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CLASS IX SCIENCE SMART NOTES

Journey Inside the Atom

NCERT-first • Concept-driven • Exam-oriented

Atomic idea > Subatomic particles > Atomic models > Z & A > Electron shells > Valency > Isotopes & isbars

How to use these notes	Golden line for this chapter
• Day 1: Learn the model journey and redraw the three atomic models from memory. • Day 3: Revise Z, A, electronic configuration and valency. • Day 7: Revise isotopes, isobars and average atomic mass. • Before exam: use the 10–15 minute revision sheet + Lakshya Smart Check.	• Atomic number Z identifies the element. • Mass number A counts nucleons: A = protons + neutrons. • For a neutral atom: electrons = protons = Z. • Valency comes from the valence-shell electrons.

Chapter Roadmap

- Atomic idea → electron → Thomson model → Rutherford model → Bohr model → neutron.
- Then build the atom using symbols, atomic number, mass number, electron distribution and valency.
- Finish with isotopes, average atomic mass and isobars.

SECTION A • 1st Revision

1. Learning Outcomes

After completing this chapter, you should be able to do the following.

You should be able to	NCERT exam focus
• Differentiate electron, proton and neutron by charge and position. • Explain Thomson, Rutherford and Bohr models of the atom. • Use atomic number Z and mass number A to find p, e and n. • Write electronic configurations up to the first 18 elements. • Explain valence electrons, valence shell and valency. • Differentiate isotopes and isobars and solve simple average atomic-mass questions.	• Connect experimental observation with scientific conclusion. • Do not confuse atomic number, mass number and average atomic mass. • Remember that symbol capitalization matters. • Show stepwise working in numerical problems.

2. From Atomic Idea to Thomson's Model

Science improves when better evidence becomes available.

Atomic idea	Electron + Thomson model
• Acharya Kanada spoke about indivisible particles called parmanus. • Leucippus and Democritus used the term atomos ("indivisible"). • John Dalton gave the first scientific atomic description based on the knowledge available in his time. • Later discoveries showed that atoms are divisible into subatomic particles.	• J. J. Thomson studied electric discharge through gases and identified the electron. • Cathode rays bend towards the positive plate, showing that they are negatively charged. • Thomson proposed the plum-pudding model: electrons embedded in a sphere of positive charge. • The atom is overall neutral because positive and negative charges balance.

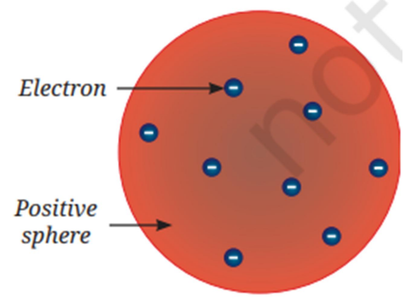


Fig. 8.2: Thomson's model of an atom

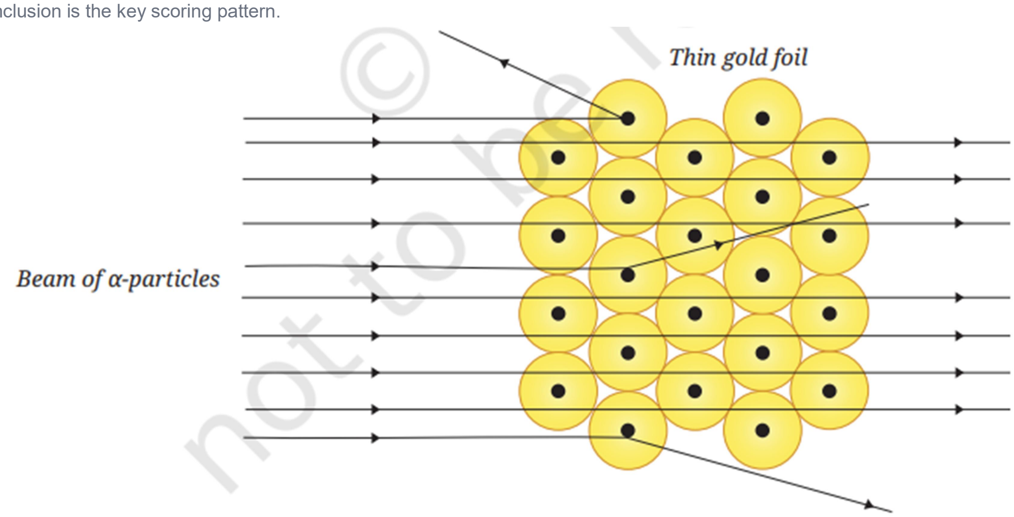
Simplified Thomson model.

