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TOPIC 2.2: ATOMIC STRUCTURE

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THE ABOUT

CHAPTER ANALYSIS

TIME

- Relatively straight forward chapter
- 2 **key** concepts
- 1 **advanced** concept

EXAM

- Usually tested in MCQs or Section A
- Tested as add-on to other chapters
  - Chemical Bonding, Periodic Table

WEIGHTAGE

- Light overall weightage
- Constitute to **1%** of marks for past 5 year papers

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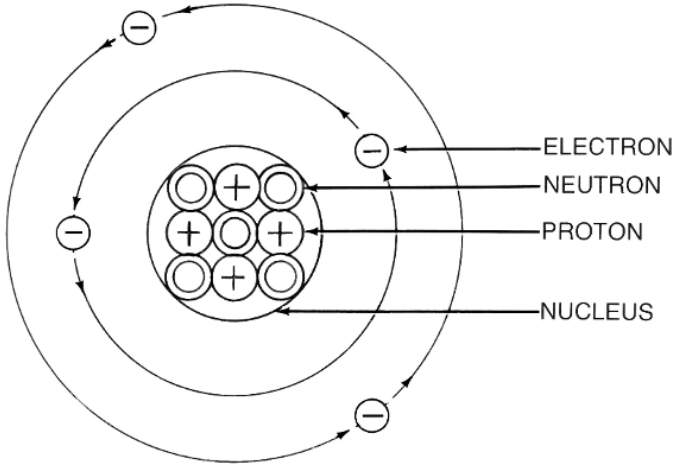
BASICS



Subatomic particle	Charge	Relative mass	Symbol	Location
Proton	+1	1	p	Nucleus
Neutron	0	1	n	Nucleus
Electron	-1	1 / 1836 **(negligible mass)**	e	Electron shell

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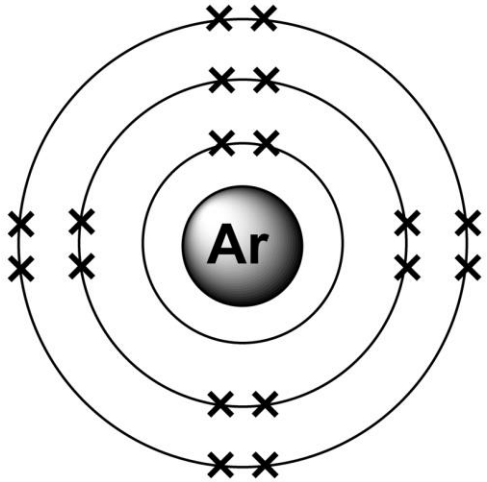
BASICS

Ar atom:
18- protons
22 - neutrons



First shell: Maximum of **2 electrons**

Second shell: Maximum of **8 electrons**

Third shell: Maximum of **8 electrons**

Must know: ***2,8,8*** *electronic configuration*

*For elements after calcium, the third shell is able to hold a maximum of 18 electrons. → *transition metals*

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BASICS

Nucleon number (protons + neutrons) — **40**

Ca — Symbol of element

Proton number / atomic number — **20**

Proton number: The total **number of protons** in an atom (number of electrons as well)
Nucleon number: The total **number of protons and neutrons** in the nucleus of an atom

Identity of an element is dependent on its proton number, not its nucleon number.
→ *To review later: Isotopes*

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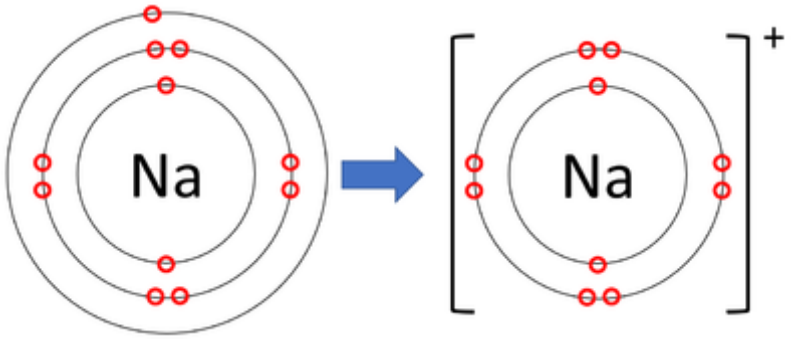
'plus' sign

FORMATION OF POSITIVE IONS

When atoms that lose electrons, there are now more protons than electrons, hence they become positively charged. They would become a **cation**.

