SECTION II
NEWTONIAN MECHANICS

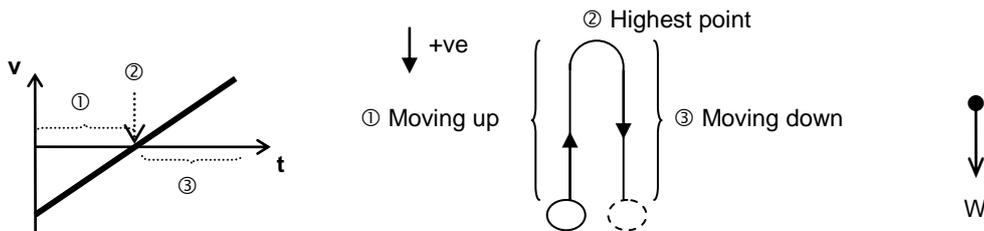|	**Chapter 2: Kinematics**
	- Rectilinear Motion
	- Non-linear Motion
a.	**Define displacement, speed, velocity and acceleration.**
	Distance: Total length covered <u>irrespective of the direction of motion</u>.
	Displacement: Distance <u>moved in a certain direction</u>
	Speed: Distance travelled per unit time.
	Velocity: is defined as the rate of change of displacement, or, displacement per unit time {**NOT**: displacement **over** time, nor, displacement **per second**, nor, rate of change of displacement per unit time}
	Acceleration: is defined as the rate of change of velocity.
b.	**Use graphical methods to represent distance travelled, displacement, speed, velocity and acceleration.**
	Self-explanatory
c.	**Find displacement from the area under a velocity-time graph.**
	The area under a velocity-time graph is the **change** in displacement.
d.	**Use the slope of a displacement-time graph to find velocity.**
	The gradient of a displacement-time graph is the {instantaneous} velocity.
e.	**Use the slope of a velocity-time graph to find acceleration.**
	The gradient of a velocity-time graph is the acceleration.
f.	**Derive, from the definitions of velocity and acceleration, equations that represent uniformly accelerated motion in a straight line.**
g.	**Solve problems using equations which represent uniformly accelerated motion in a straight line, including the motion of bodies falling in a uniform gravitational field without acceleration.**
	1. $v = u + at$: derived from definition of acceleration: $a = (v - u) / t$ 2. $s = \frac{1}{2}(u + v)t$: derived from the area under the v-t graph 3. $v^2 = u^2 + 2as$: derived from equations (1) and (2) 4. $s = ut + \frac{1}{2}at^2$: derived from equations (1) and (2)
	These equations apply only if the motion takes place <u>along a straight line</u> and the <u>acceleration is constan</u> {hence, for eg., air resistance must be negligible.}
h.	**Describe qualitatively the motion of bodies falling in a uniform gravitational field with air resistance.**
	Consider a body moving in a uniform gravitational field under 2 different conditions:
	A WITHOUT AIR RESISTANCE
	Assuming negligible air resistance, whether the body is moving up, or at the highest point or moving down, the weight of the body, W, is the <u>only force</u> acting on it, causing it to experience a <u>constant acceleration</u>. Thus, the <u>gradient</u> of the v-t graph is <u>constant throughout</u> its rise and fall. The body is said to undergo _free_

fall.

B   WITH AIR RESISTANCE
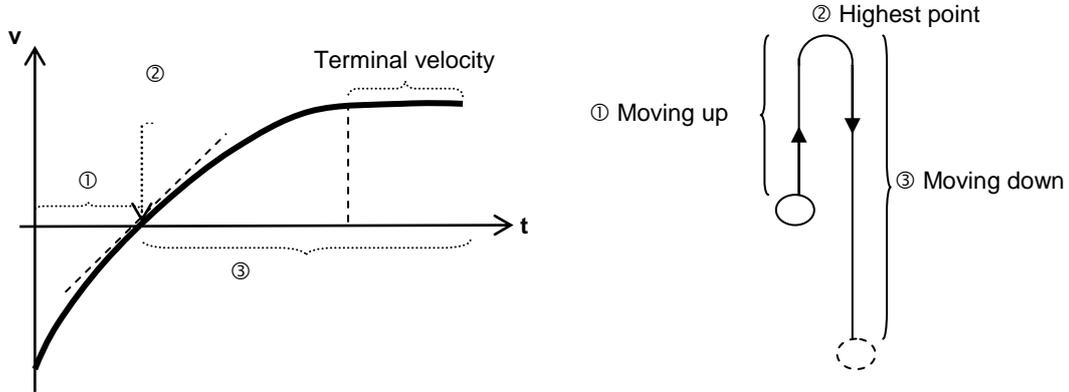
If air resistance is NOT negligible and if it is projected upwards with the same initial velocity, as the body moves upwards, **both** air resistance and weight act **downwards**. Thus its speed will decrease at a rate greater than 9.81 m s^{-2} . This causes the **time taken to reach its maximum height reached to be lower than in the case with no air resistance. The max height reached is also reduced.**

At the highest point, the body is momentarily at rest; air resistance becomes zero and hence the only force acting on it is the weight. The acceleration is thus 9.81 m s^{-2} at this point.

As a body falls, air resistance opposes its weight. The downward acceleration is thus less than 9.81 m s^{-2}. As air resistance increases with speed (Topic 5), it eventually equals its weight (but in opposite direction). From then there will be no resultant force acting on the body and it will fall with a constant speed, called the *terminal velocity.*

i.	**Describe and explain motion due to a uniform velocity in one direction and uniform acceleration in a perpendicular direction.**

Equations that are used to describe the horizontal and vertical motion

	***x* direction (horizontal – axis)**	***y* direction (vertical – axis)**
s (displacement)	$s_x = u_x t$ $s_x = u_x t + \frac{1}{2} a_x t^2$	$s_y = u_y t + \frac{1}{2} a_y t^2$ *(Note: If projectile ends at same level as the start, then s_y = 0)*
u (initial velocity)	u_x	u_y
v (final velocity)	$v_x = u_x + a_x t$ *(Note: At max height, v_x = 0)*	$v_y = u_y + at$ $v_y^2 = u_y^2 + 2 a s_y$
a (acceleration)	a_x (Note: Exists when a force in x direction present)	a_y *(Note: If object is falling, then a_y = -g)*
t (time)	t	t

Parabolic Motion: $\tan \theta = \frac{v_y}{v_x}$

θ: direction of tangential velocity {NOT: $\tan\theta = \frac{s_y}{s_x}$ }