Exam Alert

- Thomson did not place a small central nucleus in his model. The positive charge was spread throughout the atom.

3. Rutherford, Bohr and Neutron

Observation → conclusion is the key scoring pattern.



Simplified gold-foil scattering experiment.

Observation	Conclusion
Most α-particles passed straight through	Most of the atom is empty space.
Some α-particles were deflected	Positive charge is not spread uniformly.
Very few bounced back	A tiny dense positively charged nucleus is present at the centre.

Rutherford model

- Atom has a tiny, dense, positively charged nucleus at the centre.
- Most of the atom is empty space.
- Electrons revolve around the nucleus.
- Most of the atomic mass is concentrated in the nucleus.

Why Bohr's model was needed

- Rutherford's model could not explain atomic stability.
- A moving charged electron should lose energy and fall into the nucleus.
- Bohr proposed fixed-energy shells: K, L, M, N …
- An electron in an allowed shell does not lose energy.

Bohr model - must know

- Electrons occupy fixed shells or energy levels.
- Energy increases as distance from the nucleus increases.
- Electrons can move from one shell to another by absorbing or releasing a fixed amount of energy.
- This explains atomic stability at this level.

Neutron

- James Chadwick discovered the neutron in 1932.
- Neutron has no charge and a mass nearly equal to that of a proton.
- Protons and neutrons together are called nucleons.
- Atomic mass comes mainly from protons and neutrons.

Particle	Symbol	Charge	Position
Electron	e^-	−1	Outside nucleus / shells
Proton	p^+	+1	Inside nucleus
Neutron	n^0	0	Inside nucleus

SECTION B • Revise after 3 days

Build the atom correctly.

Symbols of elements
- The first letter is always capital, e.g. H, O, C.
- If two letters are used, the second letter is lowercase, e.g. Na, Cl, Al.
- Some symbols come from Latin names, e.g. Na, K, Fe.
- Capitalization mistakes can change the meaning.

Atomic number Z and mass number A
- Atomic number Z = number of protons in the nucleus.
- For a neutral atom: protons = electrons = Z.
- Mass number A = protons + neutrons.
- Neutrons = A − Z.

Z	Element	Symbol
1	Hydrogen	H
2	Helium	He
3	Lithium	Li
4	Beryllium	Be
5	Boron	B
6	Carbon	C
7	Nitrogen	N
8	Oxygen	O
9	Fluorine	F
10	Neon	Ne
11	Sodium	Na
12	Magnesium	Mg
13	Aluminium	Al
14	Silicon	Si
15	Phosphorus	P
16	Sulfur	S
17	Chlorine	Cl
18	Argon	Ar

Don’t Confuse
- Co is cobalt, but CO is a chemical formula with different meaning.
- Atomic number identifies the element. Mass number tells the total number of nucleons in one atom.
- Average atomic mass is different from mass number.

Worked Example
- For ^{23}□□Na: protons = 11, electrons = 11, neutrons = 23 − 11 = 12.

5. Electronic Configuration and Valency

For the first 18 elements, think in patterns.

Bohr–Bury rules
- Maximum number of electrons in a shell = $2n^2$.
- K shell can hold 2, L can hold 8, M can hold 18 in theory.
- At this level, the outermost shell can have a maximum of 8 electrons.
- Electrons fill shells stepwise: K → L → M → N ...

