# 2.4: In Summary

1. The *law of inertia* states that, if no external influences (forces) are acting on an object, then, if the object is initially at rest it will stay at rest, and if it is initially moving it will continue to move with constant velocity (unchanging speed and direction).
2. Reference frames in which the law of inertia is seen to hold (when the velocities of objects are calculated from their coordinates in that frame) are called *inertial*. A reference frame that is moving at constant velocity relative to an inertial frame is also an inertial frame. Conversely, accelerated reference frames are non-inertial.
3. Motion with constant velocity is fundamentally indistinguishable from no motion at all (i.e., rest). As long as the velocity (of the objects involved) does not change, only *relative* motion can be detected. This is known as the **principle of relativity**. Another way to state it is that the laws of physics must take the same form in all inertial reference frames (so you cannot single out one as being in "absolute rest" or "absolute motion").
4. *Changes* in velocity *are* detectable, and, by (1) above, are evidence of unbalanced forces acting on an object.
5. The rate of change of an object's velocity is the object's *acceleration*: the average acceleration over a time interval $\Delta t$ is $a_{av} = \Delta v / \Delta t$, and the instantaneous acceleration at a time $t$ is the limit of the average acceleration calculated for successively shorter time intervals $\Delta t$, all with the same initial time $t_i = t$. Mathematically, this means the acceleration is the derivative of the velocity function, $a = dv/dt$.
6. In a velocity versus time graph, the acceleration can be read from the slope of the line tangent to the curve (just like the velocity in a position versus time graph).
7. In a position versus time graph, the regions with positive acceleration correspond to a concave curvature (like a parabola opening up), and those with negative acceleration correspond to a convex curvature (like a parabola opening down). Points of inflection (where the curvature changes) and straight lines correspond to points where the acceleration is zero.
8. The basic equations used to describe motion with constant acceleration are (2.2.4), (2.2.7) and (2.2.10) above. Alternative forms of these are also provided in the text.
9. In more than one dimension, a change in the *direction* of the velocity vector results in a nonzero acceleration, even if the object's speed does not change.
10. An object is said to be in *free fall* when the only force acting on it is gravity. All objects in free fall experience the same acceleration at the same point in their motion, regardless of their mass or composition. Near the surface of the earth, this acceleration is approximately constant and has a magnitude $g$ = 9.8 m/s$^2$.
11. An object sliding on a frictionless inclined plane experiences (if air drag is negligible) an acceleration directed downward along the incline and with a magnitude $g \sin\theta$, where $\theta$ is the angle the incline makes with the horizontal.