13.2: Gravitational Field

The gravitational field at any point is equal to the gravitational force on some test mass placed at that point divided by the mass of the test mass. The dimensions of the gravitational field are length over time squared, which is the same as acceleration. For a single point mass M (other than the test mass), Newton's law of gravitation tells us that

$$\mathbf{g} = -\frac{GM\mathbf{r}}{r^3} \quad \text{(point mass)}, \tag{13.2.1}$$

where **r** is the position of the test point relative to the mass M. Note that we have written this equation in vector form, reflecting the fact that the gravitational field is a vector. Thus, $\mathbf{r} = \mathbf{x}_{test} - \mathbf{x}_{mass}$, where $\mathbf{x}_{test}$ and $\mathbf{x}_{mass}$ are the position vectors of the test point and the mass M. The vector **r** points from the mass to the test point. The quantity $r = |\mathbf{r}|$ is the distance from the mass to the test point.

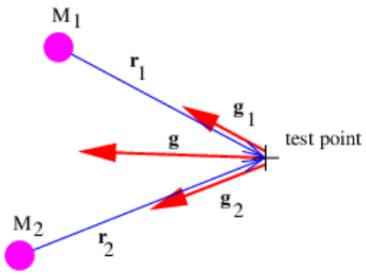

Figure 13.2.1:: Sketch showing the addition of gravitational fields at a test point resulting from two masses.

If there is more than one mass, then the total gravitational field at a test point is obtained by computing the individual fields produced by each mass at the test point and vectorially adding these fields. This process is schematically illustrated in Figure 13.2.1:.