WAVES

- **disturbances that travel through a medium or a vacuum in space** resulting in vibrations

- the **energy passing through a medium or a vacuum** *creates* the ***waves***

Mechanical Waves

- waves that **requires a medium or any matter for it's energy to travel**

- the **energy and vibrations of these waves interact with the molecules of a medium** that can come in the forms of *solid, liquid, and gaseous*

- *sound waves, water waves, seismic waves and slinky or spring waves* are some examples of this type of wave

Electromagnetic Waves

- can **travel through both matter and vacuum**

- formed through the **interaction of electric fields and magnetic fields**

- *radio waves and microwaves* are examples of this wave

Oscillations

- continuous *back-and-forth* or *side-to-side* movements of an object

- waves can *produce an oscillation in the particles of the medium* through which it travels

Transverse Waves

- particles are oscillating towards a direction *perpendicular* to the direction of the wave

- must travel through a relatively *solid medium* because **it cannot pass through *liquid* or *gaseous matter***

Transverse Waves (cont)

- consists of individual waves that oscillates in an *alternating upward and downward motion*

Longitudinal Waves

- can travel through a *solid, liquid or gaseous medium*

Characteristics of a Wave

Crest - the *peak* or *highest point* of the upward moving wave

Trough - the *lowest point* at each valley

Normal Line - the *imaginary horizontal line* in the middle of the wave

Amplitude - the *distance* between the *normal line* and the *tip of the crest or trough*

Wavelength (**λ**) - the *distance* between *two crests or two trough*

Phase - *two wave points* that are travelling with the *same speed, displacement and height* towards the *same direction*

Period - refers to the *time* that *one crest or trough completes one cycle* or *travels a distance of one wavelength*

Frequency (**f**) - the *number of full wavelengths* travelling through a *point in space* per *unit time*

the *shorter the wavelength*, the *higher the frequency* and *vice versa*

Speed of Wave

$v = \lambda f$

velocity = wavelength x frequency

wavelength = velocity / frequency

frequency = velocity / wavelength

Properties of Mechanical Waves

Reflection - the *wave's frequency and wavelength* are **simply mirrored or reflected** by the returning wave

Refraction - a wave travelling in one medium *encounters another wave* and *bends at a different angle*

Diffraction - *wave passes through the open spaces or travels around the edges of the barrier* , the *diffracted wave disperses **outwards** and **arches** as it travels*

Interference - *two waves meet along the same medium*

Constructive Interference - combination of *two interfering waves* moving towards the *same direction*

Destructive Interference - waves are *combined and decreases each others' amplitude*

ELECTROMAGNETIC WAVES

- EM WAVES

- they propagate along *two oscillating fields* that *lie perpendicular to each other*

- *oscillating electric fields* - *oscillating magnetic fields*

- travels at the same speed of 3 x 10^8 m/s in a vacuum

Light Waves - *most accessible EM wave*

Electromagnetic Spectrum

- classification of electromagnetic waves according to their *frequencies* and *wavelengths*

Seven Regions of Electromagnetic Spectrum

Radio Waves - longest wavelengths, the least amount of energy, 1cm to 1km, 3kHz to 300gHz

Microwaves - frequencies of radio waves and microwaves overlap, highest frequency for radio waves is lowest for microwaves, 1mm to 1m, 300mHz to 300gHz

Extremely High Frequency (**EHF**) - 30gHz to 300gHz, 10mm to 1cm, for radio astronomy

Super High Frequency (**SHF**) - 3gHz to 30gHz, 1cm to 10cm, for microwave ovens

Ultra High Frequency (**UHF**) - 300mHz to 3gHz, 1dm to 1m, for satellite communications

Infrared Rays - all objects near room temperature are capable of emitting infrared radiation, 0.74mcm to 1mm, 300gHz to 400tHz

Far-infrared rays - 300gHz to 30tHz

Mid-infrared rays - 30m to 120m

Near-infrared rays - 120tHz to 400 tHz

Visible Light - allows human eyes to see things around, 300nm to 700nm, 400tHz to 790tHz

Ultraviolet Light - known as *black lights* that are used in detecting skin diseases, 10nm to 40nm, frequency higher than visible light

