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SCIENCE REVIEWER

S.Y. '25 - '26 | Garduce, Nuqui, Orozco | 10-Environmentalist

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2.1 Endocrine System

Endocrine System

- Controls reproduction by sending out hormones that guide puberty, egg and sperm production, pregnancy, and sexual development

TERMINOLOGIES	
GLANDS	Body parts that make and release hormones
SECRETION	The release of hormones from glands
STIMULATE	To make organs or tissues work faster
HORMONES	Chemicals that control body activities like growth and mood
METABOLISM	The process of changing food into energy

Glands in the Endocrine System

- Hypothalamus
- Pituitary gland
- Pineal gland
- Thyroid gland
- Parathyroid glands
- Thymus
- Adrenal glands
- Pancreas
- Gonads (Ovary/Testis)

1. Hypothalamus - "Master Gland"

HORMONES	REPRODUCTIVE ROLE
Gonadotropin-Releasing Hormone (GnRH)	Signals the pituitary gland to release reproductive hormones

2. Pituitary Gland - "Control Center"

HORMONES	REPRODUCTIVE ROLE
FSH, LH, Prolactin, Oxytocin	Controls ovulation, sperm formation, milk production, and childbirth contractions
Prolactin	Primarily responsible for milk production after childbirth
Oxytocin	Two main physiological functionsL it stimulates uterine contractions during childbirth and promotes milk release during breastfeeding

3. Pineal Gland - "Sleep-Wake Cycle Regulator"

HORMONES	REPRODUCTIVE ROLE
Melatonin	Helps control puberty timing and menstrual rhythm

4. Thyroid Gland - "Metabolism Regulator"

HORMONES	REPRODUCTIVE ROLE
Thyroxine (T4), Triiodothyronine (T3)	Maintains metabolism needed for fertility and fetal growth.

5. Parathyroid Glands - "Calcium Regulator"

HORMONES	REPRODUCTIVE ROLE
Parathyroid Hormone (PTH)	Keeps calcium levels balanced for pregnancy and lactation

6. **Thymus - "Immune System Developer"**

HORMONES	REPRODUCTIVE ROLE
Thymosin	Supports immune function during puberty when sex organs mature.

7. **Adrenal Gland - "Stress and Energy Glands"**

HORMONES	REPRODUCTIVE ROLE
Androgens, Cortisol	Produces small amounts of sex hormones; helps manage stress that affects fertility.

8. **Pancreas - "Blood Sugar Regulator"**

HORMONES	REPRODUCTIVE ROLE
Insulin, Glucagon	Provides energy balance needed for ovulation and pregnancy

9. **Ovaries - "Female Reproductive Organ"**

HORMONES	REPRODUCTIVE ROLE
Estrogen, Progesterone	Regulate menstrual cycle, egg release, pregnancy, and female traits

10. **Testes - "Male Reproductive Organ"**

HORMONES	REPRODUCTIVE ROLE
Testosterone	Stimulates sperm production and develops male characteristics

COMMON DISORDERS		
NAME	***GLAND/S AFFECTED***	***DESCRIPTIONS***
POLYCYSTIC OVARY SYNDROME (PCOS)	Ovaries	• Characterized by: Hormonal imbalances, irregular periods, excess androgen, cysts on the ovaries. • Can lead to infertility & increased risk for other health issues (type 2 diabetes, etc.)
HYPOGONADISM	Testes/Ovaries	• Occurs when the body's sex glands produce little to no hormones • Might cause infertility
INFERTILITY	Pituitary	• Weak stimulation of egg & sperm production
HYPERTHYROIDISM/HYPOTHYROIDISM	Thyroid	• Overactive thyroid that produces too much hormone OR underactive thyroid that produces too little hormone • May lead to irregular cycles, miscarriage risk, or reduced fertility

2.2 Reproductive System

Reproductive System

- A group of organs that help produce offspring. Males make and deliver sperm, while females make eggs, allow fertilization, and care for the baby

TERMINOLOGIES	
OFFSPRING	The young or babies produced by parents
SPERM	the male cell that joins with the egg to form a baby
HORMONES	Chemicals that control body activities like growth and mood
OVARY	The female organ that produces eggs
FERTILIZATION	The joining of a sperm and an egg to start a new life

Male Reproductive System

- Makes sperm and testosterone, delivers sperm for fertilization

Parts of the Male Reproductive System

a. Testes
- Makes sperm and hormones
- Produce testosterone abundant in the male
- Produces spermatozoa (male reproductive cells)

b. Epididymis
- Stores sperm until ready
- Allows sperm to mature and gain the ability to swim
- comma-shaped structure in the male reproductive system, attached to the back of each testicle, where sperm mature and are stored before ejaculation

c. Vas Deferens
- Carries sperm out
- A long muscular tube that carries sperm

d. Seminal Vesicle
- Gives food/energy to sperm
- Two small glands behind the bladder

e. Prostate Gland
- produces a milky fluid that is a component of semen, helping liquefy and protect sperm and boost their motility
- Semen pusher

f. Bulbourethral Glands
- Cowper's glands
- Cleans the passage for sperm
- Two small, pea-sized glands in the male reproductive system that produce a pre-ejaculate fluid
- Produce pre-ejaculate fluid that lubricates and neutralizes acidity in the urethra

g. Urethra
- Passage for urine and sperm
- Pathway for urine and semen to exit the body (but never at the same time)

Internal Urethral Sphincter (Primary Gatekeeper)	External Urethral Sphincter (Voluntary Controller)
- At the base of the bladder - Made of smooth muscle (automatic, involuntary) - Closes tightly during ejaculation	- Below the prostate - Made of skeletal muscle (you control it) - Tightens when you "hold your pee"

h. Penis
- The external organ made of spongy tissue
- Delivers sperm to the female body

Female Reproductive System

- Makes eggs, allows fertilization, and takes care of the baby inside the body

Parts of the Female Reproductive System

a. Ovaries
- Makes eggs and hormones
- A pair of female reproductive glands located on either side of the uterus that produce and store eggs (oocytes) and produce hormones like estrogen and progesterone
- About the size of an almond and held in place by ligaments in the pelvic cavity

b. Fallopian tubes
- Where sperm meets the egg
- Transports eggs from ovaries
- A pair of muscular, hollow tubes connecting the ovaries to the uterus that are essential for reproduction
- Pear-shaped, muscular organ in the female pelvis responsible for receiving a fertilized egg, providing nourishment, and supporting fetal development

c. Uterus
- Where the baby grows

d. Cervix
- Opening between uterus and vagina

e. Vagina
- Passage for sperm and childbirth
- Muscular, elastic tube that connects the uterus to the outside of the body
- Passageway for menstrual blood, sperm to reach the egg, and a baby during childbirth (also called the birth canal)

Note:

- **Fertilization:** a sperm from the male joins an egg from the female
- Hormones control growth and body changes
- Keep your body clean and healthy to protect your reproductive system

2.3 Menstrual Cycle

Menstrual Cycle

- A series of natural changes that prepare a woman's body for pregnancy
- The uterus builds a lining every month to prepare for a baby, but if no pregnancy occurs, the lining is shed
- 28 days on average (varies for every woman)
- Controlled by hormones from the Brain (Hypothalamus & Pituitary Gland) and the Ovaries.

