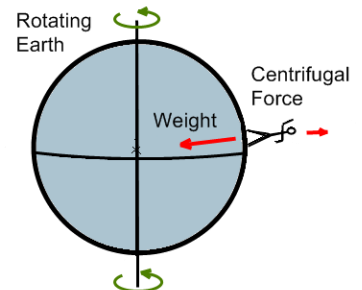
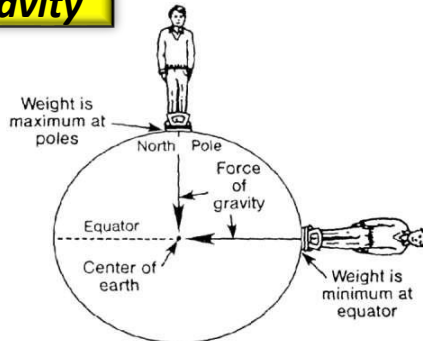
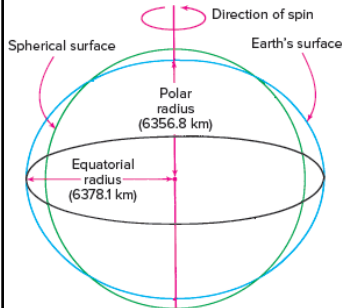


Caution!!! This PDF may seem irrelevant for exam, but its not. Students are advised to see video if they find the PDF difficult.

Many people mentioned gravity:

- Aristotle (4th cent BC)
- Brahmagupta (7th century)
- Newton (1665)

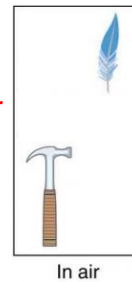
Gravity



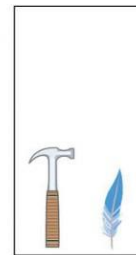
Mass remains same everywhere. But weight varies.

- Weight at mountains:** less than that at plains
- Weight on moon:** 1/6th **CORRECTION: More than that at equator**
- Weight at poles:** less than that at equator
- Weight in satellite:** zero

Less weight is due to less gravitational force
Think you are jumping / throwing a ball / etc

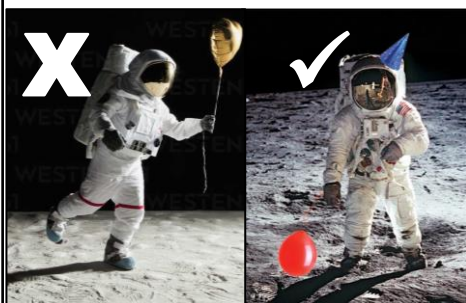


In air



In a vacuum

All objects fall with same acceleration due to gravity (9.81 m/s²)

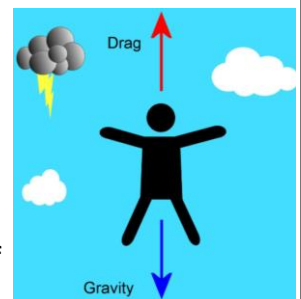


Moon:

- No atmosphere
- No air drag
- No buoyancy
- No b'day party

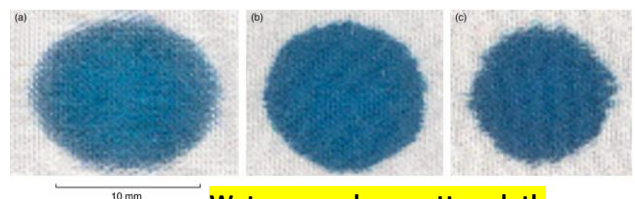
Terminal velocity:

- Maximum speed of object falling through fluid.
- Force of drag (friction) cancels force of gravity.

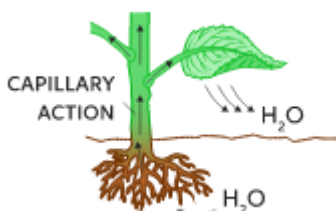


Capillary Action

- Liquid in narrow tube rises or falls without any external force
- Reason: adhesion / cohesion / surface tension



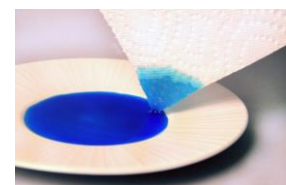
Water spreads on cotton cloth



Water from roots moves up



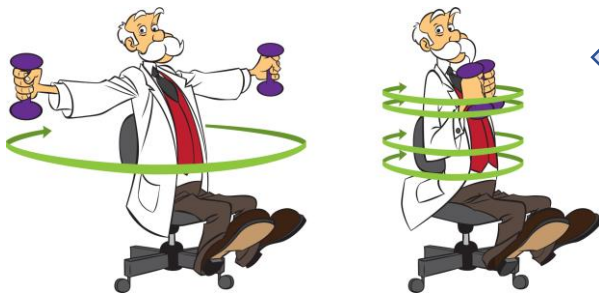
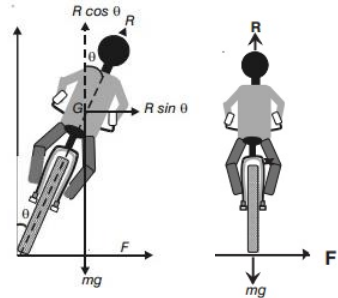
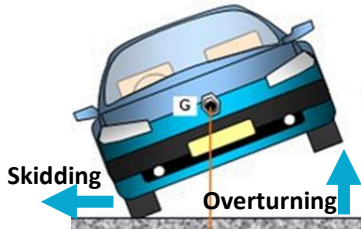
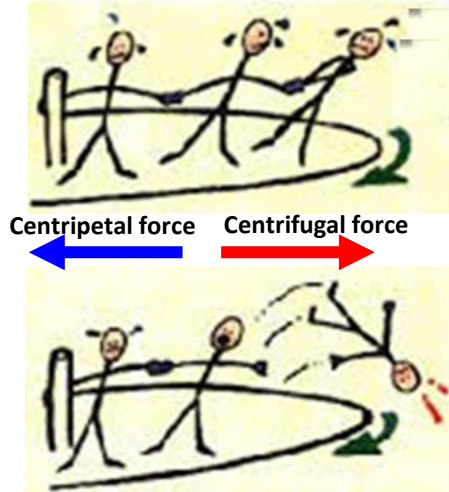
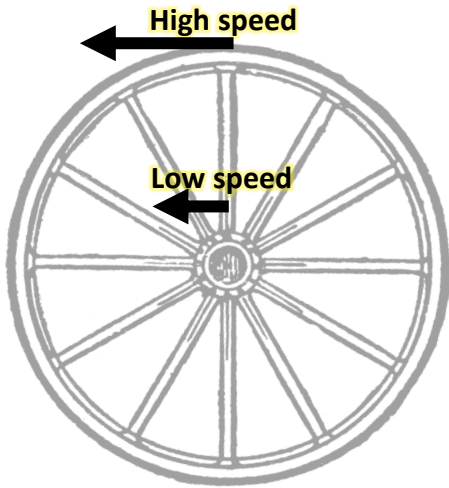
Lamp burning



