MOIZ DAWOODI

O/A LEVEL & IGCSE PHYSICS

# AS LEVEL PHYSICS 9702

## IMPORTANT FORMULAE, DEFINTIONS REASONABLE ESTIMATES & CONCEPTS

STUDENT NAME

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PHYSICS WITH MOIZ DAWOODI


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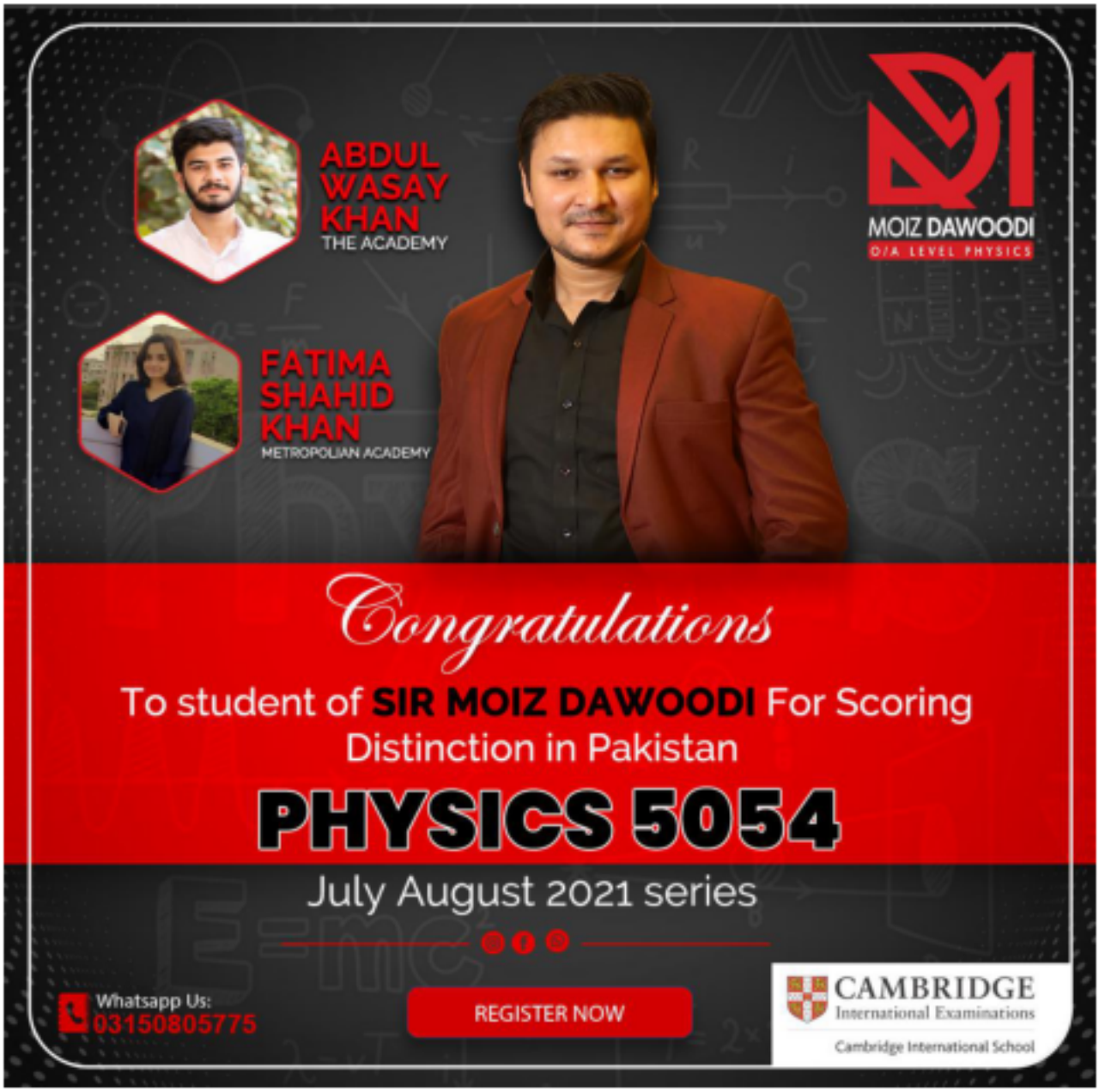
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Reasonable Estimates

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# REASONABLE ESTIMATES:

- Number of apples in 1 kg bag: 4-6 apples
- Diameter of nucleus: $1.75 \times 10^{-15}$ m
- Diameter of proton: $1 \times 10^{-15}$ m
- Diameter of neutron: $2.2 \times 10^{-15}$ m
- Diameter of an electron: Less than $10^{-15}$ m
- Diameter of an atom: 0.1nm - 0.5nm
- Diameter of an earth: $12.8 \times 10^{6}$ m
- Diameter of moon: $3.47 \times 10^{6}$ m
- Diameter of sun: $7 \times 10^{8}$ m
- Diameter of pencil: 0.5-1 cm
- Diameter of hair: $5 \times 10^{-4}$ 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: $1.2 \times 10^3$ 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: $2 \times 10^3$ - $9 \times 10^3$ cm$^3$
- Volume of a nucleus: $2.8 \times 10^{-45}$ m$^3$
- Volume of a cup of tea: 1000 - 3000 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 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 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 s
- Height of room in a house: 2-3 m
- Distance between Earth & Sun: $1.5 \times 10^{11}$ m
- Thickness of sheet of paper. 0.05 - 0.15 mm
- Length of a car: 4 m
- Kinetic energy of an 80 kg athelete: $4 \times 10^3$ J

