

CAIE Chemistry A-level

Topic 1 - Atomic Structure

Flashcards

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What are the relative masses, charges and locations of the subatomic particles?



What are the relative masses, charges and locations of the subatomic particles?

Subatomic particle	Relative mass	Relative charge	Location
Protons	1	+1	Nucleus
Neutrons	1	0	Nucleus
Electrons	Negligible (1/1840)	-1	Shells surrounding nucleus



How do protons behave in an electric field?



How do protons behave in an electric field?

Protons are deflected towards the negative plate in an electric field.



How do neutrons behave in an electric field?



How do neutrons behave in an electric field?

Neutrons are not affected by an electric field due to their lack of charge.



How do electrons behave in an electric field?



How do electrons behave in an electric field?

Electrons are deflected towards the positive plate in an electric field. The deflection is greater than protons as the electron has a smaller mass.



Where is most of the mass of an atom concentrated?

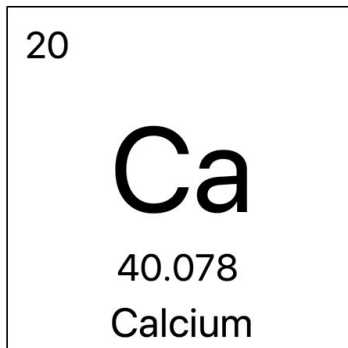


Where is most of the mass of an atom concentrated?

In the nucleus



Below is a segment from the periodic table. What do the numbers and symbols mean?



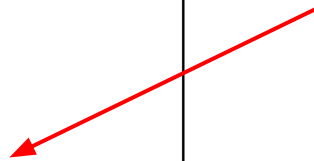
Below is a segment of the periodic table. What do the numbers and symbols mean?

Atomic (proton)
number



20
Ca
40.078
Calcium

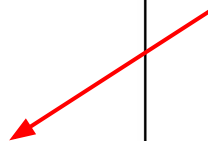
Chemical symbol



Mass/nucleon
number



Name of element



What does the atomic number represent?



What does the atomic number represent?

- The atomic number is equal to the number of protons in the nucleus of an atom of an element.
- The atomic number is the same for all atoms of the same element.
- In a neutral atom, the atomic number is the same as the number of electrons.



What does the mass number represent?



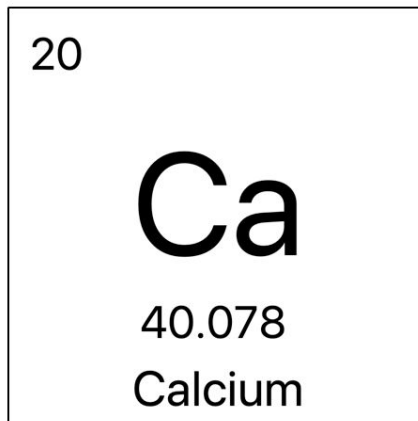
What does the mass number represent?

The mass number is equal to the sum of the numbers of protons and neutrons in the nucleus of an atom of an element.

E.g. An element with 10 protons and 10 neutrons would have a mass number of 20.



How many protons, neutrons and electrons are in a calcium atom?



20

Ca

40.078

Calcium

How many protons, neutrons and electrons are in a calcium atom?

- Atomic number is 20, so there are 20 protons.
- A calcium atom is neutral so the number of protons = the number of electrons = 20.
- Mass number is ≈ 40 . Since we know there are 20 protons, the number of neutrons = $40 - 20 = 20$.



What are isotopes?



What are isotopes?

Atoms of the same element with the same number of protons but a different number of neutrons.



What is an orbital?



What is an orbital?

A region that holds up to 2 electrons,
with opposite spin.

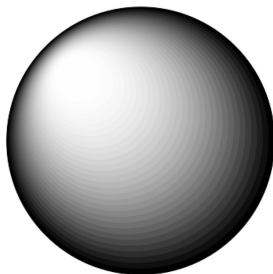


Describe and sketch the shapes of the s
and p orbitals

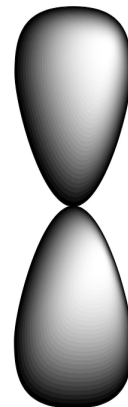


Describe and sketch the shapes of the s and p orbitals

s-orbital: spherical



p-orbital: dumb-bell



What is a subshell?