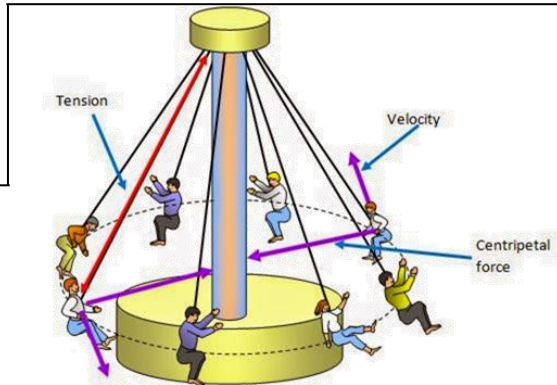
Blotting paper

I read I forget, I see I remember See explanation of this PDF on [YouTube](https://www.youtube.com/c/allinclusiveias) www.youtube.com/c/allinclusiveias

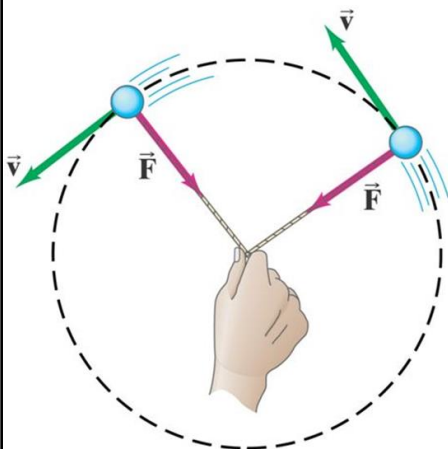
Circular Motion



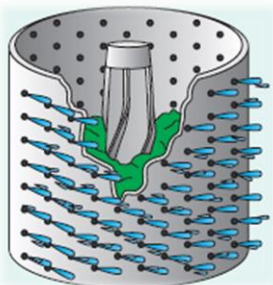
← **Conservation of angular momentum**
 Extend arms → slow rotation
 Contract arms → fast rotation



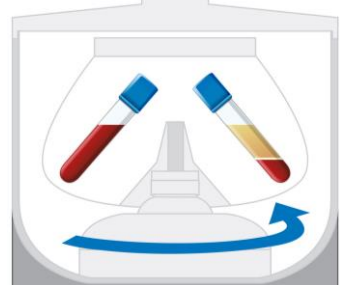
Centripetal force is necessary for circular motion. Else, object will travel in straight line.



Washing machine



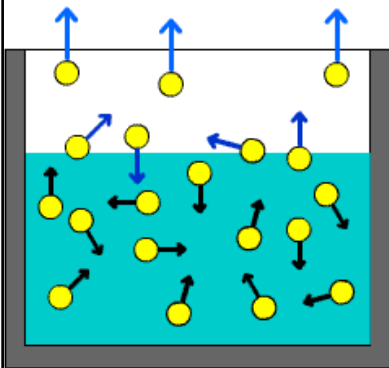
Centrifugation of blood



Evaporation



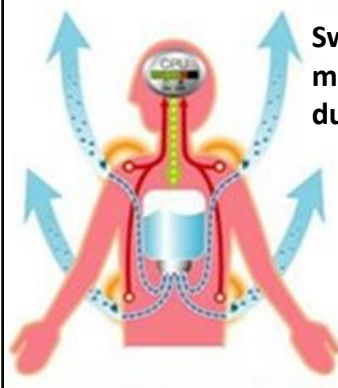
- Cold** means lower kinetic energy in molecules
- Hot** means higher kinetic energy in molecules
- Evaporation**: process in which high kinetic energy molecules leave surface of liquid
- Water in lake, earthen pot, cooler, is cool due to evaporation



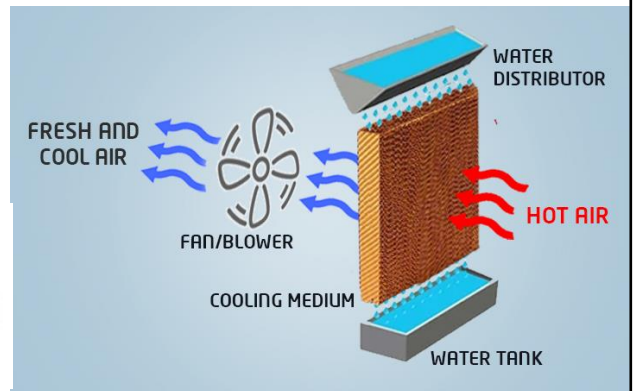
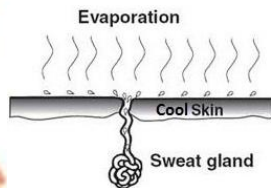
High Energy:
Evaporating

Medium Energy:
Pulled back into water

Lower Energy:
Remain as liquid

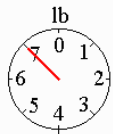


Sweat / bath / water makes us feel cool due to evaporation

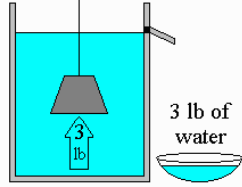
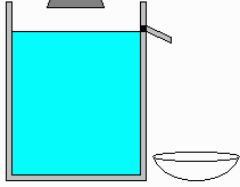
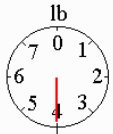


Some factors affecting evaporation

<p>Temperature</p> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p>High</p> </div> <div style="text-align: center;"> <p>Low</p> </div> </div>	<p>Surface area</p> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p>High</p> </div> <div style="text-align: center;"> <p>Low</p> </div> </div>	<p>Humidity</p> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p>High</p> </div> <div style="text-align: center;"> <p>Low</p> </div> </div>	<p>Wind speed</p> <div style="display: flex; justify-content: space-around;"> <div style="text-align: center;"> <p>High</p> </div> <div style="text-align: center;"> <p>Low</p> </div> </div>
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Archimedes' Principle
the buoyant force is equal to
the weight of the displaced water



Density

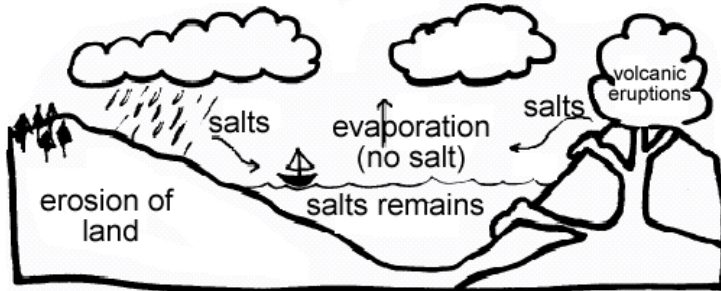
Steel needle sinks, but vessel doesn't!



When boat enters sea (from river), boat will rise.
When cargo is jettisoned, boat will rise.



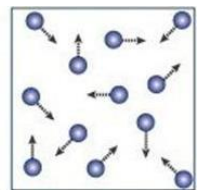
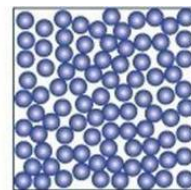
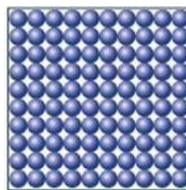
Saltwater is more dense than freshwater.
Rivers bring salt to sea, but salt can't evaporate!