- No. of Joules of energy in 1 KiloWatt: $3.6 \times 10^6$ 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 KJ
- Audible frequency: 20 - 20,000 Hz
- Frequency of x-rays: $3 \times 10^{16} - 3 \times 10^{19}$ Hz
- Wavelength of red light: 700 nm
- Wavelength of visible light: 400 - 700 nm
- Wavelength of whole Electromagnetic Spectrum: $10 \times 10^{-12} - 100 \times 10^{6}$ m
- Current in overhead supply cable: 100 - 300 A
- Power of hair dryer: 1000 - 2000 W
- Resistance of filament lamp: 300 - 3000 Ω
- Average age of human: 65 years

A'Levels

# Important Formulae

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## 01 Physical Quantities & Units

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



## 02 Kinematics

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

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

## 03 Dynamics

| QUANTITY | INFORMATION | FORMULA |
|---|---|---|
| Momentum | P = Momentum<br>m = Mass<br>v = Velocity | $P = mv$ |
| Resultant Force | $\Sigma F$ = Resultant Force<br>m = Mass<br>a = Acceleration<br>$\Delta P$ = Momentum Change<br>t = Time | $\Sigma F = ma$ or $\Sigma F = \frac{\Delta P}{t}$ |
| Gravitational Field strength | g = Gravitational Field strength<br>F = Force<br>m = Mass | $g = \frac{F}{m}$ |
| Weight | g = Gravitational Field strength<br>W = Weight<br>m = Mass | $W = mg$ |
| Principle of conservation of momentum | $m_1$ = Mass of body 1<br>$u_1$ = Velocity of body 1 before collision<br>$v_1$ = Velocity of body 1 after collision<br>$m_2$ = Mass of body 2<br>$u_2$ = Velocity of body 2 before collision<br>$v_2$ = 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<br>F = Force<br>d = Perpendicular distance | $M = F d$ |
| Principle of moment | $F_1, F_2, F_3, F_4$ = Force<br>$d_1, d_2, d_3, d_4$ = Perpendicular Distance | $\Sigma CWM = \Sigma ACWM$<br>$F_1 d_1 + F_2 d_2 = F_3 d_3 + F_4 d_4$ |
| Density | $\rho$ = Density<br>m = Mass<br>V = Volume | $\rho = \frac{m}{V}$ |
| Volume | V = Volume<br>r = radius | Sphere: $V = \frac{4}{3} \pi r^3$ |
| Pressure | P = Pressure<br>F = Force<br>A = Area | $P = \frac{F}{A}$ |
| Hydrostatic Pressure | g = Gravitational Field strength<br>P = Pressure<br>$\rho$ = Density<br>h = Depth | $P = \rho g h$ |
| Upthrust | g = Gravitational Field strength<br>P = Pressure<br>$\rho$ = Density<br>V = Volume | $U = \rho g V$ |

## 05 Deformation of Solids

| QUANTITY | INFORMATION | FORMULA |
|---|---|---|
| Hooke's Law | F = Force<br>k = Spring Constant<br>e = Extension<br>$\sigma$ = Stress | $F = k e$ |
| Stress | F = Force<br>A = Area | $\sigma = \frac{F}{A}$ |
| Strain | $\varepsilon$ = Strain<br>e = Extension<br>L = Length | $\varepsilon = \frac{e}{L}$ |

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

## 06 Energy, Work & Power

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

## 07 Waves

| QUANTITY | INFORMATION | FORMULA |
|---|---|---|
| Frequency | f = Frequency<br>T = Time Period | $f = \frac{1}{T}$ |

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

## 08 Superposition

| QUANTITY | INFORMATION | FORMULA |
|---|---|---|
| Wavelength of stationary wave on string<br><br>Wavelength of stationary wave in open pipe | $N$ = No. of Harmonics<br>$L$ = Length of string/Pipe<br>$\lambda_N$ = Wavelength of $N^{th}$ Harmonic | $\lambda_N = \frac{2L}{N}$<br><br>$N = 0, 1, 2, 3, \ldots$ |
| Frequency of stationary wave on string<br><br>Frequency of stationary wave in open pipe | $N$ = No. of Harmonics<br>$f_1$ = Fundamental Frequency<br>$f_N$ = Frequency of $N^{th}$ Harmonic | $f_N = Nf_1$<br><br>$N = 0, 1, 2, 3, \ldots$ |
| Fundamental Frequency of stationary wave on string<br><br>Fundamental Frequency of stationary wave in open pipe | $f_1$ = Fundamental Frequency<br>$L$ = Length of string/Pipe<br>$V$ = Speed of wave | $f_1 = \frac{V}{2L}$ |

| | | |
|---|---|---|
| Wavelength of stationary wave in closed pipe | N = No. of Harmonics<br>L = Length of string/Pipe<br>$\lambda_N$ = Wavelength of $N^{th}$ Harmonic | $\lambda_N = \frac{4L}{N}$<br>$N = 0, 1, 2, 3, \ldots$ |
| Frequency of stationary wave in closed pipe | N = No. of Harmonics<br>$f_1$ = Fundamental Frequency<br>$f_N$ = Frequency of $N^{th}$ Harmonic | $f_N = Nf_1$<br>$N = 1, 3, 5, \ldots$ |
| Fundamental Frequency of stationary wave in closed pipe | $f_1$ = Fundamental Frequency<br>L = Length of string/Pipe<br>V = Speed of wave | $f_1 = \frac{V}{4L}$ |
| Young's Double Slit Experiment<br><br>Diffraction Grating | x = Fringe Separation<br>$\lambda$ = Wavelength<br>D = Distance b/w slits & screen<br>a = Slit Separation<br><br>$\lambda$ = Wavelength<br>d = Diffraction grating<br>n = No. of orders<br>$\theta$ = Angle b/w two rays | $x = \frac{\lambda D}{a}$<br><br>$\lambda = \frac{d \sin\theta}{n}$ |