TERMINOLOGIES	
REGULATION	Control and maintenance of body processes
MECHANISM	System that enables a function
RESPONSE	Body's reaction to hormones
COORDINATION	Teamwork of the body parts
FLUCTUATION	Changes in hormone levels

Feedback Mechanism

Negative Feedback

- Produces/reduces hormones <u>in response</u> to an imbalance to restore the balance

Positive Feedback

- Hormone triggers more release of the same hormone
- Creates loop

Phases of the Menstrual Cycle

1. **Menstruation - Day 1-5**
   - Uterine lining (*Endometrium*) sheds; this is how period bleeding occurs
   - :"The Shedding Phase"

♡ Why does this happen?

- Progesterone & Estrogen drop sharply when the egg is not fertilized

BEFORE THE PHASE	AFTER THE PHASE
- Luteal phase ends - Corpus Luteum degenerates - <u>Progesterone & Estrogen drop</u>	- Low sex hormones remove inhibition on Hypothalamus/Pituitary Gland - <u>Negative feedback rises FSH</u> - New Follicular face starts

2. **Follicular - Day 1-13**
   - Follicle-Stimulating Hormone is released (FSH)
   - Ovaries develop several follicles or egg sacs, where usually one follicle becomes dominant & matures
   - Uterine lining starts thickening again (Proliferation) because of estrogen

♡ Why is The Menstruation Phase included?

- Because follicles already start developing

BEFORE THE PHASE	AFTER THE PHASE
- <u>FSH rise triggers follicle growth</u> - Follicles secrete Estrogen	- Moderate Estrogen gives <u>negative feedback</u> to the Pituitary Gland - <u>FSH drops</u>, causes only one follicle to be dominant - High Estrogen will trigger Ovulation

3. **Ovulation - Day 14**
   - "The Egg Release"
   - Shortest but <u>most important phase</u>
   - Estrogen peaks and LH releases the mature egg from the Ovary
   - Egg moves into the Fallopian tube

BEFORE THE PHASE	AFTER THE PHASE
- Estrogen has risen progressively from the Follicular phase - Triggers a large Luteinizing hormone surge (Positive feedback) - Causes Ovulation	- Egg released into the Fallopian tubes

4. **Luteal - Day 15-28**
   - "The preparing-for-pregnancy Phase"
   - After egg release, empty follicle becomes Corpus Luteum, which sheds when there is no pregnancy
   - Corpus Luteum produces Progesterone and some Estrogen to thicken uterine lining

BEFORE THE PHASE	AFTER THE PHASE
- Corpus Luteum produces high Progesterone and little Estrogen	- **If pregnancy occurs:** High Progesterone suppresses FSH & LH production - Releases Human-Chorionic Gonadotropin (hCG) to continue Progesterone production - **If no pregnancy occurs:** Corpus Luteum dies - Progesterone drops - Uterine lining sheds and begins Menstruation

Note:
- **Fraternal Twins:** 2 separate eggs
- **Identical Twins:** 1 egg separates into 2
- You can become pregnant at any phase in the Menstrual Cycle

2.4 Nervous System

Nervous System
- Controls & coordinates everything the body does
- Receives information, makes decisions, tells the body how to respond
- Keeps the body in homeostasis

TERMINOLOGIES	
STIMULUS	Triggers body's response
IMPULSE	Electrical signal in nerves
TRANSMISSION	Sending signals between neurons
RESPONSE	Action caused by stimulus
HOMEOSTASIS	Internal balance

Central Nervous System - "Control Center"

1. **Brain**
   - Master Controller

CEREBRUM	Thinking, learning, movement
CEREBELLUM	Balance & coordination
BRAIN STEM	Breathing, heartbeat, vital living functions

2. **Spinal Cord**
   - Communication highway between brain & body
   - Controls reflexes

Peripheral Nervous System - "Body Network"
- Roadway with two paths
- Connects CNS to the rest of the body

1. **Somatic System**
   - Comes from the Greek word "Soma" meaning Body
   - Assisted by the 5 senses
   - Any voluntary actions

CRANIAL NERVES	- Originates from the brain - Head, neck, senses
SPINAL NERVES	- Originates from spinal cords - Limbs, body sensations

2. **Autonomic System**
   - Involuntary control of the body
   - Connects brain to most internal organs

SYMPATHETIC NERVOUS SYSTEM	- "Fight or Flight" - Prepares the body for action
PARASYMPATHETIC NERVOUS SYSTEM	- "Rest & Digestion" - Restores body to normal/relaxed mode

Neuron

- Basic unit of nervous system

CELL BODY	- "Soma" - Controls neuron's activities
DENDRITES	- Receives messages - Carries impulse toward cell body
AXON	- Sends messages - When grouped together, it's called Nerves
MYELIN SHEATH	- Speeds up signals - Fatty acid
SYNAPTIC TERMINALS	- Passes messages to other cells using chemicals called Neurotransmitters - Not connected, has space between them

♡ How do Neurons work?

