Class: 9th

Subject: Chemistry

Chapter 8: Periodic Table And Periodicity

Exercise MCQs:

(i) In which period and group will you place the element which is an important part of the solar cell?

(a) Third period and 14th group ✅

(b) Second period and 14th group

(c) Third period and 15th group

(d) Third period and 16th group

(ii). Identify the electronic configuration of the outermost shell of a transition metal.

(a) $ns^2\ np^4$

(b) $nd^8\ ns^2$ ✅

(c) $ns^2\ np^6$

(d) $ns^2 np^5$

(iii) Which is the softest metal?

(a) Na ✅

(b) Ca

(c) Al

(d) Zn

(iv) A yellow solid element exists in allotropic forms which is also present in fossil fuels. Indicate the name.

(a) Carbon

(b) Iodine

(c) Aluminium

(d) Sulphur ✅

(v) How many electrons can nitrogen accept in its outermost shell?

(a) 2

(b) 3 ✅

(c) 4

(d) 5

(vi) Which element is the most reactive element?

(a) Oxygen

(b) Chlorine

(c) Fluorine ✅

(d) Nitrogen

(vii) Which element has the highest melting point?

(a) Na ✅

(b) K

(c) Rb

(d) Cs

(viii) In what order does the metallic character change in the second group?

(a) Mg > Ca > Ba > Sr

(b) Sr > Ba > Ca > Mg

(c) Mg > Sr > Ca > Ba

(d) Ba > Sr > Ca > Mg ✅

(ix) Which of the following best describe the correct order of oxygen, fluorine, and nitrogen's atomic radii?

(a) O < F < N

(b) N < F < O

(c) F < O < N ✅

(d) O < N < F

(x) The element having less value of ionization energy and less value of electron affinity is likely to belong to:

(a) Group 1 ✅

(b) Group 13

(c) Group 16

(d) Group 17

Important MCQs:

1. Which characteristic is the basis of the modern periodic table?

(a) Atomic mass

(b) Mass number

(c) Atomic number ✅

(d) Valency

2. Elements with similar properties are placed in the same:

(a) Period

(b) Group ✅

(c) Block

(d) Series

3. What are the horizontal rows in the periodic table called?

(a) Groups

(b) Periods ✅

(c) Blocks

(d) Shells

4. What are the vertical columns in the periodic table called?

(a) Shells

(b) Periods

(c) Groups ✅

(d) Orbitals

5. How many periods are present in the modern periodic table?

(a) 6

(b) 7 ✅

(c) 8

(d) 9

6. How many groups are there in the modern periodic table?

(a) 10

(b) 16

(c) 18 ✅

(d) 20

7. What is the name of the trend in which element properties repeat periodically?

(a) Reactivity

(b) Periodicity ✅

(c) Ionization

(d) Bonding

8. Elements of the same group have the same number of:

(a) Protons

(b) Neutrons

(c) Outer electrons ✅

(d) Shells

9. How many elements are present in the first period?

(a) 2 ✅

(b) 8

(c) 18

(d) 32

10. How many elements are present in the 6th and 7th periods?

(a) 8

(b) 18

(c) 32 ✅

(d) 36

11. After which element does the lanthanide series begin?

(a) Barium

(b) Actinium

(c) Lanthanum ✅

(d) Cerium

12. After which element does the actinide series begin?

(a) Uranium

(b) Thorium

(c) Actinium ✅

(d) Francium

13. What are elements in groups 3 to 12 called?

(a) Normal elements

(b) Transition elements ✅

(c) Rare earth metals

(d) Alkali metals

14. Where are the f-block elements placed in the periodic table?

(a) At the top

(b) At the bottom ✅

(c) In the center

(d) In group 1

15. Elements in which the s-subshell is being filled belong to:

(a) p-block

(b) d-block

(c) f-block

(d) s-block ✅

16. Which group of the periodic table contains highly electropositive elements?

(a) Group II

(b) Group VII

(c) Group I ✅

(d) Group VIII

17. Why do group I elements react vigorously with water?

(a) They have full valence shells

(b) They gain electrons easily

(c) They lose one electron easily ✅

(d) They form covalent bonds

18. Which of the following is a correct reaction for alkali metal with water?

(a) $Na + Cl_2 \Rightarrow NaCl$

(b) $Na + H_2O \Rightarrow NaOH + H_2$ ✅

(c) $Mg + O_2 \Rightarrow MgO$

(d) $K + HCl \Rightarrow KCl + H_2$

19. Which of the following group elements form 2+ ions by losing two electrons?

(a) Group I

(b) Group II ✅

(c) Group XVI

(d) Group XVII

20. Which group contains the most reactive non-metals?

(a) Group I

(b) Group II

(c) Group XVI

(d) Group XVII ✅

21. What happens to the atomic radius as we go from top to bottom in a group?

(a) Decreases

(b) Increases ✅

(c) First increases, then decreases

(d) Remains the same

22. What happens to ionization energy across a period from left to right?

(a) Decreases

(b) Increases ✅

(c) Remains constant

(d) Becomes zero

23. Which group forms 1– anions by gaining one electron?

(a) Group I

(b) Group II

(c) Group XVI

(d) Group XVII ✅

24. What is atomic radius?

(a) Distance between electrons

(b) Distance between nuclei of bonded atoms divided by two ✅

(c) Distance from nucleus to outer shell

(d) The total diameter of an atom

25. Which of the following correctly explains decrease in atomic size across a period?

(a) New shells are added

(b) Protons are removed

(c) Nuclear charge increases pulling electrons inward ✅

(d) Electrons are lost

26. What is electron affinity?

(a) Energy required to remove an electron

(b) Energy released when an electron is added ✅

(c) Distance between two nuclei

(d) Mass of an atom

27. Which element has the highest electron affinity among Group 17 elements?

(a) Iodine

(b) Chlorine ✅

(c) Bromine

(d) Fluorine

28. What is the trend of electron affinity down a group?

(a) Increases

(b) Decreases ✅

(c) Remains constant

(d) First increases, then decreases

29. What is always true about second electron affinity?

(a) Always zero

(b) Always negative

(c) Always positive ✅

(d) Always neutral

30. Electronegativity is defined as:

(a) Atom's ability to gain protons

(b) Atom's ability to lose electrons

(c) Atom's ability to attract shared electrons ✅

(d) Atom's ability to form cations

31. Electronegativity increases:

(a) From bottom to top in a group ✅

(b) From right to left in a period

(c) From top to bottom in a group

(d) Down the group and across the period

32. Which element is the most electronegative?

(a) Oxygen

(b) Chlorine

(c) Nitrogen

(**d**) Fluorine ✅

33. What happens to metallic character down a group?

(a) Decreases

(**b**) Increases ✅

(c) Becomes zero

(d) Remains same

34. Which of the following is true about metallic character across a period?

(a) It increases

(**b**) It decreases ✅

(c) It remains unchanged

(d) It becomes maximum at the center

35. How does density change in a group from top to bottom?

(a) Decreases

(b) Increases ✅

(c) Remains same

(d) Becomes zero

Exercise Short Questions:

i. Why was atomic number chosen to arrange the elements in the periodic table?

Atomic number represents the number of protons in an atom. It is a fundamental property that uniquely identifies an element. Arranging elements by atomic number solves the anomalies found in Mendeleev's periodic table and shows periodic properties more accurately.

ii. What is the significance of the word periodic?

The word "periodic" refers to the recurring trends or patterns in the properties of elements after regular

intervals, particularly when arranged by increasing atomic number.

iii. Why does the size of a period increase as we move down the periodic table?

This statement is incorrect. The size of a group increases as we move down the periodic table because new electron shells are added, increasing the atomic radius.

iv. In a group, the elements have the same number of electrons in the outermost shell. Why is it so?

Because elements in the same group have similar valence electron configurations, which give them similar chemical properties and the same number of valence electrons.

v. Do you expect calcium to be more reactive than sodium? Give the reason of your answer.

No, calcium is less reactive than sodium because calcium has more protons, stronger nuclear attraction, and higher ionization energy, making it harder to lose electrons compared to sodium.

vi. Which element has the maximum atomic radius and which element has the minimum atomic radius in third period?