Jettison: Throw something
from aircraft or ship



Density (generally): Solid > Liquid > Gas
But not always, e.g. water > ice



Density = mass/volume

$$\text{Specific Gravity} = \frac{\text{Density of Substance}}{\text{Density of Pure Water}}$$

Mercury (Hg): (quicksilver)
It is the only metal that is
liquid at normal conditions

Material	Density (g/cm ³)
Water	1
Glass	2-3
Aluminum	2.7
Iron/Steel	8
Nickle, Copper	9
Silver	10
Mercury	13
Gold	19

Many metals float on Mercury



Friction

You are lonely on a frictionless surface and cannot exert any horizontal force against the surface. How can you get off ?

- (a) by jumping
- (b) by spitting / sneezing / whistling
- (c) by rolling body on surface
- (d) by running very fast on the running



Standing on frictionless ice. Arrow will fly right. Man will go left.



Friction between the graphite in a pencil and a sheet of paper leaves a mark on the paper.

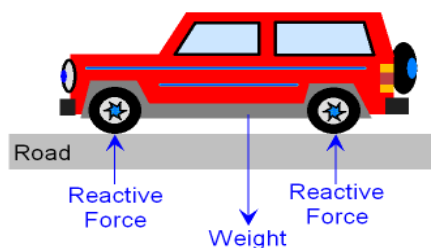


Friction between a bicycle brake pad and the rim of a wheel causes the wheel to stop turning.

Situation: Car is stationary, or at constant velocity.

Horizontal forces: Zero (Acceleration / Deceleration needs friction)

Vertical forces: Zero (normal reaction from ground equals weight)

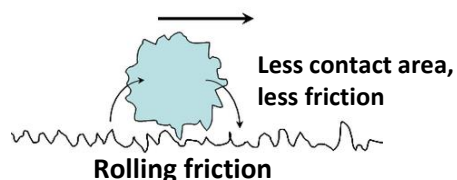
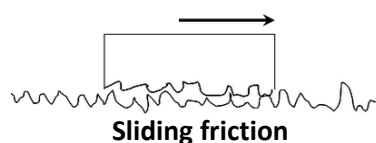
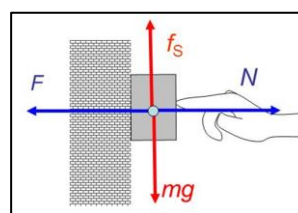


Walking on the road is easier than walking on ice



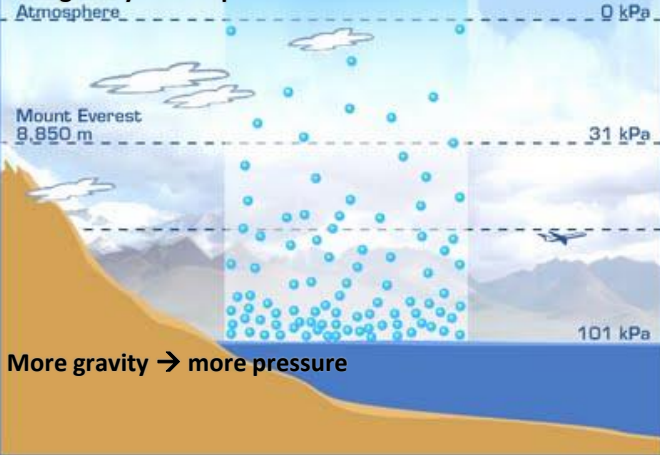
Ball bearings

- Less surface area results in less friction
- Rolling friction is much less than sliding friction
- Use in many machines, cars, etc.

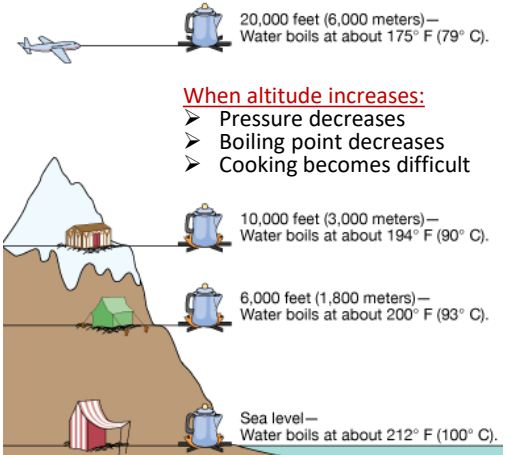


Pressure

Low gravity → low pressure



Atmospheric pressure alters the boiling point of water

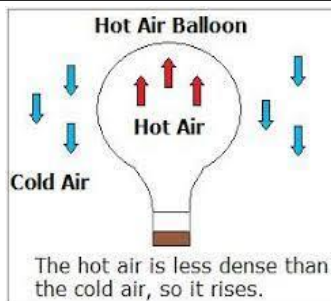
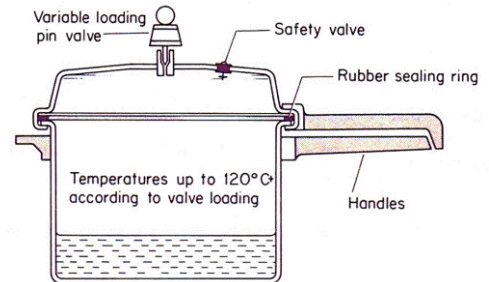


While rising:

- Size of balloon increases
- Size of bubble increases



More weight → more pressure → more temperature



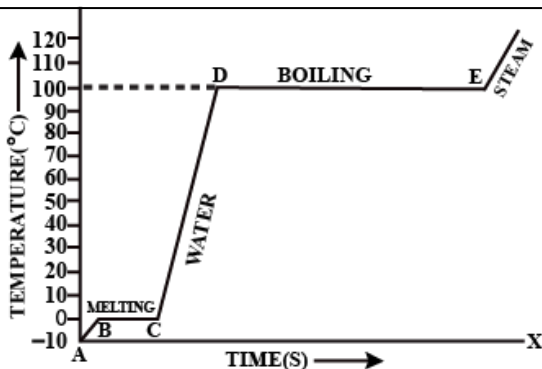
Prelims 2021:

In a pressure cooker, the temperature at which the food is cooked depends mainly upon which of the following?

1. Area of the hole in the lid
2. Temperature of the flame
3. Weight of the lid

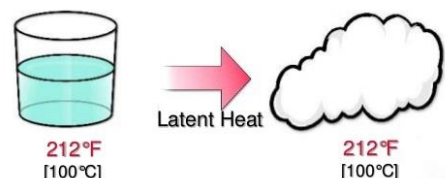
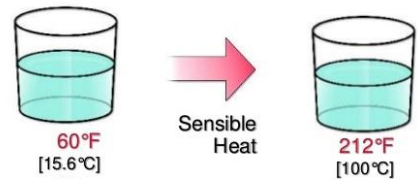
Select the correct answer

- (a) 1 and 2 only (b) 2 and 3 only
- (c) 1 and 3 only (d) 1, 2 and 3



- ❑ **Sensible heat:** causes change in temperature
 - ❑ **Latent heat:** energy absorbed or released during phase change
 - ❑ At 100°C, steam is more dangerous than water!
 - ❑ Latent heat of fusion < Latent heat of vaporization
- Just think: melting vs converting to steam

Pressure cooker → steam can't escape → higher pressure → higher boiling point of water → higher temperature for food



