Section 1: Using calculus

Crucial points

1. **Don't assume that the acceleration is constant**
In all the work so far, you have dealt with situations where acceleration is constant. Now you are extending your knowledge to situations when the acceleration is not constant. Remember that the definition of acceleration is that it is the rate at which velocity changes, $a = \frac{\mathrm{d}v}{\mathrm{d}t}$. It is only when the acceleration is constant that you may use the constant acceleration equations.

2. **Make sure you know the definitions of velocity and acceleration**
These are very important. Velocity is defined as the rate at which position changes, so $v = \frac{\mathrm{d}s}{\mathrm{d}t}$, and acceleration is defined as the rate at which velocity changes, so $a = \frac{\mathrm{d}v}{\mathrm{d}t}$.

3. **Make sure you are confident with basic differentiation**
In Mechanics you often need to work with velocities and accelerations. These are both rates of change and to calculate a rate of change you must differentiate with respect to time.

4. **Make sure you are confident with basic integration**
You already know that differentiation and integration are opposites, so to calculate position from velocity, or velocity from acceleration you must integrate with respect to time: $s = \int v\,\mathrm{d}t$ and $v = \int a\,\mathrm{d}t$.

5. **Remember the constant of integration**
Remember that whenever you work out an indefinite integral (one without limits), you must either find the value of constant of integration, or write '$+ c$' after the function you have obtained by integration. Often, in Mechanics, you will know some extra information about the situation that will enable you to calculate the value of the constant. For example, if the object you are dealing with started from rest, you know that $v = 0$ when $t = 0$.

6. **Don't muddle up constants of integration**
If you integrate more than once, there will be more than one constant of integration. To avoid muddling them up, call them different things, like c and k.