

Focus 1 – Kinematics Terms and Equations

Central Idea / Skill: Rate

Distance and Speed

- Scalar quantities
- Distance is the total length covered between two points.
- + Speed is the change in distance per unit time.

For objects moving at constant speed, its value is given by:

$$\text{speed} = \frac{\text{distance covered}}{\text{time taken}}$$

For objects moving at non-constant speed, the average speed is given by:

$$\text{average speed} = \frac{\text{total distance covered}}{\text{total time taken}}$$

- SI Unit: m/s or m s⁻¹

Displacement, Velocity and Acceleration

- Vector quantities
- Displacement is distance moved in a specified direction
- + Velocity is the change in distance in a specified direction (displacement) per unit time.

$$\text{velocity} = \frac{\text{displacement}}{\text{time taken}}$$

- + Acceleration is the change in velocity per unit time.

For constant acceleration, its value is given by:

$$\text{acceleration} = \frac{\text{change in velocity}}{\text{time}} \quad \text{i.e.} \quad a = \frac{v - u}{t}$$

- SI Unit: m/s² or m s⁻²
- Acceleration occurs when a body is

- (a) Changing magnitude of its speed
- (b) Changing direction



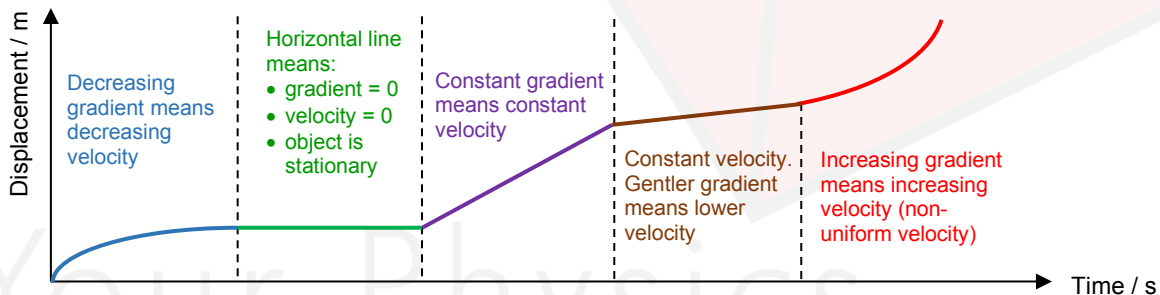
- + A body moving with uniform acceleration experiences a constant rate of change of velocity.

Focus 2 – Motion Graphs

Central Idea / Skill: Gradient and Area

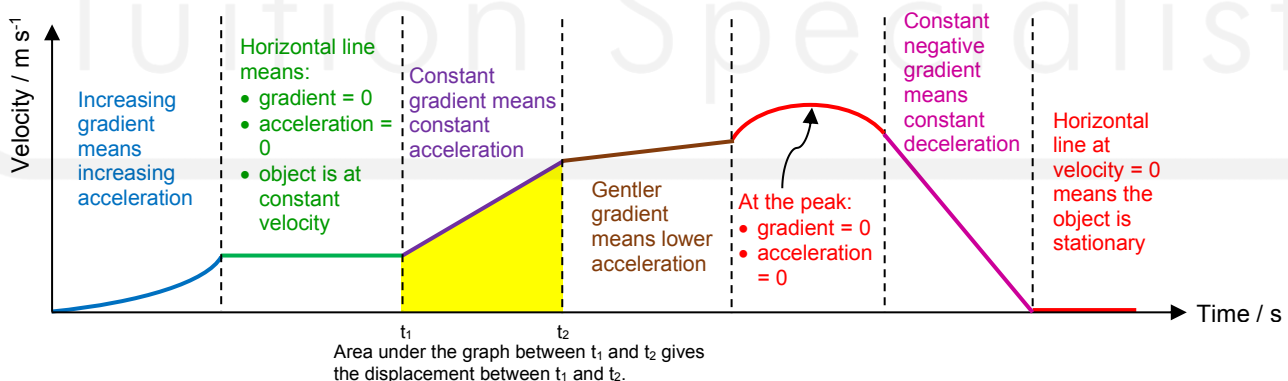
Displacement-Time Graph

- The average velocity can be calculated using average velocity = $\frac{\text{change in displacement}}{\text{time taken}}$.



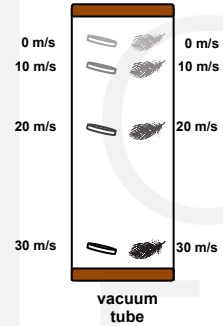
Velocity-Time Graph

- The gradient of velocity-time graph gives the acceleration.
- Area under the velocity-time is equivalent to the displacement of the object.



- Free fall is defined as the motion of an object under the influence of gravity only. The only force acting on the object is its own weight.
- Air resistance tends to slow down a moving object. It has the following properties.
 - It always opposes the motion of objects.
 - It increases with the speed of the object.
 - It increases with cross-sectional area of the object.

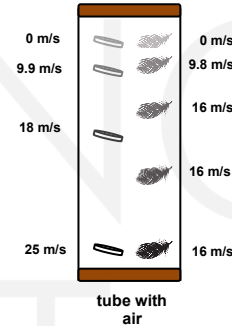
Objects falling without Air Resistance



- In the absence of air resistance, all falling objects fall with the same constant acceleration.
- + This acceleration is known as acceleration of freefall and is determined to be 10 m/s^2 .

Despite having different masses, both coin and feather will fall with the same acceleration.

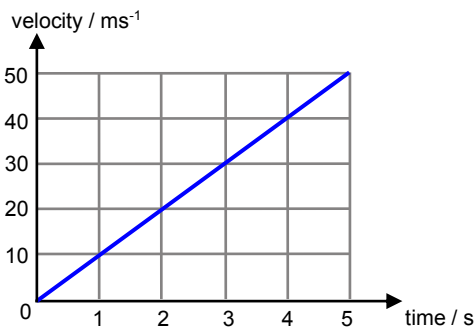
Objects falling with Air Resistance



- When the feather is released, it accelerates under the influence of gravity.
- As it speeds up, the air resistance increases.
- This causes the resultant downward force acting on the feather to decrease. As a result, the acceleration decreases.
- Eventually, the magnitude of the upward air resistance equals the magnitude of the downward weight.
- This leads to the resultant force acting on the feather to be zero. The acceleration also becomes zero and the feather reaches its maximum velocity called the terminal velocity.

The feather has less weight is subjected to greater air resistance due to its larger cross-sectional area. As a result, it reaches a lower terminal velocity in a shorter time.

Velocity-time graph of a free-falling object



Velocity-time graph of a falling object through air