## 09 Electricity

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

| | | |
|---|---|---|
| Voltage | V = Voltage<br>W = Work<br>q = Charge | $V = \frac{W}{q}$ |
| Power | P = Power<br>I = Current<br>V = Voltage<br>R = Resistance | $P = IV$<br>$P = I^2R$<br>$P = \frac{V^2}{R}$ |
| Ohm's Law | I = Current<br>V = Voltage<br>R = Resistance | $V = IR$ |
| Resistivity | ρ = Resistivity<br>R = Resistance<br>A = Cross-Sectional Area<br>L = Length | $\rho = \frac{RA}{L}$ |

## 10 DC Circuits

| QUANTITY | INFORMATION | FORMULA |
|---|---|---|
| Emf | E = Emf<br>W = Work<br>q = Charge | $E = \frac{W}{q}$ |
| Emf with Internal Resistance | E = Emf<br>I = Current<br>r = Internal Resistance<br>R = External Resistance<br>V = Terminal Voltage | $E = V + Ir$<br>$E = I(R+r)$ |
| Kirchoff 1ST Law<br>Kirchoff Current Law | I = Current entering the node<br>$I_1, I_2$ = Current leaving the node | $I = I_1 + I_2$ |
| Kirchoff 2ND Law<br>Kirchoff Voltage Law | E = Emf<br>I = Current<br>$R_1, R_2$ = Resistance | $E = IR_1 + IR_2$ |
| Equivalent Resistance in Series | R = Equivalent Resistance<br>$R_1, R_2, R_3$ = Individual Resistance in series. | $R = R_1 + R_2 + R_3$ |

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

A'Levels Important Definitions & Concepts

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## 01 Physical Quantities & Units

**ERROR:**
"The difference b/w measured & actual value."

**SYSTEMATIC ERROR:**
"A constant error which rises 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."



**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."

**ACCELARATION:**
"Change in velocity per unit time."

**UNIFORM ACCELATION:**
"Same increase in velocity per unit time."

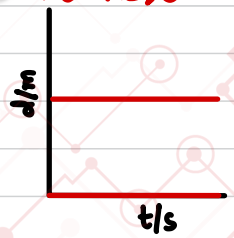
**UNIFORM DECCELERATION:**
"Same decrease in velocity per unit time."