What is a subshell?

- A division of electron shells into different orbitals.
- The subshells are called s, p, d, and f.



What rules do electrons follow when filling up orbitals?



What rules do electrons follow when filling up orbitals?

- Electrons always occupy the lowest energy orbital available.
- Generally, electrons only pair up when there are no empty orbital of the same energy level as the half-filled orbitals.



How many orbitals and electrons are there in each type of subshell?



How many orbitals and electrons are there in each type of subshell?

- s-subshell: 1 orbital / 2 electrons
- p-subshell: 3 orbitals / 6 electrons
- d-subshell: 5 orbitals / 10 electrons
- f-subshell: 7 orbitals / 14 electrons



Compare the relative energy levels of s,
p and d orbitals



Compare the relative energy levels of s, p and d orbitals

The s orbital has lowest energy and the d orbital has the highest energy.



What types of subshells are found in shells 1 to 4? What is the maximum number of electrons that could be found in each shell?



What types of subshells are found in shells 1 to 4?
What is the maximum number of electrons that could be found in each shell?

Shell	Subshell(s)	Total number of electrons present (if full)
1	s	2
2	s, p	8
3	s, p, d	18
4	s, p, d, f	32

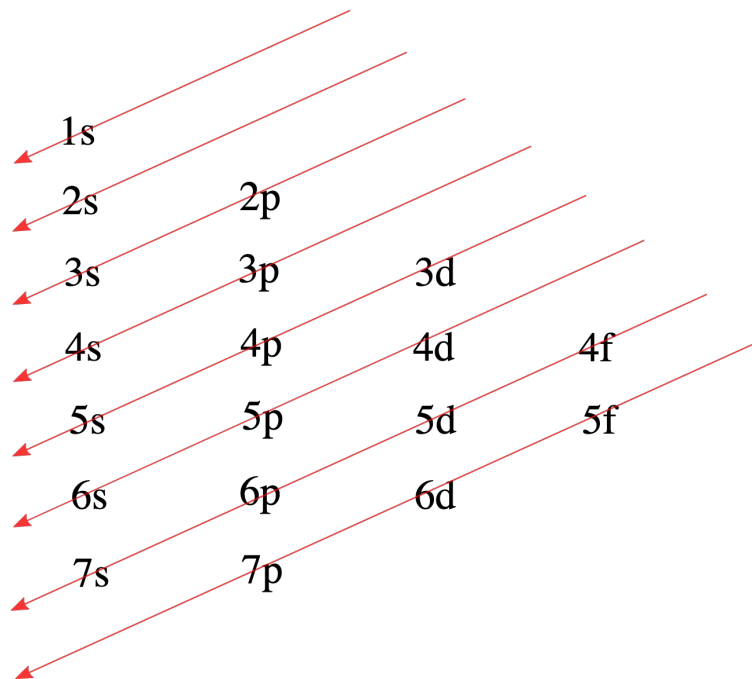


What is the order of filling up subshells?



What is the order of filling up subshell?

Follow the arrow:

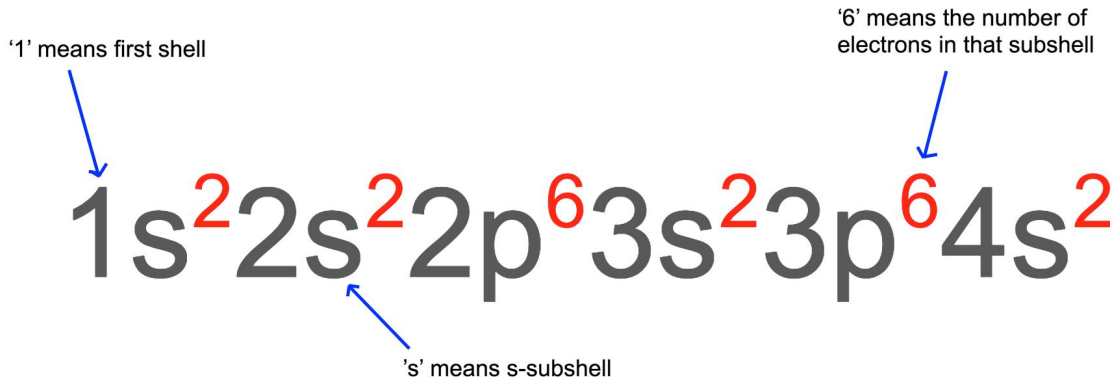


Write the electronic configuration of
calcium



Write the electron configuration of calcium

A calcium atom has 20 electrons:



What does the principal quantum number (n) represent?