I read I forget, I see I remember

See explanation of this PDF on [YouTube](https://www.youtube.com/c/allinclusiveias) www.youtube.com/c/allinclusiveias

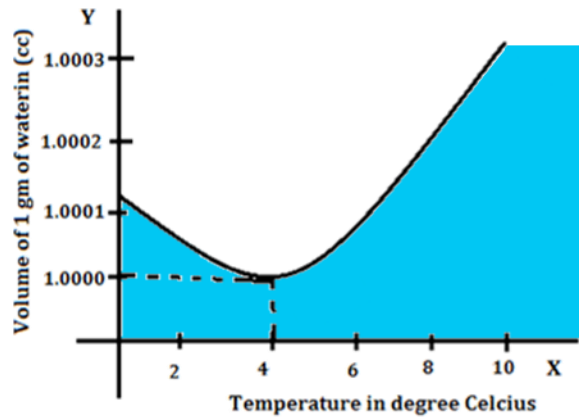
Density of water is maximum at 4°C
Volume of water is minimum at 4°C



$$C = (F-32) \times 5/9$$

$$F = (9/5 \times C) + 32$$

$$-40^\circ\text{C} = -40^\circ\text{F}$$

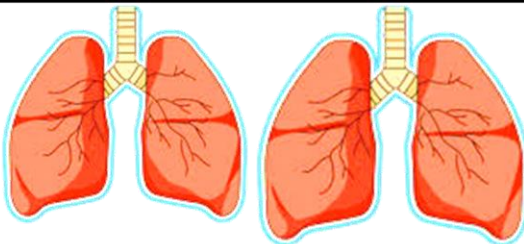


Altitude

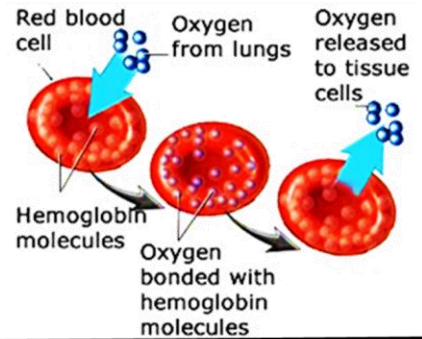
- Low atmospheric pressure
- Much less than pressure in blood vessels
- Result: nose bleed

Body adapts to low oxygen environment to prevent hypoxia (lack of oxygen in body)?

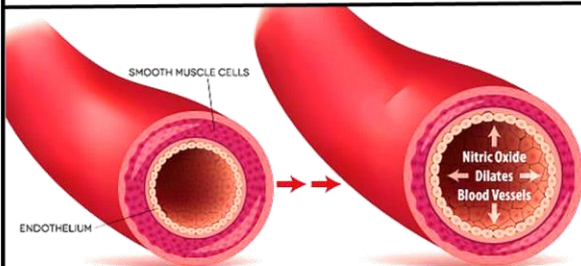
- Increase in **lung** size.
- Increased **haemoglobin** in blood
- Increase in **diameter** of blood vessels



Bigger lungs to intake more air with each breath

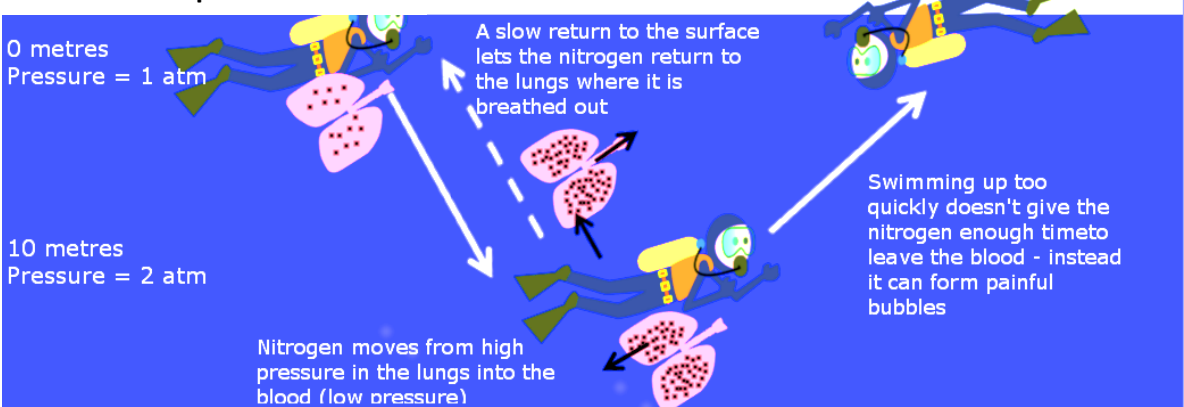


- **Hemoglobin** is a protein in Red Blood Cells that **ferries Oxygen** throughout the body.
- More Hemoglobin means more oxygen can be transported to tissues.



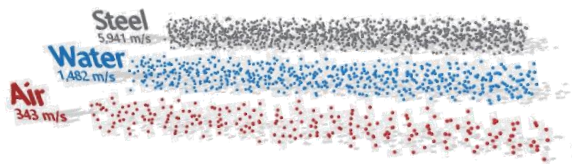
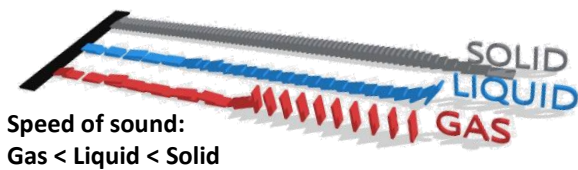
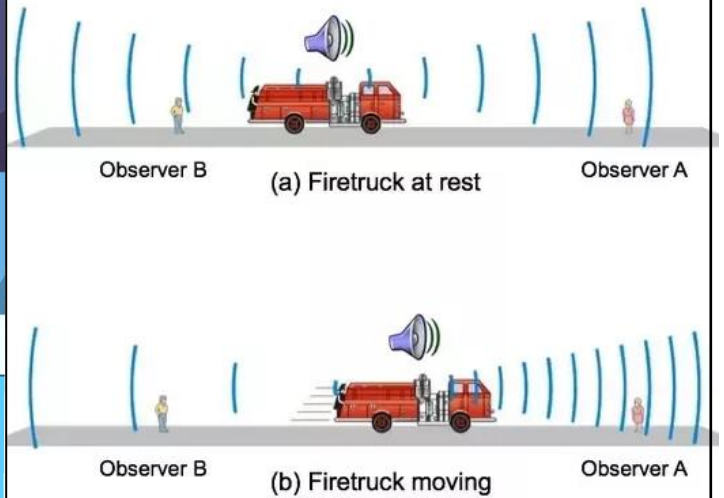
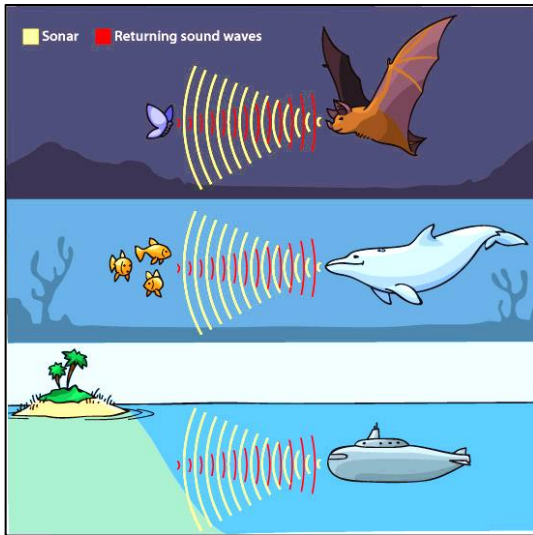
- Lungs synthesize more **Nitric Oxide** from air
- Nitric Oxide **dilates blood vessels**
- Wider blood vessels **increase blood flow**
- Increase blood flow means **more oxygen** to body tissues

