# **Chapter 1: Atomic structure**

# **Knowledge organiser**

## Development of the model of the atom

#### Dalton's model

John Dalton thought of the **atom** as a solid sphere that could not be divided into smaller parts. His model did not include protons, neutrons, or electrons.

## The plum pudding model

Scientists' experiments resulted in the discovery of sub-atomic charged particles. The first to be discovered were electrons - tiny, negatively charged particles.

The discovery of electrons led to the plum pudding model of the atom - a cloud of positive charge, with negative electrons embedded in it. Protons and neutrons had not yet been discovered.

#### Alpha scattering experiment

- 1 Scientists fired small, positively charged particles (called alpha particles) at a piece of gold foil only a few atoms thick.
- 2 They expected the alpha particles to travel straight through the gold.
- **3** They were surprised that some of the alpha particles bounced back and many were deflected (alpha scattering).
- 4 To explain why the alpha particles were repelled the scientists suggested that the positive charge and mass of an atom must be concentrated in a small space at its centre. They called this space the nucleus.



#### Nuclear model

Scientists replaced the plum pudding model with the nuclear model and suggested that the electrons orbit the nucleus, but not at set distances.

#### Size

The atom has a radius of 1×10<sup>-10</sup> m. Nuclei (plural of nucleus) are around 10000 times smaller than atoms and have a radius of around 1×10<sup>-14</sup> m.

#### Electron shell (Bohr) model

Niels Bohr calculated energy levels.

## The proton

Further experiments provided evidence that the nucleus contained smaller particles called protons. A proton has an opposite charge to an electron.

#### The neutron

James Chadwick carried out experiments that gave evidence for a particle with no charge. Scientists called this the neutron and concluded that the protons and neutrons are in the nucleus, and the electrons orbit the nucleus in shells.

### **Elements and compounds**

Elements are substances made of one type of atom. Each atom of an element will have the same number of protons.

**Compounds** are made of different types of atoms chemically bonded together. The atoms in a compound have different numbers of protons.

## **Mixtures**

- A mixture consists of two or more elements or compounds that are not chemically combined together.
- The substances in a mixture can be separated using physical processes.
- These processes do not use chemical reactions.

in solution

## Atoms and narticles

Atoms and particles							
	Relative charge	Relative mass					
Proton	+1	1	= atomic number				
Neutron	0	1	= mass number – atomic number				
Electron	-1	0 (very small)	= same as the number of protons				

All atoms have equal numbers of protons and electrons, meaning they have no overall charge:

total negative charge from electrons = total positive charge from protons

## Isotopes

Atoms of the same element can have a different number of neutrons, giving them a different overall mass number. Atoms of the same element with different numbers of neutrons are called isotopes.

The **relative atomic mass** is the average mass of all the atoms of an element:

(abundance of isotope 1 x mass of isotope 1) + (abundance of isotope 2 x mass of isotope 2)... relative atomic mass : 100

#### **Key terms** Make sure you can write a definition for

abundance atom atomic number element energy level isotop product proton react relative charge rel

One property of protons, neutrons, and electrons is relative mass - their masses compared to each other. Protons and neutrons have the same mass, so are given a relative mass of 1. It takes almost 2000 electrons to equal the mass of a single proton - their relative mass is so small that we can consider it as 0.

**Relative mass** 

electror Θ Θ Θ Θ

cloud of positive charge

actually observed: gold atoms 

# Đ

that electrons must orbit the nucleus at fixed distances. These orbits are

called shells or

## **Drawing atoms**

- Electrons in an atom are placed in fixed shells. You can put
- up to two electrons in the first shell
- eight electrons each in the second and third shells.
- You must fill up a shell before moving on to the next one.



## Separating mixtures

- filtration insoluble solids and a liquid
- crystallisation soluble solid from a solution
- simple distillation solvent from a solution
- fractional distillation two liquids with similar boiling points
- paper chromatography identify substances from a mixture

or these key terms.							
8	aqueous neutron	compound nucleus	electron orbit				
cant relative atomic mass							
ative mass		shell					

# **Chapter 1: Atomic structure**

# **Retrieval questions**

Learn the answers to the questions below then cover the answers column with a piece of paper and write as many as you can. Check and repeat.

	C1 questions		Answers
1	What is an atom?	Pu	smallest part of an element that can exist
2	What is Dalton's model of the atom?	t paper h	atoms as solid spheres that could not be divided into smaller parts
3	What is the plum pudding model of the atom?	iere	sphere of positive charge with negative electrons embedded in it
4	What did scientists discover in the alpha scattering experiment?	Put paper	some alpha particles were deflected by the gold foil – this showed that an atom's mass and positive charge must be concentrated in one small space (the nucleus)
5	Describe the nuclear model of the atom.	here	dense nucleus with electrons orbiting it
6	What did Niels Bohr discover?		electrons orbit in fixed energy levels (shells)
7	What did James Chadwick discover?	out pa	uncharged particle called the neutron
8	Where are protons and neutrons?	per he	in the nucleus
9	What is the relative mass of each sub-atomic particle?	ere	proton: 1, neutron: 1, electron: 0 (very small)
10	What is the relative charge of each sub-atomic particle?	Put pap	proton: +1, neutron: 0, electron: -1
1	How can you find out the number of protons in an atom?	er here	the atomic number on the Periodic Table
12	How can you calculate the number of neutrons in an atom?	P	mass number – atomic number
B	Why do atoms have no overall charge?	ut paper	equal numbers of positive protons and negative electrons
14	How many electrons would you place in the first, second, and third shells?	here	up to 2 in the first shell and up to 8 in the second and third shells
15	What is an element?	Pu	substance made of one type of atom
16	What is a compound?	ıt paper	substance made of more than one type of atom chemically joined together
Ð	What is a mixture?	here	two or more substances not chemically combined
18	What are isotopes?	Pu	atoms of the same element (same number of protons) with different numbers of neutrons
19	What are the four physical processes that can be used to separate mixtures?	t paper ł	filtration, crystallisation, distillation, fractional distillation, chromatography
20	What is relative mass?	here	the average mass of all the atoms of an element