What does the principal quantum number (n) represent?

It represents the shell that electrons occupy. For example, $n = 1$ indicates shell 1.

The larger the principal quantum number, the higher the energy and the further the shell is from the nucleus.



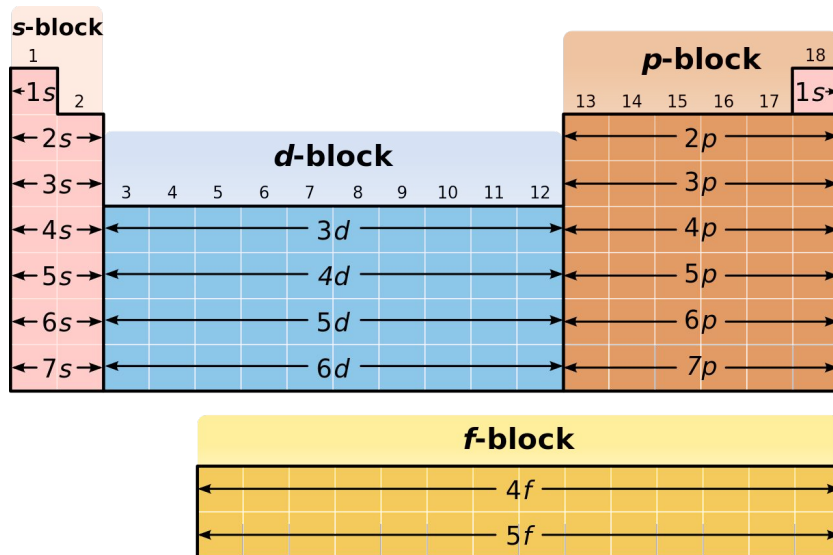
How is the periodic table divided up based on subshells?



How is the periodic table divided up, based on subshells?

The table is split into s, p, d and f blocks.

The block denotes the subshell that contains the valence electrons of the elements.



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What is meant by the term first ionisation energy?



What is meant by the term first ionisation energy?

The energy required to remove one mole of electrons from one mole of gaseous atoms to form one mole of gaseous $1+$ ions.



Is first ionisation energy exothermic or endothermic?



Is first ionisation energy exothermic or endothermic?

Endothermic



How do successive ionisation energies tell you which group an element belongs to?



How do successive ionisation energies tell you which group an element belongs to?

Look for a large increase between two different successive ionisation energies. For example, a large jump between the 7th and 8th ionisation energy suggests the 8th electron is being taken from a new, full, stable shell (and hence this requires more energy to remove).

This means that there are 7 electrons in the outer shell so the element belongs to Group 7.



What is the trend in first ionisation energy across periods 2 and 3?



What is the trend in first ionisation energy across periods 2 and 3?

Generally, as you go along the period, first ionisation energy increases.



Why does first ionisation energy increase
across a period?



Why does first ionisation energy increase across a period?

- Nuclear charge **increases**.
- Atomic radius **decreases**.
- Shielding remains the **same**.

As a result of these factors, electrostatic attraction **increases**, so more energy is needed to overcome these forces to remove an electron from the atom.



What is the trend in first ionisation energy down a group?



What is the trend in first ionisation energy down a group?

The general trend is that down the group, ionisation energy decreases.



Why does first ionisation energy decrease down a group?



Why does first ionisation energy decrease down a group?

Nuclear charge increases, but...

- Atomic radius **increases**.
- Shielding **increases**.

Therefore, electrostatic attraction **decreases**, so less energy is needed to overcome these forces to remove an electron from the atom.

