



MOIZ DAWOODI
O/A LEVEL & IGCSE PHYSICS

AS LEVEL PHYSICS 9702

**IMPORTANT FORMULAE, DEFINITIONS
REASONABLE ESTIMATES & CONCEPTS**

STUDENT NAME



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PHYSICS WITH
MOIZ DAWOODI



MOIZ AHMED DAWOODI
O'LEVEL/IGCSE/A'LEVEL

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PHYSICS

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May/June 2024-2025

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Reasonable Estimates



REASONABLE ESTIMATES:

- Number of apples in 1 kg bag: 4-6 apples
- Diameter of nucleus: $1.75 \times 10^{-15} \text{ m}$
- Diameter of proton: $1 \times 10^{-15} \text{ m}$
- Diameter of neutron: $2.2 \times 10^{-15} \text{ m}$
- Diameter of an electron: Less than 10^{-15} m
- Diameter of an atom: 0.1 nm - 0.5 nm
- Diameter of an earth: $12.8 \times 10^6 \text{ m}$
- Diameter of moon: $3.47 \times 10^6 \text{ m}$
- Diameter of sun: $7 \times 10^8 \text{ m}$
- Diameter of pencil: 0.5 - 1 cm
- Diameter of hair: $5 \times 10^{-4} \text{ m}$
- Mass of a protractor: 5-50 g
- Mass of an adult human: 50 to 100 kg
- Mass of an apple: 200 - 500 g
- Mass of 30 cm plastic ruler: 10-100 g
- Mass of an orange: 100 - 150 g
- Weight of 1000 cm^3 of water: 10 N



- Density of air: $1.2 \times 10^3 \text{ kg/m}^3$
- Density of water: 1000 kg/m^3
- Density of cooking oil: 0.91 g/cm^3
- Density of glycerin: 1.26 g/cm^3
- Volume of an adult head: $2 \times 10^3 - 9 \times 10^3 \text{ cm}^3$
- Volume of a nucleus: $2.8 \times 10^{-45} \text{ m}^3$
- Volume of a cup of tea: $1000 - 3000 \text{ cm}^3$
- Volume of small bean: 0.5 cm^3
- Pressure of 10 m depth of water: 10^5 Pa
- Speed of sound in air: $300 - 340 \text{ m/s}$ (Speed increases by 0.61 m/s for 1°C rise)
- Speed of sound in water: 1500 m/s
- Speed of jumbo jet: 220 m/s
- Speed of car: 22 m/s
- Speed of walking human: 1.5 m/s
- Speed of snail: 0.001 m/s
- Speed of Earth around Sun: $30,000 \text{ m/s}$
- Acceleration of family car: 2 m/s^2
- Acceleration of free fall on moon: 1.6 m/s^2
- Time for sound to travel 1 km in air: $3.33 - 2.94 \text{ s}$
- Height of room in a house: $2 - 3 \text{ m}$
- Distance between Earth & Sun: $1.5 \times 10^{11} \text{ m}$
- Thickness of sheet of paper: $0.05 - 0.15 \text{ mm}$
- Length of a car: 4 m
- Kinetic energy of an 80 kg athlete: $4 \times 10^3 \text{ J}$



- No. of Joules of energy in 1 Kilowatt: $3.6 \times 10^6 \text{ J}$
- Energy released from 100 kg of coal: 1010 J
- Energy of heart beat: 1 J
- Energy of burning match stick: 1000 J
- Energy of speech on ear for 1s: 0.001 J
- Energy required to boil water in kettle: $100 - 1000 \text{ KJ}$
- Audible frequency: $20 - 20,000 \text{ Hz}$
- Frequency of x-rays: $3 \times 10^{16} - 3 \times 10^{19} \text{ Hz}$
- Wavelength of red light: 700 nm
- Wavelength of visible light: $400 - 700 \text{ nm}$
- Wavelength of whole Electromagnetic Spectrum: $10 \times 10^{-12} - 100 \times 10^6 \text{ m}$
- Current in overhead supply cable: $100 - 300 \text{ A}$
- Power of hair dryer: $1000 - 2000 \text{ W}$
- Resistance of filament lamp: $300 - 3000 \Omega$
- Average age of human: 65 years

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A'levels

Important Formulae



01

Physical Quantities & Units

QUANTITY	INFORMATION	FORMULA
Absolute Uncertainty	$x = y + z$ $x = y - z$	$\delta x = \pm (\delta y + \delta z)$
Fractional Uncertainty	$x = y \times z$ $x = \frac{y}{z}$	$\frac{\delta x}{x} = \pm \left(\frac{\delta y}{y} + \frac{\delta z}{z} \right)$
Percentage Uncertainty	$x = y \times z$ $x = \frac{y}{z}$	$\frac{\delta x}{x} \% = \pm \left(\frac{\delta y}{y} + \frac{\delta z}{z} \right) \times 100$

02

Kinematics

QUANTITY	INFORMATION	FORMULA
Speed/velocity	v = Speed / Velocity d = Distance / Displacement t = Time	$v = \frac{d}{t}$
Acceleration	a = Acceleration u = Initial Velocity v = Final velocity t = Time	$a = \frac{v-u}{t}$
1 st Equation of motion	a = Acceleration u = Initial Velocity v = Final velocity t = Time	$v = u + at$



2 nd Equation of motion	a = Acceleration u = Initial Velocity S = Displacement t = Time	$S = ut + \frac{1}{2}at^2$
3 rd Equation of motion	a = Acceleration u = Initial Velocity v = Final Velocity S = Displacement	$2aS = v^2 - u^2$

03

Dynamics

QUANTITY	INFORMATION	FORMULA
Momentum	P = Momentum m = Mass v = Velocity	$P = mv$
Resultant Force	ΣF = Resultant Force m = Mass a = Acceleration ΔP = Momentum Change t = Time	$\Sigma F = ma$ <u>or</u> $\Sigma F = \frac{\Delta P}{t}$
Gravitational Field strength	g = Gravitational Field strength F = Force m = Mass	$g = \frac{F}{m}$
Weight	g = Gravitational Field strength W = Weight m = Mass	$W = mg$
Principle of conservation of momentum	m_1 = Mass of body 1 u_1 = Velocity of body 1 before collision v_1 = Velocity of body 1 after collision m_2 = Mass of body 2 u_2 = Velocity of body 2 before collision v_2 = Velocity of body 2 after collision	$m_1u_1 + m_2u_2 = m_1v_1 + m_2v_2$



04

Force, Density & Pressure

QUANTITY	INFORMATION	FORMULA
Moment	M = Moment F = Force d = Perpendicular distance	$M = F d$
Principle of moment	F_1, F_2, F_3, F_4 = Force d_1, d_2, d_3, d_4 = Perpendicular Distance	$\Sigma CWM = \Sigma ACWM$ $F_1 d_1 + F_2 d_2 = F_3 d_3 + F_4 d_4$
Density	P = Density m = Mass V = Volume	$P = \frac{m}{V}$
Volume	V = Volume r = radius	Sphere: $V = \frac{4}{3} \pi r^3$
Pressure	P = Pressure F = Force A = Area	$P = \frac{F}{A}$
Hydrostatic Pressure	g = Gravitational Field strength P = Pressure ρ = Density h = Depth	$P = \rho g h$
Upthrust	g = Gravitational Field strength P = Pressure ρ = Density V = Volume	$U = \rho g V$

05

Deformation of Solids

QUANTITY	INFORMATION	FORMULA
Hooke's Law	F = Force k = Spring Constant e = Extension σ = Stress	$F = k e$
Stress	F = Force A = Area	$\sigma = \frac{F}{A}$
Strain	E = Strain e = Extension L = Length	$E = \frac{e}{L}$