1. Stimulus triggers impulse & travels along Axon
2. Neurotransmitters cross gap

Note:

- **Negative feedback:** Keeps things balanced
- **Reflex:** Involuntary reactions to keep you from getting hurt
- **Afferent nerves:** Sensory information
- **Efferent nerves:** Motor information
- The information here is not 100% accurate from the PPT because di siya uploaded sa drive ni sir so.. Handle with caution HAHAHHA

2.5 Protein Synthesis

TERMINOLOGIES	
DNA	Carries the genetic instructions used to make proteins
RNA	Reads and carries the code needed for building proteins
PROTEIN	A molecule made of amino acids
RIBOSOME	The cell's protein-making factory that reads mRNA
AMINO ACID	Small units that link together to form protein

Protein Synthesis

- Process where cells make proteins, which are needed for growth, repair, and everyday body functions
- Has **two major stages**: transcription and translation

STEP 1: Transcription (Copying the Code)

- Happens inside the **nucleus**
- DNA instructions are copied into **mRNA (messenger RNA)**, which carries them from the nucleus to the ribosome
- Replace T with U, and pair according to base -pairing rules:
  - A → U
  - T → A
  - C → G
  - G → C

Example:

DNA: TAC GGA TTC
mRNA: AUG CCU AA

STEP 2: Translation (Building the Protein)

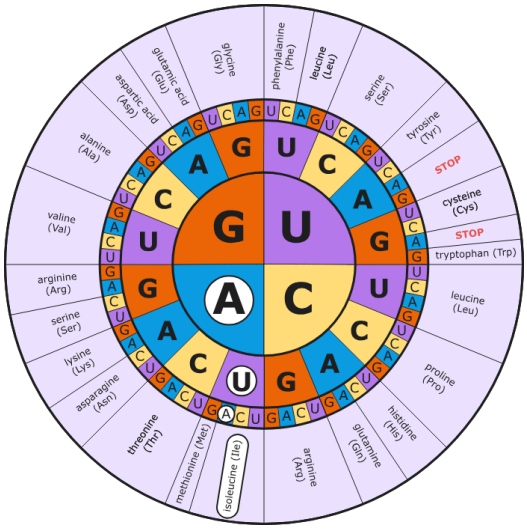
- Happens at the **ribosome**
- The ribosome reads the **mRNA** codons
- **tRNA (transfer RNA**) brings the correct **amino acids**

- The **amino acids** join together to form a **protein chain**
- **Stop codons** do not code for any amino acid**: UAA, UAG, AND UGA.**
-

First Base in the Codon	Second Base of the Codon				Third Base in the Codon
	U	C	A	G	
U	Phenylalanine Phenylalanine Leucine Leucine	Serine Serine Serine Serine	Tyrosine Tyrosine **STOP** **STOP**	Cysteine Cysteine **STOP** Tryptophan	U C A G
C	Leucine Leucine Leucine Leucine	Proline Proline Proline Proline	Histidine Histidine Glutamine Glutamine	Arginine Arginine Arginine Arginine	U C A G
A	Isoleucine Isoleucine Isoleucine **Methionine**	Threonine Threonine Threonine Threonine	Asparagine Asparagine Lysine Lysine	Serine Serine Arginine Arginine	U C A G
G	Valine Valine Valine Valine	Alanine Alanine Alanine Alanine	Aspartic Acid Aspartic Acid Glutamic Acid Glutamic Acid	Glycine Glycine Glycine Glycine	U C A G

mRNA Table of Codon Chart

- Find r**ow (left) with 1st base** of mRNA codon. Match with **column (top) of the second base** of mRNA codon. Find **row (right) with 3rd base** to determine amino acid.



mRNA Codon Wheel

- Start at the center. Move outwards, reading each letter of the mRNA codon.

2.6 Mutation

Mutation

- changes to a DNA sequence

Mutagens

- agents that cause alteration in the DNA
- can lead to permanent mutations in the DNA sequence depending on the ability of an organism to repair the damage

Types of Mutation

1. Point Mutation
2. Frameshift Mutation
3. Silent Mutation

Point Mutation

- one single nucleotide base is deleted, added or altered
- Can lead to substitution mutation: nonsense, missense, silent
    - NONSENSE: formation of a stop codon due to the substitution of one nitrogenous base
    - MISSENSE: does not form a stop codon
    - SILENT: nitrogenous base is altered but the amino acid remains the same

Frameshift Mutation

- the normal sequence of codons is disorganized by the insertion or deletion of one or more nitrogenous bases, given that the number of nitrogenous bases added or deleted is not a multiple of three
- Chromosomal Mutations:
    - DELETION: a base is deleted from the nitrogen base sequence
    - DUPLICATION: a part of a chromosome is copied (duplicated) too many times
    - INVERSION: a segment of a chromosome is reversed end to end
    - INSERTION: addition of one or more nucleotide base pairs into a DNA sequence
    - TRANSLOCATION: segments of two chromosomes are exchanged

Silent Mutation

- nitrogenous base is altered but the amino acid remains the same

MUTATION	EFFECTS AND DISEASE
SUBSTITUTION	**EFFECTS:** • One amino acid may change

	• May have no effect • May create a stop signal → shorter protein **DISEASE**: - Sickle Cell Disease
DELETION	**EFFECTS:** • Causes frameshift • Changes all codons after deletion • Protein often stop working **DISEASE**: - Cystic Fibrosis: CFTR protein folds incorrectly - Albinism: formation of melanin is reduced or absent due to the lack of activity of tyrosinase caused by deletion of tyrosinase gene - Down Syndrome: caused by translocation during meiosis that transfers most of chromosome 21
INSERTION	**EFFECTS:** • Causes frameshift • Changes most amino acids that follow • Often leads to a nonfunctional protein **DISEASE**: - Tay-Sachs: occurs when the body lacks the enzyme hexosaminidase A, causing fatty substances to build up in nerve cells and damage brain

Mutations can cause proteins to:

- Work normally (no effect)
- Work differently (reduced or increase function)
- Not work at all (disease or disorder)
- Be shorter or longer than normal
- Fold incorrectly (wrong shape)

Mutation → change in mRNA → change in amino acids → change in protein structure and function

2.7 Evolution

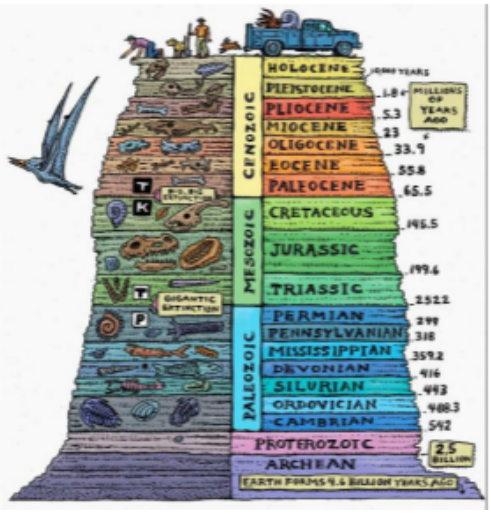
TERMINOLOGIES	
EVIDENCE	Proof that something is true
ANATOMY	Study of body parts
STRUCTURE	How something is built or arranged
EVOLUTION	Change of species overtime
ANCESTOR	The older form you came from

Evolution

- Process by which a species changes over time
- Explains how living things have adapted to their own environment & how new species have formed from earlier ones

Geological Time Scale

- Record of Earth's history
- Developed by studying rock layers & fossils worldwide



