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How to make a copy into your Google Drive:

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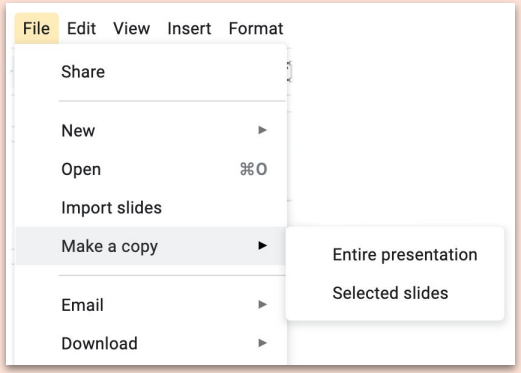

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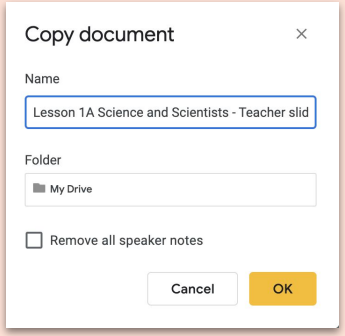

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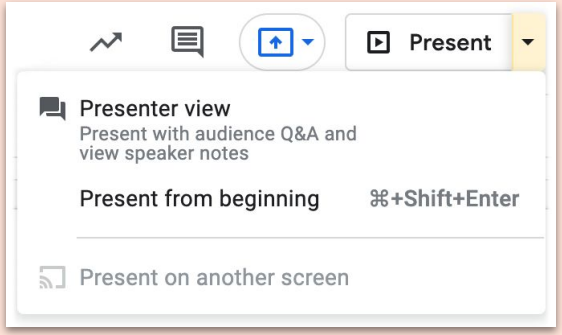
We recommend using these slides in 'Presenter view' in class, so you can see the speaker notes for each slide.



3A The structure of the atom

Content descriptor

All matter is made of atoms which are composed of protons, neutrons and electrons; natural radioactivity arises from the decay of nuclei in atoms.

Elaborations

- describing and modelling the structure of atoms in terms of the nucleus, protons, neutrons and electrons
- comparing the mass and charge of protons, neutrons and electrons