The sodium atom achieves a stable electronic configuration by losing one electron. It becomes a sodium cation with a charge of +1 and is written as Na^+.



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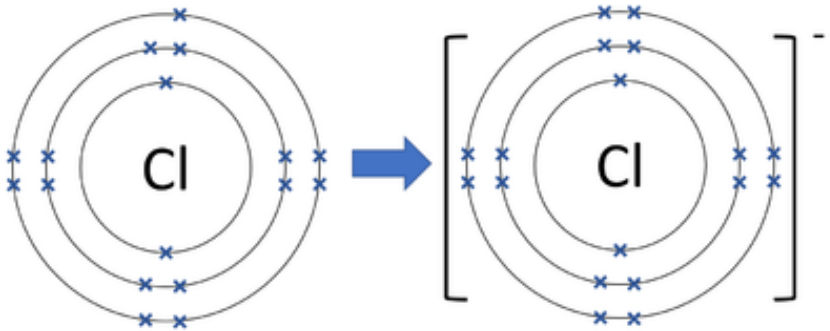
FORMATION OF NEGATIVE IONS

When atoms gain electrons, there are more electrons than protons now, they become negative ions, called an **anion**.

Negative

The chlorine atom fully completes its valence shell by gaining one electron. It is now a chlorine anion with a charge of -1 and is also written as Cl^-.



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WHY

Let's explore the **WHY**.
We will explore **why atoms turn into ions and subsequently into compounds**.

ELECTRICALLY NEUTRAL → ATOM
ELECTRICALLY STABLE → ION
CHEMICALLY STABLE → COMPOUND

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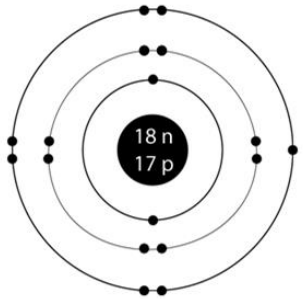
WHY

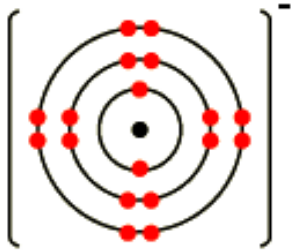
ATOM



ELECTRICALLY NEUTRAL
protons = electrons

Electrically neutral = normal person

ION

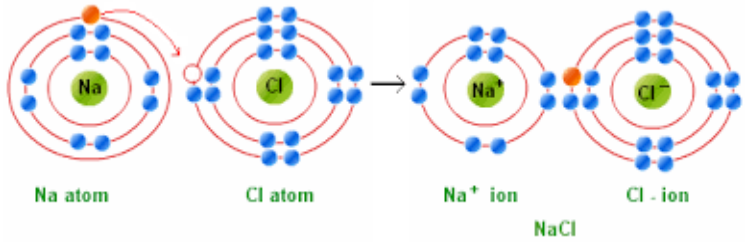


chloride ion,
Cl^- [2,8,8]$^-$

IONIC FORM
octet structure

But everyone wants to be attractive, especially to an opposite gender. Turn into an ion and seeking a partner.

COMPOUND



CHEMICALLY STABLE
Ionic bond formation

The end goal is to be in a relationship=)
Compound.

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KEY CONCEPT

Let's delve deeper into the understanding of isotopes, **a common killer question** at 'O' levels.