Young's Modulus	E = Young's Modulus F = Force L = Length A = Area e = Extension	$E = \frac{FL}{Ae}$
Strain Energy	E = Strain energy k = spring constant F = Force e = Extension	$E = \frac{1}{2}ke^2$ <u>or</u> $E = \frac{1}{2}Fe$

06

Energy, Work & Power

QUANTITY	INFORMATION	FORMULA
Work	W = Work F = Force d = Displacement	$W = Fd$
Work done in piston	W = Work P = Pressure ΔV = Volume change	$W = P \Delta V$
Power	P = Power W = Work t = Time F = Force v = Speed/velocity	$P = \frac{W}{t}$ <u>or</u> $P = Fv$
Efficiency	E_{eff} = Efficiency P_o = Power output P_i = Power input E_o = Energy output E_i = Energy input t = Time	$\text{Eff} = \frac{P_o}{P_i}$ <u>or</u> $\text{Eff} = \frac{E_o}{E_i}$
Kinetic Energy	E_k = Kinetic Energy m = mass v = speed/velocity	$E_k = \frac{1}{2}mv^2$
Gravitational Potential Energy	E_p = Potential energy m = Mass h = Height g = Gravitational Field strength	$E_p = mgh$

07

Waves

QUANTITY	INFORMATION	FORMULA
Frequency	f = Frequency T = Time Period	$f = \frac{1}{T}$



Wave Equation	v = Speed f = Frequency λ = Wavelength	$v = f \lambda$
Intensity	I = Intensity P = Power A = Area	$I = \frac{P}{A}$
Intensity- Amplitude Expression	I = Intensity k = Constant A = Amplitude	$I = k A^2$
Doppler's Effect (Source moves towards)	f' = Observed Frequency f = Actual Frequency v = Speed of Sound v_s = Speed of Source	$f' = f \left[\frac{v}{v - v_s} \right]$
Doppler's Effect (Source moves away)	f' = Observed Frequency f = Actual Frequency v = Speed of Sound v_s = Speed of Source	$f' = f \left[\frac{v}{v + v_s} \right]$
Malus's Law	I = Intensity observed I_0 = Max. Intensity θ = Angle b/w analyser & Polarizer	$I = I_0 \cos^2 \theta$

08

Superposition

QUANTITY	INFORMATION	FORMULA
Wavelength of stationary wave on string	N = No. of Harmonics	$\lambda_N = \frac{2L}{N}$
Wavelength of stationary wave in open pipe	L = Length of string/Pipe λ_N = Wavelength of N th Harmonic	$N = 0, 1, 2, 3, \dots$
Frequency of stationary wave on string	N = No. of Harmonics	$f_N = N f_1$
Frequency of stationary wave in open pipe	f_1 = Fundamental Frequency f_N = Frequency of N th Harmonic	$N = 0, 1, 2, 3, \dots$
Fundamental Frequency of stationary wave on string	f_1 = Fundamental Frequency L = Length of string/Pipe v = Speed of wave	$f_1 = \frac{v}{2L}$
Fundamental Frequency of stationary wave in open pipe		



Wavelength of stationary wave in closed pipe	N = No. of Harmonics L = Length of string/Pipe λ_N = Wavelength of N th Harmonic	$\lambda_N = \frac{4L}{N}$ $N = 0, 1, 2, 3, \dots$
Frequency of stationary wave in closed pipe	N = No. of Harmonics f_1 = Fundamental Frequency f_N = Frequency of N th Harmonic	$f_N = N f_1$ $N = 1, 3, 5, \dots$
Fundamental Frequency of stationary wave in closed pipe	f_1 = Fundamental Frequency L = Length of string/Pipe v = Speed of wave	$f_1 = \frac{v}{4L}$
Young's Double Slit Experiment	x = Fringe Separation λ = Wavelength D = Distance b/w slits & screen a = Slit Separation	$x = \frac{\lambda D}{a}$
Diffraction Grating	λ = Wavelength d = Diffraction grating n = No. of orders θ = Angle b/w two rays	$\lambda = \frac{d \sin \theta}{n}$

09

Electricity

QUANTITY	INFORMATION	FORMULA
Charge	q = Charge I = Current t = Time	$q = It$
Current	q = Charge I = Current t = Time	$I = \frac{q}{t}$
Drift Speed	I = Current n = Number density A = Cross-Sectional Area e = Elementary Charge v = Drift speed	$I = n A v e$
Number Density	n = Number density V = Volume	$n = \frac{\text{no. of electrons}}{V}$



Voltage	$V = \text{Voltage}$ $W = \text{Work}$ $q = \text{Charge}$	$V = \frac{W}{q}$
Power	$P = \text{Power}$ $I = \text{Current}$ $V = \text{Voltage}$ $R = \text{Resistance}$	$P = IV$ $P = I^2 R$ $P = \frac{V^2}{R}$
Ohm's Law	$I = \text{Current}$ $V = \text{Voltage}$ $R = \text{Resistance}$	$V = IR$
Resistivity	$\rho = \text{Resistivity}$ $R = \text{Resistance}$ $A = \text{Cross-Sectional Area}$ $L = \text{Length}$	$\rho = \frac{RA}{L}$
10 DC Circuits		
QUANTITY	INFORMATION	FORMULA
Emf	$E = \text{Emf}$ $W = \text{Work}$ $q = \text{Charge}$	$E = \frac{W}{q}$
Emf with Internal Resistance	$E = \text{Emf}$ $I = \text{Current}$ $r = \text{Internal Resistance}$ $R = \text{External Resistance}$ $V = \text{Terminal Voltage}$	$E = V + Ir$ $E = I(R+r)$
Kirchoff 1 ST Law Kirchoff Current Law	$I = \text{Current entering the node}$ $I_1, I_2 = \text{Current leaving the node}$	$I = I_1 + I_2$
Kirchoff 2 ND Law Kirchoff Voltage Law	$E = \text{Emf}$ $I = \text{Current}$ $R_1, R_2 = \text{Resistance}$	$E = IR_1 + IR_2$
Equivalent Resistance in Series	$R = \text{Equivalent Resistance}$ $R_1, R_2, R_3 = \text{Individual Resistance in series.}$	$R = R_1 + R_2 + R_3$



Equivalent Resistance in Parallel	$R = \text{equivalent Resistance}$ $R_1, R_2, R_3 = \text{Individual Resistance in series.}$	$R = \frac{R_1 \times R_2}{R_1 + R_2} \text{ (2 Resistors in Parallel)}$ $\frac{1}{R} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$
Potential Dividers	$V_o = \text{Voltage Output}$ $V_{in} = \text{Voltage Input}$ $R' = \text{Resistance whose voltage is found}$ $R_1, R_2 = \text{Resistors in series}$	$V_o = \left(\frac{R'}{R_1 + R_2} \right) V_{in}$
Potentiometer	$E_A = \text{known emf}$ $L_A = \text{Length of wire of known emf}$ $E_B = \text{Unknown emf}$ $L_B = \text{Length of wire of unknown emf}$	$\frac{E_A}{E_B} = \frac{L_A}{L_B}$
11 Particle Physics		
QUANTITY	INFORMATION	FORMULA
Number of Neutrons	$N = \text{Neutron number}$ $A = \text{Nucleon number}$ $Z = \text{Proton number}$	$N = A - Z$
Energy in Nuclear Reactions	$E = \text{Energy}$ $m = \text{Difference in mass}$ $c = \text{Speed of light}$ $(3 \times 10^8 \text{ ms}^{-1})$	$E = mc^2$



A'levels

Important Definitions & Concepts



01

Physical Quantities & Units

ERROR:

"The difference b/w measured & actual value."

