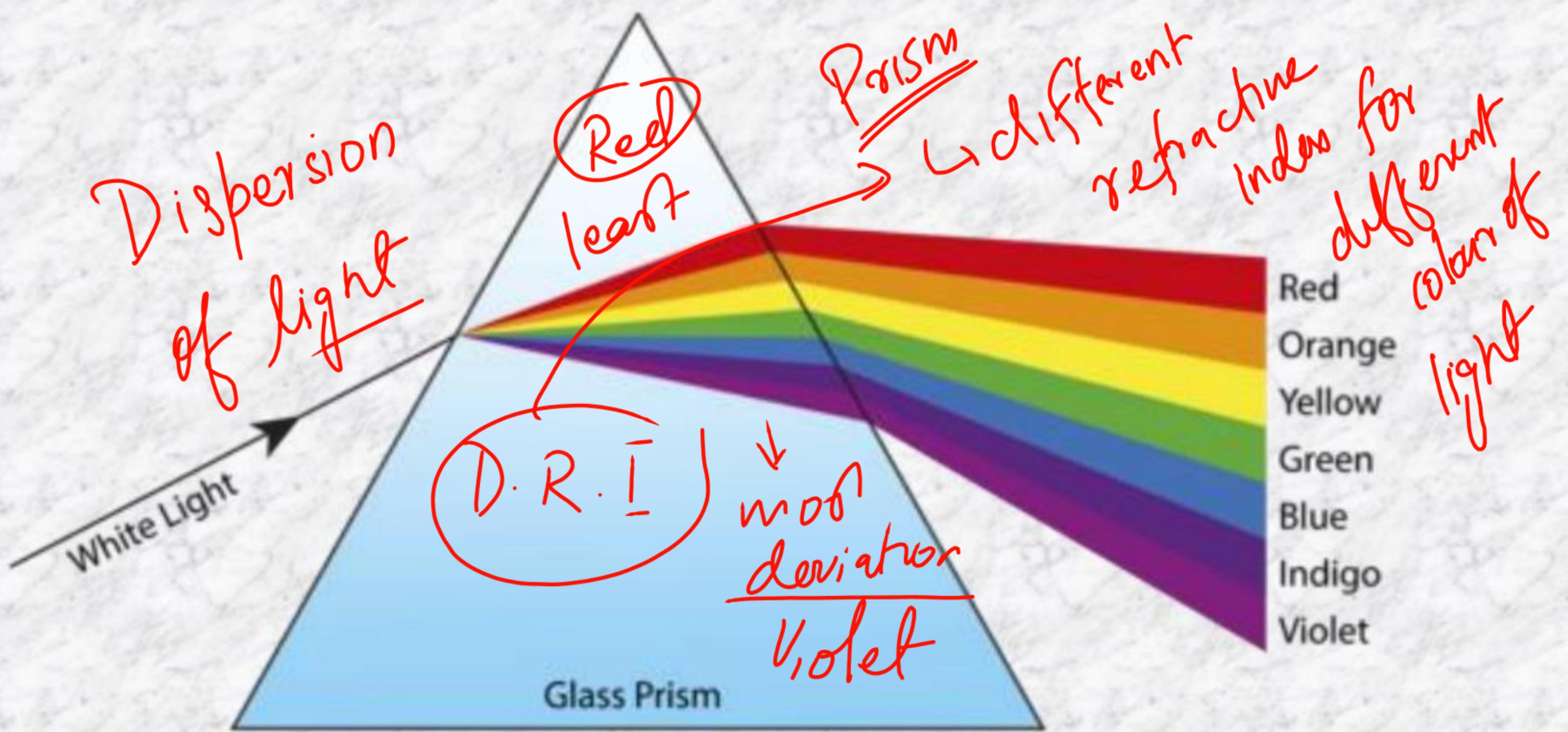


Light

Dispersion of Light:

When white light or sun light passes through a prism it splits up into constituent colours. This phenomenon is called dispersion and arises due to the fact that refractive index of prism is different for different colours of light.

Total Internal Reflection: Total internal reflection happens at a time when a light ray that travels from a denser to a rarer medium. The ray is incident at an angle of incidence that is greater than the critical angle. After that, the light rays are reflected in another denser medium. It is the same medium before reflection. The entire process is known as Total internal reflection.