In the third period:

- Maximum atomic radius: Sodium (Na)
- Minimum atomic radius: Chlorine (Cl)

vii. Why are the most electronegative elements present in sixth and seventh groups?

This is incorrect. The most electronegative elements are present in group 17 (halogens) and the top right of the periodic table, especially fluorine, due to their small size and high nuclear charge.

viii. The first ionization energy value of magnesium is less than the second one. Give reason.

The first electron is removed from a neutral atom, but the second is removed from a positively charged ion, which holds the remaining electrons more tightly, requiring more energy.

ix. Is it possible for two metals or two non-metals to form an ionic bond?

No, ionic bonds usually form between a metal (which loses electrons) and a non-metal (which gains electrons). Two metals or two non-metals typically form metallic or covalent bonds, respectively.

x. Which element has the least value of ionization energy and which element has the highest value of electronegativity?

- Least ionization energy: Cesium (Cs)
- Highest electronegativity: Fluorine (F)

Important Short Questions:

1. Why are elements arranged according to atomic number in the modern periodic table?

Answer:

Elements are arranged by increasing atomic number because it reflects the order of their protons and electronic configurations, which determine their chemical properties. This

arrangement ensures a periodic repetition of properties.

2. What is the difference between a group and a period in the periodic table? Explain with definitions.

Answer:

Groups are vertical columns in the periodic table where elements have similar properties and the same number of outermost electrons.

Periods are horizontal rows where elements show gradual change in properties due to increasing atomic number.

3. What is meant by periodicity in properties? Give one example.

Answer:

Periodicity means the repetition of chemical properties of elements after regular intervals.

Example: Elements in Group 1 (alkali metals) show similar reactivity.

4. Why do elements in the same group show similar chemical properties?

Answer:

Because they have the same number of electrons in their outermost shell, leading to similar bonding and reactivity.

5. What is the significance of the term "periodic" in the periodic table?

Answer:

The term "periodic" refers to the regular repetition of chemical and physical properties of elements when arranged by increasing atomic number.

6. Why are lanthanides and actinides placed separately at the bottom of the periodic table?

Answer:

They are placed separately to keep the table compact and manageable, as these series contain 14 elements each that would otherwise make the table too wide.

7. How many groups and periods are there in the modern periodic table?

Answer:

There are 18 groups and 7 periods in the modern periodic table.

8. What are s-block and p-block elements? Give examples.

Answer:

s-block elements are those in which the s-subshell is being filled (e.g., Hydrogen, Sodium).

p-block elements are those in which the p-subshell is being filled (e.g., Oxygen, Chlorine).

9. Why do elements in a period show gradual change in their properties?

Answer:

Because the atomic number increases across a period, changing the number of protons and electrons, which alters the atomic size and other properties.

10. Which groups contain normal elements and which contain transition elements?

Answer:

- Normal elements are in Groups 1–2 and 13–17.
- Transition elements are in Groups 3–12.

11. How do alkali metals react with halogens? Give an example.

Alkali metals react vigorously with halogens to form halide salts. In this reaction, alkali metals lose one electron to form cations, while halogens gain one electron to form anions.

For example:

Sodium reacts with chlorine to form sodium chloride, a salt.

12. Define atomic radius.

Atomic radius is defined as half the distance between the nuclei of two identical atoms bonded together. It represents the size of an atom.

13. What is the trend of atomic radius across a period and down a group?

- **Across** a **period** (left to right), **atomic radius** decreases because the nuclear charge increases, pulling electrons closer to the nucleus.
- **Down** a **group** (top to bottom), **atomic radius** increases because new electron shells are added, increasing the size of the atom.

14. Define electron affinity. How does it vary in a group?

- Electron affinity is the amount of energy released or absorbed when an electron is added to an isolated gaseous atom.
- In a group, electron affinity decreases from top to bottom because as atomic size increases, the nucleus attracts the added electron less strongly.

15. What is electronegativity?

Electronegativity is the ability of an atom to attract

the shared pair of electrons towards itself in a chemical bond.