Smart method
- Step 1: Number of electrons = Z for a neutral atom.
- Step 2: Fill K with up to 2 electrons.
- Step 3: Fill L with up to 8 electrons.
- Step 4: Put the remaining electrons in M (up to 8 for the first 18 elements).
- Step 5: Outermost-shell electrons are valence electrons.

Sodium: 11 electrons → 2,8,1

Z	Symbol	Electronic configuration	Valence e^-	Valency
1	H	1	1	1
2	He	2	2	0
3	Li	2,1	1	1
4	Be	2,2	2	2
5	B	2,3	3	3
6	C	2,4	4	4
7	N	2,5	5	3
8	O	2,6	6	2
9	F	2,7	7	1
10	Ne	2,8	8	0
11	Na	2,8,1	1	1
12	Mg	2,8,2	2	2
13	Al	2,8,3	3	3
14	Si	2,8,4	4	4
15	P	2,8,5	5	3
16	S	2,8,6	6	2
17	Cl	2,8,7	7	1
18	Ar	2,8,8	8	0

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- Valence electrons = electrons in the valence shell.
- Valency = number of electrons gained, lost or shared to become stable.
- Example: chlorine has 7 valence electrons but valency 1.

SECTION C • Revise after 7 days

6. Isotopes, Average Atomic Mass and Isobars

Same element? Same Z. Same mass number? Check Z.

$^{1}_{1}H$	$^{2}_{1}H$	$^{3}_{1}H$
Protium	**Deuterium**	**Tritium**
1p, 0n	1p, 1n	1p, 2n

Same atomic number (Z = 1), different mass numbers (A)

Isotopes
- Isotopes are atoms of the same element having the same atomic number but different mass numbers.
- They have the same number of electrons and similar chemical properties.
- Their physical properties can differ.

Hydrogen isotopes
- Protium: $^{1}_{1}$ H → 1 proton, 0 neutron.
- Deuterium: $^{2}_{1}$ H → 1 proton, 1 neutron.
- Tritium: $^{3}_{1}$ H → 1 proton, 2 neutrons.

Isotope	Use
^{235}□□U	Fuel in nuclear reactors
^{60}□□Co	Cancer treatment
^{131}□□I	Treatment of thyroid disorders / goitre
^{14}□C	Dating fossils and artefacts

Average Atomic Mass
- Natural samples often contain more than one isotope.
- So we use a weighted average, not a simple average.
- For chlorine: (35×75 + 37×25)/100 = 35.5 u.
- 35.5 u is the average atomic mass, not the mass number of one atom.

Isobars
- Isobars are atoms of different elements having the same mass number but different atomic numbers.
- Example: ^{40}□□Ar and ^{40}□□Ca.

Feature	Isotopes	Isobars
Atomic number Z	Same	Different
Mass number A	Different	Same
Elements	Same element	Different elements
Example	^{35}□□Cl and ^{37}□□Cl	^{40}□□Ar and ^{40}□□Ca

7. Model Evolution - One Look Revision

Science moved from idea → evidence → better model.

Model	What it explained	Why a new model was needed
Dalton	Matter is made of atoms	Could not explain subatomic particles
Thomson	Presence of electrons in a neutral atom	Failed to explain gold-foil results
Rutherford	Tiny dense nucleus; atom mostly empty	Could not explain atomic stability
Bohr	Fixed-energy shells and atomic stability at this level	Later found incomplete for full atomic behaviour

Indian Contribution
- The chapter highlights the contribution of Homi Jehangir Bhabha and India’s peaceful work in atomic science.