Dispersion of light

Red leaf

Prism

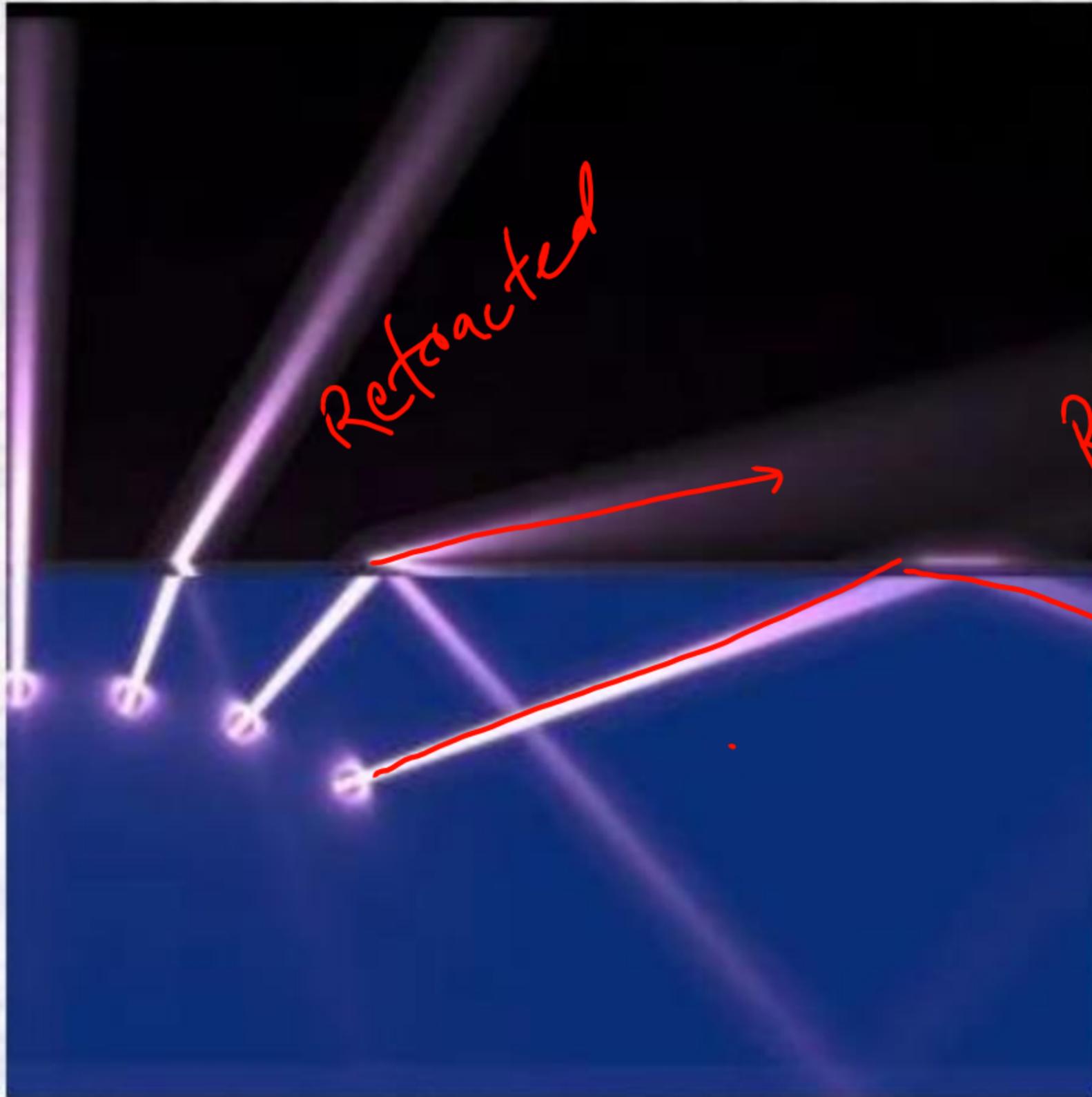
different refractive index for different colour of light

D.R.I.

min deviation Violet

Glass Prism

- Red
- Orange
- Yellow
- Green
- Blue
- Indigo
- Violet

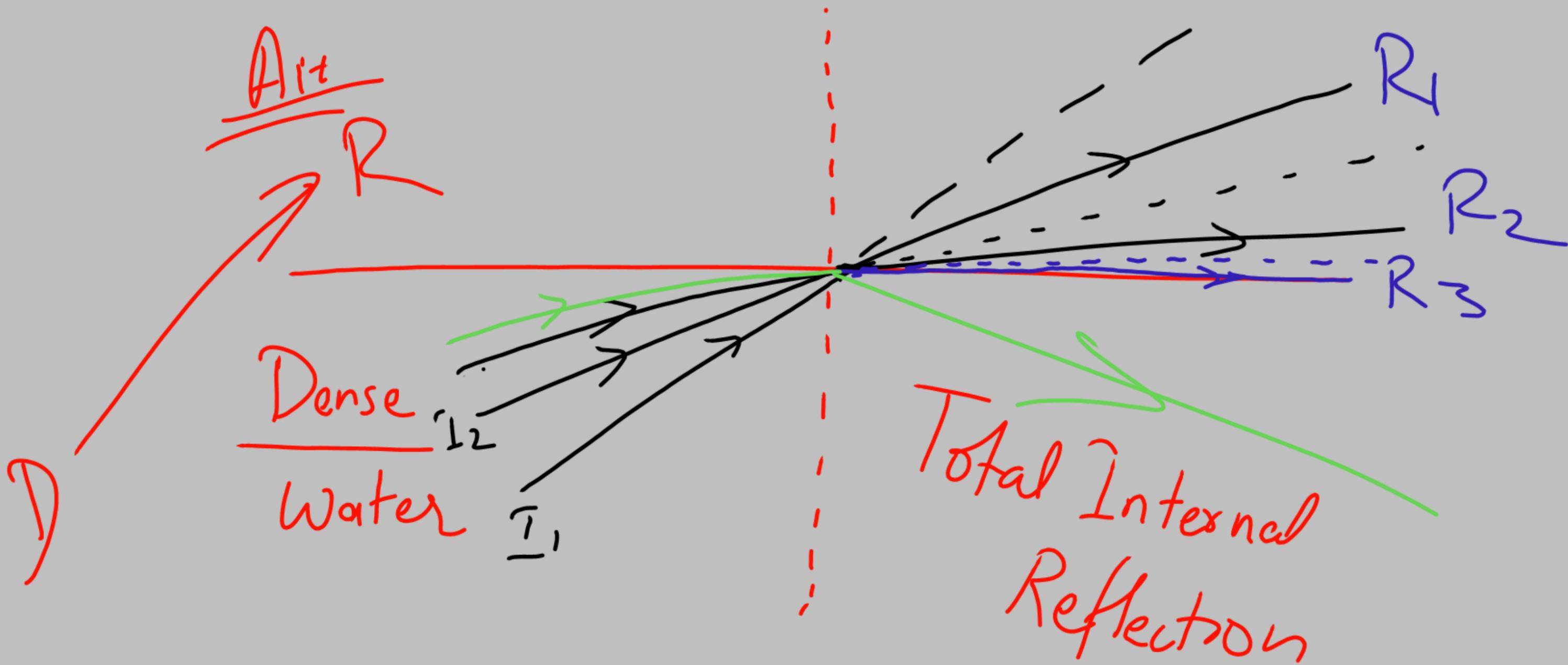


Refracted

Rare

Dense

Total
Internal
Reflection



Light

When light travels between two surfaces made of transparent materials, then it gets refracted. This is also called as the bending of light. Light or rays that come towards or drive away from the normal have interfered. This happens due to a change of one medium to another medium. This gives the simple definition of total internal reflection