SYSTEMATIC ERROR:

"A constant error which arises due to wrongly calibrated instrument or fault in the instrument."

RANDOM ERROR:

"An error which results readings being scattered around accepted value."

PRECISION:

"The property which shows closeness of readings with each other."

ACCURACY:

"The property which shows closeness of readings with actual answer."

O/A LEVEL PHYSICS

SCALARS:

"Quantities that are specified by magnitudes & unit only."

VECTORS:

"Quantities that are specified by magnitudes, unit as well as specific direction."

02

Kinematics

DISTANCE:

"The actual path covered by a body."



DISPLACEMENT:

"Shortest distance b/w starting & ending point."

SPEED:

"Distance covered per unit time."

AVERAGE SPEED:

"Total distance covered per total time."

VELOCITY:

"Displacement covered per unit time."

UNIFORM VELOCITY:

"Same displacement covered per unit time."

ACCELERATION:

"Change in velocity per unit time."

UNIFORM ACCELERATION:

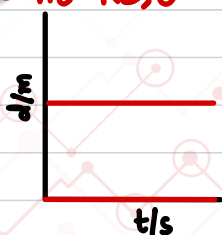
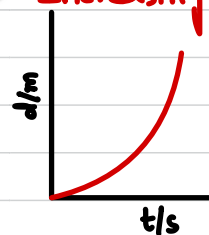
"Same increase in velocity per unit time."

UNIFORM DECELERATION:

"Same decrease in velocity per unit time."

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MOTION GRAPHS

DISPLACEMENT - TIME GRAPHS (GRADIENT: VELOCITY):**• At Rest****• Uniform Velocity****• Increasing Velocity****• Decreasing Velocity****CONDITIONS FOR EQUATIONS OF MOTION:**

- Uniform Acceleration.
- Motion in a straight line.
- Speed of body < speed of light

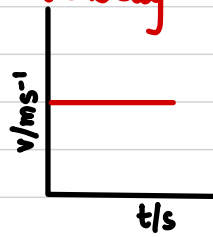


VELOCITY - TIME GRAPHS (GRADIENT: ACCELERATION):

• At Rest



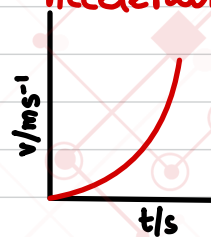
• Uniform Velocity



• Uniform Acceleration



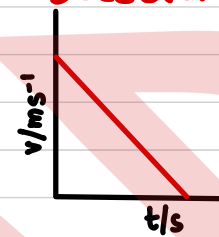
• Increasing Acceleration



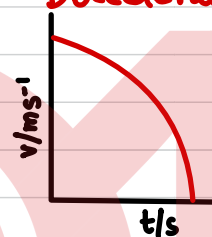
• Decreasing Acceleration



• Uniform Deceleration



• Increasing Deceleration

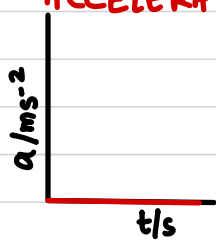


• Decreasing Deceleration

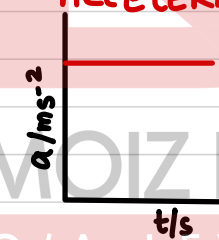


ACCELERATION - TIME GRAPHS:

• ZERO ACCELERATION



• UNIFORM ACCELERATION



• INCREASING ACCELERATION



• DECREASING ACCELERATION



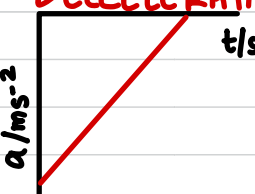
• UNIFORM DECELERATION



• INCREASING DECELERATION



• DECREASING DECELERATION

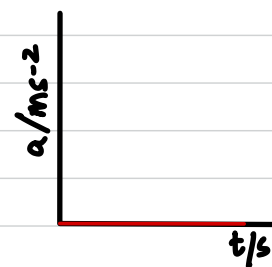
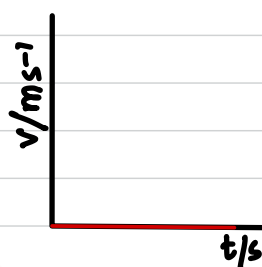
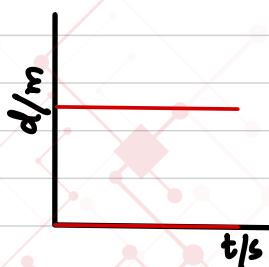


MOTION GRAPH CONVERSIONS:

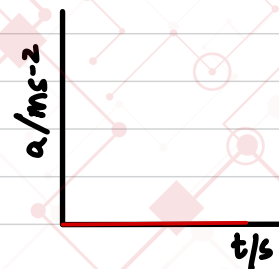
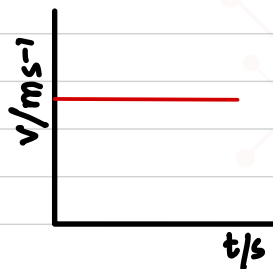
At Rest

$$v = 0$$

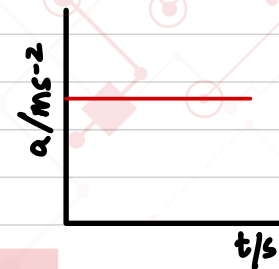
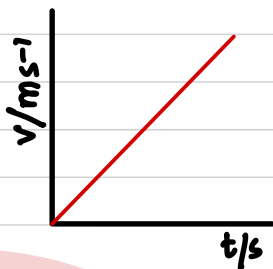
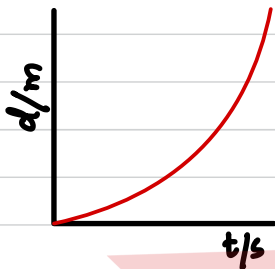
$$a = 0$$



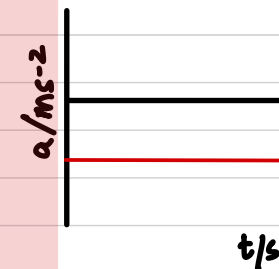
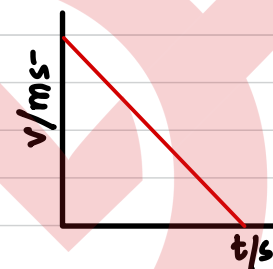
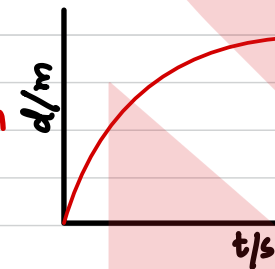
Uniform
Velocity
 $a = 0$



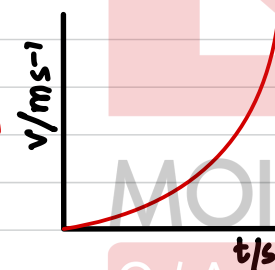
Uniform
Acceleration



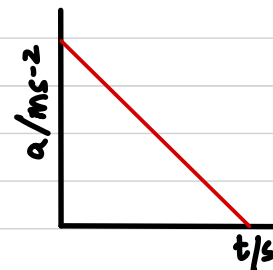
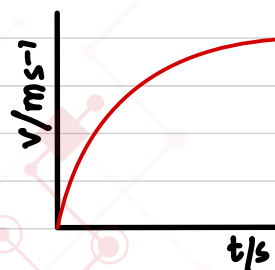
Uniform
Deceleration