Bends: Decompression sickness

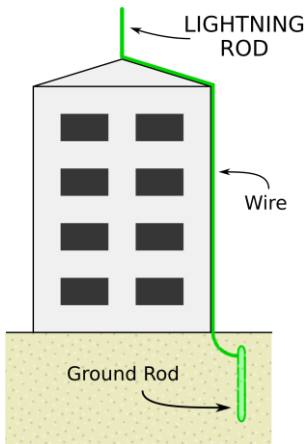
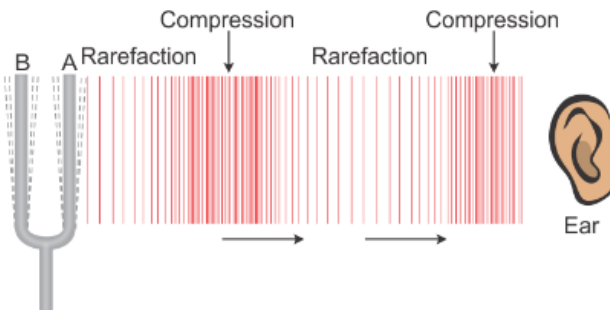


I read I forget, I see I remember | See explanation of this PDF on **YouTube** www.youtube.com/c/allinclusiveias

Sound



- Speed of sound in air:**
- Increases with humidity
 - Increases with temperature
 - Independent of pressure

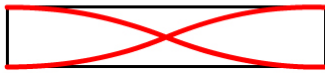


- Cumulonimbus clouds often form thunderstorms
- Lightning is the spark seen during thunderstorm
- Thunder is the sound that comes after lightning

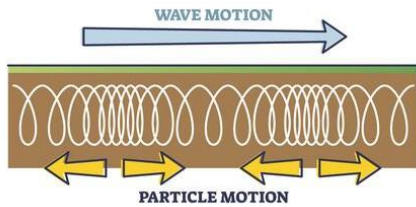
- Lightning is due to difference in charge
- Thunder is due to rapid expansion of air



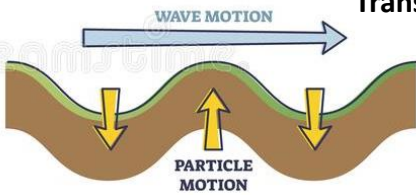
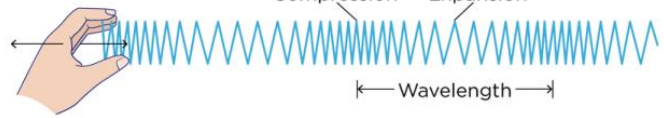
Short flute → short wavelength → high frequency



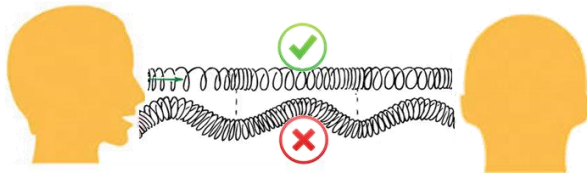
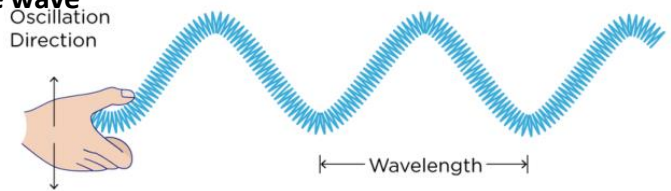
Long flute → long wavelength → low frequency



Longitudinal wave

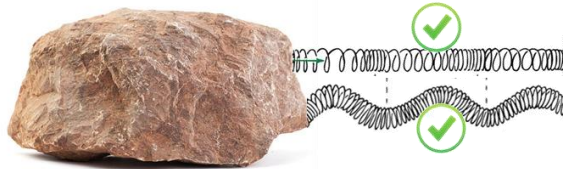


Transverse wave



Sound travels in air as:

- ✓ longitudinal waves
- ✗ transverse waves



Sound travels in solids as:

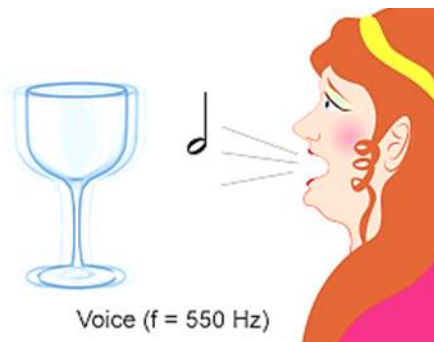
- ✓ longitudinal waves
- ✓ transverse waves

RESONANCE

If, Frequency of steps = Frequency of bridge
Then, bridge will oscillate, and may break.




If, Frequency of singer = Frequency of glass
Then, glass will vibrate, and may break.



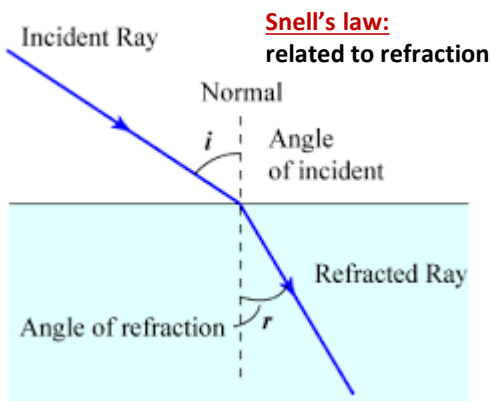
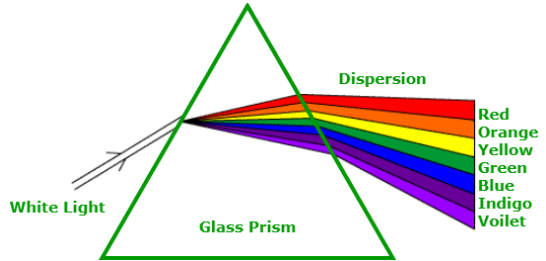
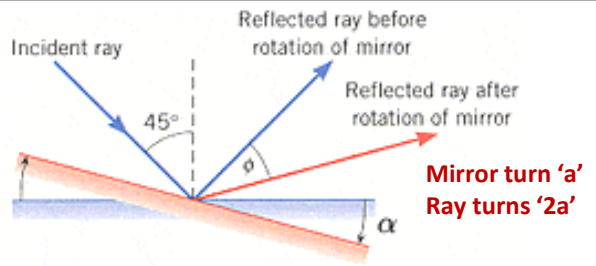
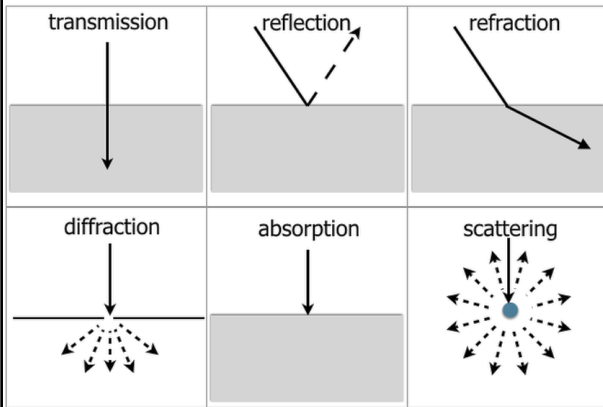
Loudness of sound is measured in decibels (dB)