16. Which group contains the most electronegative elements and why?

Group 17 (halogens) contains the most electronegative elements because they have seven electrons in their outermost shell and a strong tendency to attract one more electron to complete their octet. Elements like fluorine and chlorine are highly electronegative.

17. What is metallic character?

Metallic character is the tendency of an element to lose electrons and form positive ions (cations). Elements that easily lose electrons show high metallic character.

18. How does metallic character change down a group?

Metallic character increases as we move down a group because ionization energy decreases, making it easier for elements to lose electrons.

19. Explain the trend of metallic character across a period.

Across a period from left to right, metallic character decreases. This is because the nuclear charge increases, pulling valence electrons more strongly and making it harder to lose electrons.

20. How does chemical reactivity vary in a period from left to right?

Chemical reactivity generally decreases from left to right in a period for metals, as it becomes harder to lose electrons. However, reactivity increases again towards the non-metals on the right side, which tend to gain electrons.

21. Define density and explain its trend in groups and periods.

Density is the mass of a substance per unit volume, expressed in g/cm³. Density generally increases down a group due to increasing atomic mass, but it varies less noticeably across a period from left to right.

Important Long Questions:

Q1: Describe the basis of the modern periodic table and explain how elements are arranged in it.

1. Basis of Modern Periodic Table:

- The **modern periodic** table is based on increasing atomic number (number of protons in the nucleus).
- It was proposed by Henry Moseley in 1913, correcting the flaws of Mendeleev's table which was based on atomic mass.

2.Arrangement of Elements:

- Horizontally arranged rows are called periods. There are 7 periods in total.
- Vertically arranged columns are called groups. There are 18 groups.

3. Electron Configuration Pattern:

- Elements in a period have the same number of electron shells, but increasing valence electrons.

- Elements in a group have the same number of valence electrons, giving them similar chemical properties.

4. Periodicity of Properties:

- Properties like atomic radius, ionization energy, electronegativity, etc., show repeating patterns across periods and down groups.
- This repetition of properties is known as periodicity.

5. Usefulness of the Table:

- The table helps predict the chemical behavior of elements.
- It provides a systematic layout that makes learning, teaching, and applying chemistry easier.

Q2: Compare the modern periodic table with earlier periodic tables in terms of arrangement and accuracy in predicting element properties.

1. Earlier Periodic Tables (e.g., Mendeleev's Table):

- Elements were arranged by increasing atomic

mass.

- Mendeleev left gaps for undiscovered elements and made adjustments to place similar elements together.
- Some elements were placed out of order based on atomic mass to preserve chemical similarities (e.g., Te and I).

2. Modern Periodic Table:

- Arranged by increasing atomic number, which is more accurate and scientific.
- Solves all inconsistencies of earlier tables (e.g., the Te-I issue).
- No need for arbitrary placement of elements.

3. Accuracy in Predicting Properties:

- Modern table shows clear trends in properties like atomic size, reactivity, ionization energy, etc.
- It accurately predicts chemical behavior based on group and period position.

- Elements in the same group show similar valency and chemical reactions.

4. Inclusion of New Elements:

- Modern table includes noble gases, transition elements, and lanthanides/actinides properly.
- Has space for newly discovered or synthetic elements.

5. Scientific Advantage:

- More systematic and logical.
- Used worldwide as a standard reference in chemistry.

Q3: Define atomic radius. Explain its types and describe the variation of atomic radius in periods and groups.

Definition:

Atomic radius is the distance from the nucleus of an atom to the outermost shell of electrons.

Since electron clouds don't have sharp boundaries, it is usually defined as half the distance between

nuclei of two bonded identical atoms.

Unit: picometer (pm)

Types of Atomic Radius:

1. Covalent Radius:

- Half of the distance between the nuclei of two atoms bonded by a single covalent bond.
- **Example**: Bond length in Cl_2 = 198 pm ’n Covalent radius = 99 pm

2. Metallic Radius:

- Half the distance between nuclei of two adjacent metal atoms in a metallic lattice.
- Found in metals like Fe, Na, Cu etc.