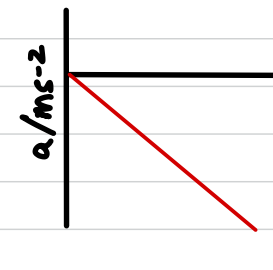
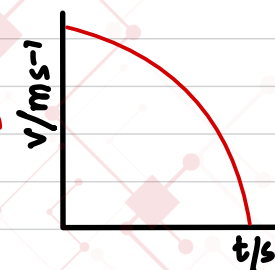
Increasing
Acceleration



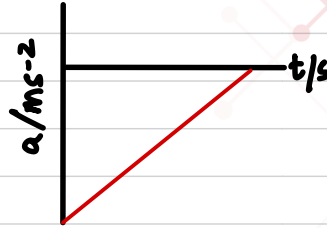
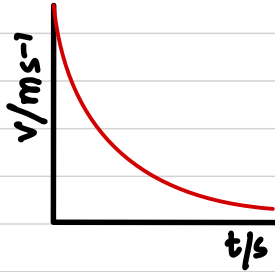
Decreasing
Acceleration



Increasing
Deceleration

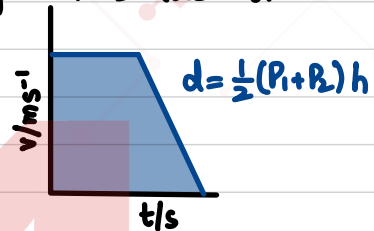
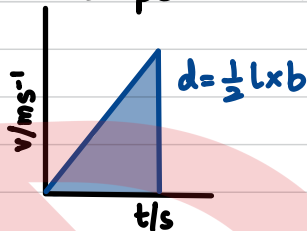
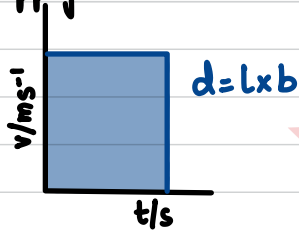


Decreasing
Deceleration



AREA UNDER GRAPH:

When velocity time graph is given & displacement needs to be found, apply formula of area of shape of the graph & shade it.



03

Dynamics

1ST LAW OF MOTION:

"A body at rest remains at rest & a body in motion remains in uniform motion until an unbalanced force acts on it."

2ND LAW OF MOTION:

"Resultant force is directly proportional to the rate of change of momentum."

3RD LAW OF MOTION:

"Every action has an equal but opposite reaction."

Mass:

"Amount of matter in a body."

INERTIA:

"Property of mass which resist the change in its state."

MOMENTUM:

"Product of mass & velocity."

FORCE:

"Rate of change of momentum."



GRAVITATIONAL FIELD STRENGTH:

"The ratio of force per unit mass."

WEIGHT:

"The force which pulls the body downwards towards Earth."

FRICTION:

"Force which opposes motion of a body."

FREE FALL:

"Irrespective to the mass of the bodies all bodies fall with same acceleration of free fall."
 9.81 ms^{-2} for Earth.

TERMINAL VELOCITY:

"Uniform velocity achieved under free fall when weight balances air resistance."

PRINCIPLE OF CONSERVATION OF MOMENTUM:

"The total momentum before & after collision remains conserved under isolated conditions."

TO PROVE ELASTIC COLLISION:

"Sum of all kinetic energies before collision is equal to sum of all kinetic energies after collision."

$$\frac{1}{2} m_1 u_1^2 + \frac{1}{2} m_2 u_2^2 = \frac{1}{2} m_1 v_1^2 + \frac{1}{2} m_2 v_2^2$$

OR

"Relative velocity of approach is equal to relative velocity of separation."

$$u_1 - u_2 = v_2 - v_1$$



04

Force, Density & Pressure

MOMENT:

"The product of force & perpendicular distance."

TORQUE OF COUPLE:

"Product of force & couple arm."

CENTER OF GRAVITY:

"The point at which whole weight of the body appears to act."

PRINCIPLE OF MOMENTS:

"Sum of clockwise moment is equal to sum of anticlockwise moment at equilibrium."

CONDITIONS OF EQUILIBRIUM:

- Resultant moment is equal to zero.
- Resultant force is equal to zero.

DENSITY:

"Ratio of mass over volume."

VOLUME:

"Space occupied by an object."

PRESSURE:

"Pressure is force per unit area."

HYDROSTATIC PRESSURE:

"The product of density, gravitational field strength & depth."

ARCHIMEDES PRINCIPLE:

"The upthrust force is equal to the weight of the liquid displaced when object is immersed in the liquid."

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05

Deformation of Solids

HOOKE'S LAW:

"Load is directly proportional to the extension provided that limit of proportionality is not reached."

LIMIT OF PROPORTIONALITY:

"Point on load vs extension graph until graph is a straight line."

ELASTIC LIMIT:

"Point on load vs extension graph beyond which spring is permanently deformed."

STRESS:

"The deforming force per unit area."

STRAIN:

"Ratio of extension over original length."

YOUNG'S MODULUS:

"The ratio of stress over strain."

06

Energy, Work & Power

WORK:

"Product of force & displacement in the direction of force."

POWER:

"Rate of doing work."

EFFICIENCY:

"Ratio of output power over input power."

OR

"Ratio of output energy over input energy."

ENERGY:

"Ability to do work."

KINETIC ENERGY:

"Energy due to motion."



GRAVITATIONAL POTENTIAL ENERGY:

"Energy due to height."

PRINCIPLE OF CONSERVATION OF ENERGY:

"Energy can't be created or destroyed but can be converted from one form to another provided that total energy remains conserved."

07**Waves****WAVE OR WAVE MOTION:**

"Disturbance in the medium which transfers energy without transferring the medium."

TRANSVERSE WAVE:

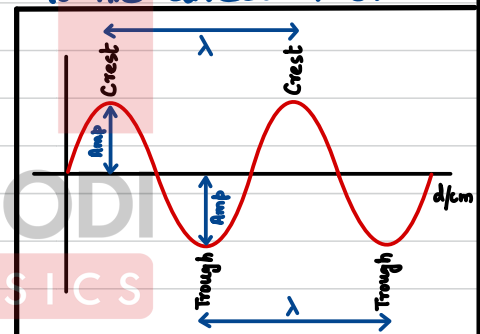
"Wave in which particles vibrate perpendicular to the direction of propagation of wave."

LONGITUDINAL WAVE:

"Wave in which particles vibrate parallel to the direction of propagation of wave."

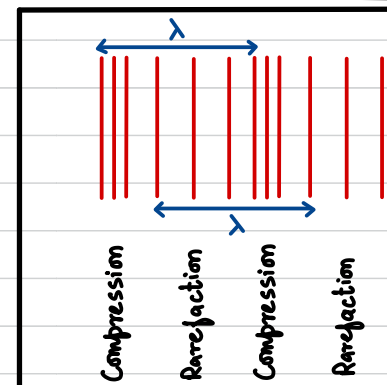
AMPLITUDE:

"The maximum displacement is called amplitude."

**WAVELENGTH:**

"Distance b/w two consecutive crest or trough."

OR
"Distance b/w two consecutive compression or rarefaction."

**PHASE DIFFERENCE:**

"The angle by which one wave leads or lags with other wave."

TIME PERIOD:

"The time required to complete one wave."

FREQUENCY:

"No. of waves completed per second."



INTENSITY:

"Power transmitted per unit area."

OR

"Ratio of energy per unit area per unit time."

INTENSITY - AMPLITUDE RELATIONSHIP:

"Intensity is directly proportional to the square of amplitude."

DOPPLER'S EFFECT:

"Apparent change in frequency observed when the source moves towards or away from stationary observer."