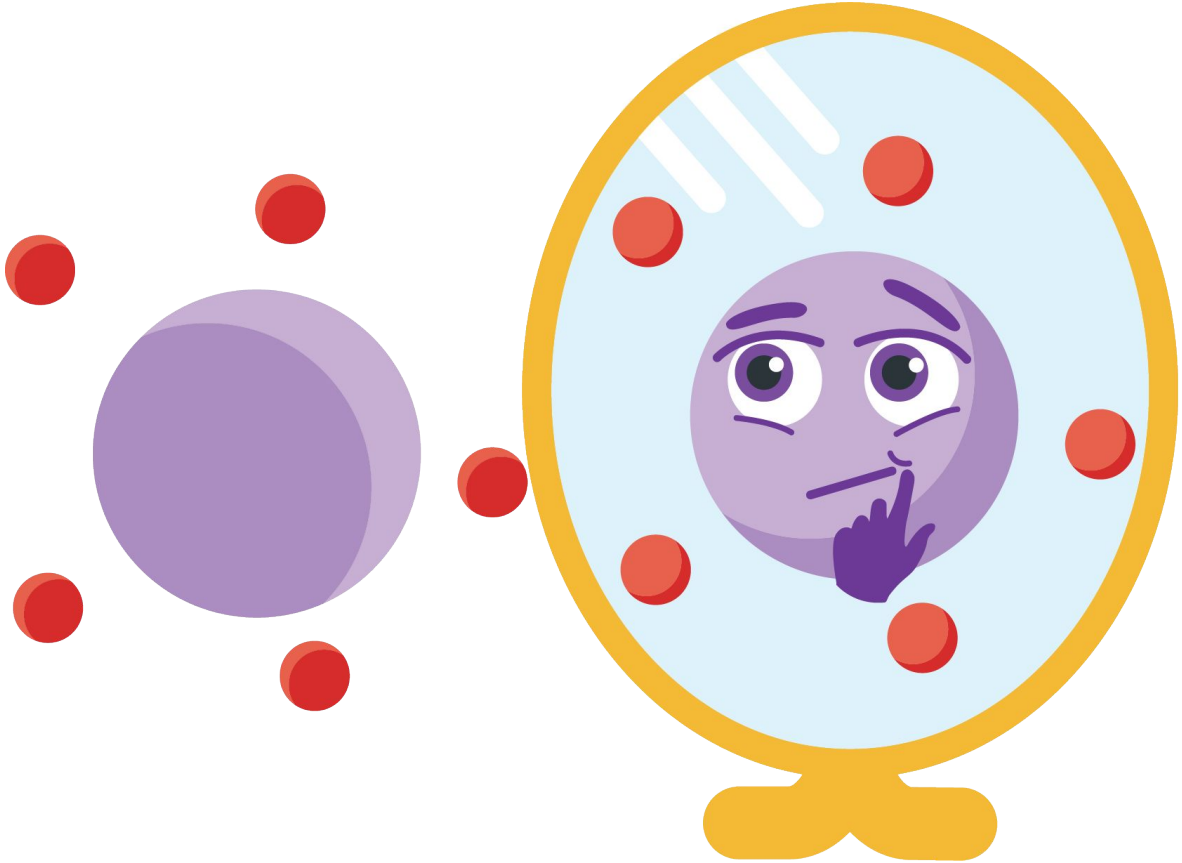
Learning intention

I will be able to describe the structure of the atom.

Success measure

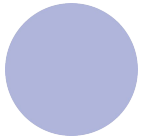
I can use protons, neutrons, and electrons to model the structure of the atom.

Atoms make up everything. What makes an atom?

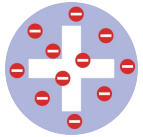


The development of the atomic model

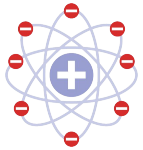
Current knowledge of the atom comes from the work of many scientists, including:



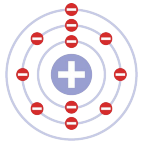
Dalton (1803) stated that **atoms** are **indivisible** and indestructible.



Thomson (1904) produced the 'plum pudding' model – showing that the atom is comprised of electrons spread throughout a positive sphere.



Rutherford (1911) proposed the nuclear model – the atom is mostly empty space with a positive centre called the **nucleus**.



Bohr (1913) proposed the planetary model – modelling that electrons **orbit** the nucleus in different energy levels.

Schrödinger (1926) stated that electrons move in waves – orbiting in a cloud around the nucleus.

KEY TERMS

atoms the smallest unit of matter

indivisible cannot be divided into smaller parts

nucleus the core of an atom, made up of protons and neutrons

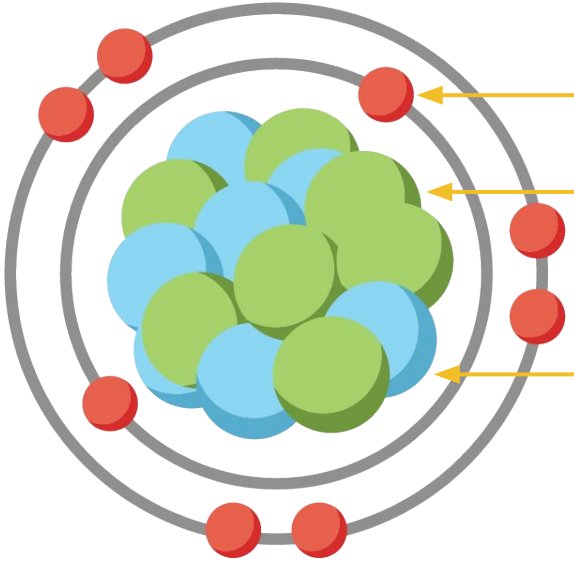
orbit move in a circle

WATCH ME

The 2400 year search for the atom

Atoms are made up of subatomic particles

The research of previous scientists has led to our current model of the atom. This model shows the atom is made up of three subatomic particles. These are outlined below.