Frequency that humans can hear: 20 Hz to 20 kHz

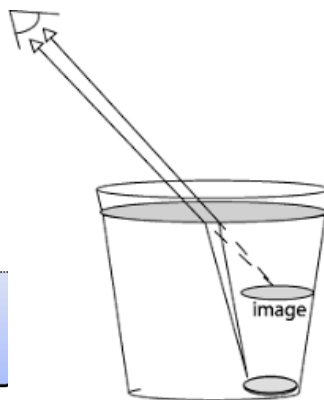
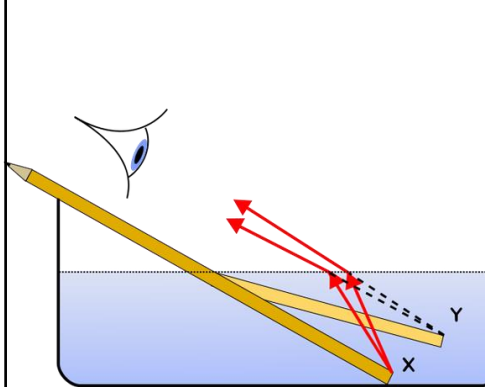
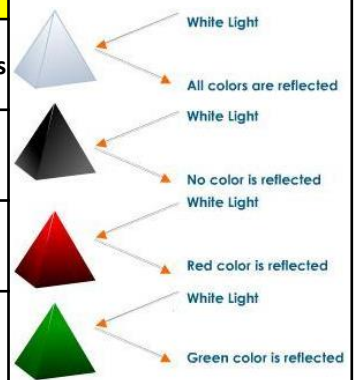
Frequency (pitch) of female voice is generally more than male voice

I read I forget, I see I remember | See explanation of this PDF on  www.youtube.com/c/allinclusiveias

Light



Object	Absorbs	Reflects
White	Nothing	All colors
Black	All colors	Nothing
Red	All except red	Red
Green	All except green	Green



During Refraction:
Frequency does not change

Moving into denser medium:
Speed slows, wavelength decreases

Due to refraction:
Coin appears near to surface
Stick appears bent and short

$$n = \frac{c}{v}$$

index of refraction

velocity of light in vacuum

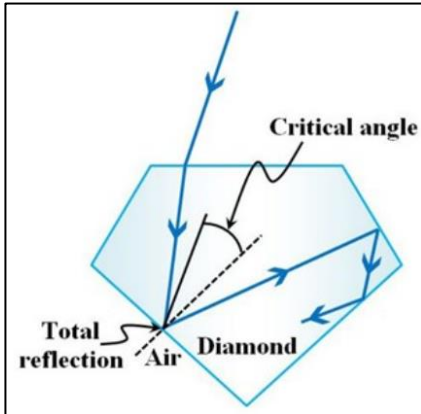
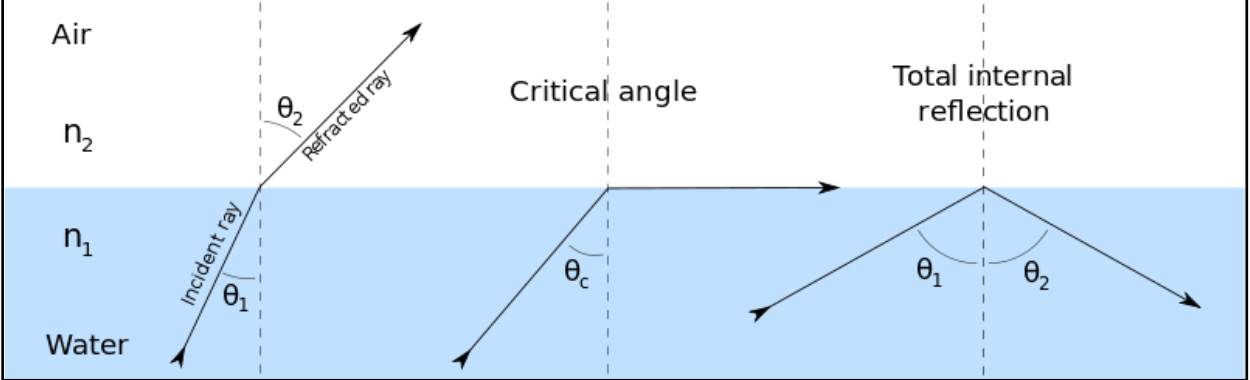
velocity of light in the medium

Material	Index of Refraction (n)
Vacuum	1.000
Air	1.000277
Water	1.333333
Ice	1.31
Glass	About 1.5
Diamond	2.417

Speed 75%

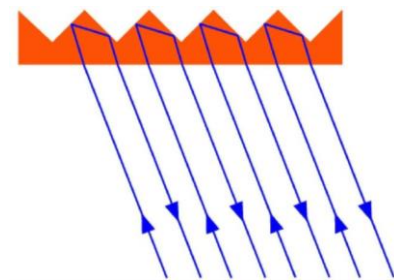
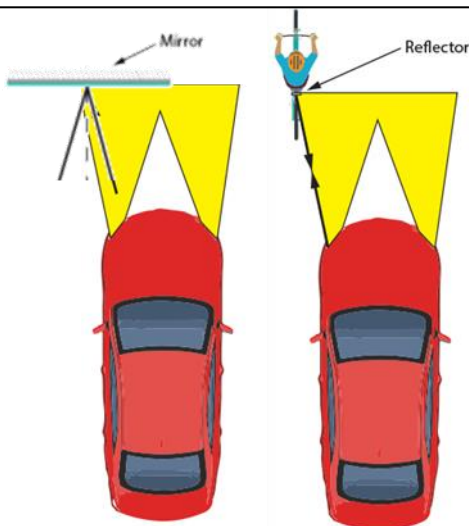
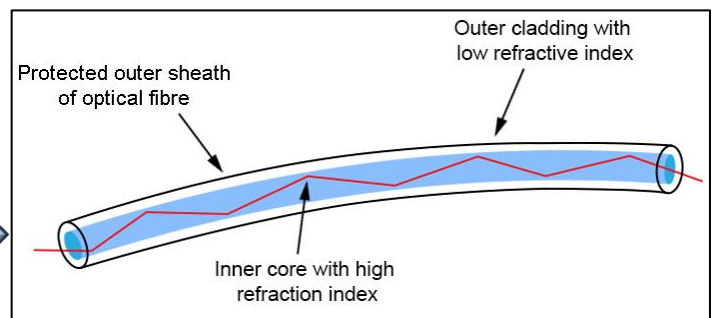
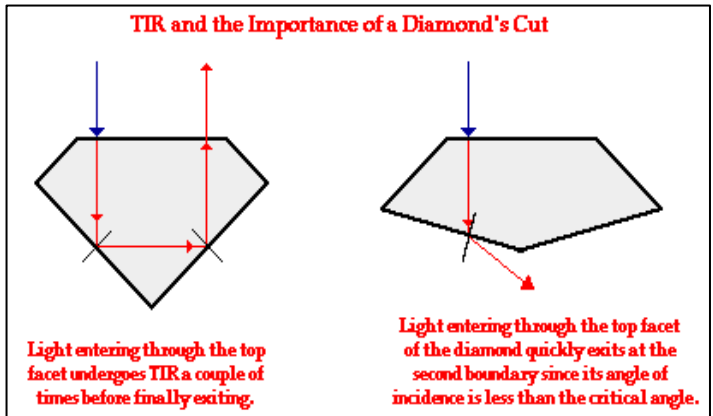
Speed 66%

