3.1.5 Projectile Motion

When a particle moves in a vertical plane during free–fall its acceleration is constant; the acceleration has magnitude $9.80\,\frac{\mathrm{m}}{\mathrm{s}^2}$ and is directed downward. If its coordinates are given by a horizontal x axis and a vertical y axis which is directed upward, then the acceleration of the **projectile** is

$$a_x = 0 \qquad a_y = -9.80\,\tfrac{\mathrm{m}}{\mathrm{s}^2} = -g \tag{3.20}$$

For a projectile, the horizontal acceleration a_x is zero!!!

Projectile motion is a special case of constant acceleration, so we simply use Eqs. 3.16–3.19, with the proper values of a_x and a_y.

3.1.6 Uniform Circular Motion

When a particle is moving in a circular path (or part of one) at *constant speed* we say that the particle is in **uniform circular motion**. Even though the speed is not changing, *the particle is accelerating* because its velocity $\mathbf{v}$ is changing *direction*.

The acceleration of the particle is directed toward the center of the circle and has magnitude

$$a = \frac{v^2}{r} \tag{3.21}$$

where r is the radius of the circular path and v is the (constant) speed of the particle. Because of the direction of the acceleration (i.e. toward the center), we say that a particle in uniform circular motion has a **centripetal acceleration**.

If the particle repeatedly makes a complete circular path, then it is useful to talk about the time T that it takes for the particle to make one complete trip around the circle. This is called the **period** of the motion. The period is related to the speed of the particle and radius of the circle by:

$$T = \frac{2\pi r}{v} \tag{3.22}$$

3.1.7 Relative Motion

The velocity of a particle depends on who is doing the measuring; as we see later on it is perfectly valid to consider “moving” observers who carry their own clocks and coordinate systems with them, i.e. they make measurements according to their own **reference frame**; that is to say, a set of Cartesian coordinates which may be in motion with respect to another set of coordinates. Here we will assume that the axes in the different system remain parallel to one another; that is, one system can move (translate) but not *rotate* with respect to another one.

Suppose observers in frames A and B measure the position of a point P. Then then if we have the definitions:

$$\mathbf{r}_{PA} = \text{ position of } P \text{ as measured by } A$$

$$\mathbf{r}_{PB} = \text{ position of } P \text{ as measured by } B$$