APPROXIMATED WAVELENGTHS OF ELECTROMAGNETIC WAVES:

Radiation	Radiowave	Microwave	Infrared	Visible Light	Ultraviolet	X-rays	Gamma Rays
Wavelength (m)	$10^1 - 10^4$ & Longer	$10^3 - 10^1$	$10^2 - 10^6$	$4 \times 10^7 - 7 \times 10^7$	$10^{-7} - 10^{-9}$	$10^{-9} - 10^{-12}$ & shorter	$10^{-10} - 10^{-16}$ & shorter

POLARIZATION:

"Property of transverse wave which allows wave to vibrate only in one plane."

MALUS'S LAW:

"If an analyser is rotated by an angle ' θ ' with respect to polariser, the intensity of light transmitted by the analyser is given by $I = I_0 \cos^2 \theta$."

08

Superposition**SUPERPOSITION PRINCIPLE:**

"When two waves overlap with each other, the resultant displacement is the sum of individual displacement."

FORMATION OF STATIONARY WAVE:

"When two waves having same speed, frequency & amplitude travelling in opposite direction overlap, then stationary wave is formed."

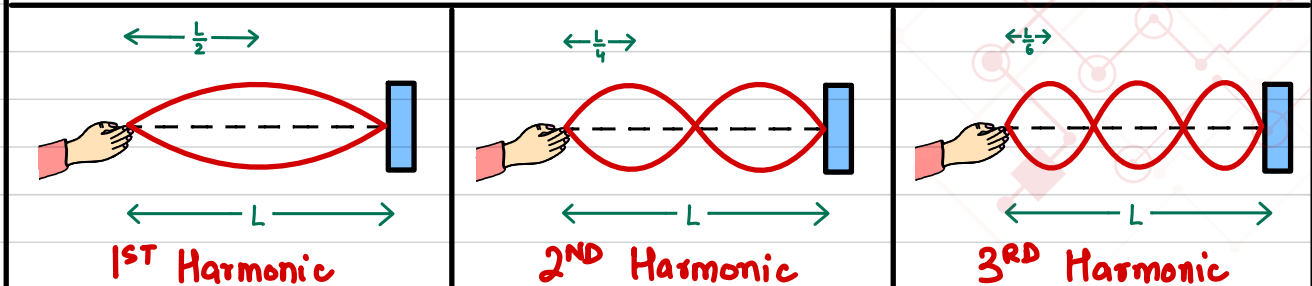
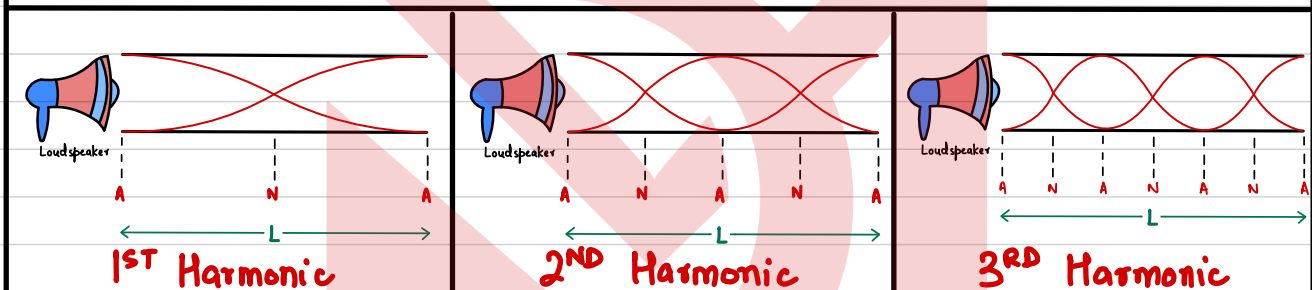
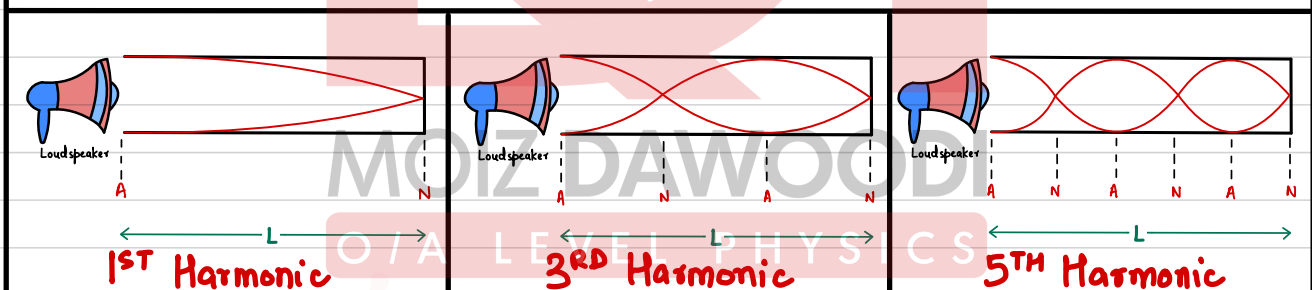
NODE:

"The point on stationary wave where amplitude is zero."



ANTINODE:

"The point on stationary wave where amplitude is maximum."

STATIONARY WAVE ON STRING:**STATIONARY WAVE IN OPEN PIPE:****STATIONARY WAVE IN CLOSED PIPE:****STATIONARY WAVES**

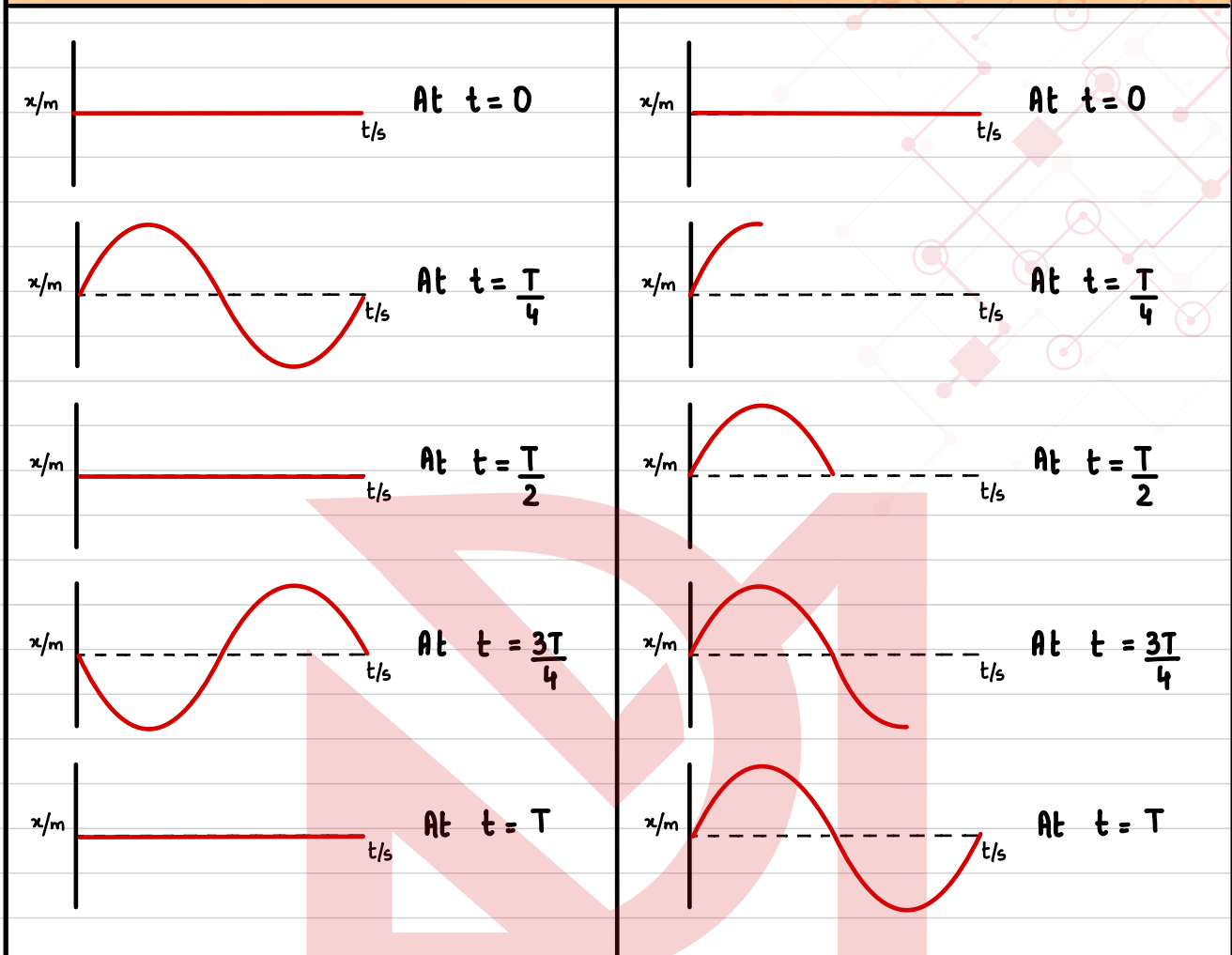
- Stationary wave do not transfer energy from one place to another.
- In Stationary Waves, all the points b/w successive nodes are in phase.
- In Stationary Waves, amplitude varies from zero at node & maximum at antinode.