## 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

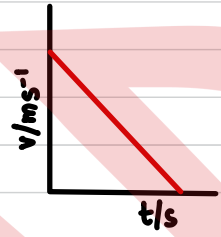

- Uniform Velocity


- Uniform Acceleration

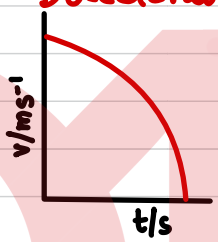

- Increasing Acceleration


- Decreasing Acceleration


- Uniform Deceleration




- Increasing Deceleration

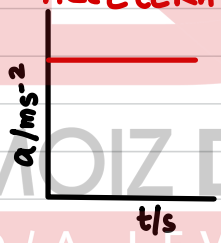



- Decreasing Deceleration


## ACCELERATION - TIME GRAPHS:

- ZERO ACCELERATION


- UNIFORM ACCELERATION




- INCREASING ACCELERATION


- DECREASING ACCELERATION

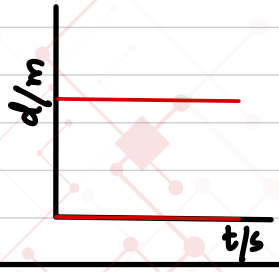

- UNIFORM DECCELERATION

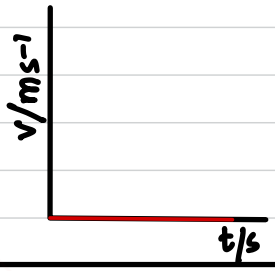

- INCREASING DECCELERATION

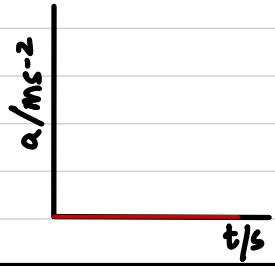

- DECREASING DECCELERATION


## MOTION GRAPH CONVERSIONS:

At Rest
v = 0
a = 0

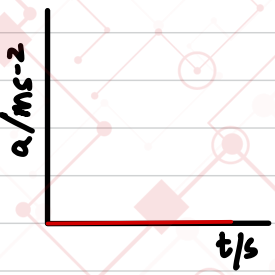


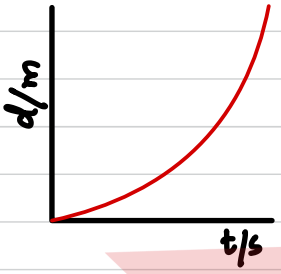



**Uniform Velocity**
$a = 0$



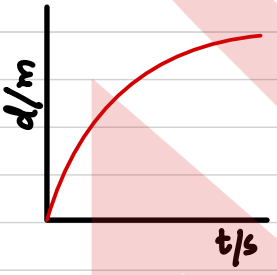



**Uniform Acceleration**



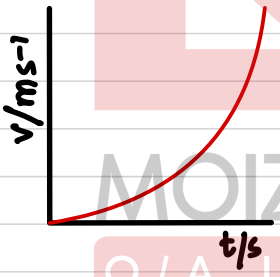


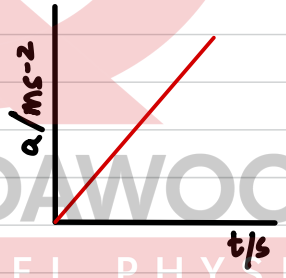

**Uniform Deceleration**






**Increasing Acceleration**

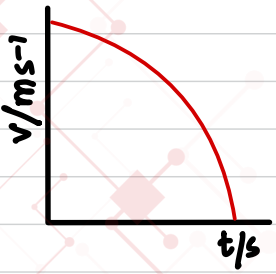


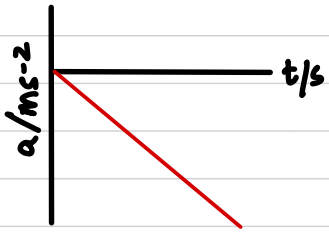




**Decreasing Acceleration**

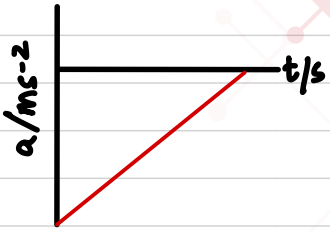


**Increasing Deceleration**



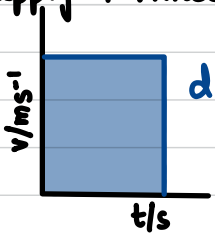



Decreasing Deceleration

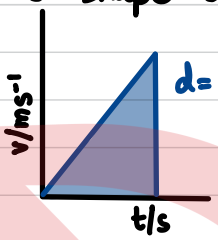




## AREA UNDER GRAPH:

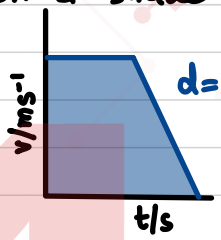
When velocity time graph is given & displacement needs to be found, apply formula of area of shape of the graph & shade it.




$d = l \times b$




$d = \frac{1}{2} l \times b$




$d = \frac{1}{2}(P_1 + P_2)h$

# 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.

$$\frac{1}{2}m_1u_1^2 + \frac{1}{2}m_2u_2^2 = \frac{1}{2}m_1v_1^2 + \frac{1}{2}m_2v_2^2$$

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."

## 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 permenantly 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."

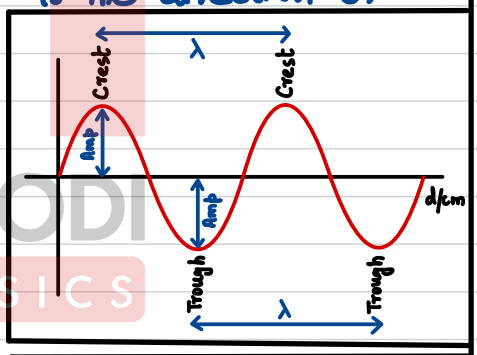
**PRINCIPLE OF CONSERVATION OF ENERGY:**
"Energy can't be created or destroyed but can be converted from one form to another provided that total energy remains conserved."

## 07 Waves

**WAVE OR WAVE MOTION:**
"Disturbance in the medium which transfers energy without transferring the medium."

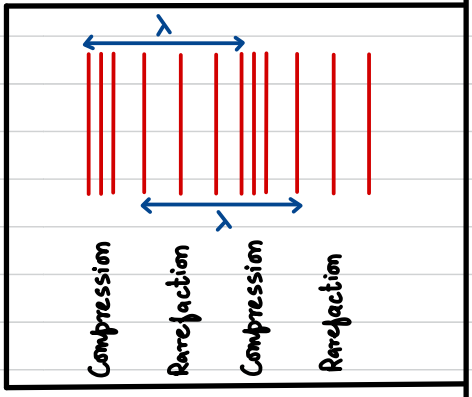
**TRANSVERSE WAVE:**
"Wave in which particles vibrate perpendicular to the direction of propagation of wave."

**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 | $10^{-3} - 10^{-1}$ | $10^{-2} - 10^{-6}$ | $4\times10^{-7} - 7\times10^{-7}$ | $10^{-7} - 10^{-9}$ | $10^{-9} - 10^{-12}$ & 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."

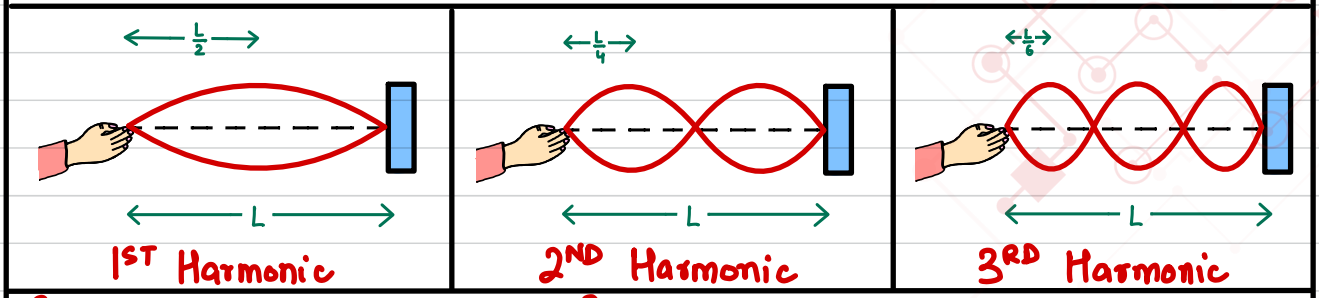
**FORMATION OF STATIONARY WAVE:**
"When two waves having same speed, frequency & amplitude travelling in opposite direction overlap, then stationary wave is formed."

