Physics

1. Mechanics

- Mechanics is a branch of physics that studies **motion** and the **forces** that cause it.
- It has two parts:
    1. **Kinematics** – Study of motion **without forces**.
    2. **Dynamics** – Study of **forces** and their **effects on motion**.

2. Scalars and Vectors

- **Scalar Quantity**: Needs **only magnitude** (number + unit).
  Examples: Mass, distance, speed, time, temperature.
- **Vector Quantity**: Needs **magnitude and direction**.
  Examples: Displacement, velocity, force, acceleration.

3. Representation of Vectors

- Vectors are shown with **arrows**.
  Length = magnitude, arrow direction = direction of vector.
- Written as: **→v**, **→F**, etc.
- Measured from **x-axis** in **anticlockwise** direction using **angles**.

4. Resultant Vector

- The **combined effect** of two or more vectors.
- Use **head-to-tail** method to find resultant.
- Resultant vector = from **start of first vector** to **end of last vector**.

5. Rest and Motion

- A body is in **rest** if it **does not change position** with respect to surroundings.
- A body is in **motion** if it **changes position** with respect to surroundings.
- Motion is **relative** – it depends on the observer's point of view.

6. Types of Motion

1. **Translatory Motion**: Whole body moves in **same direction**.
    - **Linear Motion**: Along a straight line (e.g., falling object).
    - **Random Motion**: In an irregular path (e.g., flying bee).
    - **Circular Motion**: Along a circle (e.g., moving ball in a circle).
2. **Rotatory Motion**: Body rotates around a **fixed axis** (e.g., fan blades).
3. **Vibratory Motion**: Body moves **back and forth** (e.g., swing).

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7. Distance and Displacement

- **Distance**: Actual path covered; scalar.
- **Displacement**: **Shortest straight line** from start to end; vector.

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8. Speed and Velocity

- **Speed** = Distance ÷ Time (scalar).
- **Velocity** = Displacement ÷ Time (vector).
- **Instantaneous Speed**: Speed at a given moment (shown on speedometer).
- **Average Speed** = Total distance ÷ Total time.
- **Average Velocity** = Total displacement ÷ Total time.

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9. Uniform and Non-uniform Velocity

- **Uniform Velocity**: Speed and direction remain **same**.
- **Non-uniform Velocity**: Speed or direction or both **change**.

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10. Acceleration

- Acceleration = Rate of Change of velocity in unit Time.
- **Positive acceleration** = Speeding up (When Velocity is increasing).
- **Negative acceleration (Retardation)** = Slowing down (When Velocity is decreasing).
- **Uniform acceleration** = When Same rate of change of velocity.
- **Non-uniform acceleration** = When Different rates of change of velocity.

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11. Graphical Representation of Motion

- Use **graph** to show motion.
- **x-axis** = time (independent variable).
- **y-axis** = distance or velocity (dependent variable).
- Origin is the point **(0, 0)**.
- Useful for understanding changes in speed or position over time.

Graphical Analysis of Motion

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12. Distance-Time Graph

Definition: A graph showing how distance changes with time.

Key Points:

1. Time is taken along the **x-axis**, and distance along the **y-axis**.
2. A **straight line** means **uniform speed** (equal distance in equal time).
3. A **curved upward line** means **increasing speed** (acceleration).
4. A **curved downward line** means **decreasing speed** (deceleration).
5. A **horizontal line** means the object is **not moving** (at rest).

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13. Gradient of a Distance-Time Graph

Definition: Gradient (slope) is the measure of how steep a line is.

Formula:

- Gradient = Change in Distance / Change in Time = $S_2 - S_1$ / $t_2 - t_1$
- It gives the **average speed** of the body.

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14. Speed-Time Graph

Definition: A graph that shows how speed changes with time.

Types of Graphs:

1. **Straight line sloping upward** = **Uniform acceleration**.
2. **Horizontal line** = **Constant speed**.

15. Gradient of a Speed-Time Graph

Definition: Gradient of speed-time graph = **Average acceleration**.

Formula:
Gradient = Change in Speed / Change in Time = $v_2 - v_1$ / $t_2 - t_1$

16. Area Under Speed-Time Graph

Definition: The **area under** a speed-time graph gives the **distance** covered.

For Constant Speed:
Distance = Speed × Time

(Area of rectangle)

For Increasing Speed:
Distance = ½ × Speed × Time

(Area of triangle)

Motion Under Gravity

17. Equations of Motion

Used when a body moves in a straight line with uniform acceleration.

Equations:

1. $v = vi + at$
2. $S = vit + 1/2\ at^2$
3. $v^2 = vi^2 + 2aS$

18. Rules for Solving Problems

- Take **initial velocity vi=0** if body is dropped.
- Take **acceleration (a)** as **positive** if motion is downward.
- Take **acceleration (a)** as **negative** if motion is upward.

19. Free Fall

Definition: When a body falls only under the force of **gravity**.

Key Points:

- Gravity causes **uniform acceleration**.
- This acceleration is called **g = 9.8 m/s²** (take **g = 10 m/s²** for simple calculations).
- The equations of motion become:
- $v=vi + at$
- $S=vit + 1/2\ at^2$
- $v^2= vi^2 + 2aS$

20. Special Note: Theory of Relativity

- Proposed by **Albert Einstein** in **1905**.
- States that **speed of light is always constant** ($\approx 3 \times 10^8$ m/s).
- **Nothing can move faster than light** — this is the **universal speed limit**.