



CHEM · CHEMISTRY

11. S & P Block Elements

Official PMDC Solved Past Paper Topical Booklet · High-Yield Examination Series

🕒 104 Solved Questions

📅 2010 to 2024 Archive

🏛️ Boards: BUMHS, DUHS, KMU, MDCAT, NUMS, PMDC

📊 Weightage: 27% of MDCAT (54 MCQs)

Curated by Ibrahim for fellow bees. Every question in this chapter has been verified against official UHS, NUMS, SZABMU, DUHS, and KMU answer keys. Propolis cognitive autopsies are provided at the end of this booklet to explain core concepts and break down common distractor traps.

OFFICIAL SOLVED EDITION**Q1.**

UHS 2024

The difference of lithium from the other alkali metals is mainly because of: **[UHS (2024)]**

- (A) Large radius and low charge density
- (B) Large radius and high charge density
- (C) Small radius and low charge density
- (D) Small radius and high charge density

Q2.

UHS 2024

Which of the following is not Basic in nature **[UHS (2024)]**

- (A) Aluminium oxide
- (B) Potassium oxide
- (C) Magnesium oxide
- (D) Sodium oxide

Q3.

UHS 2024

The solubility of sulphates of alkaline metals generally **[UHS (2024)]**

- (A) Increases down the group
- (B) Increase then decrease down the group
- (C) Decrease down the group
- (D) Doesn't change down the group

Q4.

SZABMU 2024

Metallic character of alkaline earth metals ____ down the groups. **[SZABMU (2024)]**

- (A) Decreases
- (B) Increases
- (C) Gradually increases then decreases
- (D) Remains same

Q5.

SZABMU 2024

Which of the following metal forms superoxide when reacted with oxygen? **[SZABMU (2024)]**

- (A) Beryllium
- (B) Magnesium
- (C) Lithium
- (D) Potassium

Q6.

SZABMU 2024

Which of the following metal hydroxide is the strongest base? **[SZABMU (2024)]**

- (A) $\text{Ca}(\text{OH})_2$
- (B) $\text{Mg}(\text{OH})_2$
- (C) LiOH
- (D) NaOH

Q7.

SZABMU 2024

The correct stability order of M^{+4} cations is (Out of syllabus) **[SZABMU (2024)]**

- (A) $\text{Ge}^{+4} < \text{Pb}^{+4} < \text{Sn}^{+4}$
- (B) $\text{Ge}^{+4} > \text{Pb}^{+4} > \text{Sn}^{+4}$
- (C) $\text{Ge}^{+4} < \text{Sn}^{+4} < \text{Pb}^{+4}$
- (D) $\text{Ge}^{+4} > \text{Sn}^{+4} > \text{Pb}^{+4}$

Q8.

SZABMU 2024

When potassium superoxide reacts with carbon dioxide, following products are formed [SZABMU RC-(2024)]

- (A) $K_2CO_3 + O_2$
- (B) $KO_2 + O_2 + [O]$
- (C) $K_2CO_3 + CO_2$
- (D) $KO_2 + CO_2$

Q9.

SZABMU 2024

The color imparted by the Li wire when subjected to flame is [SZABMU RC-(2024)]

- (A) Crimson red
- (B) Pale green
- (C) Greyish white
- (D) Brick red

Q10.

SZABMU 2024

The trend of increasing order of densities among Group 1 elements is [SZABMU RC-(2024)]

- (A) Li, Na, K, Rb
- (B) Li, Na, Rb, Cs
- (C) Na, K, Rb, Cs
- (D) Cs, Rb, Na, Li

Q11.

SZABMU 2024

Which of following sulphate of Group-II elements are insoluble? [SZABMU RC-(2024)]

- (A) $MgSO_4$
- (B) $BeSO_4$
- (C) $CaSO_4$
- (D) $BaSO_4$

Q12.

SZABMU 2024

Which of the following element is s-block element? [SZABMU RC-(2024)]

- (A) Sulphur
- (B) Potassium
- (C) Iron
- (D) Neon

Q13.

KMU 2024

Electronegativity of Al is approximately equal to that of [ETEA (2024)]

- (A) B
- (B) Mg
- (C) Be
- (D) Na

Q14.

KMU 2024

Third period element that initially reacts rapidly with oxygen to form a protective oxide coating that prevents further reactions is [ETEA (2024)]

- (A) Al
- (B) Na
- (C) Mg
- (D) Si

Q15.

DUHS 2024

The alkali metal gives a yellow color during a flame test is: [DUHS (2024)]

- (A) Ba
- (B) K
- (C) Na
- (D) Cs

Q16.

DUHS 2024

Oil of Vitriol refer to: [DUHS (2024)]

- (A) Caustic soda
- (B) Borax
- (C) Alum
- (D) Sulfuric acid

Q17.