Bohr-Rutherford model of the atom

Subatomic particle	Charge	Relative mass	Location
electron	negative (–1)	1/1840	orbiting the nucleus in levels
proton	positive (+1)	1	inside the nucleus
neutron	neutral (0)	1	inside the nucleus

KEY TERMS

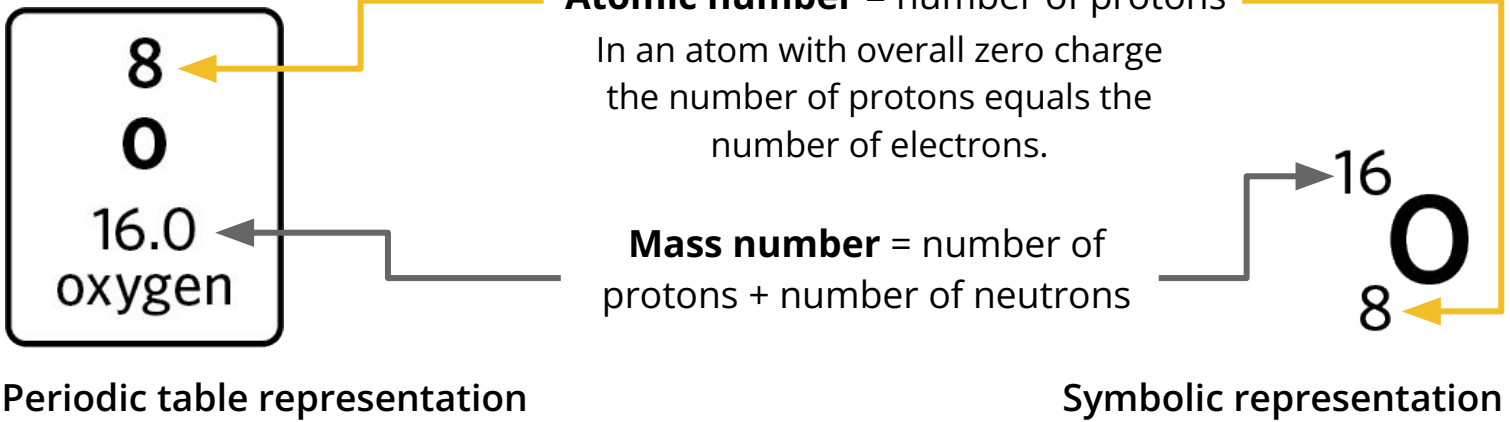
electron negatively charged particle orbiting the nucleus

proton positively charged particle located inside the nucleus

neutron particle of no charge located inside the nucleus

Proton number determines the element

Atoms are the smallest units of an **element** that retain the element's properties. Each element is defined by the number of protons in the nucleus of the atom. For example, oxygen has 8 protons, and so it is number 8 on the periodic table. Elements can be represented in two key ways:



Periodic table representation

Symbolic representation

KEY TERMS

element atoms with the same characteristics and number of protons

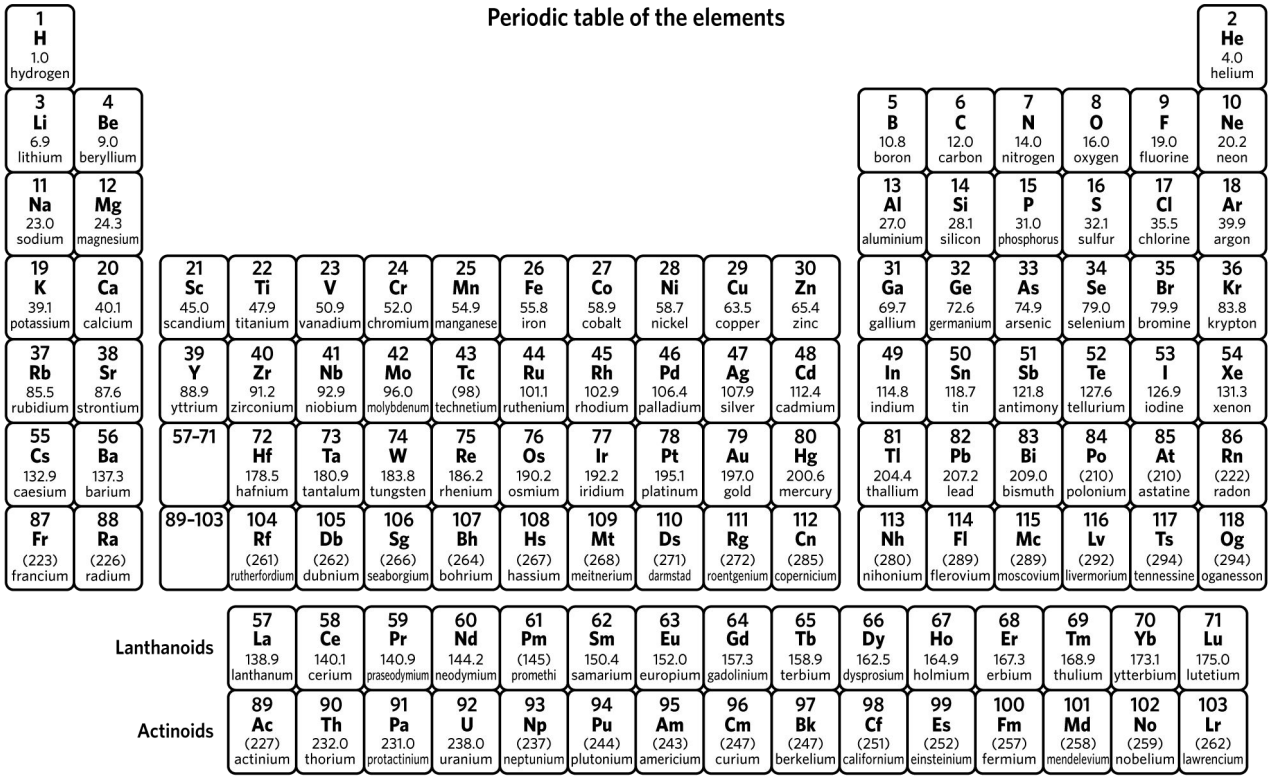
atomic number the number of protons in an element