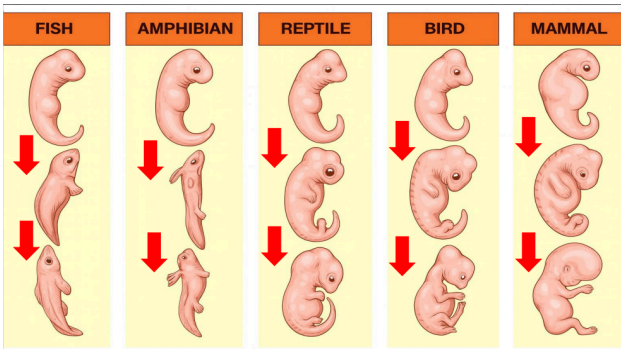
Evidences of Evolution

- **Fossil Evidence**
  - Fossils are remains of ancient organisms
  - Show how a species has changed over time & helps scientists understand the earth's history

- **Comparative Anatomy**

- Homologous Structures : Similar body parts in different species
- Analogous Structures : Different body parts in different species serving similar functions

- **Embryology**
  - Many animals look similar in their early stages



- **Genetics & DNA**
  - Shows how closely related different species are
  - More recent DNA = Recent common ancestor

- **Biogeography**
  - Studies where species live
  - Similar species in different areas (ex: Camels) suggest they adapted to similar environments

Theories of Evolution

- *Jean Baptiste de Lamarck*
  - French naturalist
  - First believed that organisms change over time & evolve in response to their environment
  - Evolve = "change gradually"

- **Theory of Need**
  - "Organisms change in response to changes in their environment"

- **Theory of Use and Disuse**
  - "Organs not used will disappear over time while those constantly used will be developed."
  - Ex: Necks in Giraffes (shorter to longer)

- **Theory of Acquired Characteristics**
  - "If an organism changes during its life to adapt to its environment, these traits will be passed to its offspring." (What Lamarck Believed by NESCI)
  - From Lamarck's book *"The Theory of Inheritance of Acquired Characteristics"*

- *Charles Darwin*
  - Wrote "On the Origins of Species by Means of Natural Selection"

- **Theory of Evolution**
  - Based on natural selection
  - (On giraffes) Giraffes had varying necks but only the ones with longer necks survived while the shorter necks starved because they couldn't eat the vegetation on the trees.

Evolutionary Patterns

- **Natural Selection**
  - Nature selects organisms that will or will not survive based on existing traits
  - The existing traits of survivors/favored ones are passed down
  - As the years pass, the population will have different traits from their ancestors

- **Genetic Drift**
  - Change in a population's genes caused by chance
  - Some traits may decrease/disappear because of unexpected events
  - Survival and Death happen by chance

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Additional Information

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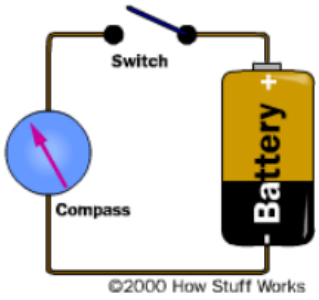
2.1 Electromagnetic Waves

Introduction to Electromagnetic Waves

- Major discoveries about electromagnetic waves in the 19th century
- These led to new technologies that transformed modern life

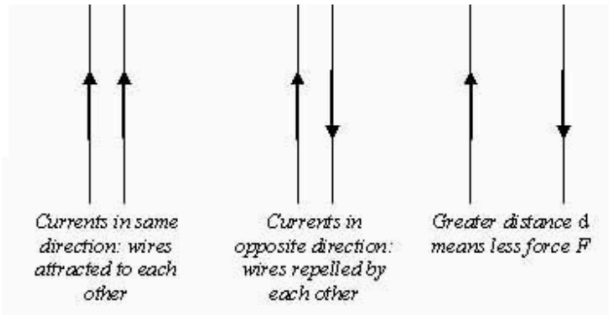
Hans Christian Oersted

- found that electric current deflects a compass needle in 1821
- showed that current creates a magnetic field, leading to new discoveries



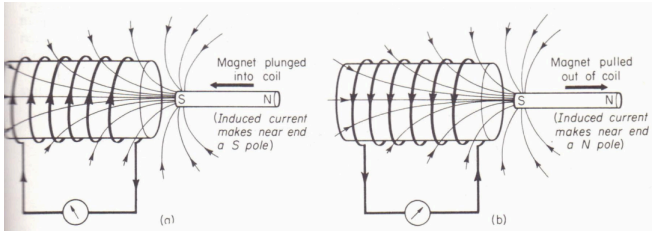
André-Marie Ampère

- Right after Oersted's discovery, Ampère formulated **Ampere's Law** (1820–1826): mathematical description of how currents create magnetic fields



Michael Faraday and Joseph Henry

- discovered **induction** in 1832: a moving magnetic field produces an electric field



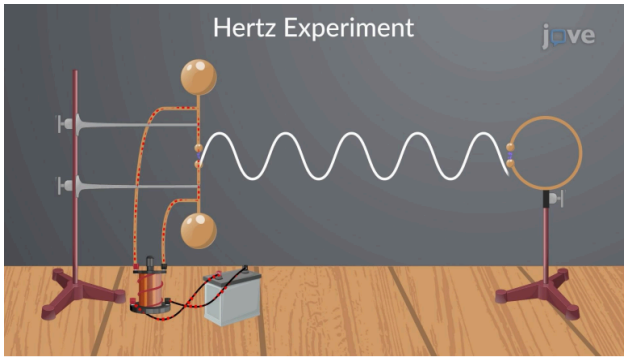
- Unlike electrostatic fields, induced electric fields form closed loops with no start or end points

James Clerk Maxwell

- proposed that changing electric fields create changing magnetic fields, leading to the prediction of electromagnetic waves
- showed that light is an electromagnetic wave

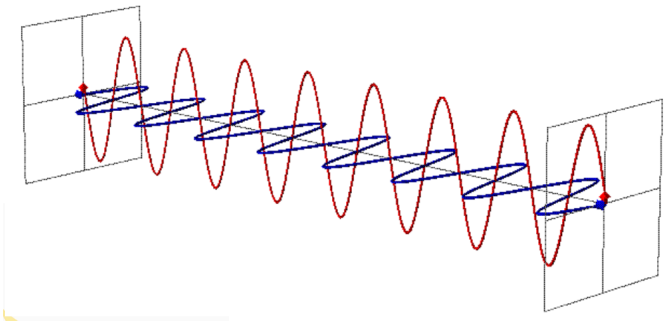
Heinrich Hertz

- experimentally proved Maxwell's prediction by generating and detecting radio waves in the lab (1886–1889)
- founder of wireless communication
- Spark Gap Experiment:



Electromagnetic Waves

- waves that can travel without a medium
- consist of electric and magnetic fields vibrating at right angles



Properties of EM Waves

1. All EM waves are transverse waves
2. Do not require any medium to travel through
3. They travel at the speed of 3.00×108 m/s in vacuum
4. Can all be reflected or refracted
5. Can all be emitted or absorbed by matter
6. Obey the wave equation

$$v = f \cdot \lambda$$

Where v = speed of wave (m/s)
f = frequency of wave (Hz)
λ = wavelength (m)

Sample Problem

What is the frequency of radio waves with a wavelength of 20 m ?