X-rays - used to examine the condition of human bones, 0.01nm to 10nm, 30pHz to 30eHz

Hard X-rays - penetrating numerous solid matter, energy >10KeV

Soft X-rays - energy used in producing images of microscopic objects

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Seven Regions of Electromagnetic Spectrum (cont)

Gamma Rays - similar characteristics as X-rays, <10pcm, greatest energy 50KeV to 50GeV

REFLECTION OF LIGHT ON MIRRORS 1

Reflection - when light rays is emitted by a particular source that interacts with a medium that serves as a *barrier* which the ray of light bounces back

Specular Reflection - when light hits a smooth, flat surface and reflects an image almost identical to the object

Diffused Reflection - when light hits a rough, uneven surface and the reflected light rays scatter in different directions

Law of Reflection - the ray of light approaching the mirror is called *incident ray* (IR), while the bounces ray from the mirror is called *reflected ray* (RR). at the point where the IR meets the surface of the mirror a hypothetical vertical line, perpendicular to the surface between the two rays is called *normal* divides the angle formed by the IR and RR. the *angle of incidence* (θi) refers to the angle formed by the incident ray and the normal, while the *angle of reflection* (θr) refers to the angle formed by the reflected ray and the normal. **when light hits a barrier, the angle of incidence is equal to the angle of reflection** [**θi = θr**]

Plane Mirrors - made up of flat, reflective surfaces that produce a reflection that is similar to the object

REFLECTION OF LIGHT ON MIRRORS 1 (cont)

line of sight - the process of directing your sight towards a certain point in space

lateral inversion - "*mirroring*" the reflection is reversed forwards and backwards because the object and the mirror is facing each other

virtual image - forms when the light rays bouncing from an illuminated object appear to be meeting or converging with each other at a definite point but not actually meet

Curved Mirrors - crescent--shaped mirror that is a part of a reflective sphere

Concave Mirrors - reflective surface that curves inwards [*real image*]

Convex Mirrors - reflective surface that bulges outwards [*virtual image*]

REFLECTION OF LIGHT ON MIRRORS 2

center of curvature - center of the curvature and the center of the sphere itself

principal axis - line in the middle that intersect points and divides the sphere into two hemispheres

vertex - where the axis meets the edge of the sphere or the surface of the curved mirror

focal point - marks the midpoint between the center of the curvature and the vertex

focal length - the distance between the focal point and the mirror's vertex [one half the radius of the curvature

REFLECTION OF LIGHT ON MIRRORS 2 (cont)

radius of curvature - marking the distance between the vertex and the center of the curvature

Ray Diagram Method - determines the location of images formed in curved mirrors by tracing the path of light rays passing through an object and bouncing on the surface of a mirror

OPTICAL INSTRUMENTS

human eyes - windows which light enters and enables humans to see, an inch in diameter

cornea - clear protective outer layer of the eye

sclera - white part of the eye

retina - nervous tissue composed of millions of nerve cells

farsightedness / **hyperopia** - distant objects are much clear than nearby objects

nearsightedness / **myopia** - nearby objects are much clear than distant objects

astigmatism - causes blurred vision due to an irregular-shaped cornea

microscope - optical instrument for magnifying the tiniest elements

eyepiece lens - makes up the top of the microscope

objective lenses - magnify the view of the specimen

focusing mechanisms - two to four objective lenses with varying magnification power

telescope - for viewing enormous but distant celestial objects

OPTICAL INSTRUMENTS (cont)

refracting telescope - use lenses to collect weak light from heavenly objects and magnify the image

reflecting telescope - use of mirrors that bend parallel light rays and make them converge into a focus

Newtonian reflector - flat mirror that directs the reflected rays to an eyepiece

Cassegrain reflector - primary mirror with a hole in the middle and convex secondary mirror

Coude telescope - secondary convex mirror and an angled mirror

binoculars - has two small side by side telescopes

camera obscura - closed box with a tiny hole, light passes and projects inverted image

daguerreotype camera - smaller box with an ocular tube in the middle, polished silver-coated plate, light sensitive surface

film camera - late 19th to early 21st century, used convex lens and film strips

digital camera - advanced photography, 21st century, convex lens, sensor that collects pixels

Largest Telescopes - Hubble Space Telescope, Extremely Large Telescope

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