PROGRESSIVE WAVES

- Progressive Wave transfers energy from one place to another without transferring the matter.
- In Progressive Wave, two adjacent points are not in same phase
- In Progressive Wave, each point achieve same amplitude.



MOTION OF ONE COMPLETE WAVE

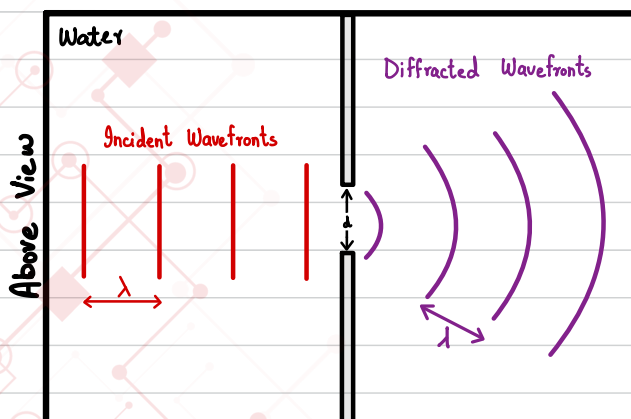


DIFFRACTION:

"Spreading of wave as it passes through narrow/wide gap or sharp obstacles."

● DIFFRACTION THROUGH NARROW GAP: ($\lambda \geq d$, Circular wavefronts)

When gap width is less than or equal to wavelength, circular wavefronts are produced.



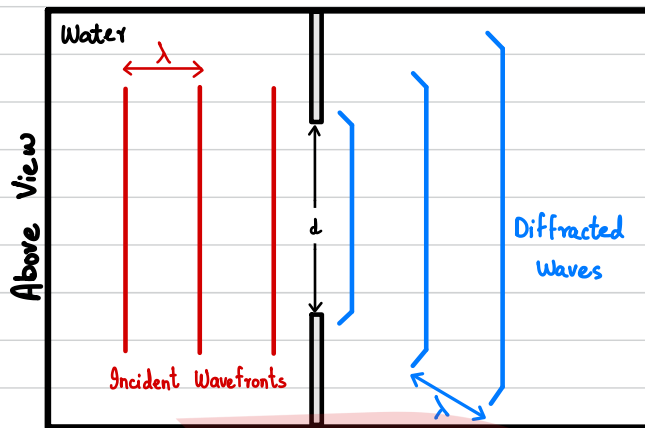
Here:

- Speed: Same
- Wavelength: Same
- Frequency: Same



● DIFFRACTION THROUGH WIDE GAP & EDGES: ($\lambda < d$, Plane wavefronts)

When gap width is more than wavelength, plain wavefronts are produced though due to edges, some curvature is produced.



Here:

- Speed: Same
- Wavelength: Same
- Frequency: Same

CONSTRUCTIVE INTERFERENCE.

"When two or more waves overlap with each other such that the resultant displacement is maximum."

This happens when Path Difference = $0\lambda, 1\lambda, 2\lambda, 3\lambda, \dots$ $n = 0, 1, 2, 3, \dots$
 Phase Difference = $0^\circ, 360^\circ, 720^\circ, 1080^\circ, \dots$

DESTRUCTIVE INTERFERENCE.

"When two or more waves overlap with each other such that the resultant displacement is minimum."

This happens when Path Difference = $0.5\lambda, 1.5\lambda, 2.5\lambda, 3.5\lambda$ $n = 0, 1, 2, 3, \dots$
 Phase Difference = $180^\circ, 540^\circ, 900^\circ, 1280^\circ, \dots$

COHERENCE:

"Two waves are said to be coherent if two waves have constant phase difference throughout."

DIFFRACTION GRATING:

"A sheet of glass or metal which is ruled with thousands of equidistant, parallel & very close lines which diffracts the incident wave."



09

Electricity

CHARGE:

"Product of current & time." OR
 "Loss or gain of an electron."

CURRENT:

"Flow of charges per unit time."

CONVENTIONAL CURRENT:

"Flow of positive charges from positive to negative terminal of the battery."

ELECTRON FLOW:

"Flow of negative charges from negative to positive terminal of the battery."

Number Density:

"No. of electron per unit volume."

POTENTIAL DIFFERENCE/VOLTAGE:

"Energy per unit charge which drives a charge through a single component."

POWER:

"Product of current & voltage."

RESISTANCE:

"Ratio of voltage over current."

FACTORS OF RESISTANCE:

- Resistance is directly proportional to length ($R \propto L$).
- Resistance is inversely proportional to cross-sectional area ($R \propto \frac{1}{A}$).
- Resistance is directly proportional to temperature ($R \propto T$).

OHM'S LAW:

"Current is directly proportional to the voltage at constant temperature."

- Gradient of IV graph is $\frac{1}{R}$.
- Gradient of VI graph is R .



CONCEPT OF FILAMENT LAMP:

As voltage increases, filament heats up more so resistance increases so current through filament lamp decreases.

CONCEPT OF THERMISTOR:

As temperature of thermistor increases so its resistance decreases hence it works as a conductor.

As temperature of thermistor decreases so its resistance increases hence it works as an insulator.

CONCEPT OF LDR:

As light intensity on LDR increases so its resistance decreases hence it works as a conductor.

As light intensity on LDR decreases so its resistance increases hence it works as an insulator.

DIODE:

"A component which allows the current to flow only in one direction."

• When anode is at positive & cathode is at negative, diode works as a conductor. 

• When anode is at negative & cathode is at positive, diode works as an insulator. 

O/A LEVEL PHYSICS

RESISTIVITY:

"Resistance of unit area of a conductor."

10**DC Circuits****EMF:**

"Energy per unit charge which drives a charge throughout the circuit."

KIRCHOFF'S CURRENT LAW (1ST LAW):

"The sum of all currents entering the node is equal to sum of all currents leaving the node."

• KCL talks about conservation of charge.



KIRCHOFF'S VOLTAGE LAW (2ND LAW):

"The emf is equal to the product of current & resistance through each component."

- KVL talks about conservation of energy.

EMF SOURCES IN SERIES.

The total emf is the sum of individual emf sources in series.

