5.6: The acceleration due to gravity

If you have studied some physics before reading this textbook, you may have been surprised by our choice of dimension for g to be force per unit mass rather than acceleration. This is indeed an unconventional choice as g is usually presented as "the acceleration due to Earth's gravity" instead of the "strength of Earth's gravitational field". Our choice comes from the potential difference between inertial mass, m_I, and gravitational mass, m_G, which we distinguish in this section.

Consider the simple model of a mass falling freely near the surface of the Earth in the absence of air-resistance. The only force exerted on the mass is its weight, $m_G\vec{g}$, which is given in terms of gravitational mass (the mass that determines how an object experiences gravity). Both the weight and the acceleration of the object point downwards. The free-body diagram for the mass is shown in Figure $5.6.1$, where the y axis was chosen to be vertically upwards (co-linear with the acceleration).

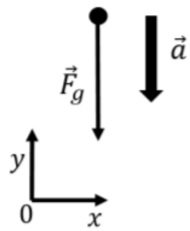

Figure $5.6.1$: Free-body diagram for a mass that is free-falling in the absence of air resistance (drag).

Writing out the y component of Newton's Second Law, being careful to distinguish between inertial and gravitational mass, and noting that both the weight and the acceleration are in the negative y direction:

$$\sum F_y = -F_g = -m_I a$$

$$\therefore m_G g = m_I a$$

This makes it clear that g is not necessarily the acceleration due to gravity. It is only the acceleration due to gravity in the limit that the inertial and gravitational masses are the same. If $m_G = m_I$, then we have:

$$a = g$$

and indeed, the acceleration of objects near the surface of the Earth has a magnitude of g. It is also clear that the dimensions of g can also be written as an acceleration, and in most cases, one writes that, near the surface of the Earth, $g = 9.8 \mathrm{m/s^2}$. You should however remember that this is only true when inertial and gravitational masses are the same, and that g really should be thought of as the strength of the gravitational field, not as an acceleration.