3. Van der Waals Radius:

- Half the distance between the nuclei of two adjacent atoms of different molecules, not bonded but close due to intermolecular forces.
- Common in noble gases like He, Ne, Ar.

Variation in Atomic Radius:

Across a Period (left to right):

- Atomic radius decreases
- Reason: Nuclear charge increases, pulling electrons closer, reducing size.

Down a Group (top to bottom):

- Atomic radius increases
- **Reason**: More electron shells are added, increasing atomic size.

Q4: What is ionization energy? Describe its types and explain the trend of ionization energy across periods and down groups.

Definition:

- **Ionization energy** is the minimum energy required to remove the most loosely held electron from a gaseous atom to form a cation.
- It is a measure of how tightly electrons are held.
- Unit: kJ/mol

Types of Ionization Energy:

1. First Ionization Energy:

Energy required to remove the first electron.

Example:

$Na(g) \Rightarrow Na^+(g) + e^-$

$\Delta H = +496$ kJ/mol

2. Second Ionization Energy:

Energy needed to remove a second electron from the already formed Na^+ ion.

$Na^+(g) \Rightarrow Na^{2+}(g) + e^-$

3. Successive Ionization Energies:

- Energies required to remove more electrons one by one.
- Each next ionization energy is higher than the previous one due to stronger attraction to the nucleus.

Trends in Ionization Energy:

Across a Period (left to right):

Increases

Reason: Smaller size and increased nuclear charge make electrons harder to remove.

Down a Group (top to bottom):

Decreases

Reason: More shells and shielding reduce nuclear attraction, making it easier to remove electrons.

Q5: Define metallic character. Explain how it varies in periods and groups with examples.

Definition of Metallic Character:

Metallic character refers to the tendency of an element to lose electrons and form positive ions (cations). It is a key property of metals, which are good conductors of electricity and heat, and are malleable and ductile.

Variation in Periods (Left to Right):

- As we move from left to right in a period, the nuclear charge increases because the number of protons increases.
- The valence electrons are pulled more strongly

by the nucleus, making it harder to lose electrons.

- As a result, the **metallic character** decreases from left to right.

Example:

- In the **2nd period**, Sodium (Na) has a strong metallic character.
- But as we move to **Magnesium** (Mg), Aluminum (Al), and Silicon (Si), the metallic character becomes weaker.
- **Elements** like **Oxygen** (O) and Fluorine (F) are non-metals with **no** metallic character.

Variation in Groups (Top to Bottom):

- As we move down a group, the atomic size increases due to the addition of new electron shells.
- The outer **electrons** are less strongly attracted to the nucleus, making it easier to lose electrons.
- Hence, **metallic character** increases down a

group.

Example:

In Group 1 (Alkali Metals): Lithium (Li) is less metallic than Sodium (Na), and Potassium (K) is even more metallic.

Q6: What is the relationship between metallic character and chemical reactivity?

Relationship:

- **Metallic character** and chemical reactivity are closely related, especially for metals.
- A **higher metallic** character means the element can lose electrons more easily, making it more reactive.
- For **non-metals**, reactivity depends on their ability to gain electrons, so the relationship is opposite.

For Metals:

- **Reactivity increases** down a group as metallic character increases (due to lower ionization

energy).

- **Reactivity decreases** across a period as metallic character decreases (due to stronger nuclear attraction).

Example:

- **Sodium** (Na) is more reactive than Aluminum (Al) in Period 3.
- In Group 1, Potassium (K) is more reactive than Lithium (Li).

For Non-Metals:

- **Reactivity increases** across a period as non-metals become more electronegative.
- **Reactivity decreases** down a group as atomic size increases.

Example:

- **Fluorine** (F) is more reactive than Iodine (I) in Group 17.

3. Constructed Response Questions:

i. Suppose a new element is discovered. Where would you like to accommodate this element in the periodic table?

The new element would be placed based on:

1. Its atomic number.
2. Its electronic configuration.
3. Its chemical properties.
4. It would be placed in the same group as elements with similar valence electrons.
5. Its period is determined by the number of electron shells.

ii. What is the first element of the periodic table? Will it lose an electron or gain it?