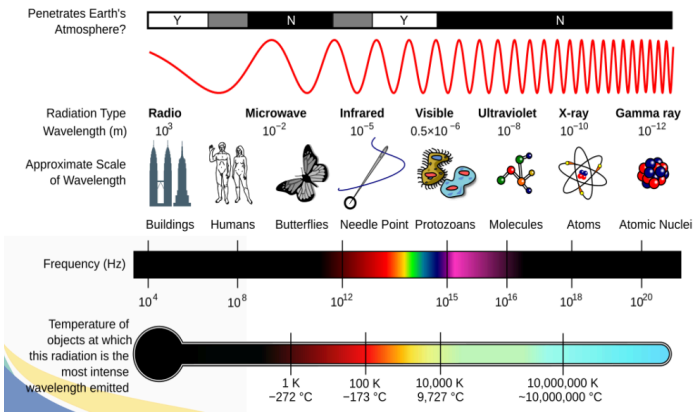
Given: v= 3×10^8(299,792, 458) m/s; λ = 20 m; f=?
Required: Frequency
Equation: f = v/λ
Solution:

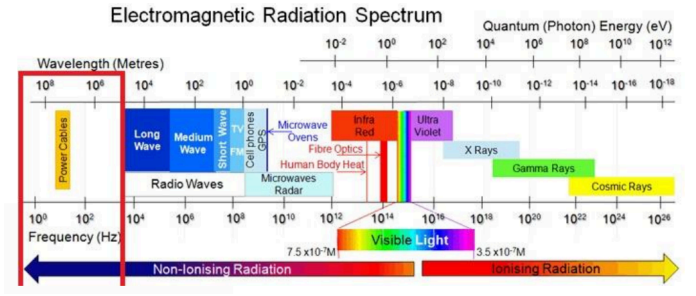
f= 299, 792, 458/20
f = 14, 989, 622,9 Hz
$=1.5 \times 10^7$ Hz

Answer: f = 1.5×10^7 Hz

Electromagnetic Spectrum

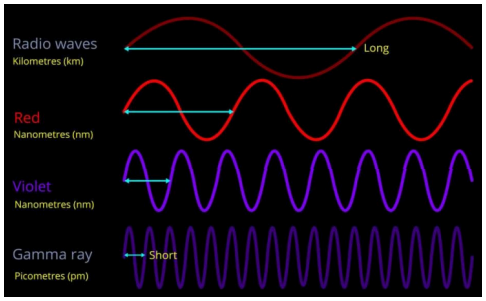
- full range of electromagnetic waves
- arranged by wavelength and frequency





Comparing EM Waves

- As wavelength decreases, frequency and energy increase (**inverse relationship**)
- Radio waves → longest wavelength, lowest energy.
- Gamma rays → shortest wavelength, highest energy



2.2 Application of EM Waves

Wave Equation

- v = f x λ
- describes the relationship between a wave's speed (v), frequency (f), and wavelength (λ)
- a wave's speed is equal to its frequency multiplied by its wavelength, meaning that if the

speed is constant, frequency and wavelength are inversely proportional

Energy in Waves

- E = hf
  - h =6.63×10^{-34} J•s
  - e = energy of one photon
  - f = frequency
- the higher the frequency, the more energy each photon carries
- **quanta**: energy transformed in form of chunks
- If the wavelength is known, you can calculate the energy using the wave equation to calculate the frequency and then apply Planck's equation to find the energy

Since $f = \frac{v}{\lambda}$,

substitute:

$$E = h(\frac{v}{\lambda})$$

simplify $E = \frac{hv}{\lambda}$

Example:

1. Find the energy of a photon with wavelength 600×10^{-9}m

Given:

λ = 600×10^{-9}m; v = 3×10^{8}m/s; h = 6.63×10^{-34} J•s

Required: energy (E)

Equation: E = hv/λ

Solution:

E = (6.63×10^{-34} J•s)(3×10^{8} m/s) / m

E =1.9878×10^{-25} J•m / 600×10^{-9}m

Answer: E =3.31×10^{-19} J

2. *(sample from Youtube)* What is the kinetic energy of an electron with a frequency of 8.3×10^{14} Hz? Estimate h as 4.14×10^{-15} eVs

Given:

f = 8.3×10^{14} Hz; h = 4.14×10^{-15} eVs

Required: energy (E)

Equation: E = hv/λ

Solution:

E = (8.3×10^{14} Hz)(4.14×10^{-15} eVs)

Answer: E = 3.4 eV

Devices for EM Waves

★ **Microphone**
- transducer that converts sound energy to electrical signals.
- captures the speaker's voice or sound and turns it into an electrical signal to be transmitted

★ **Receiving Antenna**
- captures the EM waves from the air
- converts the waves back into electrical signals for processing

★ **Oscillator**
- produces the carrier wave needed for transmission
- generates a high frequency carrier wave (radio frequency) that acts as the "blank signal" to carry the message

★ **Amplifier**
- strengthens the weak electrical signals from the microphones
- Increases the power of the signal so it can travel longer distances without fading

★ **Loudspeaker**
- converts electrical signals back into sound energy
- reproduces the original voice or music for the listener to hear.

★ **Demodulator**
- Extracts the original information bearing signal from the modulated carrier wave separating it from the carrier wave
- separates the audio (voice/music) or data from the high-frequency carrier so it can be amplified and converted back to sound

★ **Modulator**
- Imbeds or mixes the data signal onto the carrier wave
- Alters the carrier wave's amplitude, frequency, or phase (e.g., AM or FM) to carry the information.
- Prepares the signal for transmission through the antenna.