EMF SOURCES IN PARALLEL:

Emf remains same in parallel

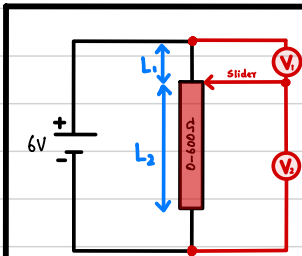
- Life of cells increases in parallel.
- If one cell runs down other works
- Current remains same in series.
- Voltage/emf remains same in parallel.

RATIO METHOD:

$\frac{12}{2} = 6V$ 	$R_1 : R_2 = V_1 : V_2$ $10 : 10$ $1 : 1 = 1 \times 6 : 1 \times 6$ $= 6V : 6V$	$\frac{10}{5} = 2V$ 	$R_1 : R_2 = V_1 : V_2$ $6 : 4$ $3 : 2 = 3 \times 2 : 2 \times 2$ $= 6V : 4V$
$\frac{8}{4} = 2V$ 	$R_1 : R_2 = V_1 : V_2$ $40 : 120$ $1 : 3 = 1 \times 2 : 3 \times 2$ $= 2V : 6V$	$\frac{15}{5} = 3V$ 	$R_1 : R_2 = V_1 : V_2$ $10 : 40$ $1 : 4 = 1 \times 3 : 4 \times 3$ $= 3V : 12V$
	$R_1 : R_2 = V_1 : V_2$ $4 : 8$ $1 : 2 = 1 \times 100 : 2 \times 100$ $= 100\Omega : 200\Omega$		$R_1 : R_2 = V_1 : V_2$ $8 : 2$ $4 : 1 = 4 \times 120 : 1 \times 120$ $= 480\Omega : 120\Omega$
	$R_1 : R_2 = V_1 : V_2$ $1 : 1 = 1 \times 50 : 1 \times 50$ $= 50\Omega : 50\Omega$		$R_1 : R_2 = V_1 : V_2$ $1 : 7 = 1 \times 500 : 7 \times 500$ $= 500\Omega : 3500\Omega$

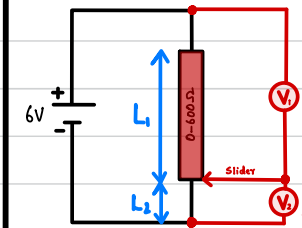


POTENTIAL DIVIDER WITH VARIABLE RESISTOR:



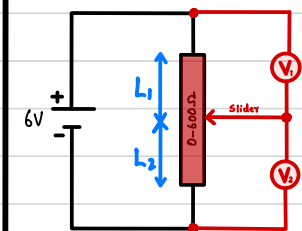
Since $L_1 = 0$, so $R_1 = 0$ hence $V_1 = 0$

Since $L_2 = \text{max.}$, so $R_2 = \text{max.}$ hence $V_2 = \text{max.} = 6\text{V}$



Since $L_1 = \text{max.}$, so $R_1 = \text{max.}$ hence $V_1 = \text{max.} = 6\text{V}$

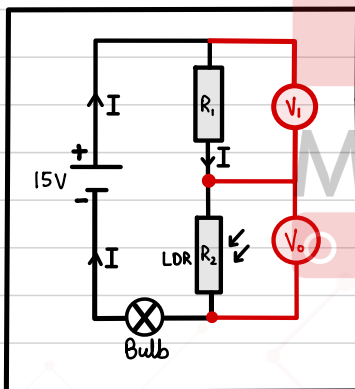
Since $L_2 = 0$, so $R_2 = 0$ hence $V_2 = 0$



Since $L_1 = \text{half}$, so $R_1 = \text{half}$ hence $V_1 = \text{half} = 3\text{V}$

Since $L_2 = \text{half}$, so $R_2 = \text{half}$ hence $V_2 = \text{half} = 3\text{V}$

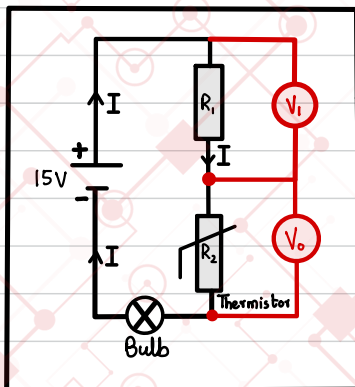
POTENTIAL DIVIDER WITH LDR:



Light	R_{LDR}	I	V_0	V_1	Bulb
↑	↓	↑	↓	↑	ON
↓	↑	↓	↑	↓	OFF

When light increases on LDR, its resistance & voltage decreases, hence more voltage appears on V_1 . Due to less resistance of LDR, overall resistance decreases so current increases & bulb glows.

POTENTIAL DIVIDER WITH THERMISTOR:

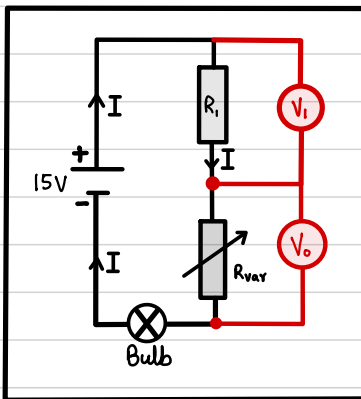


Heat	R_T	I	V_0	V_1	Bulb
↑	↓	↑	↓	↑	ON
↓	↑	↓	↑	↓	OFF

When heat increases on thermistor, its resistance & voltage decreases, hence more voltage appears on V_1 . Due to less resistance of thermistor overall resistance decreases so current increases & bulb glows.



POTENTIAL DIVIDER WITH FIXED & VARIABLE RESISTOR:



R_1	R_{var}	I	V_0	V_1	Bulb
Same	↓	↑	↓	↑	ON
Same	↑	↓	↑	↓	OFF

When resistance of variable resistor increases, voltage across it increases too hence less voltage appears at V_1 . Since overall resistance is increased so current decreases & bulb switches off.

POTENTIOMETER:

"A device which is used to compare potential differences."

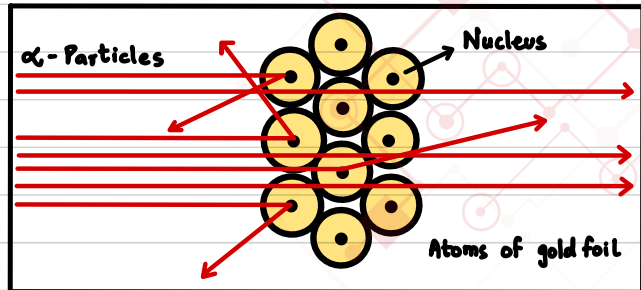
CIRCUIT SYMBOLS:

SYMBOL	COMPONENT	SYMBOL	COMPONENT	SYMBOL	COMPONENT
	Cell DC		Thermistor		Transformer
	Battery DC		LDR		Speaker
	Power Supply DC		Fuse		Cross Wires
	Variable Power Supply DC		Ammeter		Joint Wires
	Alternating Current Source AC		Voltmeter		Earth Connection
	Open Switch		Galvanometer		Relay
	Close Switch		Motor		
	Two way Switch		Bulb		
	Resistor		Diode		
	Variable Resistor		LED		
	Heater		CRO		



OUTCOMES OF GEIGER-MARSDEN ALPHA SCATTERING EXPERIMENT:

- The bending of the path of alpha particle proves that nucleus carry positive charge.
- The size of nucleus is very small as compared to the size of atom as most of the alpha particles went undeflected.
- Atom is highly empty.



PROTON NUMBER:

"Number of proton inside the nucleus."

NUCLEON NUMBER:

"Sum of proton & neutron inside the nucleus."

ISOTOPE:

"Atoms of same element having same no. of proton but different number of neutrons."