mass number a sum of the number of neutrons and protons in an element

DON'T GET TRICKED

The number of protons and neutrons are not always the exact same.

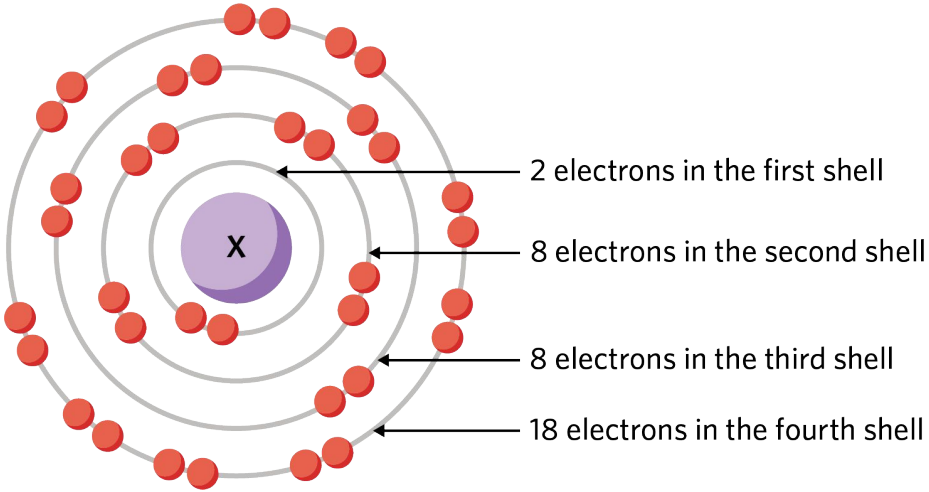
The periodic table



Electrons orbit the nucleus in shells

Electrons can be found in different orbits around the nucleus (also known as shells or **energy levels**). Each orbit is often represented as a circle.

The arrangement of electrons in an atom is known as its **electron configuration**. Electrons usually fill the closest shell to the nucleus first before occupying the next shell. Up to element 20, each shell of an atom has a maximum capacity of electrons it can hold. The maximum number of electrons for each shell is:



KEY TERMS

energy levels distances from the nucleus where electrons can be found

electron configuration the arrangement of electrons in each level around a nucleus