ISOTOPES
SAME NUMBER OF PROTONS
DIFFERENT NUMBER OF NEUTRONS

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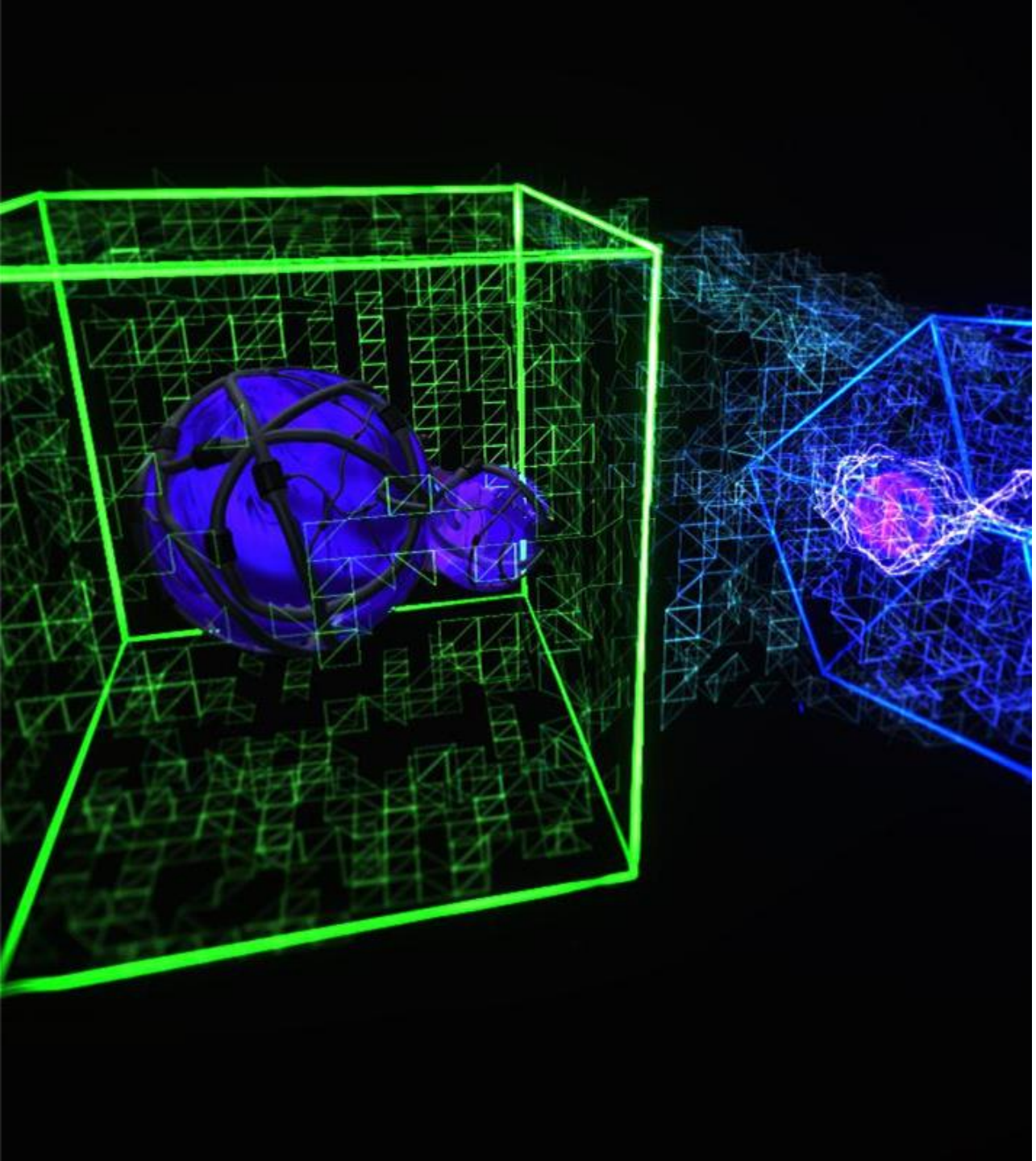

Isotopes are atoms of the same element that have the **same amount of protons and electrons** but **different amount of neutrons.**

Isotopes of an element have **same chemical properties**, as they have **the same amount of electrons**. Hence, they will undergo the same chemical reactions to form compounds with the same chemical formula. (Recall electronic configuration)

However, isotopes will have **differences in physical properties** as having **different amount of neutrons** means that they have slightly different masses. This would also affect other physical properties like their density.

