PHYS 2325 Equations

Contents

1 Kinematics

Some Constant Acceleration Equations

Surprisingly enough, these equations apply when acceleration is constant, such as when you drop something.

$$v = v_0 + at \tag{1.1}$$

$$\Delta x = v_0 t + \frac{1}{2}at^2 \tag{1.2}$$

$$v^2 = v_0^2 + 2a\Delta x \tag{1.3}$$

$$\Delta x = \frac{1}{2}(v_0 + v)t \tag{1.4}$$

3D motion

You should also be able to find displacement, velocity, and acceleration in 3D using vectors, e.g.

$$\Delta\vec{r} = \vec{r}_2 - \vec{r}_1 = (x_2 - x_1)\hat{\imath} + (y_2 - y_1)\hat{\jmath} + (z_2 - z_1)\hat{k} \tag{1.5}$$

$$\vec{v}_{\text{ave}} = \frac{\Delta\vec{r}}{\Delta t} \tag{1.6}$$

$$\vec{v} = \frac{\mathrm{d}r}{\mathrm{d}t} = \frac{\mathrm{d}x}{\mathrm{d}t}\hat{\imath} + \frac{\mathrm{d}y}{\mathrm{d}t}\hat{\jmath} + \frac{\mathrm{d}z}{\mathrm{d}t}\hat{k} \tag{1.7}$$

And similarly with $\vec{a}$.

Circular motion

Particle goes in circle.

$$a_{\text{radial}} = \frac{v^2}{r} \tag{1.8}$$

a_{radial} refers to the component of acceleration which is perpendicular to velocity (i.e. pointing inwards) and gives the change in direction. This applies to uniform circular motion and non-uniform circular motion.

$$a_{\tan} = \frac{\mathrm{d}|\vec{v}|}{\mathrm{d}t} \tag{1.9}$$

$a_{\tan}$ refers to the component of acceleration which is parallel to velocity and gives the change in speed. In uniform circular motion, this value is zero.

$$T = \frac{2\pi r}{v} \tag{1.10}$$

Just a reminder that T, the period, is the time it takes for the particle to complete one revolution of the circle. It is the reciprocal of frequency.

Projectile motion

These equations are typically used in 2D motion where one component has constant acceleration and the other component has zero acceleration and there is some initial velocity. They describe a parabolic trajectory with equation:

$$y(x) = x\tan(\theta) - \frac{ax^2}{2v_0^2\cos^2(\theta_0)} \tag{1.11}$$

Note that in these equations it is assumed that the y-component of motion has the constant acceleration because of gravity.

I don't think these equations are that helpful since they just do the component finding for you but here they are anyway:

$$x(t) = (v_0 cos(\theta))t \tag{1.12}$$

$$y(t) = (v_0 sin(\theta))t - \frac{1}{2}at^2 \tag{1.13}$$

Max height of projectile motion. This will not be given in the exam.

$$h = \frac{v_0^2\sin^2\theta_0}{2a} \tag{1.14}$$

Max range (how far it goes horizontally). This will also not be given in the exam.

$$x_{\max} = \frac{v_0^2}{a}\sin(2\theta_0) \tag{1.15}$$

Shows that the range is maximized when the launch angle $\theta_0 = 45°$.