Periodic Classification of Elements - Lesson Plan

Std. 10 Maharashtra State Board (Science and Technology Part 1, Chapter 2)

Introduction

The **periodic table** is a chart that arranges all **elements** (like Oxygen, Iron, etc.) in a systematic way. It helps us understand how elements behave, predict their properties, and study chemistry easily. This lesson explains the periodic table, its history, structure, trends, and importance for Std. 10 students.

Learning Objectives

By the end of this lesson, students will:

- Understand the history of the periodic table.
- Learn the structure of the modern periodic table (periods, groups, blocks).
- Explain trends like atomic size, valency, and electronegativity.
- Identify properties of key groups (e.g., alkali metals, halogens).
- Appreciate the importance of the periodic table in chemistry.

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1. History of the Periodic Table

a. Dobereiner's Triads (1817)

Sr. No.	Triad	Element -1 Actual atomic mass(a)	Element - 2		Element - 3 Actual atomic mass (c)
			Mean = $\frac{a+c}{2}$	Actual atomic mass	
1	Li, Na, K	Lithium (Li) 6.9	Sodium $\frac{6.9 + 39.1}{2} = 23.0$	(Na) 23.0	Potassium (K) 39.1
2	Ca, Sr, Ba	Calcium (Ca) 40.1	Strontium $\frac{40.1 + 137.3}{2} = 88.7$	(Sr) 87.6	Barium (Ba) 137.3
3	Cl, Br, I	Chlorine (Cl) 35.5	Bromine $\frac{35.5 + 126.9}{2} = 81.2$	(Br) 79.9	Iodine (I) 126.9

- Johann Dobereiner grouped 3 elements with similar properties into **triads.**
- The middle element's atomic mass was the average of the other two.
- **Example**: Lithium (Li, mass 7), Sodium (Na, mass 23), Potassium (K, mass 39).
    - Average: (7 + 39)/2 = 23 (matches Na).
- **Problem**: Worked only for a few elements.

b. Newlands' Law of Octaves (1864)

- John Newlands arranged elements by **increasing atomic mass.**
- Every 8th element had similar properties (like musical notes).
- **Example**: Li, Be, B, C, N, O, F, Na (Na is similar to Li).
- **Problem**: Worked only for lighter elements, not heavier ones.

c. Mendeleev's Periodic Table (1869)

- Dmitri Mendeleev arranged elements by **increasing atomic mass.**
- Similar elements were placed in **columns (groups)** and **rows (periods).**
- **Good Points**:
    - Left gaps for undiscovered elements (e.g., Gallium, Germanium).
    - Predicted their properties correctly.
    - Corrected some atomic masses (e.g., Beryllium).
- **Problems**:
    - Could not place isotopes (same element, different masses).
    - Some elements were in wrong order (e.g., Argon before Potassium).

d. Modern Periodic Table (1913)

- Henry Moseley arranged elements by **increasing atomic number** (number of protons).
- Fixed Mendeleev's problems (e.g., Argon-Potassium order).
- **Modern Periodic Law**: Properties of elements repeat regularly based on their atomic number.

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2. Structure of the Modern Periodic Table

The periodic table has:

- **Periods**: 7 horizontal rows.
  - Period 1: 2 elements (H, He).
  - Periods 2 & 3: 8 elements each (e.g., Na to Ar in Period 3).
  - Periods 4 & 5: 18 elements each.
  - Period 6: 32 elements (includes lanthanides).
  - Period 7: Incomplete (includes actinides).
- **Groups**: 18 vertical columns.
  - Elements in the same group have **similar properties** because they have the **same number of valence electrons** (outermost electrons).
  - **Key Groups**:
    - **Group 1**: Alkali metals (Li, Na, K) – very reactive.
    - **Group 2**: Alkaline earth metals (Mg, Ca) – less reactive.
    - **Group 17**: Halogens (F, Cl, Br) – reactive non-metals.
    - **Group 18**: Noble gases (He, Ne, Ar) – don't react (inert).
- **Blocks**:
  - **s-block**: Groups 1 & 2 (valence electrons in s-orbital).
  - **p-block**: Groups 13 to 18 (valence electrons in p-orbital).
  - **d-block**: Groups 3 to 12 (transition metals like Fe, Cu).
  - **f-block**: Lanthanides and actinides (bottom of the table).