**NODE:**
"The point on stationary wave where amplitude is zero."

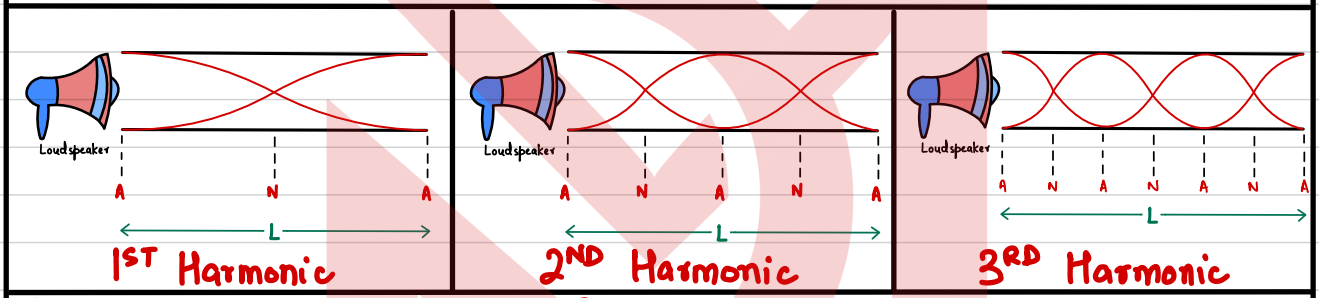
## ANTINODE:

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

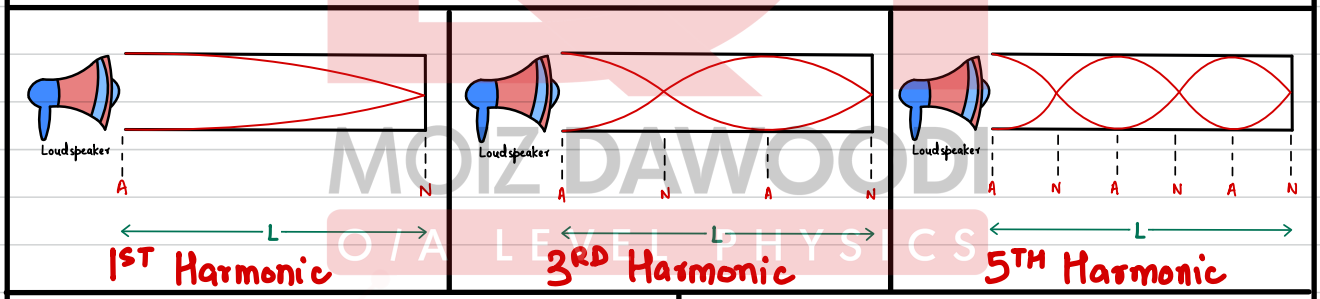
## STATIONARY WAVE ON STRING:




