Motion in 1D & 2D Notes

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MOTION:- an object's change in position relative to a reference point

LINEAR MOTION:- motion in a straight line, in one dimension, however, the motion may not be uniform

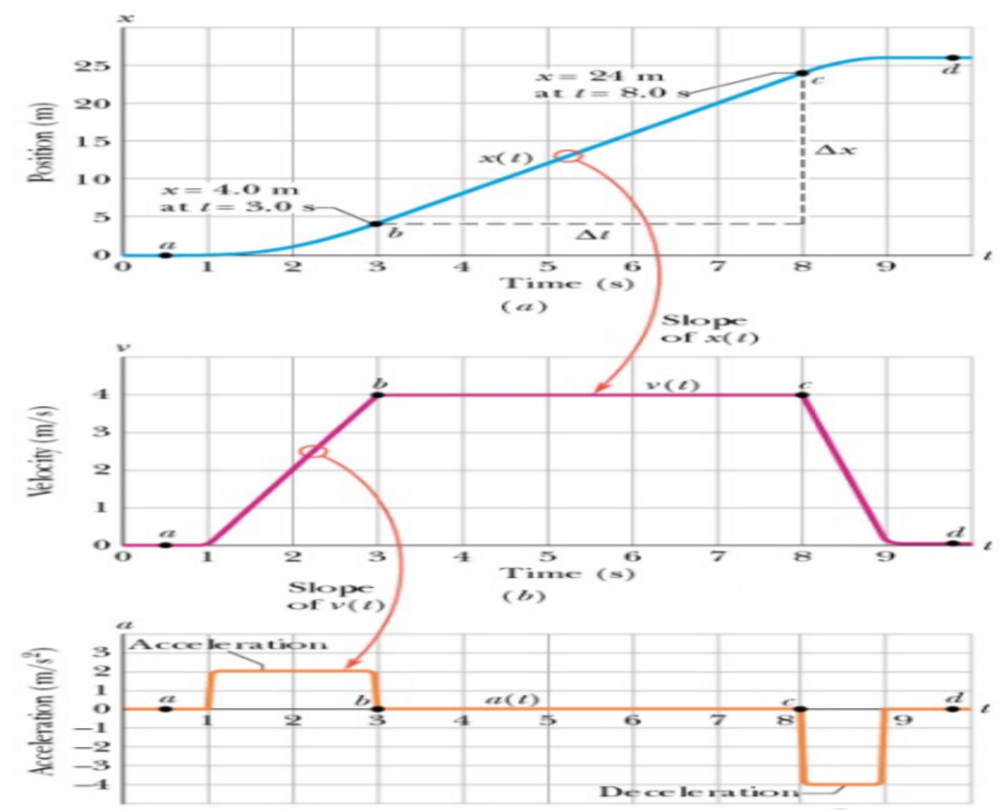
BASIC QUANTITIES IN KINEMATICS:-
- displacement
- velocity
- time
- acceleration

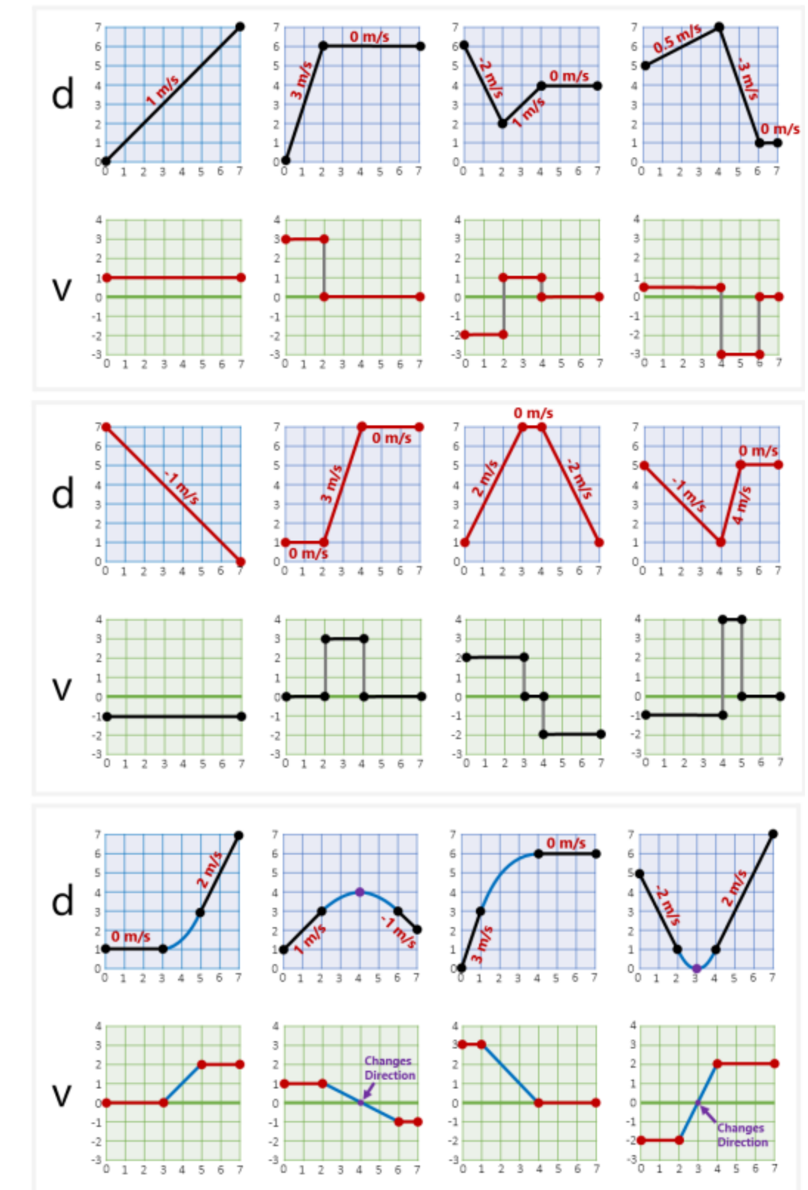
DISPLACEMENT:- change of position in time
- $\Delta x = x_f - x_i$
- distance and position-time graphs, displacement = shortest dist b/w 2 points, distance = whole route.