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3. Trends in the Periodic Table

Elements show patterns in their properties:

1. **Atomic Size** (size of atom):
    - **Across a period**: Gets smaller (left to right).
        - Why? More protons pull electrons closer to the nucleus.
        - Example: In Period 3, Sodium (Na, 186 pm) is bigger than Chlorine (Cl, 99 pm).
    - **Down a group**: Gets bigger.
        - Why? More electron shells are added.
        - Example: In Group 1, Li < Na < K.
2. **Metallic Character**:
    - **Across a period**: Decreases (metals on left, non-metals on right).
        - Example: Na (metal) to Cl (non-metal).
    - **Down a group**: Increases for metals.
        - Example: In Group 1, K is more reactive than Li.
3. **Valency** (electrons shared/lost/gained):
    - **Across a period**: Increases from 1 to 4, then decreases to 0.
        - Example: Period 2: Li (1), Be (2), C (4), F (1), Ne (0).
    - **Down a group**: Stays the same.
        - Example: Group 1 (Li, Na, K) all have valency 1.
4. **Electronegativity** (ability to attract electrons):
    - **Across a period**: Increases.
        - Example: F (4.0) > Na (0.9).
    - **Down a group**: Decreases.
        - Example: In Group 17, F > Cl.
5. **Ionization Energy** (energy to remove an electron):
    - **Across a period**: Increases.
        - Example: Cl needs more energy than Na.
    - **Down a group**: Decreases.
        - Example: K < Na < Li.

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4. Important Groups and Their Properties

1. **Group 1 – Alkali Metals** (Li, Na, K):
    - Soft, very reactive, form basic oxides (e.g., Na_2O).
    - Example: Na + water → NaOH + H_2 gas.
2. **Group 2 – Alkaline Earth Metals** (Mg, Ca):
    - Less reactive than Group 1, form basic oxides (e.g., MgO).
3. **Group 17 – Halogens** (F, Cl, Br):
    - Very reactive non-metals, form acidic oxides (e.g., Cl_2O).
4. **Group 18 – Noble Gases** (He, Ne, Ar):
    - Don't react because they have a full outer electron shell.
5. **Transition Metals** (Groups 3–12):
    - Form colored compounds, have variable valency (e.g., Fe^{2+}, Fe^{3+}).

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5. Importance of the Periodic Table

- Predicts how elements behave (e.g., reactivity, bonding).
- Helps study chemical reactions and compounds.
- Makes learning chemistry easier by organizing elements.
- Helps discover new elements.

