KINEMATICS

Physical Quantities Representing Motion

Scalars:

- **Distance** (x) is the total length moved by an object irrespective of the direction of motion.
- **Speed** of an object is defined as the rate of change of distance travelled with respect to time.
  - → average speed $= \frac{\Delta x}{\Delta t}$
  - → instantaneous speed $= \frac{dx}{dt}$

Vectors:

- **Displacement** (s) is the shortest linear distance of the position of a moving object from a given reference point.
- **Velocity** of an object is defined as the rate of change of its displacement with respect to time.
  - → average velocity $= \frac{\Delta s}{\Delta t}$
  - → instantaneous velocity $= \frac{ds}{dt}$
- **Acceleration** of an object is defined as the rate of change of its velocity with respect to time.
  - → average acceleration $= \frac{\Delta v}{\Delta t}$
  - → instantaneous acceleration $= \frac{dv}{dt}$
  - → Acceleration can refer to increase or decrease in velocity. Negative acceleration DO NOT necessary indicate that object is slowing down. To determine if object is speeding up or slowing down, compare the directions of the velocity and acceleration vectors. If both velocity vector and acceleration vector are in the SAME direction, object speeds up. If velocity vector and acceleration vector are in OPPOSITE direction, object slows down.

Graphical Representations of Motion

Features	**s – t graph**	**v – t graph**	**a – t graph**
Axes	Displacement	Instantaneous velocity	Instantaneous acceleration
Gradient	Instantaneous velocity $v = \frac{ds}{dt}$	Instantaneous acceleration $a = \frac{dv}{dt}$	----
Area under graph	----	Net change in displacement	Net change in velocity

Rectilinear Motion (1-D Motion)

Equations of Motion (*suvat*)

- ONLY applicable for motion
  - → in a straight line
  - → with constant acceleration
- Need to be able TO DERIVE from definitions of velocity and acceleration.
- (1) $v = u + at$

  (2) $v^2 = u^2 + 2as$

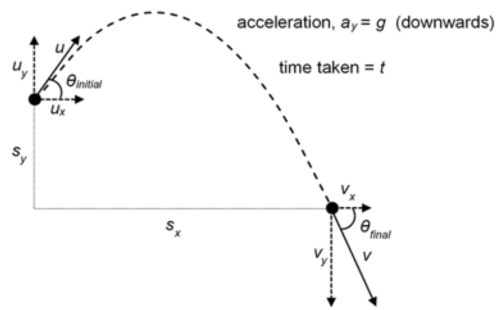
  (3) $s = ut + \frac{1}{2}at^2$

  (4) $s = \frac{1}{2}(u + v)t$

  Remember to take into account sign convention when applying these equations

Projectile Motion (2-D Motion)

- Object projected in a uniform gravitational field with negligible air resistance, results in a parabolic path



- Step 1:
  If you are given the initial velocity, **resolve it into its x and y components.**
- Step 2:
  Analyze the horizontal (x) and vertical (y) motion **separately**.
- Step 3:
  Recall that
  (i) time t links the x and y component motions
  (ii) $a_y = 9.81\ \text{m s}^{-2}$ and is directed downwards
  (iii) at max height, $v_y = 0$
  (iv) $v_x = u_x$ (since $a_x = 0$)
- Step 4 :
  Apply the relevant equations of motion (suvat).
  Remember to take sign conventions into consideration!