Total internal reflection occurs when light travels from denser medium to rarer medium.
Critical angle is the angle at which refracted ray is at 90°



Compared to glass, Diamond has higher refractive index and smaller critical angle (24°), hence more number of TIRs

Total Internal Reflection in Optical Fiber

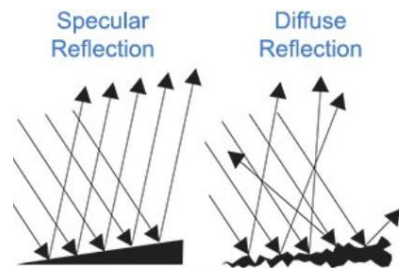
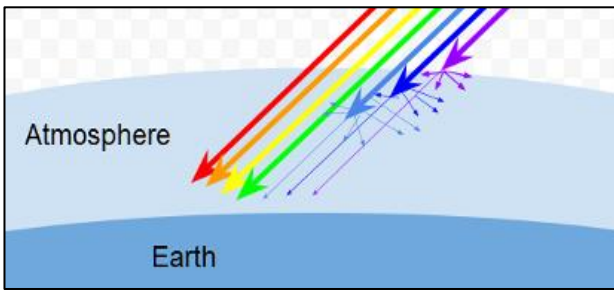


Total Internal Reflection makes road reflectors work

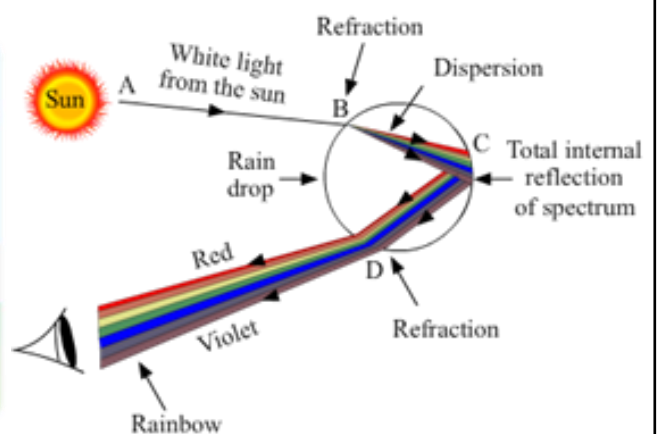
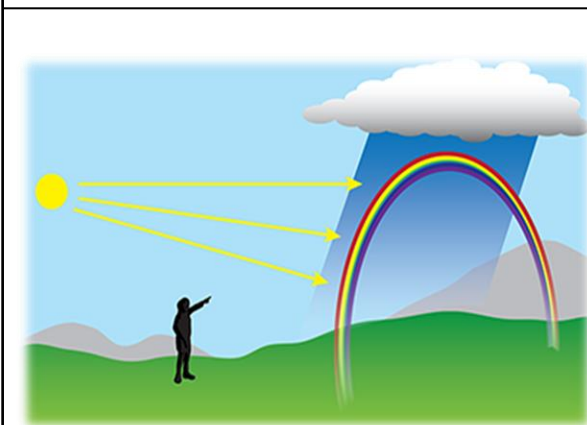
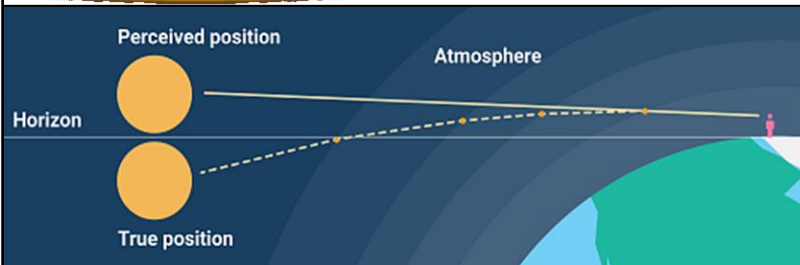
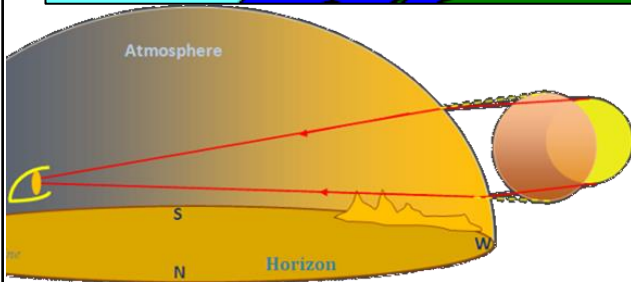
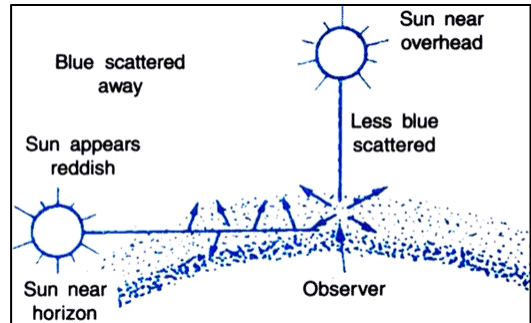
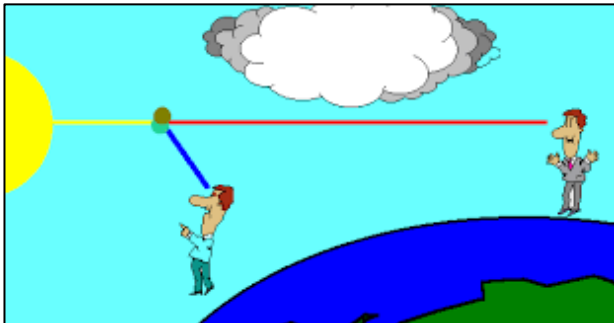
Red: long wavelength, scatters least, intensity not reduced due to scattering, used in traffic signal.