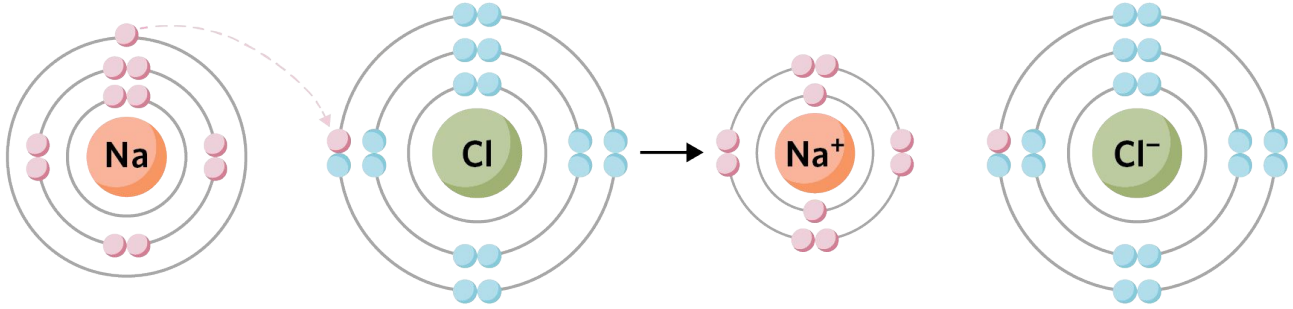
DID YOU KNOW?

Atoms with full outer shells of electrons are far more stable than those without, which are more reactive.

Electrons can be lost or gained

An atom is more stable when its outer shell has a full **octet** of electrons. Electrons can be lost or gained (from another atom) in order to achieve this.

When an atom gains electrons it becomes an **ion** with a negative overall charge (an **anion**). When an atom loses electrons it becomes an ion with a positive overall charge (a **cation**).



Na	Cl	Na^+	Cl^-
sodium atom	**chlorine atom**	**sodium ion (a cation)**	**chloride ion (an anion)**
loses an electron	gains an electron	full octet	full octet

KEY TERMS

octet atoms tend to prefer 8 electrons in the outer shell

ion an atom that has a positive or negative charge

anion negatively charged ion

cation positively charged ion

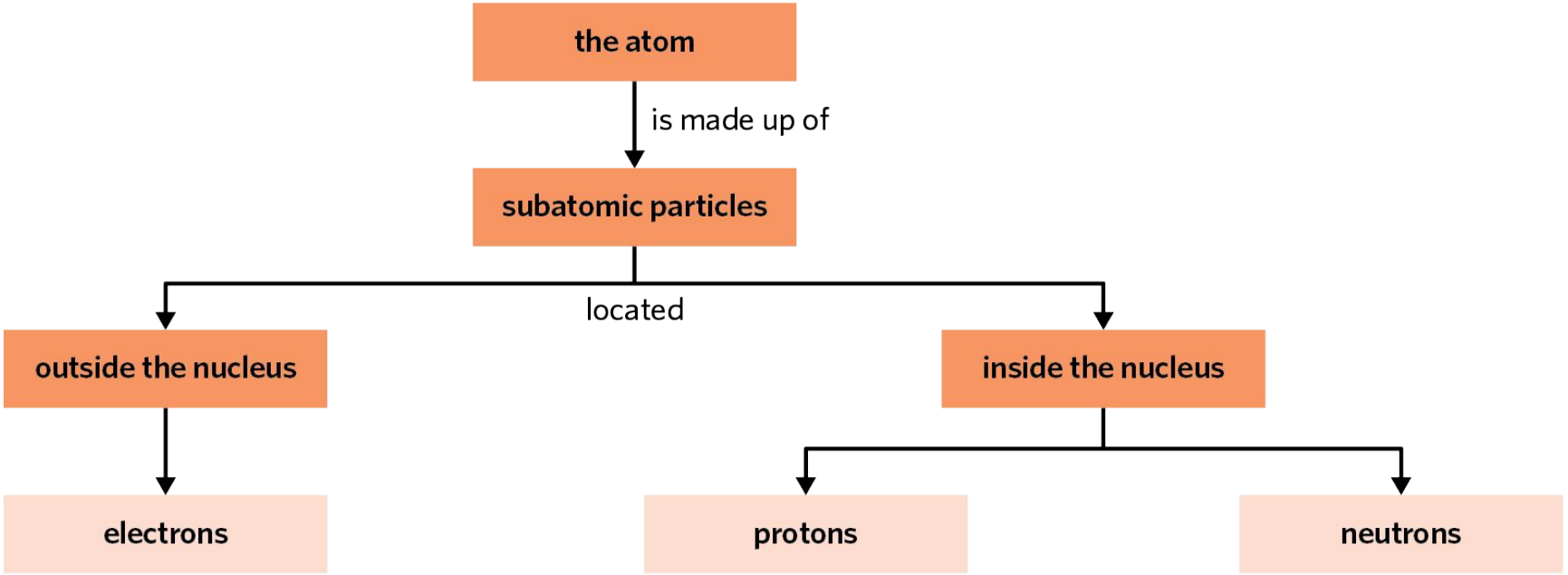
DON'T GET TRICKED

Helium is a special case which prefers 2 electrons in its outer shell.