## STATIONARY WAVE IN OPEN PIPE:



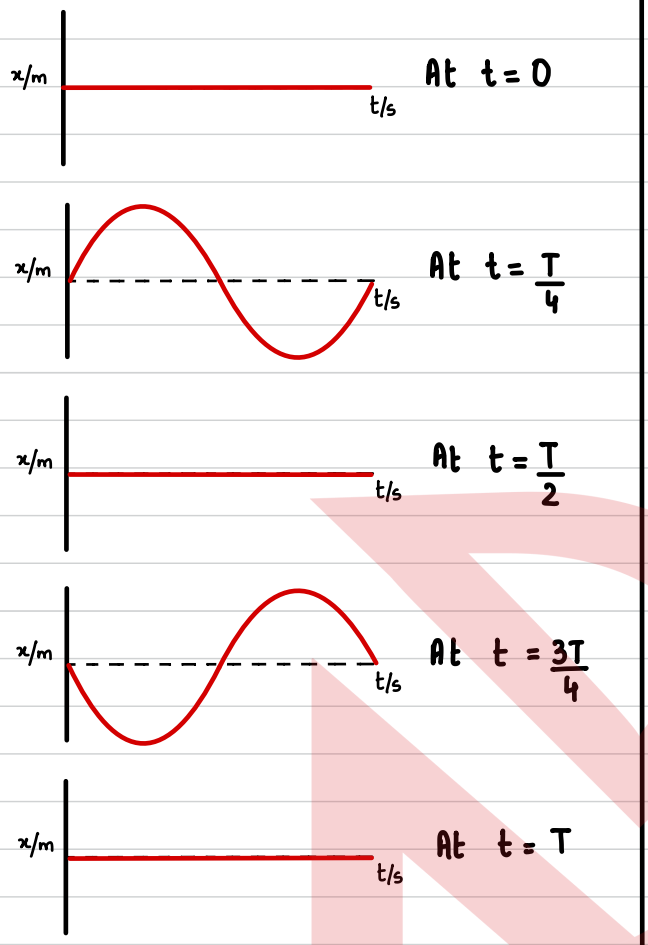

## STATIONARY WAVE IN CLOSED PIPE:

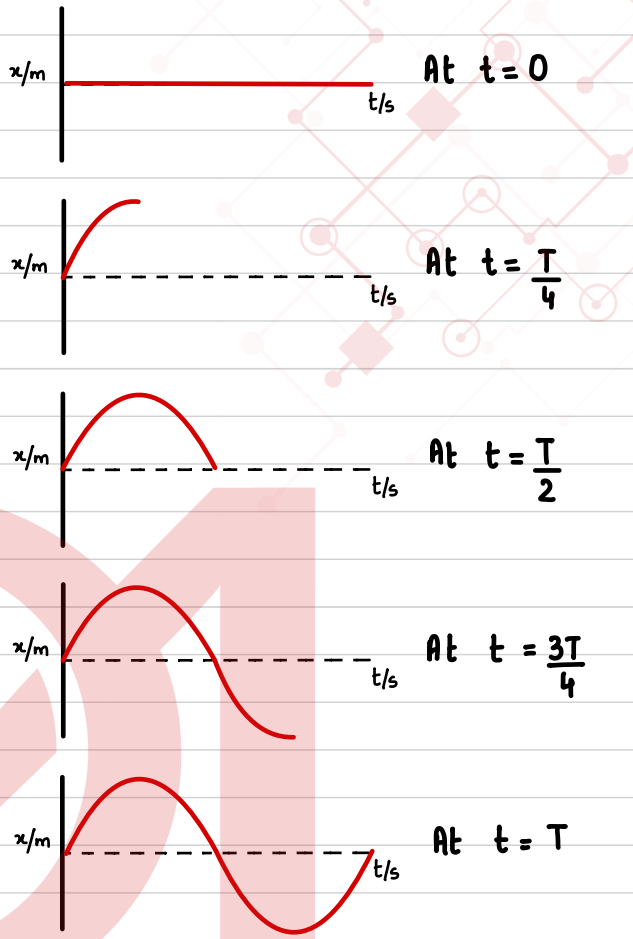





| STATIONARY WAVES | PROGRESSIVE WAVES |
|---|---|
| • Stationary wave donot transfer energy from one place to another. | • Progressive Wave transfers energy from one place to another without transferring the matter. |
| • In Stationary Waves, all the points b/w successive nodes are in phase. | • In Progressive Wave, two adjacent points are not in same phase |
| • In Stationary Waves, amplitude varies from zero at node & maximum at antinode. | • In Progressive Wave, each point achieve same amplitude. |

## Motion Of One Complete Wave



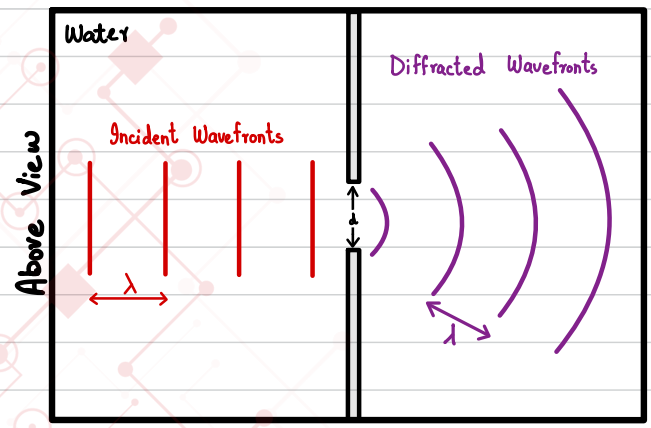

**DIFFRACTION:**

"Spreading of wave as it passes through narrow/wide gaps 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.

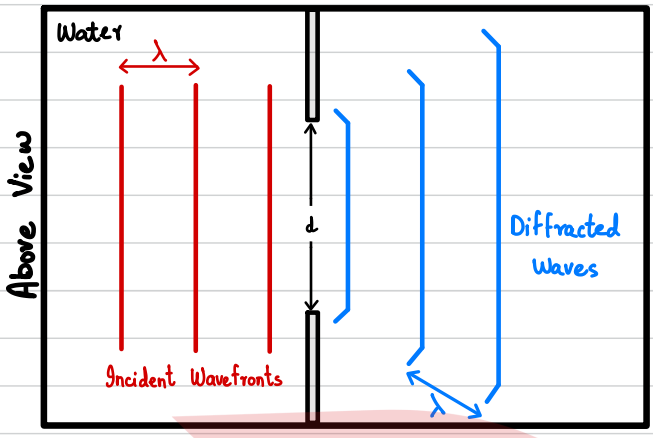



Here:

- 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 = $0\lambda, 1\lambda, 2\lambda, 3\lambda \ldots$ $n = 0,1,2,3,\ldots$

Phase Difference = $0^\circ, 360^\circ, 720^\circ, 1080^\circ, \ldots$

## Destructive Interference.

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

This happens when Path Difference = $0.5\lambda, 1.5\lambda, 2.5\lambda, 3.5\lambda$ $n = 0,1,2,3,\ldots$

Phase Difference = $180^\circ, 540^\circ, 900^\circ, 1280^\circ, \ldots$



## 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 $1/R$.
- 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. 



## 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.

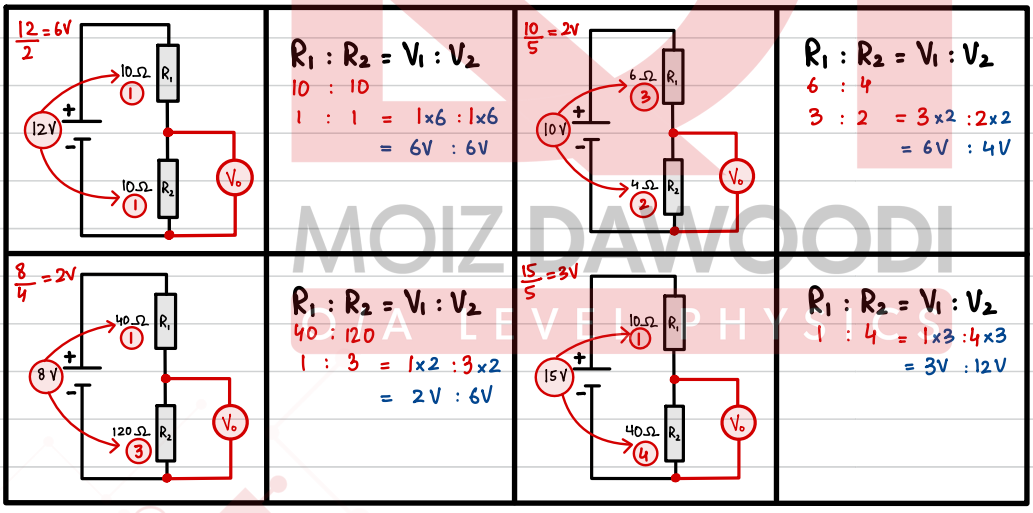
## EMF SOURCES IN PARALLEL:

Emf remains same in parallel

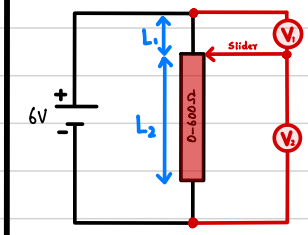
- Life of cells increases in parallel.
- If one cell runs down other works

- Current remains same in series.
- Voltage/emf remains same in parallel.