★ **Transmitting Antenna**
- Radiate radio waves into space, effectively carrying signals
- Converts the modulated signal into EM waves and sends it out
- Radiates the signal into space so that distant antennas can receive it

Application of EM Waves

1. **Microwaves**
   - shorter wavelengths than radio waves.
   - used in cooking (microwave oven), satellite transmission, and WiFi.
   - Excessive exposure can cause heating of tissues.
2. **Radio waves**
   - Radio and television communication
3. **Infrared**
   - felt as heat.
   - used in remote controls, thermal imaging, and night-vision devices.
   - invisible to the naked eye
   - Emitted by all objects
4. **Visible Light**
   - ranges from red (longer wavelength) to violet (shorter wavelength).
   - our eyes are sensitive to wavelengths ranging from 4 x 10^-7 m to 7 x 10^-709 m
   - visible spectrum: spectrum of white light
   - Also used for fiber optic cables, endoscope
5. **Ultraviolet Ray**
   - shorter wavelengths than visible light
   - used in sterilization and black lights
   - overexposure can damage skin and eyes
6. **X-Rays**
   - discovered by Wilhelm Conrad Roentgen in 1895
   - X-ray are produced using an X-ray tube, emitted when fast moving electrons hit a metal target
7. **Gamma Rays**
   - shortest wavelengths and highest frequencies, which means they carry the most energy and are therefore more dangerous
   - naturally emitted by stars and some radioactive substances
   - can kill living cells, but this property is also used for beneficial applications (ex. Radiotherapy: Treating cancer by targeting and destroying cancerous cells)

2.3 Reflection

Reflection

- The bouncing off light rays when it hits a surface like plane mirror
- When light is turned back by the surface without entering the object, the light is said to be reflected

Types of Materials

- **Transparent:** light is transmitted when it passes through
- **Translucent:** transmits light but allows light to scatter making it difficult to identify the objects that are behind them
- **Opaque:** does not transmit light at all

Important Terms

- **Incident Ray** - the ray of light approaching the mirror represented by an arrow approaching an optical element like mirrors
- **Reflected Ray** - the ray of light which leaves the mirror and is represented by an arrow pointing away from the mirror
- **Normal Line** - the imaginary line (labeled N) that can be drawn perpendicular to the surface of the mirror at the point of incidence where the ray strikes the mirror
- **Angle of Incidence / θi** - the angle between the incident ray and the normal line
- **Angle of Reflection / θr** - the angle between the reflected ray and the normal line

Types of Reflection

- **Regular / Specular Reflection:** when parallel light rays strike polished materials, light rays are reflected in a regular pattern
- **Diffused / Irregular Reflection:** when parallel light strike unpolished surfaces which scatter reflected light rays in all directions

Periscope

- An instrument for observation over, around or through an object, obstacle or condition that **prevents direct line of sight observation** from an observer's current position

- As the **angle** between two mirrors **decreases**, the **number** of images **increases**,

- Conversely, as the **angle** between the mirrors **increases**, the **number** of images formed **decreases**

Angle (θ)	Number of Images (N)
90°	3
60°	5
45°	7
30°	11

$$N = \frac{360}{\theta} - 1$$

- where N = no. of images
- θ = angle between

Laws of Reflection

- **1st Law** states that the angle of reflection equals the angle of incidence — **θr = θi**
- **2nd Law** states that the incident ray, the reflected ray, and the normal to the surface of the mirror, all lie in the same plane

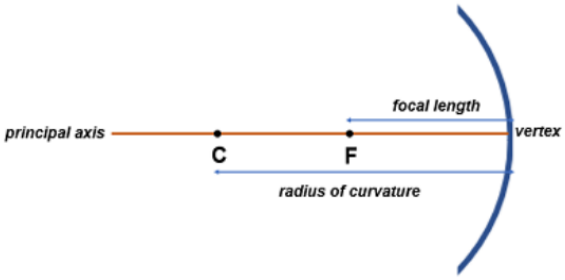
2.4 Reflection in Curved Mirrors

2 kinds of Spherical Mirror

1. **Concave Mirror (converging mirror)**
   - light rays converge at one point after they strike and are reflected from the surface
   - Ex: inside of a spoon
2. **Convex Mirror (diverging mirror)**
   - Curved mirror in which the reflective surface bulges towards the light source
   - Ex: mirror in 7/11, road/street mirror

Images Formed by Curved Mirrors

1. **Center of Curvature, C**: center of the sphere of which the mirror is part
   - **Radius**: Its distance from the mirror
2. **Vertex, V**: center of the mirror.
3. **Focal Point/Focus, F**: point between the center of the curvature and vertex
   - **Focal length**: Its the distance from the mirror



Ray Diagram

- tool for determining the path taken by light from the object to the mirror to our eyes

4 Principal Rays in Concave Mirrors

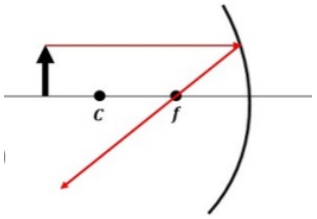
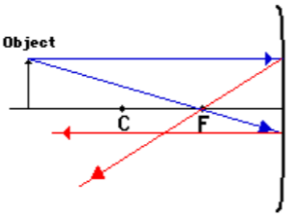
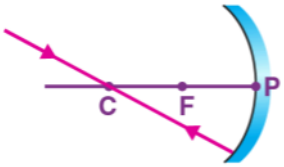
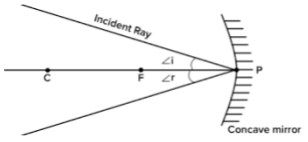
1. P-F Ray: A ray of light parallel to the principal axis is reflected passing through the principal focus, F.	
2. F-P Ray: A ray of light passing through the focus, F is reflected parallel to the principal axis	
3. C-C Ray: A ray of light passing through the center of curvature, C reflects back along the own path	
4. V Ray: A ray of light directed to the vertex at equal angle from the principal axis	

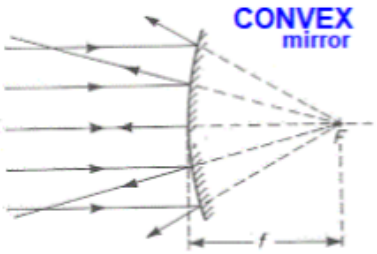
Image Characteristics of Plane Mirror

1. Virtual (T)
2. Erect/Upright (O)
3. Same size as the object (S)
4. Image distance = object distance (L)
5. Laterally inverted