MEMORY DEVICE

Cations are 'pawsitive'.

Sum it up



- negatively charged
- orbits the nucleus in shells
- can be lost or gained by other atoms
- lighter than protons and neutrons

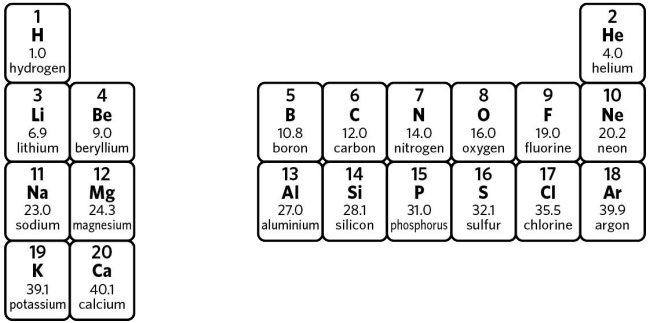
- positively charged
- forms part of the mass number
- determines the atomic number
- similar mass to neutrons

- no charge (neutral)
- forms part of the mass number
- similar mass to protons

Skill sharpener: Processing and analysing

Representing the atom

1. Choose an element from the first 20 and design a model using everyday objects.



Include in your model

- the subatomic particles – proton, neutron, and electron
- the location of each subatomic particle
- the position of electrons on each shell.

2. Submit a labelled photo of your model.

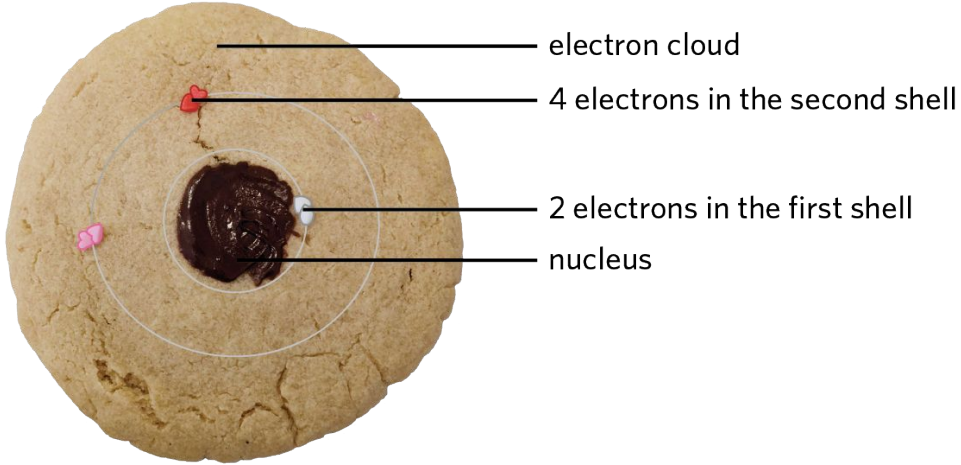
Extension

Analyse the model you have developed. Come up with a list of advantages and disadvantages of the model when considering all the information and models known about the atom.

Achievement standards
Year 8: Select and construct appropriate representations to organise and process data and information.
Year 9: Select and **construct appropriate representations** to organise, process and **summarise data** and information.
Year 10: Select and construct effective representations to organise, process and summarise data and information.

Example answer

Representing a Carbon atom



Extension

Advantages	Disadvantages
• shows the electron cloud as an area where the electrons exist • nucleus is placed in the middle • displays electrons on different levels based on scattered placement	• no display of the protons and neutrons in the nucleus – can't count to make sure that there are the correct number of each subatomic particle • not in motion so the electron movement in the cloud is not modelled • no electron orbits shown either – making it difficult to check the right number of electrons are placed based on 2, 8, 8, 18 rule

Question 1

Which description best fits the current model of the atom?

A negative electrons contained within a positive sphere

B electrons and neutrons contained within a nucleus, protons surrounding the nucleus

C negative protons and positive neutrons inside a nucleus, neutral electrons orbiting in shells

D positive protons and neutral neutrons inside a nucleus, negative electrons orbiting in shells

Question 1 – answer

Which description best fits the current model of the atom?

