A few samples of Physics Formula on Class XI Syllabus in +2 Levels:

1. Displacement of a moving particle $\vec{S} = \Delta\vec{r} = \vec{r}_2 - \vec{r}_1$ = Change in Position.

2. Distance traversed by the moving particle d = Length of the total path traversed.

3. The relation between the magnitude of displacement and distance travelled by moving particle is given by $|\vec{S}| \leq d$

4. Velocity of a moving particle is the rate of displacement or the rate of change of position and it is mathematically given by $\vec{v} = \frac{\vec{S}}{\Delta t} = \frac{\Delta\vec{r}}{\Delta t}$

5. Speed of a moving particle is the distance travelled in unit time. This is given by $v_o = \frac{d}{\Delta t}$ where $v_o \geq |\vec{v}|$ and $v_o]_{min} = |\vec{v}|$

6. Instantaneous velocity $\vec{v} = \lim_{\Delta t \to 0} \frac{\Delta\vec{r}}{\Delta t} = \frac{d\vec{r}}{dt}$ where $|\vec{v}|$ = Slope of position-time graph

7. Acceleration of an accelerated particle is estimated by the time rate of change of velocity and is given by $\vec{a} = \frac{\Delta\vec{v}}{\Delta t}$

8. Instantaneous acceleration $\vec{a} = \lim_{\Delta t \to 0} \frac{\Delta\vec{v}}{\Delta t} = \frac{d\vec{v}}{dt}$ where $|\vec{a}|$ = Slope of velocity-time graph

9. Average velocity

$$\vec{v}]_{av} = \frac{\vec{S}_1 + \vec{S}_2 + \vec{S}_3 + \ldots\ldots\ldots}{\Delta t_1 + \Delta t_2 + \Delta t_3 + \ldots\ldots} = \frac{\sum \vec{S}}{\sum \Delta t} = \frac{\text{Total Displacement}}{\text{Total Time}} = \frac{\sum \Delta\vec{r}}{\sum \Delta t}$$

$$= \frac{\text{Total Change of Position}}{\text{Total Time}}$$

10. Average speed $v_o]_{av} = \frac{\text{Total Distance Traversed}}{\text{Total Time}} = \frac{\sum d}{\sum \Delta t}$

11. Average acceleration $\vec{a}]_{av} = \frac{\sum \Delta\vec{v}}{\sum \Delta t} = \frac{\text{Total Change of Velocity}}{\text{Total Time Elapsed}}$

12. Magnitude of total area of velocity-time graph $= \left|\int_{t_1}^{t_2} \vec{v}dt\right| = |\Delta\vec{r}| = |\vec{S}|$

$$= \text{Magnitude of total displacement} = \text{distance travelled in one dimension}$$

13. Magnitude of total area of acceleration-time graph

$$= \left| \int_{t_1}^{t_2} \vec{a} dt \right| = |\Delta \vec{v}| = \text{magnitude of total change of velocity}$$

14. Relative Velocity $\vec{v}_{12} = \vec{v}_1 - \vec{v}_2$; $\vec{v}_{21} = \vec{v}_2 - \vec{v}_1$; $\vec{v}_{12} = - \vec{v}_{21}$; where $|\vec{v}_{12}| = |\vec{v}_{21}| = v_{relative}$ and we also have

$$v_{relative} = |\vec{v}_{12}| = |\vec{v}_{21}| = \sqrt{v_1^2 + v_2^2 - 2v_1v_2 Cos\alpha}$$

15. $[v_{relative}]_{max} = v_1 + v_2$ for v_1 and v_2 in opposite direction, $[v_{relative}]_{min} = v_1 \sim v_2$ for v_1 and v_2 in same direction.

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18. For translational motion with uniform acceleration $\vec{a}$ in one dim we have $v = u \pm at$, $s = ut \pm \frac{1}{2}at^2$, $v^2 = u^2 \pm 2as$.

19. Distance traversed in t^{th} time in one dimension is $S_t = ut \pm \frac{1}{2}a(2t - 1)$

20. For translational motion with non uniform acceleration $\vec{a}$ (t) we have $v(t) = u \pm \int_{t_1}^{t_2} \vec{a}(t) dt$

21. For motion in 2 dimension, velocity $\vec{v} = v_x\hat{i} + v_y\hat{j}$, acceleration $\vec{a} = a_x\hat{i} + a_y\hat{j}$

where $v_x = \frac{dx}{dt}, v_y = \frac{dy}{dt}, v_z = \frac{dz}{dt}$ and $a_x = \frac{d^2x}{dt^2}, a_y = \frac{d^2y}{dt^2}, a_z = \frac{d^2z}{dt^2}$

22. For motion in 3 dimension, velocity $\vec{v} = v_x\hat{i} + v_y\hat{j} + v_z\hat{k}$, acceleration $\vec{a} = a_x\hat{i} + a_y\hat{j} + a_z\hat{k}$

where $v_x = \frac{dx}{dt}, v_y = \frac{dy}{dt}, v_z = \frac{dz}{dt}$ and $a_x = \frac{d^2x}{dt^2}, a_y = \frac{d^2y}{dt^2}, a_z = \frac{d^2z}{dt^2}$

23. For motion of particle in curved path, the radial component of velocity $v_r = \frac{dr}{dt}$, the transverse or cross radial component of velocity $v_\theta = r\frac{d\theta}{dt}$.