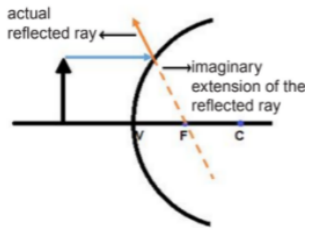
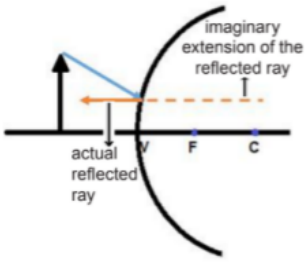
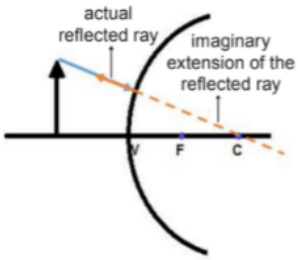
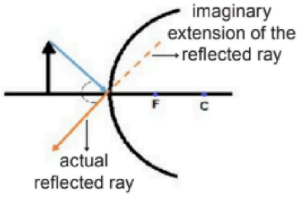
L - LOCATION
O - ORIENTATION
S - SIZE

T - TYPE OF IMAGE

Principal Rays in Convex Mirrors



parallel light rays meeting a convex curved mirror

1. P-F Ray: A ray of light parallel to the principal axis is reflected as if passing through the principal focus, F	
2. F-P Ray: A ray of light directed towards the focus, F is reflected parallel to the principal axis	
3. C-C Ray: A ray of light directed towards the center of curvature, C reflects back along its own path	
4. V Ray: A ray of light directed to the vertex reflects at equal angle from the principal axis	

Geometric Optics

- Branch of optics where light is described by **rays**
- Light rays are conceived as geometrical lines originating from sources
- Image formed by mirror & Image formed by lens

Mirror

- A reflecting surface and can be explained by the **law of reflection**
- **Two types:** convex and concave mirror

Image Formation by Mirror

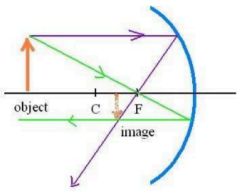
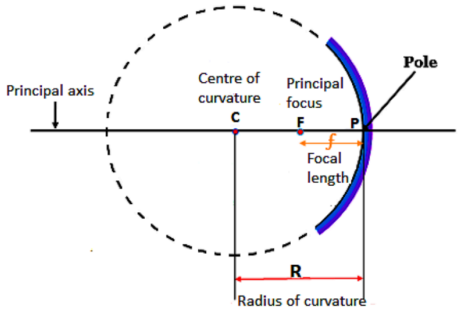
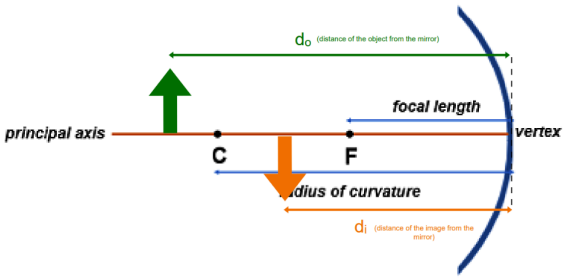


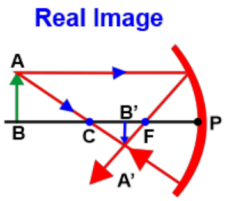
Diagram Method

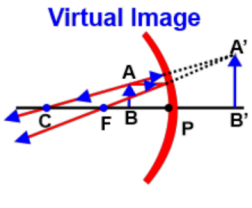
$$\frac{1}{f} = \frac{1}{d_i} + \frac{1}{d_o}$$

Mathematical Method









if d_i is + then the image is real

the image will be formed in front of the mirror (left side)

if d_i is - then the image is virtual

the image will be formed in behind the mirror (right side)

Key Equations

Focal length: $\frac{1}{f} = \frac{1}{do} + \frac{1}{di}$

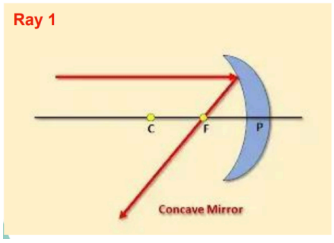
Magnification: $m = \frac{hi}{ho} = \frac{-di}{do}$

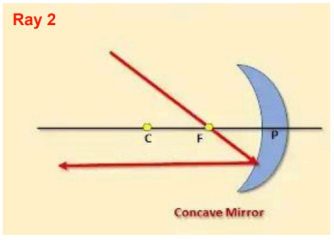
Sign Convention for Spherical Mirrors & Lenses

Quantity	Conditions	Sign
Focal Length, f	Concave mirror Convex mirror Convex lens Concave lens	+ – + –
Object distance, d_o	Always	+
Image distance, d_i	Image real Image virtual	+ –
Magnification, m	Image upright Image inverted	+ –

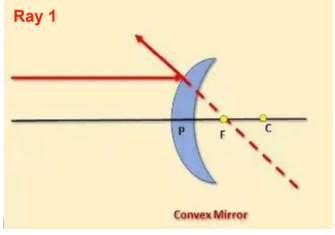
Rules in Creating Ray Diagram

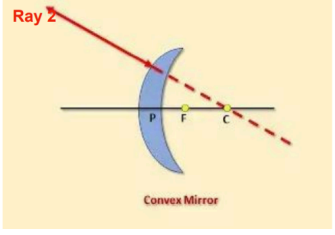
For Concave Mirror





For Convex Mirror





SIGN CONVENTION FOR SPHERICAL MIRRORS & LENSES		
QUANTITY	**CONDITIONS**	**SIGN**
Focal Length, f	Concave mirror Convex mirror Convex lens Concave lens	+ - + -
Object distance, do	Always	+
Image distance, di	Image real Image virtual	+ -
Magnification, m	Image upright Image inverted	+ -

Key Equations

focal length

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

magnification

$$m = \frac{h_i}{h_o} = \frac{-d_i}{d_o}$$

Example

A concave mirror has a focal length of 8 cm. An object 4 cm high is placed 24 cm from the mirror. Determine the image distance (di) and the image height (ℏi)

Given:

f = 8cm
ho = 4cm
do = 24cm

Required:

di = ?
hi = ?
m = ?