A negative electrons contained within a positive sphere

B electrons and neutrons contained within a nucleus, protons surrounding the nucleus

C negative protons and positive neutrons inside a nucleus, neutral electrons orbiting in shells

positive protons and neutral neutrons inside a nucleus, negative electrons orbiting in shells

Protons are positive, neutrons are neutral, and electrons are negative.

Question 2

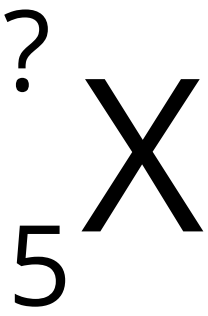
Determine the mass number and atomic number of an atom with 5 protons and 5 neutrons.

A Mass number: 5, Atomic number: 10

B Mass number: 10, Atomic number: 5

C Mass number: 15, Atomic number: 5

D Mass number: 5, Atomic number: 15



Question 2 – answer

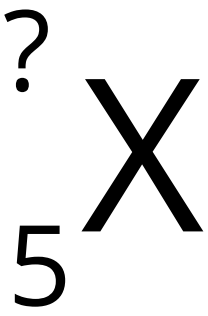
Determine the mass number and atomic number of an atom with 5 protons and 5 neutrons.

A Mass number: 5, Atomic number: 10

✓ **Mass number: 10, Atomic number: 5**

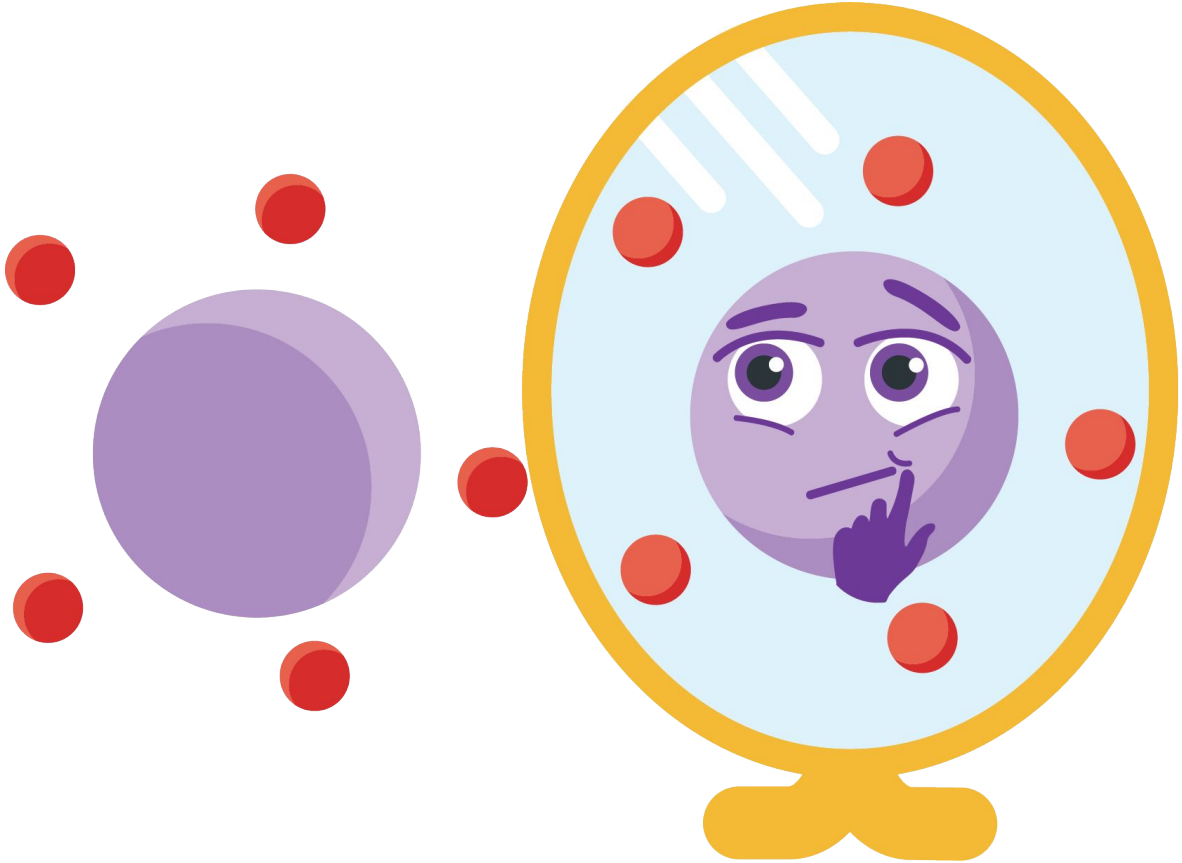
C Mass number: 15, Atomic number: 5

D Mass number: 5, Atomic number: 15



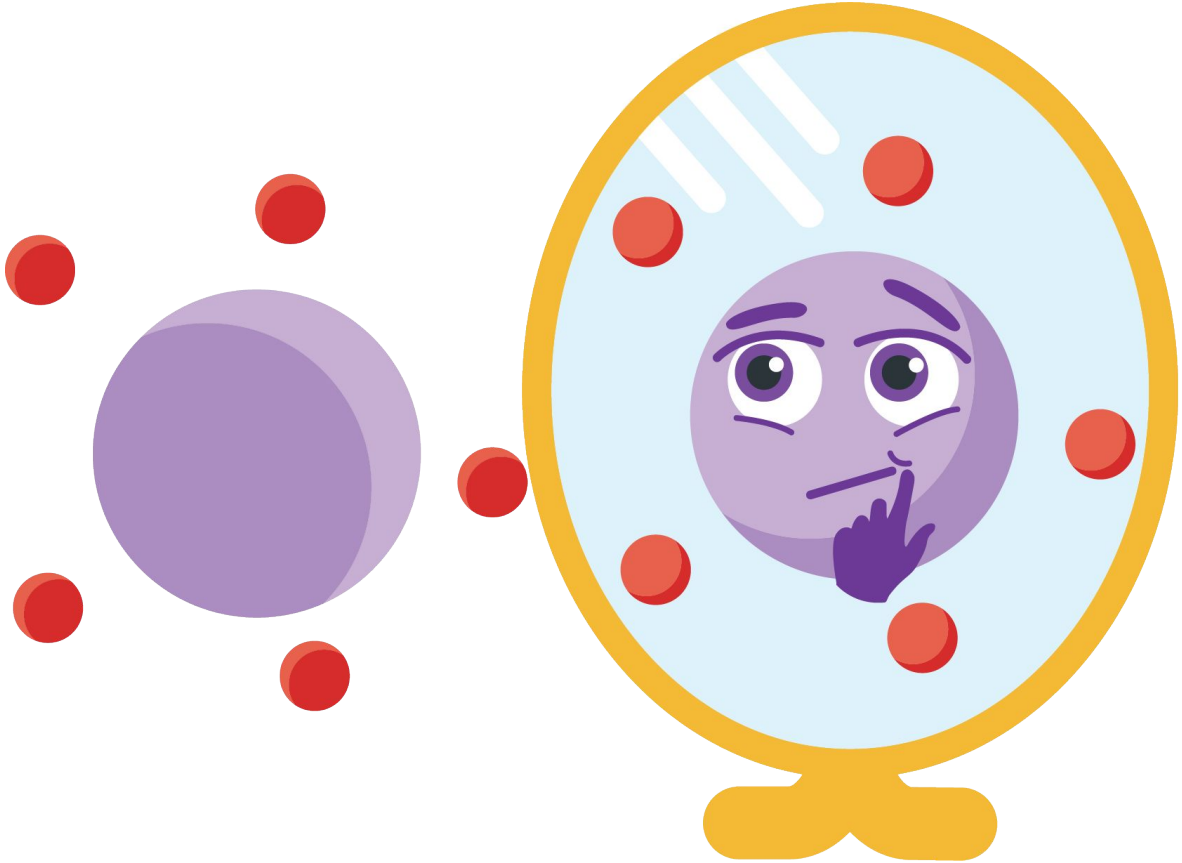
The mass number is the sum of the number of protons and neutrons.

Atoms make up everything. What makes an atom?



Atoms make up everything. What makes an atom?

Subatomic particles make up an atom: protons, neutrons, and electrons. The number of each determines the properties of an atom.



Success measure

I can use protons, neutrons, and electrons to model the structure of the atom.

Not yet

Partly

Yes