24. For motion of particle in curved path, the radial component of acceleration, $a_r = \frac{d^2r}{dt^2} - r\left(\frac{d\theta}{dt}\right)^2$ the transverse or cross radial component of acceleration, $a_\theta = r\frac{d^2\theta}{dt^2} + 2\left(\frac{dr}{dt}\right)\left(\frac{d\theta}{dt}\right)$

25. For motion of particle in circular path, the tangential acceleration $a_t = \frac{dv}{dt}$, the normal acceleration $a_\rho = \frac{v^2}{\rho}$ where ρ is the radius of curvature at the position of particle on the curved path.

26. For a moving particle, its instantaneous velocity cannot be zero but its average velocity may be zero.

27. For a moving particle its instantaneous velocity may change its direction but in a certain interval of time its average velocity will have certain direction for that time interval.

28. For two dimensional motion of a particle it can have one dimensional acceleration. As for example it is true for projectile motion.

29. For circular motion of a particle which is a two dimensional motion, both the velocity and acceleration will be non uniform, but only for uniform circular motion, the speed of that rotating particle will be uniform. So in this case of uniform circular motion of the particle we should have $\frac{d}{dt}(|\vec{v}|) = 0$ where $\left|\frac{d\vec{v}}{dt}\right| \neq 0$

30. For a uniformly accelerated particle with acceleration a, if u be the initial velocity and v be the final velocity of that moving particle in a certain time interval Δt then the average velocity of that particle in that time interval will be $v]_{av} \equiv \frac{S}{\Delta t} = \frac{u+v}{2}$

31. For uniformly accelerated particle its position – time graph will be parabolic.

32. For a moving particle if its acceleration increases or decreases with time at a constant rate then the velocity – time graph for that moving particle will be parabolic with slope of the graph continuously increasing or decreasing with time.

33. For projectile motion with velocity of projection u and angle of projection α, if projectile be thrown from horizontal ground then i) Maximum height reached $H = \frac{u^2 Sin^2\alpha}{2g}$ ii) Time of flight $T = \frac{2uSin\alpha}{g}$ iii) Range of projectile motion $R = \frac{u^2 Sin2\alpha}{g}$; $R_{max} = \frac{u^2}{g}$ at $\alpha = \frac{\pi}{4}$ iv) Equation of the locus of path traversed by the projectile $y = ax + bx^2 = (tan\alpha)x + (-\frac{g}{2u^2Cos^2\alpha})x^2$

34. Projectile be thrown horizontally from a certain height h then basic equations of motion are

$$h = \frac{1}{2}gT^2 \Rightarrow T = \sqrt{\frac{2h}{g}} \ , \quad R = uT = u\sqrt{\frac{2h}{g}}$$

35. Projectile be thrown at an angle α from a certain height h in upward sense then basic equations of motion are $h = -uSin\alpha . T + \frac{1}{2}gT^2$, $R = uCos\alpha . T$

36. Projectile be thrown at an angle α from a certain height h in downward sense then basic equations of motion are $h = uSin\alpha . T + \frac{1}{2}gT^2$, $R = uCos\alpha . T$

37. Projectile be thrown at an angle α with respect to the horizontal direction in upward sense from the bottom of an inclined surface having inclination θ then i) Time of flight $T = \frac{2uSin(\alpha-\theta)}{gCos\theta}$

ii) Range of projectile motion on inclined surface

$$R = \frac{u^2[Sin(2\alpha-\theta) - Sin\theta]}{gCos^2\theta} ; \ R_{max} = \frac{u^2[1 - Sin\theta]}{gCos^2\theta} \text{ at } (2\alpha - \theta) = \frac{\pi}{2}$$

38. Projectile be thrown at an angle α with respect to the horizontal direction in downward sense from the top of an inclined surface having inclination θ then i) Time of flight $T = \frac{2uSin(\alpha+\theta)}{gCos\theta}$ ii) Range of projectile motion on inclined surface

$$R = \frac{u^2[Sin(2\alpha+\theta) + Sin\theta]}{gCos^2\theta} ; \ R_{max} = \frac{u^2[1 + Sin\theta]}{gCos^2\theta} \text{ at } (2\alpha + \theta) = \frac{\pi}{2}$$

39. For projectile motion with velocity of projection u and angle of projection α , if projectile be thrown from horizontal ground then average velocity for the whole motion will be equal to the minimum velocity attend and this is given by

$$v_{av} = \frac{S}{\Delta t} = \frac{R}{T} = \frac{u^2Sin2\alpha/g}{2uSin\alpha/g} = uCos\alpha = v_{min}$$

40. For projectile motion with velocity of projection u and angle of projection α, if projectile be thrown from horizontal ground then for its instantaneous velocity v at any instantaneous position θ we basically have $vCos\theta = uCos\alpha$, $vSin\theta = uSin\alpha - gt$

41. When a swimmer wants to cross the river of width d in shortest path then for his own velocity v and the velocity of the stream of the river u , he should swim at angle θ with the direction of the stream when $Sin(\theta - 90) = \frac{u}{v}$.

In this case the time taken to cross the river by the swimmer is $t = \frac{d}{\sqrt{v^2-u^2}}$

42. When a swimmer wants to cross the river of width d in shortest time, he should swim normal to the bank of the river at right angles with the direction of stream of the river. In this case the minimum time taken will be $t_{min} = \frac{d}{v}$.