Light

When light travels between two surfaces made of transparent materials, then it gets refracted. This is also called as the bending of light. Light or rays that come towards or drive away from the normal have interfered. This happens due to a change of one medium to another medium. This gives the simple definition of total internal reflection

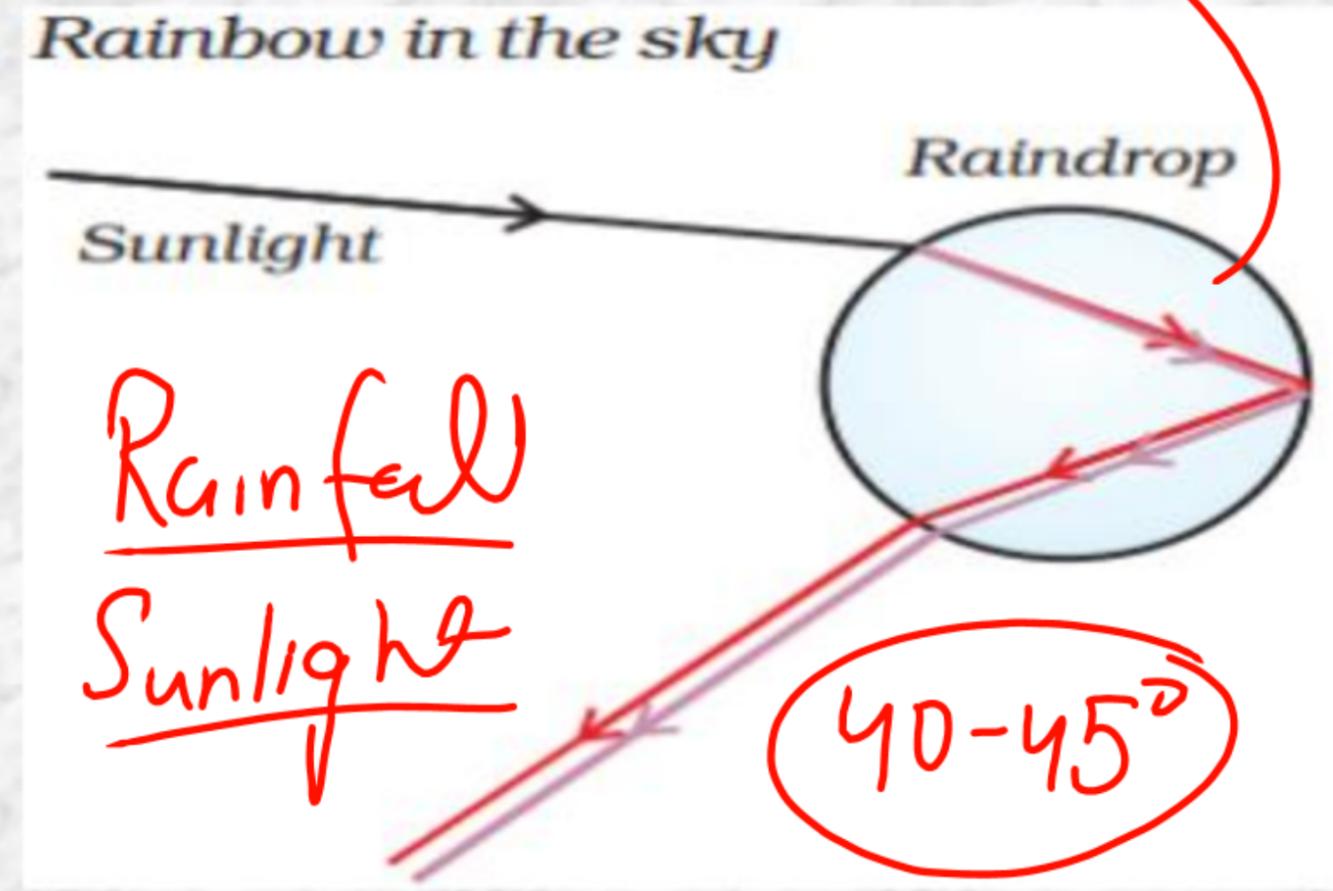
Application of Total Internal Reflection:

Optical fibers: Fiber optics uses total internal reflection, which has many advantages in telecommunications. Fiber optics are light-travelling glass or plastic threads the size of a hair. When light contacts the core-cladding boundary at an angle of incidence larger than the critical angle, it is refracted back into the core. As a result, light can travel many kilometers with little energy loss.

Endoscope: An endoscope is a medical device used for diagnostic and surgical procedures. It has two fiber-optic tubes in a pipe. The light enters the patient's organ through one of the endoscope's fiber tubes and is then reflected by the physician's viewing lens through the outer fiber tube thus confirming total internal reflection.

Light

Rainbow Formation: A rainbow is a natural spectrum appearing in the sky after a rain shower. It is caused by dispersion of sunlight by tiny water droplets, present in the atmosphere. A rainbow is always formed in a direction opposite to that of the Sun. The water droplets act like small prisms. They refract and disperse the incident sunlight, then reflect it internally, and finally refract it again when it comes out of the raindrop. Due to the dispersion of light and internal reflection, different colours reach the observer's eye.