SAME CHEMICAL PROPERTIES

DIFFERENT PHYSICAL PROPERTIES

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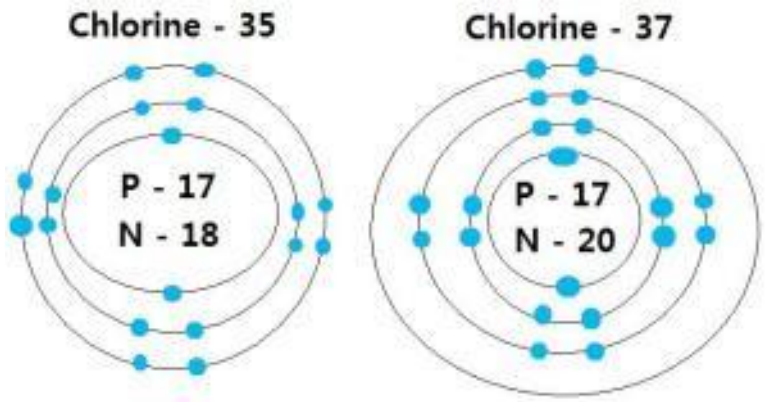
Case Study: Chlorine mass: 35.5



Isotopes	Percentage Abundance
^{35}Cl	75%
^{37}Cl	25%

Chlorine mass on the periodic table is 35.5.

Does it mean it has 35.5 proton + neutron?

The answer? No.

Chlorine exists as chlorine-35 and chlorine-37 atoms. There are more chlorine-35 atoms however.

The final **atomic mass** seen on the periodic table is the sum of **atomic mass/percentage abundance of all the isotopes** of chlorine.

Represented by calculation:

35 x 75% + 37 x 25% = *35.5 (average mass)*

 Hence, chlorine's Ar is 35.5.

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KEY CONCEPT

things to note

Understanding isotopes

Different number of neutrons

This causes **differences in physical properties** such as density.

Same number of protons/electrons

Isotopes have **similar chemical properties** as atoms would undergo the same chemical reactions to form compounds with same chemical formula.

Atomic mass is an average mass of the element's isotopes

By taking into account the **percentage composition** of the different isotopes and their respective masses, the periodic table displays that calculated **average atomic mass.**

Case study: Chlorine's Ar is 35.5

Try it yourself! (TYS Question)

9. A new element was first synthesised in 2006.
It has been given the name oganesson and is represented by $^{294}_{118}Og$.
Which statement about an atom of oganesson is correct? (N2020/P1/Q6)

A It contains 118 electrons and 176 nucleons.
B It contains 118 electrons and 176 protons.
C It contains 118 protons and 176 neutrons.
D It contains 118 protons and 176 nucleons. ( )

Answer:

9. **C**
The proton number of Og is 118. Since the number of electrons is the same as the number of protons in an atom, it has 118 protons and 118 electrons. The nucleon number is 294, so Og has (294 − 118 =) 176 neutrons.

Try it yourself! (TYS Question)

10. Four elements are shown as P, Q, Rand S. The letters do not represent the chemical symbols of the elements.
Which atom forms an ion with a 2- charge that has the electronic structure 2,8,8?

(N2020/P1/Q7)

A $^{16}_{8}P$

B $^{32}_{16}Q$

C $^{40}_{18}R$

D $^{40}_{20}S$

( )

Answer:

10. **B**
An ion of charge 2− is formed when an atom gains 2 electrons. The proton number of this atom is (2 + 8 + 6 =) 16.

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