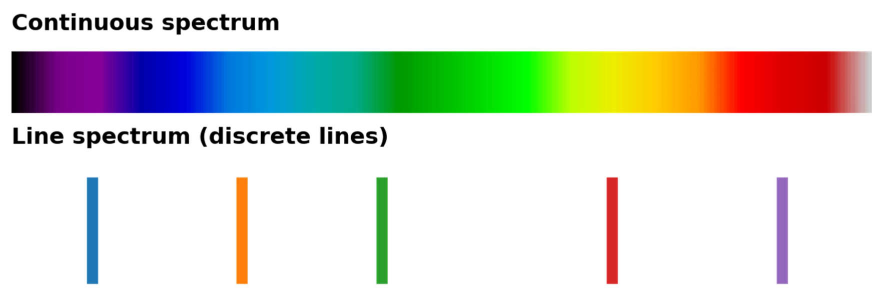
ADVANCED EDGE

8. Advanced Edge (Optional)

Useful enrichment after the Standard part is complete.

- Canal rays are positively charged and depend on the gas used.
- With hydrogen, the lightest positive particle corresponds to the proton.
- Chadwick discovered the neutron using beryllium and alpha particles.

- Line spectrum has distinct lines and is characteristic of an element.
- Hydrogen gives a line spectrum.
- Bohr's fixed-energy levels explain why only specific spectral lines are observed.



Advanced Edge: line spectra indicate discrete energy differences

Bohr Model Limitations

- Could not explain fine details of the hydrogen spectrum.
- Could not explain spectra of multi-electron atoms completely.
- Could not explain Zeeman and Stark effects.

9. Important Definitions and Quick Comparisons

High-yield final recall.

Term	Meaning
Atomic number (Z)	Number of protons in the nucleus
Mass number (A)	Total number of protons and neutrons
Nucleons	Protons and neutrons
Electronic configuration	Distribution of electrons among shells
Valence electrons	Electrons in the outermost shell
Valency	Combining capacity / electrons gained, lost or shared for stability
Isotopes	Same Z, different A
Isobars	Same A, different Z
Average atomic mass	Weighted average mass of naturally occurring isotopes

Don't Confuse

- Atomic number ≠ mass number.
- Mass number ≠ average atomic mass.
- Valence electrons ≠ valency.
- Co ≠ CO.

Memory Aids

- Neutral atom: p = e = Z.
- Neutrons: n = A − Z.
- Same Z → isotopes.
- Same A but different Z → isobars.
- Valency wave for Li→Ne and Na→Ar: 1,2,3,4,3,2,1,0.

PRACTICE

10. Mixed Practice

Use these for homework, classwork and oral revision.

Very short / short answers

- 1. Define atomic number and mass number.
- 2. State two observations of Rutherford's experiment.
- 3. Why was Bohr's model needed?
- 4. What are valence electrons?
- 5. Differentiate isotopes and isobars.

Reasoning / application

- 6. Why are isotopes chemically similar?
- 7. Why can average atomic mass be a decimal?
- 8. Why is chlorine's valency 1 although it has 7 valence electrons?
- 9. Why does symbol capitalization matter?
- 10. Explain model evolution from Thomson to Bohr.

Numerical practice

- 11. For ^{24}□□Mg, find p, e, n, electronic configuration and valency.
- 12. An atom has A = 35 and Z = 17. Find p, e and n.
- 13. An atom has 20 protons and 21 neutrons. Find Z and A.
- 14. Find the average atomic mass of chlorine if ^{35}Cl = 75% and ^{37}Cl = 25%.

Error detection

- 15. "Cobalt symbol is CO." Correct the error.
- 16. "Cl has valency 7." Correct the error.
- 17. "35.5 is the mass number of chlorine." Correct the error.
- 18. "Mg electronic configuration is 2,10." Correct the error.

NUMERICAL BANK

11. Solved Numerical Bank

Identify → Formula → Substitute → Calculate → Unit → Recheck

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- Protons = 17; electrons = 17; neutrons = 35 − 17 = 18.

Example 2

- Given: ^{24}□□Mg.
- p = 12, e = 12, n = 12.
- Electronic configuration = 2,8,2.
- Valence electrons = 2; valency = 2.