S

Total Internal Reflection

Prism

VIBGYOR

Refraction X

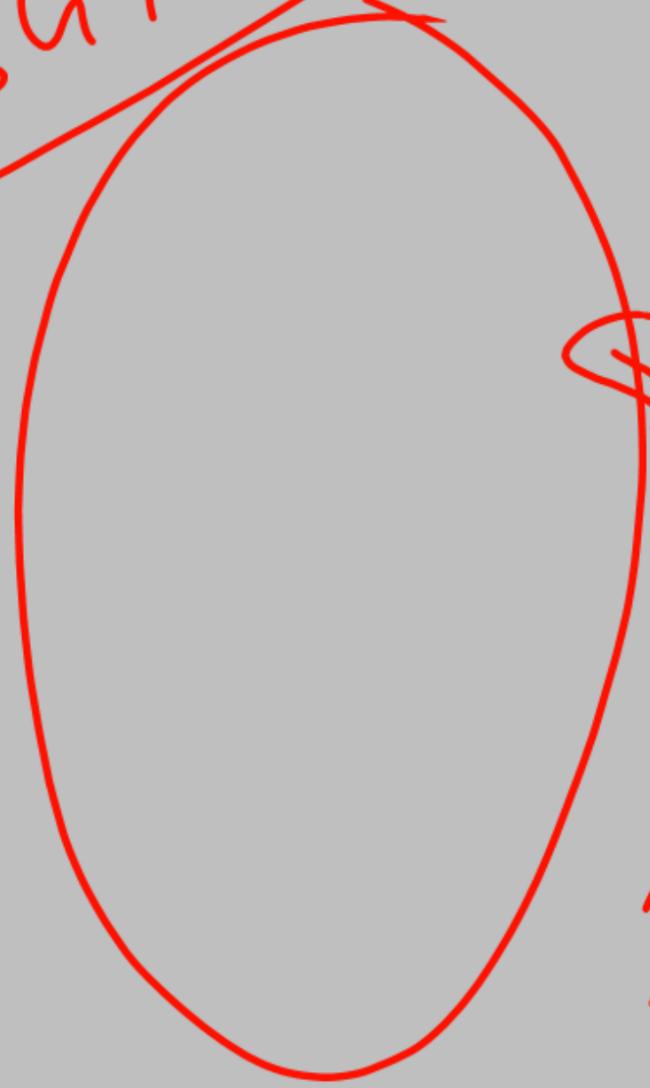
Refraction T.I.R

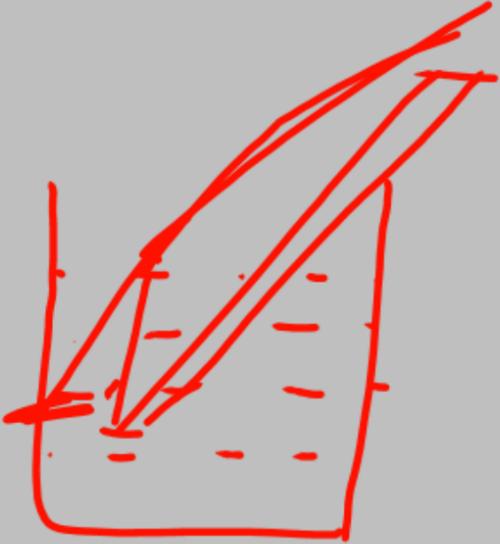
Water droplet

→ Dispersion

→ Total Internal Reflection

→ Refraction.