SPEED:- rate of change of distance
- average speed = $\frac{\text{total distance}}{\text{total time}}$
- instantaneous speed = speed at any given instant of time, what the speedometer reads

VELOCITY:-
- rate of change of displacement
- average velocity = $\frac{\Delta x}{\Delta t} = \frac{x_f - x_i}{\Delta t}$
- instantaneous velocity = $\frac{\Delta x}{\Delta t} = \frac{dx}{dt}$, $v = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} = \frac{dx}{dt}$ (tangent to the particle's path at the particle's position
- measured through slope of distance/position-time graph
- in uniformed velocity, instantaneous velocities are always the same and equal to the average velocity

ACCELERATION:-
- rate of change of velocity
- average $a_x = \frac{\Delta v_x}{\Delta t} = \frac{v_{xf} - v_{xi}}{\Delta t}$
- instantaneous $a_x = \lim_{\Delta t \to 0} \frac{\Delta v_x}{\Delta t} = \frac{dv_x}{dt}$
- slope of velocity-time graph.





MOTION WITH UNIFORM ACCELERATION EQUATIONS:-

① $v = u + at$

② $v^2 = u^2 + 2as$

③ $s = ut + \frac{1}{2}at^2$

Motion in 2D/3D Notes

POSITION AND DISPLACEMENT:-
- position vector extends from the origin of a coordinate system to the particle. $\vec{r} = x\hat{i} + y\hat{j} + z\hat{k}$
- displacement vector represents a particle's position change during a certain time interval. $\Delta r = \vec{r_2} - \vec{r_1} = (x_2 - x_1)\hat{i} + (y_2 - y_1)\hat{j} + (z_2 - z_1)\hat{k}$

VELOCITY:-
- $\vec{v}_{avg} = \frac{\Delta \vec{r}}{\Delta t} = \frac{\Delta x}{\Delta t}\hat{i} + \frac{\Delta y}{\Delta t}\hat{j} + \frac{\Delta z}{\Delta t}\hat{k}$
- instantaneous $\vec{v} = \frac{d\vec{r}}{dt} = \frac{dx}{dt}\hat{i} + \frac{dy}{dt}\hat{j} + \frac{dz}{dt}\hat{k}$

ACCELERATION:-
- $\vec{a}_{avg} = \frac{\vec{v_2} - \vec{v_1}}{\Delta t} = \frac{\Delta \vec{v}}{\Delta t}$
- instantaneous $\vec{a} = \frac{d\vec{v}}{dt} = \frac{dv_x}{dt}\hat{i} + \frac{dv_y}{dt}\hat{j} + \frac{dv_z}{dt}\hat{k}$

→ a free falling object is an object which is falling under the sole influence of gravity

→ free falling objects do not encounter air resistance, and they accelerate downwards at 9.8 m/s²

→ terminal velocity → when force of gravity = force of air resistance

CIRCULAR MOTION:-
- centripital acceleration $a = \frac{v^2}{r}$ (always points towards centre of circle)
- time period $T = \frac{2\pi r}{v}$
- $\tan\theta = \frac{a_y}{a_x}$
- radial acceleration $a_r = \frac{v^2}{r}$
- tangential acceleration $a_t = \frac{d|v|}{dt}$
- total acceleration $a = a_r + a_t$

The trajectory formula assists us in determining the gravitational force acting on an object. It is used to calculate the trajectory or flight path of a moving object that is subject to gravity's pull.

$$y = x\tan\theta - \frac{gx^2}{2u^2\cos^2\theta}$$

y is the vertical component, It represents the height above the launch point.
x is the horizontal component, It represents the horizontal distance traveled by the projectile.
θ is the angle at which projectile is thrown from the horizontal,
g is a constant called the acceleration due to gravity,
u is the initial velocity of projectile.

MORE FORMULAS:-
- The Equation Path → $y = (\tan\theta_0)x - \frac{gx^2}{2(v_0\cos\theta_0)^2}$ (trajectory)
- The Horizontal Range (horizontal dist. travelled when it returns to its initial height) → $R = \frac{v_0^2}{g}\sin 2\theta$, $R_{max} = \frac{v_0^2}{g}$
- Maximum Height → $h = \frac{(v_0\sin\theta)^2}{2g}$
- Total Time $T = \frac{2v_0\sin\theta}{g}$
- $\tan\theta = \frac{a_y}{a_x}$ or $\tan\theta = \frac{v_y}{v_x}$