## RATIO METHOD:

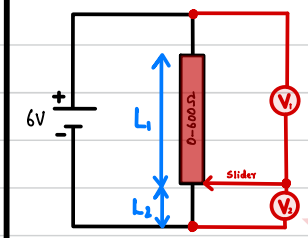


## Potential Divider With Variable Resistor:



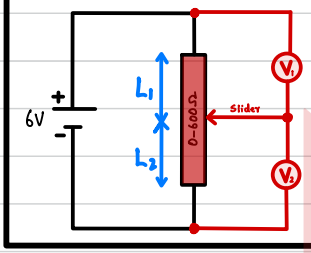

Since $L_1 = 0$, so $R_1 = 0$ hence $V_1 = 0$

Since $L_2$ = max., so $R_2$ = max. hence $V_2$ = max. = 6V




Since $L_1$ = max., so $R_1$ = max. hence $V_1$ = max. = 6V

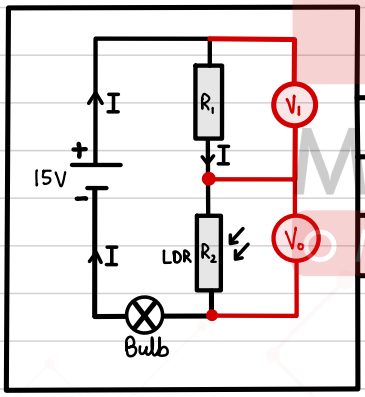
Since $L_2 = 0$, so $R_2 = 0$ hence $V_2 = 0$




Since $L_1$ = half, so $R_1$ = half hence $V_1$ = half = 3V

Since $L_2$ = half, so $R_2$ = half hence $V_2$ = half = 3V

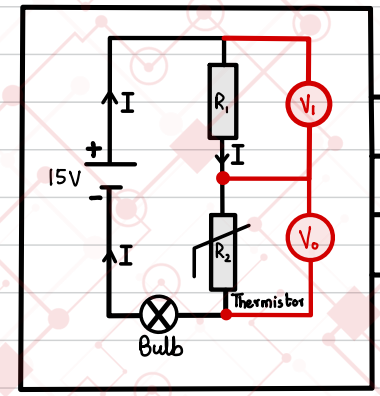
## Potential Divider With LDR:




| Light | $R_{LDR}$ | I | $V_o$ | $V_1$ | 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.

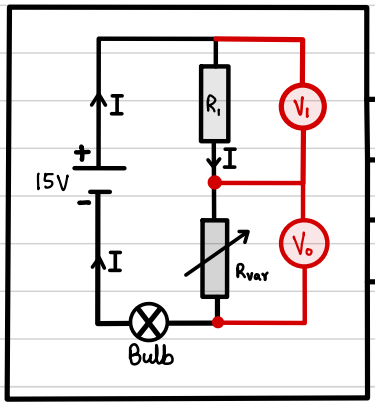
## Potential Divider With Thermistor:




| Heat | $R_T$ | I | $V_o$ | $V_1$ | 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 | $V_o$ | $V_1$ | 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.

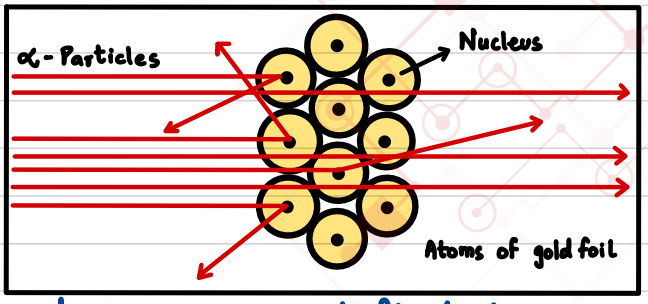
## Potentiometer:

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

## Circuit Symbols:

| Symbol | Component | Symbol | Component | Symbol | Component |
|---|---|---|---|---|---|
| DC | Cell | | Thermistor | | Transformer |
| DC | Battery | | LDR | | Speaker |
| DC | Power Supply | | Fuse | | Cross Wires |
| DC | Variable Power Supply | A | Ammeter | | Joint Wires |
| AC | Alternating Current Source | V | Voltmeter | | Earth Connection |
| | Open Switch | | Galvanometer | | Relay |
| | Close Switch | M | Motor | | |
| | Two way Switch | | Bulb | | |
| | Resistor | | Diode | | |
| | Variable Resistor | | LED | | |
| | Heater | M | 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. ${}^{4}_{2}\alpha = {}^{4}_{2}He$ | Equivalent to fast moving electrons ${}^{0}_{-1}e = {}^{0}_{-1}\beta$ | Member of electro magnetic 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 | $1.5 \times 10^{7}\ ms^{-1}$ | $2.7 \times 10^{8}\ ms^{-1}$ | $3 \times 10^{8}\ ms^{-1}$ |

