Relative charges of subatomic particles

4.1.1.4 · Atomic structure and the periodic table · revision notes

The relative charges of protons, neutrons and electrons, why atoms have no overall charge, and what the atomic number tells you. Questions are usually short: complete a table, use an atomic number, or explain why an atom is neutral.

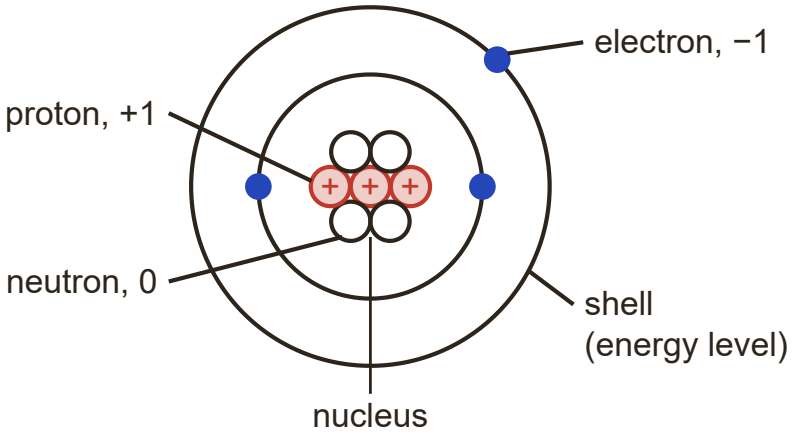
Key facts

- Proton: relative charge +1, in the nucleus
- Electron: relative charge −1, in shells around the nucleus
- Atomic number = number of protons
- Neutron: relative charge 0, in the nucleus
- In an atom: number of electrons = number of protons, so no overall charge
- Overall charge = protons − electrons

Notes

The three subatomic particles

- **Proton**: relative charge **+1**, found in the nucleus.
- **Neutron**: relative charge **0** (neutral), found in the nucleus.
- **Electron**: relative charge **−1**, found in shells (energy levels) around the nucleus.
- The nucleus is positive overall, because it contains positive protons and neutral neutrons.



A lithium atom: 3 protons, 4 neutrons, 3 electrons. It has no overall charge.

Why atoms have no overall charge

- In an atom, the number of electrons is **equal to** the number of protons.
- Each +1 charge is cancelled by a −1 charge, so the atom has no overall electrical charge.
- If an atom loses or gains electrons, it becomes an **ion** with an overall charge. The number of protons does not change.
- Overall charge = number of protons − number of electrons.

Atomic number

- The **atomic number** of an element is the number of protons in each of its atoms.
- All atoms of a particular element have the same number of protons, e.g. every carbon atom has 6.
- Atoms of different elements have different numbers of protons, so the atomic number tells you which element an atom is.
- Because atoms are neutral, the atomic number also tells you the number of electrons in an atom (but not in an ion).
- The periodic table lists the elements in order of atomic number.

How to answer each type of question

Complete a table of charges and positions

2 to 3 marks | **Grade 3**

1. Charges: proton +1, neutron 0, electron −1 (include the sign).
2. Positions: protons and neutrons in the nucleus; electrons in shells around the nucleus.

Example. Complete the table.

Particle	Relative charge	Where it is found
Proton	.....	in the nucleus
Neutron	0	.....
Electron	.....	.....

Model answer.

Particle	Relative charge	Where it is found
Proton	**+1**	in the nucleus
Neutron	0	**in the nucleus**
Electron	**−1**	**in shells / energy levels around the nucleus**

Proton charge +1 (1); neutron in the nucleus (1); electron −1 **and** in shells around the nucleus (1).

Explain why an atom has no overall charge

2 marks | **Grade 5**

1. State the number of electrons and say it equals the number of protons.
2. Say that the positive and negative charges cancel (neutrons have no charge).

Example. An atom of fluorine has 9 protons.
Explain why the atom has no overall charge.

Model answer. The atom has 9 electrons, the same number as protons (1). The +9 charge of the protons is cancelled by the −9 charge of the electrons, and neutrons have no charge (1).

Use the atomic number

1 mark each | Grade 5

1. In an atom, atomic number = protons = electrons.
2. Find the element with that atomic number in the periodic table.

Example. An atom has 19 electrons.
(a) Give the atomic number of the element.
(b) Use the periodic table to name the element.
(c) Explain why every atom of this element has the same atomic number.

Model answer.

(a) 19 (1)
(b) potassium (1)
(c) All atoms of an element have the same number of protons (1).

Work out the charge on a particle

2 marks | Grade 6

1. Subtract the number of electrons from the number of protons.
2. If the answer is not zero, the particle is an ion.

Example. A particle contains 16 protons, 16 neutrons and 18 electrons.
(a) Give the overall charge of the particle.
(b) Is the particle an atom or an ion? Give a reason.

Model answer.

(a) 16 − 18 = −2, so the charge is 2− (1)
(b) An ion, because the number of electrons is not equal to the number of protons (1).

Don’t lose marks

- Giving the neutron a charge of −1 or +1. Its relative charge is 0.
- Saying atoms are neutral because they have equal numbers of protons and neutrons. It is protons and electrons.
- Giving the mass number when the question asks for the atomic number.
- Saying ions form by gaining or losing protons. Only electrons are gained or lost.

More tips

Memory tricks

- Positive Proton, Neutral Neutron; the electron is the negative one.
- Atomic number is the smaller of the two numbers in a nuclear symbol or periodic table box (they are only equal for hydrogen).
- Charge on a particle: protons minus electrons.

Exam technique

- Give relative charges as +1, 0 and −1, with the sign and without units.
- When explaining why an atom is neutral, name both particles and use the words 'equal number'.
- Use the periodic table on the data sheet to look up atomic numbers.

What each grade needs

What you need to be able to do, from the first marks up to the top grade.

Grade 3 — **Recall the charges of subatomic particles**
Proton +1, neutron 0, electron −1.

Grade 3 — **State where each particle is found**
Protons and neutrons are in the nucleus; electrons are in shells around it.

Grade 4 — **Define atomic number**
The number of protons in an atom; all atoms of the same element have the same number.

Grade 5 — **Explain why atoms have no overall charge**
The number of electrons equals the number of protons, so the charges cancel.

Grade 5 — **Identify an element from its proton number**
Different elements have different numbers of protons, so the atomic number tells you the element.

Grade 6 — **Work out a particle's overall charge**
Charge = protons − electrons, e.g. 12 protons and 10 electrons gives a 2+ ion.

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