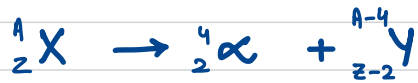
PROPERTIES OF α , β & γ :

	ALPHA PARTICLE	BETA PARTICLE	GAMMA RADIATION
NATURE	Equivalent to helium nuclei. ${}^4_2\alpha = {}^4_2\text{He}$	Equivalent to fast moving electrons ${}^0_{-1}e = {}^0_{-1}\beta$	Member of electromagnetic spectrum.
MASS	Heaviest, 2 protons 2 neutrons.	Lighter, 1 electron.	Negligible mass.
CHARGE	2 protons, +2e.	1 electron, -1e.	Neutral.
IONIZATION	Heaviest charge, Best ionizer.	Less charge, Moderate ionizer.	High energy, no charge Worst ionizer.
SPEED	$1.5 \times 10^7 \text{ ms}^{-1}$	$2.7 \times 10^8 \text{ ms}^{-1}$	$3 \times 10^8 \text{ ms}^{-1}$



- During nuclear reactions, proton number, nucleon number, charge & energy remains conserved.

α -DECAY:



β^- DECAY:



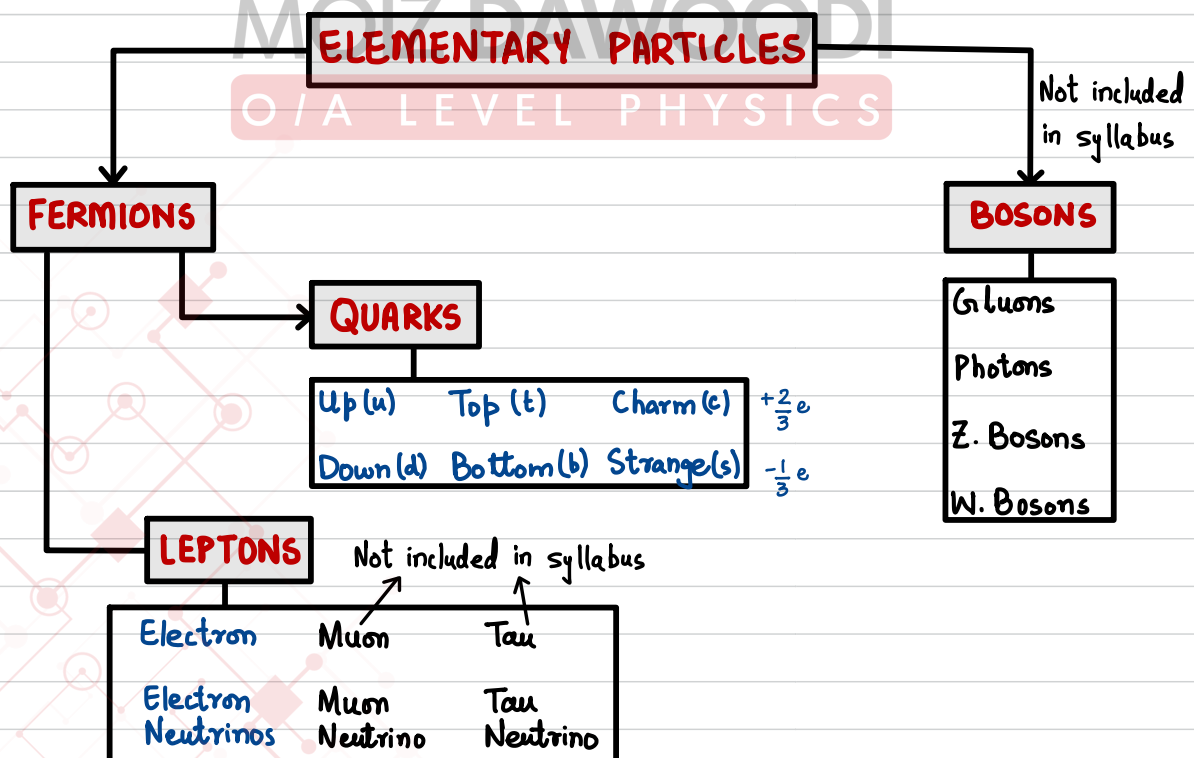
- In β -electron decay, one neutron breaks into proton & β -electron.
 $n = p + \beta^-$

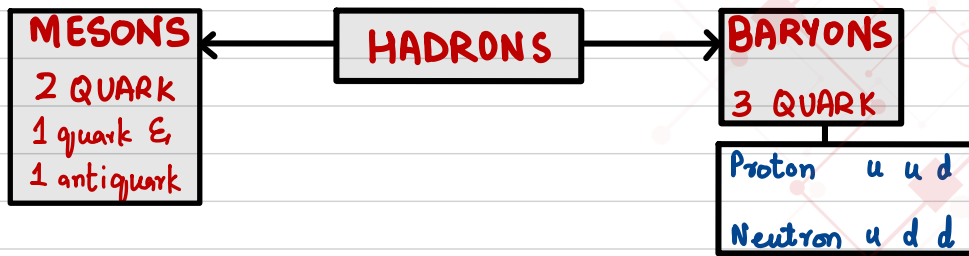
β^+ DECAY:



- In β -Positron decay, one proton breaks into neutron & β -Positron.
 $p = n + \beta^+$

γ -DECAY:



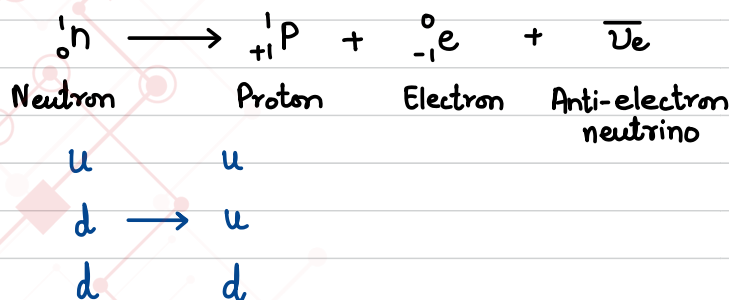


	Up (u)	Down (d)	Top (t)	Bottom (b)	Strange (s)	Charm (c)
Charge of Quark	$+\frac{2}{3}e$	$-\frac{1}{3}e$	$+\frac{2}{3}e$	$-\frac{1}{3}e$	$-\frac{1}{3}e$	$+\frac{2}{3}e$
Charge of Anti Quark	$-\frac{2}{3}e$	$+\frac{1}{3}e$	$-\frac{2}{3}e$	$+\frac{1}{3}e$	$+\frac{1}{3}e$	$-\frac{2}{3}e$

- Quark & antiquark has same magnitude of charge & mass but opposite sign of charge.

CHARGE OF PROTON			CHARGE OF NEUTRON		
u	u	d	u	d	d
$+\frac{2}{3}e$	$+\frac{2}{3}e$	$-\frac{1}{3}e$	$+\frac{2}{3}e$	$-\frac{1}{3}e$	$-\frac{1}{3}e$
$\frac{+2e + 2e - e}{3}$			$\frac{+2e - e - e}{3}$		
$\frac{+4e - e}{3}$			$\frac{+2e - 2e}{3}$		
$\frac{+3e}{3}$			$\frac{0e}{3}$		
$+e$			0		

Q Figure out if quark composition remains conserved or not.



Strong nuclear forces binds the nucleus & makes quark composition conserved.

Quark composition is not conserved. In this reaction one down quark has converted into one up quark.

Weak nuclear force is responsible for this beta electron decay.





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O/A LEVEL & IGCSE PHYSICS

'Yesterday is not ours to recover, but tomorrow is ours to win or to lose'

Lyndon B. Johnson

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