Example 3

- Given: 35 u (75%) and 37 u (25%).
- Average atomic mass = (35×75 + 37×25)/100 = 35.5 u.

Common Numerical Errors

- Using A as the number of electrons.
- Forgetting the neutral-atom rule before taking e = Z.
- Writing valence electrons as valency.
- Confusing mass number with average atomic mass.

FINAL REVISION

12. Lakshya 10–15 Minute Revision Sheet

Final revision before a test or exam.

Model Journey

- Dalton → Thomson → Rutherford → Bohr → Chadwick.
- Thomson: electrons in positive sphere.
- Rutherford: tiny dense nucleus, atom mostly empty.
- Bohr: fixed-energy shells.
- Chadwick: neutron.

Fast Facts

- e^- : −1, outside nucleus.
- p^+ : +1, inside nucleus.
- n^0: 0, inside nucleus.
- Z = p; A = p + n; n = A − Z.
- Valency wave: 1,2,3,4,3,2,1,0.

Shells + Valency

- Shell capacity = $2n^2$.
- For the first 18 elements: 2,8,8 pattern is important.
- Valence electrons are in the outermost shell.
- Valency is electrons needed for stability.

Isotopes + Mass

- Same Z → isotopes.
- Same A but different Z → isobars.
- Average atomic mass is a weighted average.
- Cl average atomic mass = 35.5 u.

10 Must-Remember Checks

- 1. Observation → conclusion in Rutherford answers.
- 2. Thomson model had no central nucleus.
- 3. Neutral atom: p = e.
- 4. Z identifies the element.
- 5. A = p + n.
- 6. Chlorine has 7 valence electrons but valency 1.
- 7. Symbol capitalization matters.
- 8. Average atomic mass can be decimal.
- 9. Same Z means isotopes.
- 10. Same A with different Z means isobars.

SMART CHECK

13. Lakshya Smart Check

Attempt first, then verify with the answer key.

MCQs

- 1. The particle that determines atomic number is _____.
- 2. Which observation shows that most of the atom is empty space?
- 3. Configuration 2,8,6 has valency _____.
- 4. ^{37}□□Cl and ^{35}□□Cl are _____.
- 5. Correct symbol for aluminium is _____.

Short answers

- 6. Define a nucleon.
- 7. Write neutrons in terms of A and Z.
- 8. Name the scientist who discovered neutron.
- 9. What is the valence shell?
- 10. Why is the average atomic mass of chlorine not a whole number?

Conceptual

- 11. Why was Rutherford's model an improvement over Thomson's model?
- 12. Why could Rutherford's model not explain atomic stability?
- 13. Why are isotopes chemically similar?
- 14. Differentiate valence electrons and valency using chlorine.
- 15. Why is atomic number more useful than mass number for identifying an element?

Calculation / Application

- 16. For A = 31 and Z = 15, find p, e and n.
- 17. For Z = 13, write electronic configuration, valence electrons and valency.
- 18. Calculate average atomic mass for 35 u (75%) and 37 u (25%).
- 19. Compare ^{40}□□Ar and ^{40}□□Ca.
- 20. If 2 neutrons are added to ^{35}□□Cl, what type of atom is formed?

14. Answer Key

Q	Answer
1	Proton
2	Most α-particles passed straight through
3	2
4	Isotopes
5	Al
6	A proton or neutron in the nucleus
7	n = A − Z
8	James Chadwick
9	The outermost shell containing electrons
10	Because it is a weighted average of isotopes
11	It introduced the nucleus and explained scattering results
12	A revolving electron should lose energy and collapse into the nucleus
13	They have the same atomic number and same electronic configuration
14	Cl has 7 valence electrons but valency 1
15	Atomic number equals number of protons and uniquely identifies the element
16	p = 15, e = 15, n = 16
17	2,8,3; valence electrons = 3; valency = 3
18	35.5 u
19	They are isobars: same A, different Z
20	An isotope of chlorine