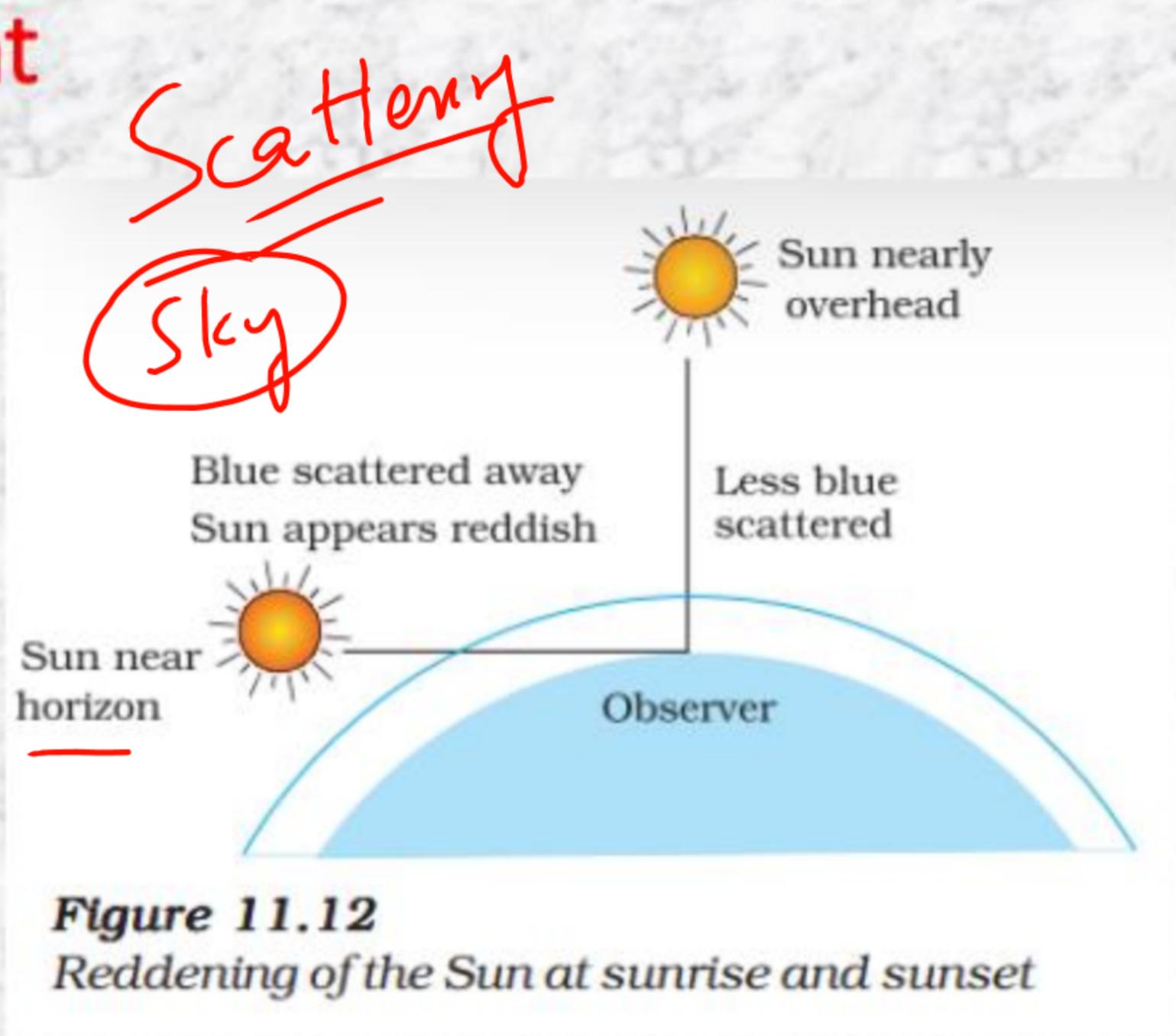




Light

Scattering of Light

When light passes from one medium to another, say air, a glass of water, then a part of the light is absorbed by particles of the medium, preceded by its subsequent radiation in a particular direction. This phenomenon is termed a scattering of light



Scattering

Most scattering of Blue colour

Blue Colour
of Sky

White

→ 7

colour →

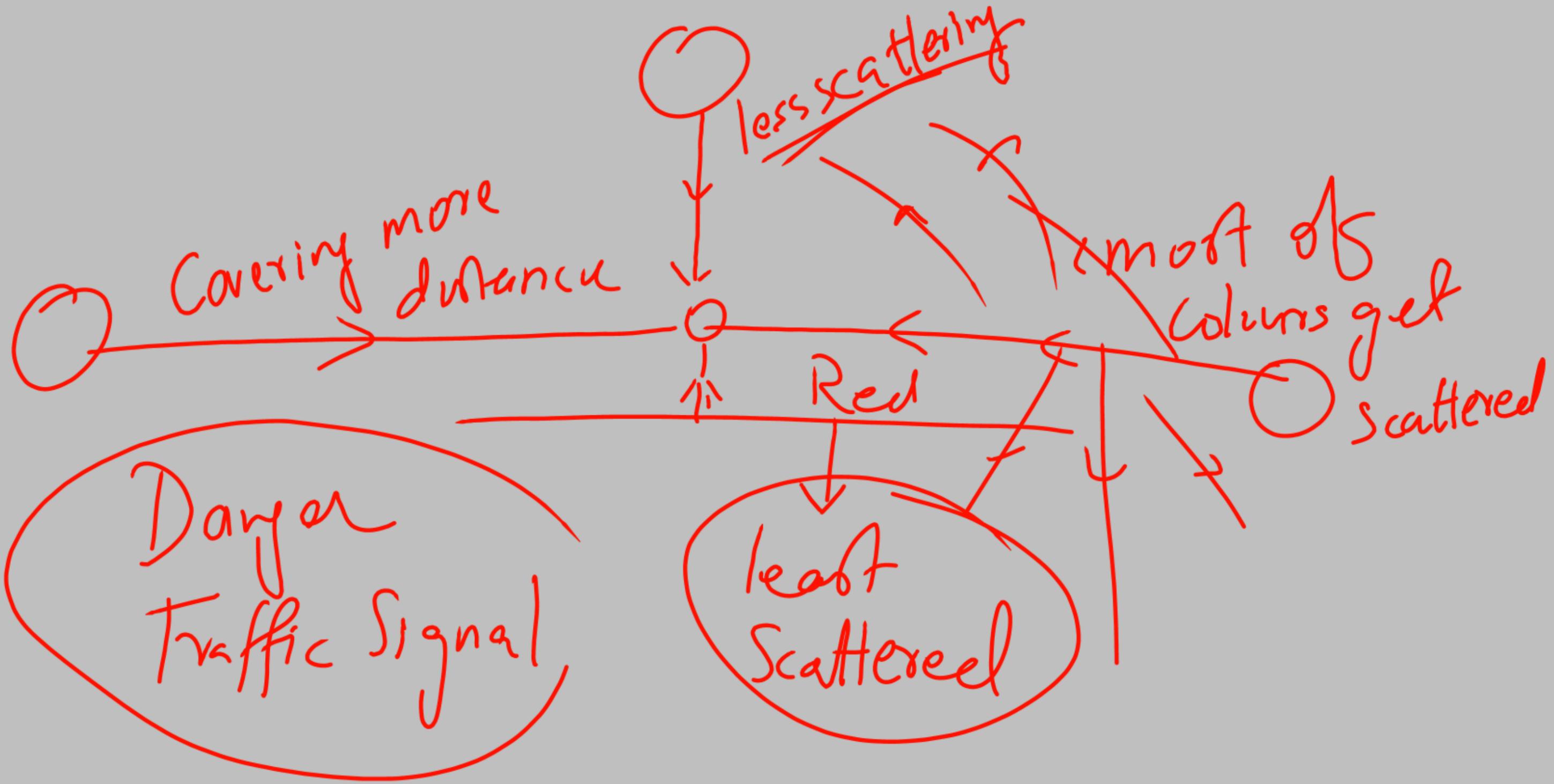
Red colour of
Sun at sunrise
and sunset

Sun

→ White

→ Atm





Light

Why is the colour of the clear Sky Blue? The molecules of air and other fine particles in the atmosphere have size smaller than the wavelength of visible light. These are more effective in scattering light of shorter wavelengths at the blue end than light of longer wavelengths at the red end. The red light has a wavelength about 1.8 times greater than blue light. Thus, when sunlight passes through the atmosphere, the fine particles in air scatter the blue colour (shorter wavelengths) more strongly than red. The scattered blue light enters our eyes. If the earth had no atmosphere, there would not have been any scattering. Then, the sky would have looked dark

Light

The sky appears dark to passengers flying at very high altitudes, as scattering is not prominent at such heights. You might have observed that 'danger' signal lights are red in colour. Do you know why? The red is least scattered by fog or smoke. Therefore, it can be seen in the same colour at a distance.