Blue: short wavelength, scatters more, gives sky blue color (Rayleigh scattering)

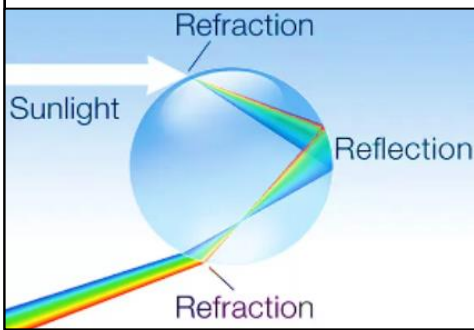
Color of sky in space/moon? No atmosphere, no scattering, no color (its just Black!)



Dust particles diffuse sunlight in atmosphere



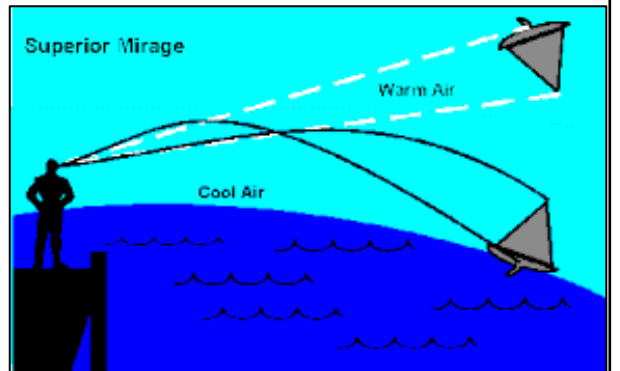
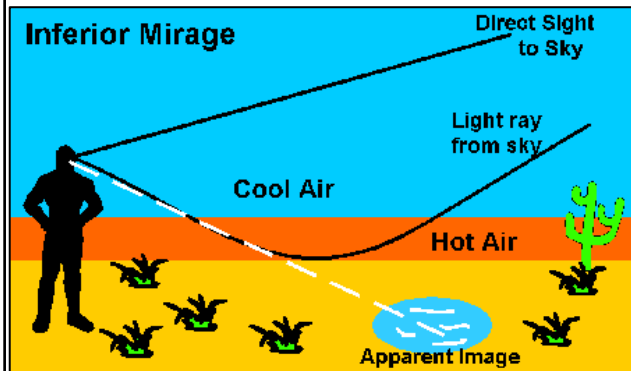
(Refraction)



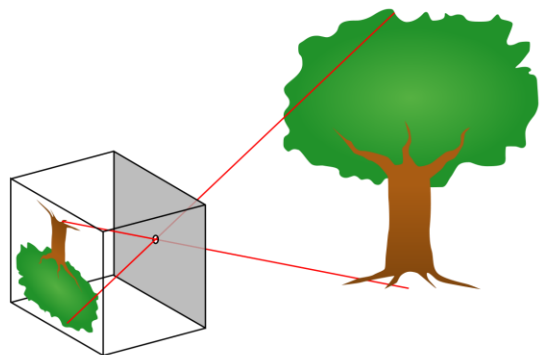
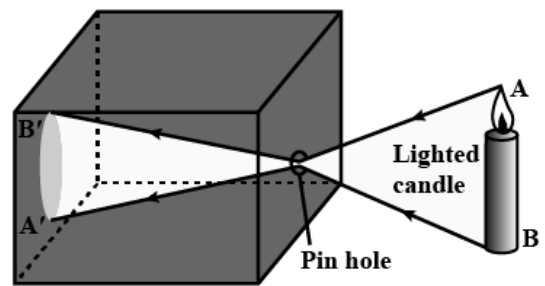
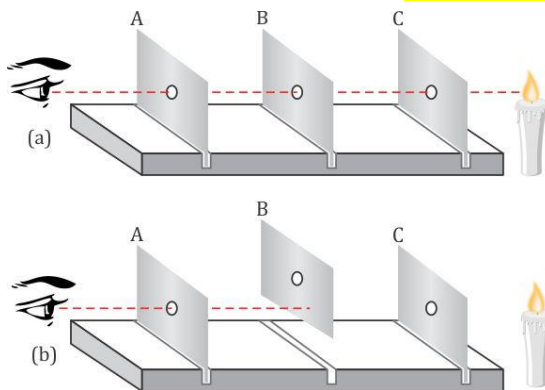
(Multiple reflections and Thin film interference)

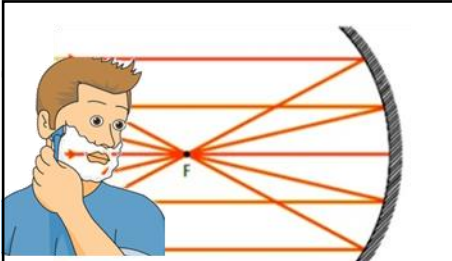


Mirage

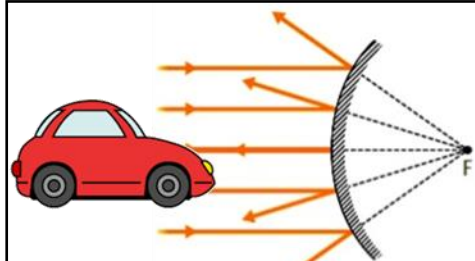


Rectilinear propagation of light

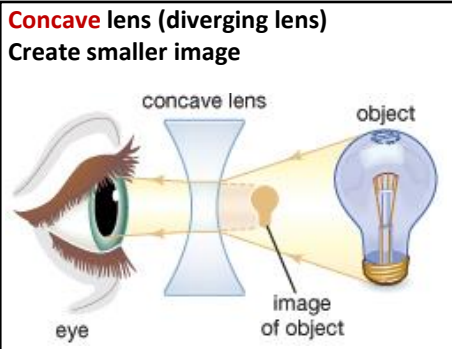




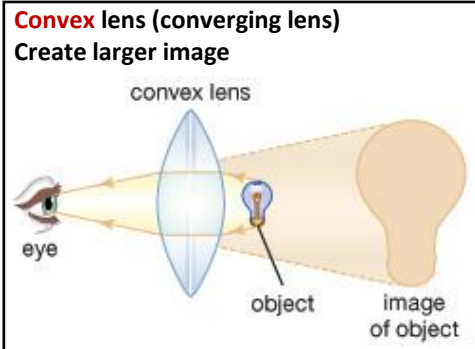
Concave mirror (converging mirror)
Create larger image



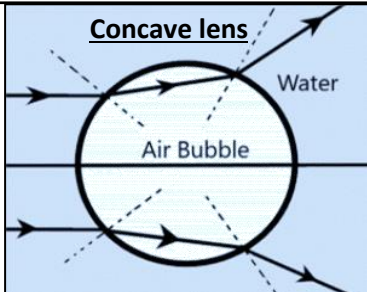
Convex mirror (diverging mirror)
Create smaller image (large field of view)



Concave lens (diverging lens)
Create smaller image



Convex lens (converging lens)
Create larger image

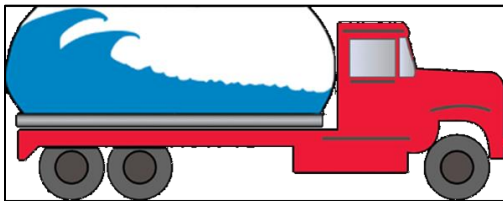


Some optical illusions:

- Blue sky; Rainbow; mirage
- Size/position/color of sun/moon
- Twinkling stars
- Twinkling planets? No!
- Moon during day? No!

Inertia

Tank accelerating



Tank braking



Tank with Baffles