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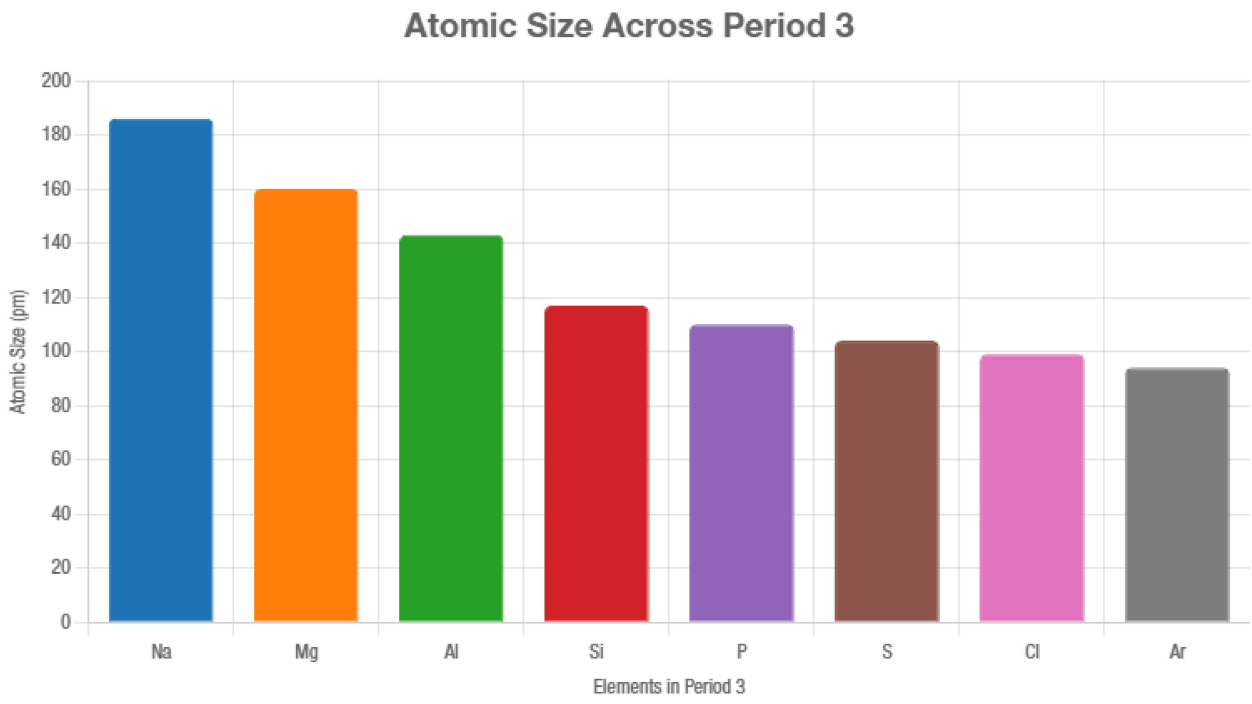
6. Diagram: Atomic Size Trend Across Period 3

Description for PDF: Include a bar chart showing the atomic size (in picometers, pm) of elements in Period 3 (Na, Mg, Al, Si, P, S, Cl, Ar). The chart shows that atomic size decreases from Sodium (186 pm) to Argon (94 pm) because the number of protons increases, pulling electrons closer to the nucleus.

Chart Details:

- **Title**: Atomic Size Across Period 3
- **X-axis**: Elements (Na, Mg, Al, Si, P, S, Cl, Ar)
- **Y-axis**: Atomic Size (pm)
- **Data**: Na (186 pm), Mg (160 pm), Al (143 pm), Si (117 pm), P (110 pm), S (104 pm), Cl (99 pm), Ar (94 pm)
- **Colors**: Use distinct colors for each bar (e.g., blue for Na, orange for Mg, green for Al, etc.).
- **Note**: In a PDF, you can generate this chart using software like MS Word, Google Docs, or Canva by inputting the data into a bar chart tool.



7. Quick Revision Table

Property	Across a Period	Down a Group
Atomic Size	Decreases	Increases
Metallic Character	Decreases	Increases (for metals)
Valency	Increases (1–4), then decreases	Constant
Electronegativity	Increases	Decreases
Ionization Energy	Increases	Decreases

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8. Practice Questions

1. What is the Modern Periodic Law? (2 marks)
2. Why does atomic size decrease across a period? Give an example. (3 marks)
3. Name three elements in Group 1 and list two properties. (2 marks)
4. Compare Mendeleev's and Modern Periodic Table (any 4 points). (4 marks)
5. What is the valency of elements in Group 17? Give an example. (2 marks)

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9. Exam Tips

- **Memorize**:
  - Modern Periodic Law.
  - Examples: Group 1 (Li, Na, K), Group 17 (F, Cl, Br), Group 18 (He, Ne, Ar).
  - Trends with examples (e.g., Na vs. Cl for atomic size).
- **Understand**:
  - Why atomic number is better than atomic mass for classification.
  - Properties of key groups.
- **Practice**: Drawing the periodic table structure and explaining trends.

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10. Summary

The periodic table organizes elements by atomic number, making it easy to study their properties. From Dobereiner to Moseley, scientists improved the table. It has 7 periods, 18 groups, and shows trends like decreasing atomic size across a period. Key groups like alkali metals and halogens have unique properties. The periodic table is a powerful tool for learning chemistry!