The light from the Sun overhead would travel relatively shorter distance. At noon, the Sun appears white as only a little of the blue and violet colours are scattered. Near the horizon, most of the blue light and shorter wavelengths are scattered away by the particles. Therefore, the light that reaches our eyes is of longer wavelengths. This gives rise to the reddish appearance of the Sun

Electricity

Electron theory According to this theory, every object consists of extremely fine particles, which are called atoms. It was found by experiments that the atom itself is made up of two types of very fine electrical particles.

Out of this, one type of particle is called a proton, which has a positive electric charge and another type of particle is called an electron, which has a negative electric charge.

When we rub two objects together, the electrons of one object transfer to another. The object that loses the electron becomes positively charged. Conversely, the object on which electrons move becomes negatively charged. Thus we see that there are two types of charge - (1) positive charge and (2) negative charge

Electricity

What are conductors?

The materials from which electric charge flows easily are called electric conductors. In contrast, these substances in which charge cannot flow are called insulators. All metals are electrical conductors. Our body is also an electrical conductor. Water and moisture are also electrical conductors. Rubber, plastic, dry wood, enamel paint are some examples of insulating materials. Dry air is insulated, while moist air is not insulated

Electricity

What are semi-conductors?

Semiconductors are materials which have a conductivity between conductors (generally metals) and non-conductors or insulators (such as most ceramics). Semiconductors can be pure elements, such as silicon or germanium, or compounds such as gallium arsenide or cadmium selenide. In a process called doping, small amounts of impurities are added to pure semiconductors causing large changes in the conductivity of the material.

Electricity

The Presence of Electricity in Clouds?

Thunderstorms are caused by small electrically-charged particles.

As water molecules in the cloud are heated and cooled and they move up and down against each other, there is a separation of charge. Forming 2 poles within the cloud. One part becomes negatively charged, and the other part becomes positively charged.

Objects on the ground then become oppositely charged to the lower part of the cloud.

This imbalance tries to resolve itself, by passing current between the differently charged poles.

Charged particles always flow in the direction where there are less particles of the same charge. This results in a lightning bolt.

The electrical arc of the lightning bolt heats the surrounding air to extreme temperatures. In fact, the air around it can be heated to 5 times hotter than the sun!

This heat causes the surrounding air to rapidly expand and vibrate. Which is the rumbling thunder that we hear.

Each bolt carries about 10 billion Watts. That's enough power for 32 million people a year!

10 billion watts per bolt, and given that 50 bolts strike the earth's surface every single second means the power of lightning is extraordinary.

Magnetism

Magnetic phenomena are universal in nature. Vast, distant galaxies, the tiny invisible atoms, humans and beasts all are permeated through and through with a host of magnetic fields from a variety of sources. The earth's magnetism predates human evolution. The word magnet is derived from the name of an island in Greece called magnesia where magnetic ore deposits were found, as early as 600 BC. Shepherds on this island complained that their wooden shoes (which had nails) at times stayed struck to the ground. Their iron-tipped rods were similarly affected. This attractive property of magnets made it difficult for them to move around.

Magnetism

Features:

(i) **Directive Property:** A small bar magnet, when suspended freely on its center of mass so as to rotate about a vertical axis, always stays in approximately geographical north-south direction.

(ii) **Attractive Property:** A magnet attracts small pieces of magnetic materials like iron, nickel and cobalt. The force of attraction is maximum at points near the ends of the magnet. These points are called poles of the magnet. In a freely suspended magnet, the pole which points towards the geographical north is called north pole and the one which points towards the geographical south is called south pole.

(iii) Unlike poles of two magnets attract each other and like poles repel.

(iv) The poles of a magnet are inseparable, i.e. the simplest specimen providing magnetic field is a magnetic dipole.

(v) When a magnet is brought close to a piece of iron, the nearer end of the piece of iron acquires opposite polarity and the farther end acquires same polarity. This phenomenon is called magnetic induction.