- The first element is Hydrogen.
- It has 1 electron in its outer shell.

It can:

1. Lose one electron to form H^+ (like alkali metals).

2. Gain one electron to form H^- (like halogens).

But usually, it loses one electron to form H^+ ion.

iii. Atomic radii of boron and aluminum are 88 pm and 125 pm respectively. Which element is expected to lose electron or electrons easily?

Boron atomic radius = 88 pm

Aluminum atomic radius = 125 pm

Points:

1. A larger **atomic radius** means electrons are farther from the nucleus.

2. They are less tightly held, so easier to remove.

3. **Aluminum**, having a larger radius, loses electrons more easily than boron.

iv. How would you find the atomic radius of an atom?

Atomic radius can be found using the following method:

1. Take two bonded atoms of the same element.

2. Measure the distance between their nuclei.

3. Divide the distance by 2.

Formula:

Atomic Radius = (Distance between nuclei) / 2

v. Why is it not possible for oxygen atom to accept three electrons to form O^{3-} ion like nitrogen which can accept electrons to form N^{3-}?

Points:

1. **Oxygen** has 6 electrons in its outer shell.

2. It needs only 2 more electrons to complete its octet (total 8).

3. **Accepting** a third **electron** would cause strong repulsion.

4. The **extra negative** charge would make the ion highly unstable.

5. Therefore, **O^{3-}** ion is not possible, while N^{3-} is stable because nitrogen has 5 electrons and needs 3 to complete the octet.

4. Descriptive Questions:

i. Which information is needed to locate the elements in the periodic table if you do not know its atomic number? Is atomic mass helpful for this purpose?

To locate an element, atomic number is most accurate.

But if atomic number is unknown, we can use:

1. **Atomic** mass (approximate position).

2. **Electronic** configuration based on atomic mass.

3. **Chemical** properties or valence electrons.

Yes, atomic mass is somewhat helpful, but not

as reliable as atomic number.

ii. How many blocks of elements are present in the periodic table? Are these blocks helpful in studying the properties of elements?

There are four blocks in the periodic table:

1. s-block

2. p-block

3. d-block

4. f-block

Yes, blocks are helpful because:

1. Elements in the same block have similar electronic configurations.

2. They show similar chemical properties.

3. They help understand trends like reactivity, valency, etc.

iii. Explain the variation in the following properties in the periods giving reasons.

(a) Atomic Radius

Decreases across a period.

Reason:

1. Number of protons increases.

2. Nuclear charge becomes stronger.

3. Electrons are pulled closer to the nucleus.

(b) Ionization Energy

Increases across a period.

Reason:

1. Atomic size decreases.

2. Electrons are held more tightly.

3. More energy is needed to remove the outer electron.

iv. Which physical properties of elements may lead us to know what type of bond it will form?

Following properties help identify the type of bond:

1. **Electronegativity** – large difference leads to ionic bond.

2. **Ionization energy** – low ionization energy means tendency to lose electrons (forms ionic bond).

3. **Electron affinity** – high value means tendency to gain electrons.

4. **Atomic size** – affects attraction/repulsion between atoms.

v. Write down the names of four non-metals which exist in solid state at normal temperature.

1. Carbon

2. Sulphur

3. Phosphorus

4. Iodine

vi. Why do second and third periods have equal number of elements while all other

periods contain different number of elements?

Second and third periods have 8 elements each because:

1. Their outermost electrons fill the 2nd and 3rd shells.

2. The maximum number of electrons in these shells is 8 (according to $2n^2$ rule).

Other periods are longer because:

1. They involve filling of d- and f-orbitals.

2. This increases the number of elements in those periods (e.g., 18 or 32 elements).

Note:

This chapter is designed to provide a solid foundation of knowledge, with the goal of deepening understanding and encouraging further exploration of the subject. The content has been carefully selected to support effective learning and inspire students to engage with the topic more deeply.

Author: Muhammad Asghar

Purpose: To contribute to education by offering insightful, valuable content that enhances learning and understanding.

Copyright & Usage Policy