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

## α - DECAY:

$$^{A}_{Z}X \rightarrow {}^{4}_{2}\alpha + {}^{A-4}_{Z-2}Y$$

## $\beta^{-1}$ DECAY:

$$^{A}_{Z}X \rightarrow {}^{0}_{-1}\beta + {}^{A}_{Z+1}Y + {}^{0}_{0}\overline{\nu}_e \text{ (Electron anti neutrino).}$$

- In β-electron decay, one neutron breaks into proton & β-electron.

$$n = p + \beta^{-1}$$

## $\beta^{+1}$ DECAY:

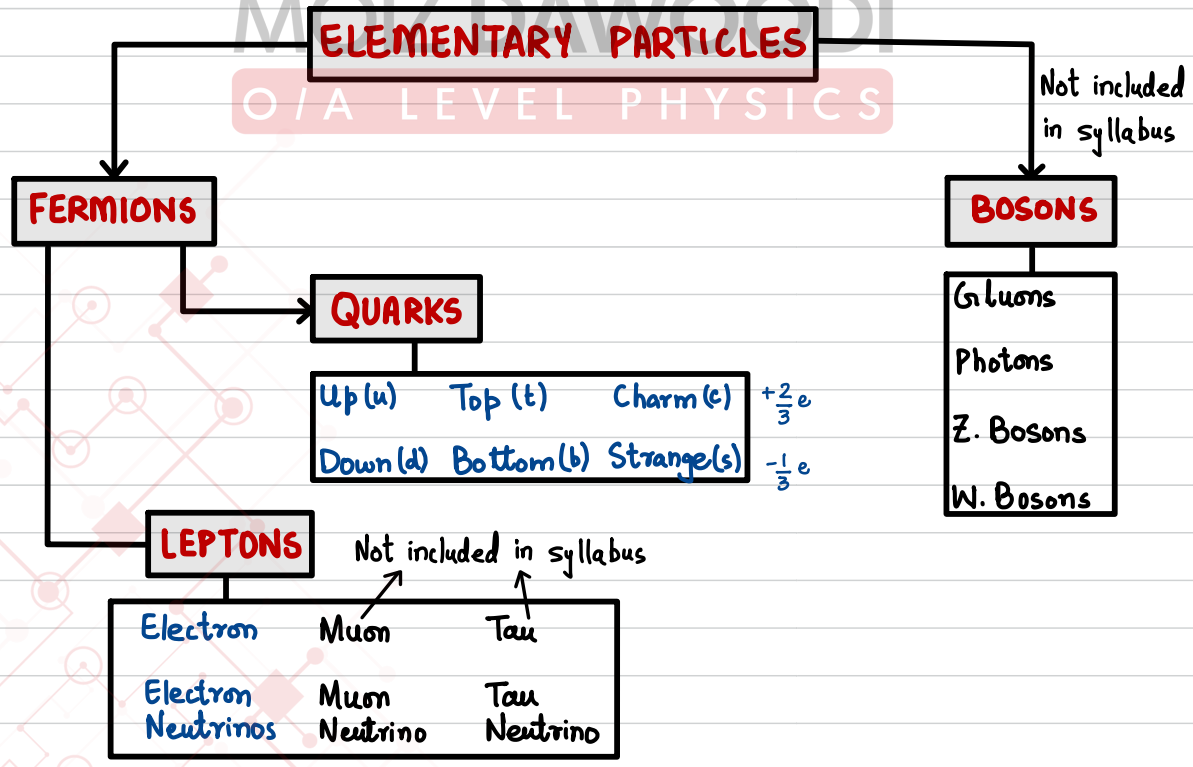
$$^{A}_{Z}X \rightarrow {}^{0}_{+1}\beta + {}^{A}_{Z-1}Y + {}^{0}_{0}\nu_e \text{ (Electron neutrino).}$$

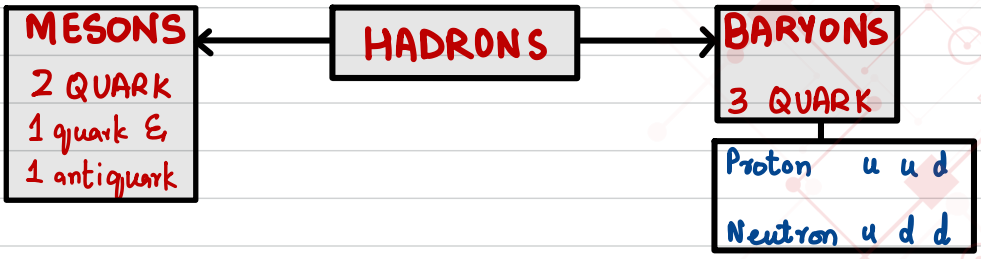
- In β-Positron decay, one proton breaks into neutron & β-Positron.

$$p = n + \beta^{+1}$$

## γ - DECAY:

$$^{A}_{Z}X^{*} \rightarrow {}^{0}_{0}\gamma + {}^{A}_{Z}X$$






| | 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**

u u D

$+\frac{2}{3}e \quad +\frac{2}{3}e \quad -\frac{1}{3}e$

$\frac{+2e+2e-e}{3}$

$\frac{+4e-e}{3}$

$\frac{+3e}{3}$

$+e$

**CHARGE OF NEUTRON**

u D D

$+\frac{2}{3}e \quad -\frac{1}{3}e \quad -\frac{1}{3}e$

$\frac{+2e-e-e}{3}$

$\frac{+2e-2e}{3}$

$\frac{0e}{3}$

$0$



Q Figure out if quark composition remains conserved or not.

$${}^{1}_{0}n \longrightarrow {}^{1}_{+1}P + {}^{0}_{-1}e + \overline{\nu}e$$

Neutron — Proton — Electron — Anti-electron neutrino

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

$$d \longrightarrow u$$

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.

# MOIZ DAWOODI

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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