Magnetism

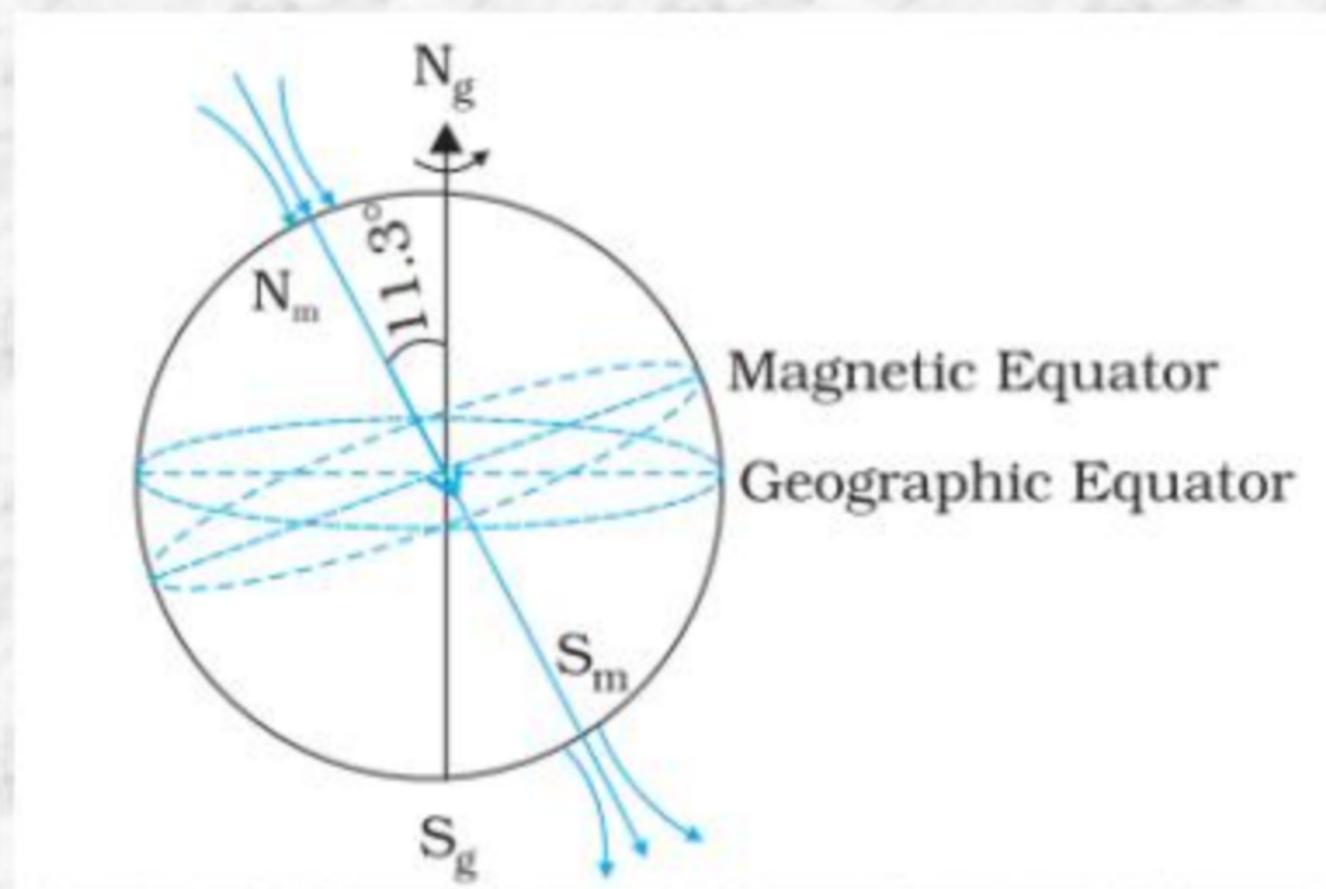
Earth's magnetic field is now thought to arise due to electrical currents produced by convective motion of metallic fluids (consisting mostly of molten iron and nickel) in the outer core of the earth. This is known as the dynamo effect.

The magnetic field lines of the earth resemble that of a (hypothetical) magnetic dipole located at the centre of the earth. The axis of the dipole does not coincide with the axis of rotation of the earth but is presently tilted by approximately 11.3° with respect to the later.

Magnetism

In this way of looking at it, the magnetic poles are located where the magnetic field lines due to the dipole enter or leave the earth. The location of the north magnetic pole is at a latitude of 79.74° N and a longitude of 71.8° W, a place somewhere in north Canada. The magnetic south pole is at 79.74° S, 108.22° E in the Antarctica.

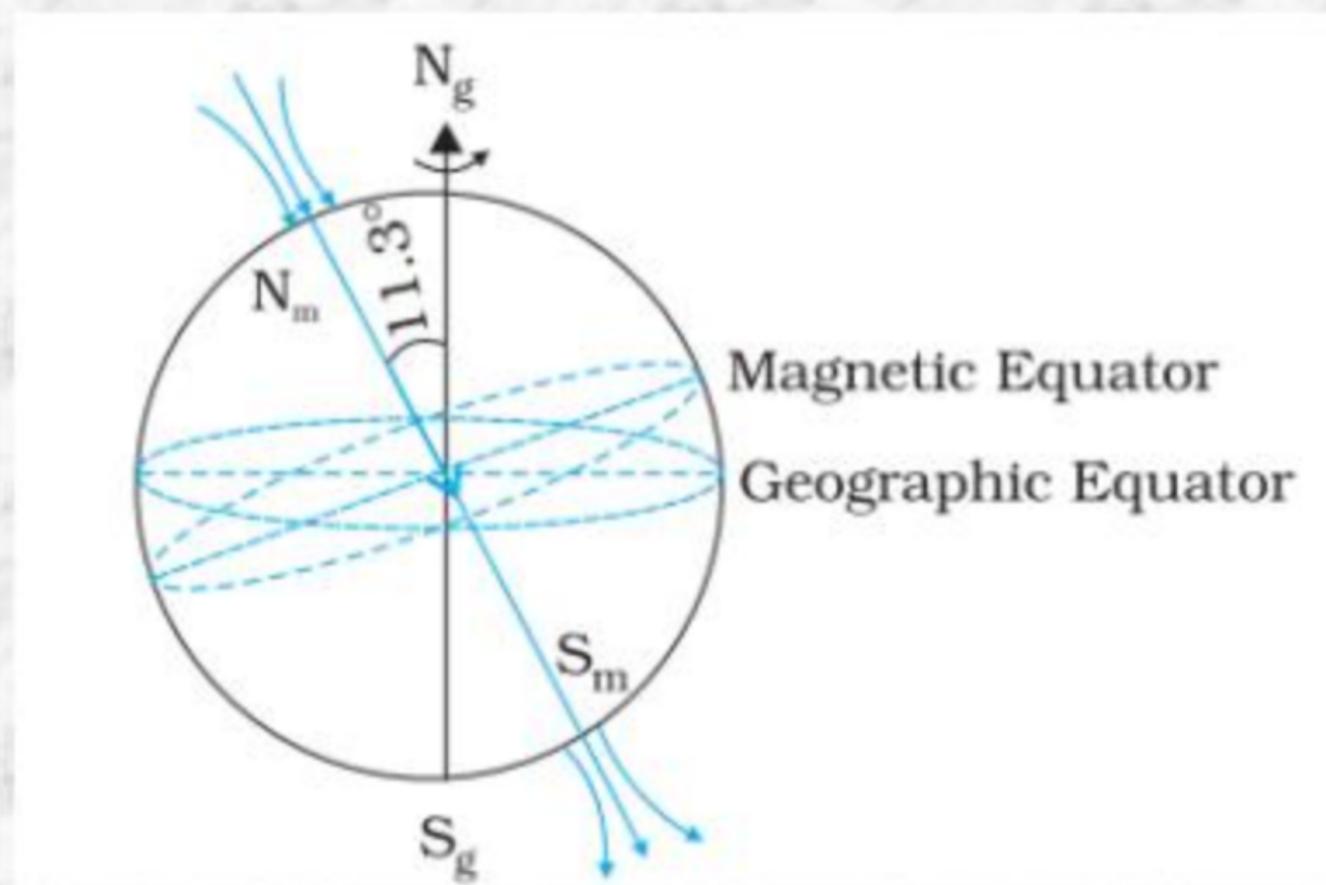
The pole near the geographic north pole of the earth is called the north magnetic pole. Likewise, the pole near the geographic south pole is called the south magnetic pole.



