There are four chapters covering the development of our knowledge of atoms and sub-atomic particles.

1. **What are atoms made of** begins with ideas about the origin of the universe, then goes on to consider what matter is: elements and compounds made of atoms. The chapter concludes with a simple introduction to atomic structure.

2. **Inside the atom** introduces ideas of the three sub-atomic particles in atoms, followed by atomic number and symbol notation. The chapter concludes with a brief history of the development of the periodic table.

3. **Splitting atoms** begins with a look at the formation of ions and proceeds to explain the formation of electrostatic charge.

4. **Back to the beginning** introduces the fundamental particles that make up sub-atomic particles and describes how atoms were formed following the ‘Big Bang’.
Curriculum links (using the COL keyword scheme)

Scientific enquiry
Science: historical & contemporary examples

Solids, liquids & gases
Particle theory

Atoms & molecules
Atomic structure
Nucleus: protons, neutrons
Electrons - generally
Ionic bonds

Elements, compounds & mixtures
Periodic table
Elements
Compounds - generally

Electricity & magnetism
Electrostatic forces
Electrostatic phenomena & uses

The earth & beyond
Stars
Origin & evolution of the universe
Extraterrestrial life

Web links

Big Bang timeline (interactive animation)
www.schoolscience.co.uk/flash/bang.htm

Solids, liquids and gases
www.schoolscience.co.uk/content/3/physics/bama/aerosch2pg1.html

Materials: solids, liquids and gases
www.schoolscience.co.uk/content/3/chemistry/materials/match1pg3.html

A world of atoms (KS4)
www.schoolscience.co.uk/content/4/physics/atoms/partch1pg4.html
1 - Atoms and atomic structure

Make up a concentrated solution of potassium manganate(VII). Measure out 10 cm$^3$ of this solution and add it to a 1000 cm$^3$ beaker or measuring cylinder. Fill up to 1000 cm$^3$.

Allow pupils to observe the colour of the potassium manganate(VII) that can still be seen. Take 10 cm$^3$ of the diluted solution and repeat the process. Do this until the colour can no longer be seen. Talk about the idea of fewer particles being present at each dilution. Could we eventually get to just one particle present in the solution? Lead on to the idea of matter being made of very small particles called atoms.

Give each pupil an A4 card with the name and details of physical and chemical properties of an element from the periodic table (use elements in atomic order for all of the class, but do not use elements from the Transition Metals). Put pupils in a line in order of the atomic number of each element.

Call out a property e.g. reacts vigorously with water, and tell pupils who have an element with that property to gather in a group. Repeat this idea until pupils are gathered in eight groups. Now arrange the groups to make up the first part of the periodic table. Explain to pupils how elements were arranged in order of mass (initially, later atomic number) but in rows of eight so that similar elements came together.

2 - Static electricity

Introduce ideas of electrons ‘rubbing off’ atoms by letting pupils carry out an investigation to find the best way to stick a balloon onto a wall. Get them to try rubbing a balloon with one of a selection of materials e.g. nylon, wool, cotton, acrylic, silk, linen, fur, paper, polyester, acetate, terylene, viscose. Make sure that they use fair testing by rubbing the same way and time for each. Which makes the balloon stick best, i.e. which gives the largest electrostatic charge?

If you have one available, demonstrate a van de Graaff generator. Take care that pupils who are ‘charged up’ by the machine do not have a pacemaker! Charge up a pupil with recently washed hair to demonstrate that like charges repel by their hair standing on end, or charge up an electroscope to show this idea.

Suspend a pith ball on cotton, charge by touching with a rod that has been rubbed to generate electrostatic charge. Bring a rod of different material or one rubbed with a different material near to the pith ball to see if it is attracted or repelled. Use rods of wood, acetate, iron, polythene, glass et al. and rubbing material of fur, linen, cotton, nylon et al.
New particles

Construct a table to present the information listed below for each of the three types of sub-atomic particles in an atom.

- Charge
- Mass
- Position in the atom
- Fundamental particles it is made of

Try to find out who discovered each of the sub-atomic particles and when the discovery was made. Put these into a timeline. Why were some sub-atomic particles discovered much later than others?
Big Bang timeline

We think that the Universe began with a ‘Big Bang’. Following the ‘Big Bang’ the Universe expanded and cooled, eventually allowing atoms to form.

Have a look at the Big Bang interactive timeline at:

www.schoolscience.co.uk/flash/bang.htm

Make a timeline from the Big Bang to today. Put the appearance of each of the particles listed below on this timeline, and show the temperature at the time each was formed.

- atoms
- carbon and iron atoms
- electrons
- helium and hydrogen atoms
- helium nuclei
- leptons
- neutrons
- protons
- quarks