Equation:

$$\frac{1}{f} = \frac{1}{do} + \frac{1}{di}$$

$$m = \frac{hi}{ho} = \frac{-di}{do}$$

Solution:

$$\frac{1}{f} - \frac{1}{do} = \frac{1}{di}$$

$$\frac{1}{di} = \frac{1}{f} - \frac{1}{do}$$

$$di = \frac{1}{\frac{1}{8cm} - \frac{1}{24cm}}$$

di = 12cm

$$m = \frac{hi}{ho} = \frac{-di}{do}$$

$$hi = ho\ \frac{-di}{do}$$

$$hi = 4cm\ \frac{-12cm}{24cm}$$

$$hi = 4cm\ \frac{-1}{2}$$

$$hi = -\ 2cm$$

di = 12cm; hi = -2 cm (inverted)

2.6 Light and Optics

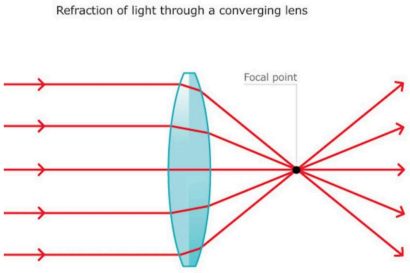
- Dispersion
- Reflection
- **Refraction** - the bending of a light wave when it enters a medium where its speed is different

Lenses

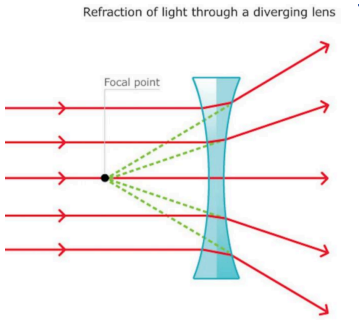
- A piece of clear plastic or glass with curved surfaces
- Light refracts most at the outer surface while **no refraction occurs in the middle**
- Light rays will either converge or diverge **behind the lens**

2 Types of Lenses

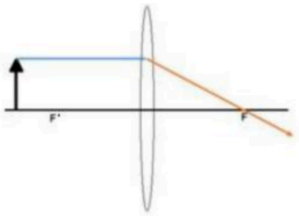
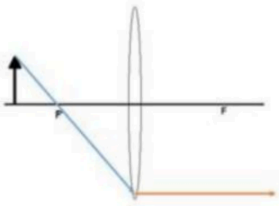
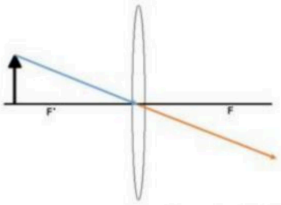
1. **Convex Lens (converging lens)**
    - **Thicker** at the **center** than edges
    - It forms real images and virtual images **depending on position of the object**
    - It is also called Converging Lens because the light passes through it tends to **converge at a particular point** called the **focal point**



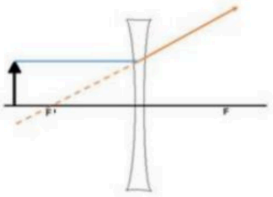
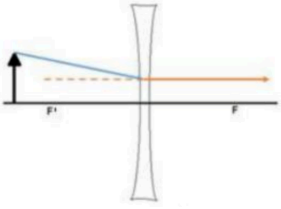
2. **Concave Lens (diverging lens)**
    - **Thicker** at the **edges** and thinner in the center
    - It forms **upright** and **reduced** images.
    - It is also called Diverging Lens because the light that passes through it tends to **diverge at a particular point** called the **focal point**

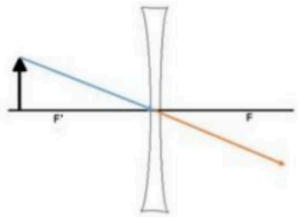


3 Principal Rays in Convex Lenses

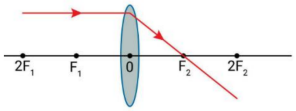
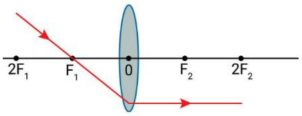
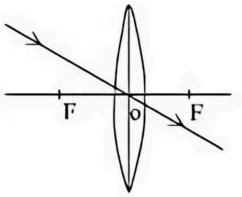
1. P-F Ray: A ray of light parallel to the principal axis is refracted passing through the principal focus, F behind the lens	
2. F-P Ray: A ray of light passing through the focus, F in front of the lens if refracted parallel to the principal axis	
3. V Ray: A ray of light passing through the exact center of the lens (vertex) continue to travel in the same direction	

3 Principal Rays in Concave Lenses

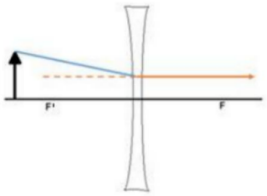
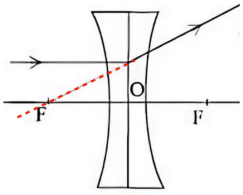
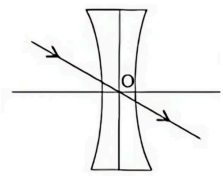
1. P-F Ray: A ray of light parallel to the principal axis is refracted as if passing through the principal focus, F in front of the lens	
2. F-P Ray: A ray of light directed towards the focus, F behind the lens if refracted parallel to the principal axis	

3. V Ray: A ray of light passing through the exact center of the lens (vertex) continue to travel in the same direction	

Rules in Creating Ray Diagram (Convex Lenses)

Ray 1 A ray parallel to the axis bending towards F (right side)	
Ray 2 A ray coming from the F going the lens then a ray parallel on the image side	
Ray 3 A ray coming from the object going straight towards the optical center	

Rules in Creating Ray Diagram (Concave Lenses)

Ray 1 A ray going to F then parallel to the principal axis	
Ray 2 A ray parallel to the axis bending outwards apparent to F (left side)	
Ray 3 A ray coming from the object going straight towards the optical center	

Example

A 4.00-cm tall object is placed a distance of 10 cm from a double convex lens having a focal length of 4 cm. Determine the image distance and the image size.

Given:

f = 4cm
ho = 4.00cm
do = 10cm

Required:

di = ?
hi = ?

Equation:

$$\frac{1}{f} = \frac{1}{do} + \frac{1}{di}$$

$$m = \frac{hi}{ho} = \frac{-di}{do}$$

Solution:

$$\frac{1}{f} - \frac{1}{do} = \frac{1}{di}$$

$$\frac{1}{di} = \frac{1}{f} - \frac{1}{do}$$

$$di = \frac{1}{\frac{1}{4cm} - \frac{1}{10cm}}$$

$$di = \frac{1}{\frac{5}{20cm} - \frac{2}{20cm}}$$

di = 6.67 cm

$$m = \frac{hi}{ho} = \frac{-di}{do}$$

$$hi = ho\frac{di}{do}$$

$$hi = 4cm\ (\frac{-6.67cm}{10cm})$$

$$hi = -\ 2.67cm$$

di = 6.67cm; hi = -2.67cm (inverted)

Pwede kayo magpatulong sakin (dewi) pag nahihirapan kayo sa solving :))