Magnetism

There is some confusion in the nomenclature of the poles. If one looks at the magnetic field lines of the earth, one sees that unlike in the case of a bar magnet, the field lines go into the earth at the north magnetic pole (N_m) and come out from the south magnetic pole (S_m).

The convention arose because the magnetic north was the direction to which the north pole of a magnetic needle pointed; the north pole of a magnet was so named as it was the north seeking pole. Thus, in reality, the north magnetic pole behaves like the south pole of a bar magnet inside the earth and vice versa.

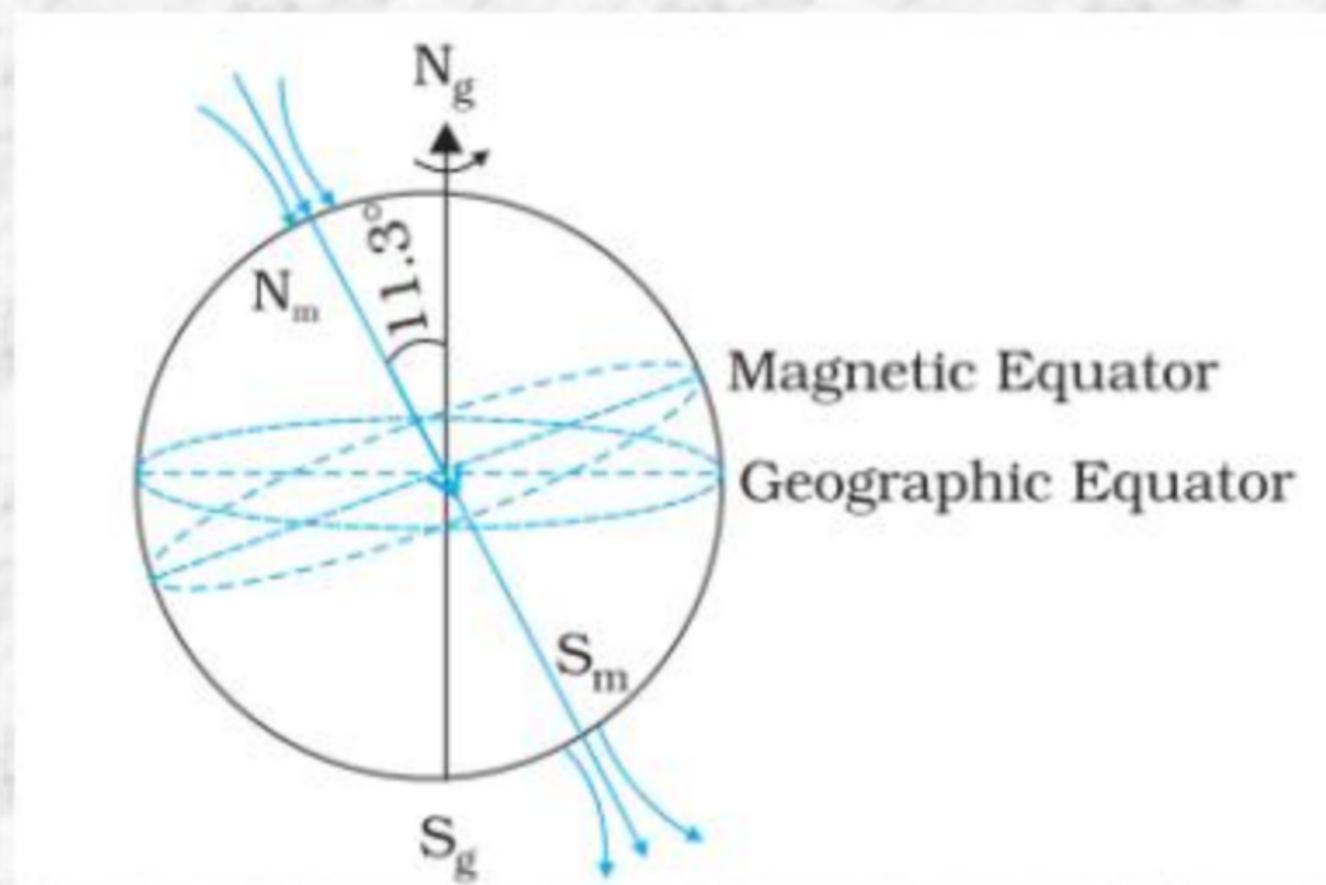


Magnetism

Variation in Magnetic Field of Earth:

The variation of earth's magnetic field with time is no less fascinating. There are short term variations taking place over centuries and long term variations taking place over a period of a million years.

In a span of 240 years from 1580 to 1820 AD, over which records are available, the magnetic declination at London has been found to change by 3.5° , suggesting that the magnetic poles inside the earth change position with time. On the scale of a million years, the earth's magnetic fields has been found to reverse its direction.



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