DUHS 2024

Deficiency of ____ causes loss of weight, appetite, and taste: (Out of syllabus) [DUHS (2024)]

- (A) K
- (B) Fe
- (C) P
- (D) Zn

Q18.

DUHS 2024

Mostly p block elements react with ____ to form binary compounds: (Wrong) [DUHS (2024)]

- (A) Oxygen
- (B) Halogen
- (C) Water
- (D) Nitrogen

Q19.

BUMHS 2024

Which of the following elements react rapidly with water at room temperature? [BMU-2024]

- (A) Cu
- (B) Na
- (C) Fe
- (D) Al

Q20.

BUMHS 2024

Sodium nitrate (NaNO_3), on heating, decomposes forming [BMU–2024]

- (A) Na_2O and NO_2
- (B) NaNO_2 and O_2
- (C) Na , NO_2 and O_2
- (D) Na_2O_3 , NO_2 and O_2

Q21.

NUMS 2024

When a metal carbonate is heated at 100°C , which of the following compound will readily decompose? [NUMS (2024)]

- (A) BaCO_3
- (B) BeCO_3
- (C) MgCO_3
- (D) SrCO_3

Q22.

UHS 2023

Which element has the ground state electronic configuration of $1s^2 2s^2 2p^6, 3s^2, 3p^6$? [UHS (2023)]

- (A) Ar
- (B) Cl
- (C) Na
- (D) S

Q23.

UHS 2023

Which oxyacid of halogen is strong oxidizing agent? [UHS (2023)]

- (A) HClO_4
- (B) HClO_3
- (C) HClO
- (D) HClO_2

Q24.

UHS 2023

Oxidation number of free magnesium is? [UHS (2023)]

- (A) 0
- (B) +1
- (C) +2
- (D) +3

Q25.

UHS 2023

Select the metal which is extracted from bauxite? [UHS (2023)]

- (A) Al
- (B) Ca
- (C) Mg
- (D) Cu

Q26.

UHS 2023

Which of the following has the highest atomic radius in its period? [UHS (2023)]

- (A) Alkaline earth metals
- (B) Alkali metals
- (C) Chalcogens
- (D) halogens

Q27.

UHS 2023

The electronic configurations of some elements are given below. Recognize the element that belongs to group IIIA [UHS (2023)]

- (A) $1s^2 2s^2 2p^3$
- (B) $1s^2 2s^2 2p^4$
- (C) $1s^2 2s^2 2p^1$
- (D) $1s^2 2s^2 2p^2$

Q28.

UHS 2023

All alkali metals react with chlorine gas to form white metal chlorides salt. The metal chlorides salt formed is: [UHS (2023)]

- (A) Insoluble
- (B) Soluble in water to give neutral solution of pH 7
- (C) Soluble in water to give acidic solution of pH 1
- (D) Soluble in water to give alkaline solution of pH 14

Q29.

UHS 2023

Which one of them is amphoteric in nature? [UHS (2023)]

- (A) Lithium oxide
- (B) Beryllium oxide
- (C) Calcium oxide
- (D) Potassium oxide

Q30.

SZABMU 2023

A metal reacts vigorously with cold water melting in to a ball of molten metal, moves across the surface of water giving off Hydrogen gas and burns with yellowish golden flame. What could be the identity of this metal? [SZABMU (2023)]

- (A) Potassium
- (B) Sodium
- (C) Lithium
- (D) Calcium

Q31.

SZABMU 2023

Among alkali metals which element reacts slowly with H_2O ? [SZABMU (2023)]

- (A) Na
- (B) K
- (C) Rb
- (D) Li

Q32.

SZABMU 2023

Which element has smaller shielding effect among the following? [SZABMU (2023)]

- (A) Mg
- (B) Ca
- (C) Rb
- (D) Sr

Q33.

SZABMU 2023

The oxidation number of oxygen in Na_2O_2 is: [SZABMU (2023)]

- (A) -1
- (B) +2
- (C) -2
- (D) +1

Q34.

SZABMU 2023

The melting point of sulphur is higher than that of phosphorous because: [SZABMU (2023)]

- (A) Sulphur has strong van der Waals forces
- (B) Sulphur has weak van der Waals forces
- (C) Phosphorus has strong van der Waals forces
- (D) Phosphorous has weak van der Waals forces

Q35.

KMU 2023

Choose the element that forms normal oxide only: [EATA (2023)]

- (A) Li
- (B) Na
- (C) K
- (D) Rb

Q36.

KMU 2023

Element whose salts do not impart color to flame test is: [EATA (2023)]

- (A) Be
- (B) Cs
- (C) Ca
- (D) K

Q37.

KMU 2023

Indicate superoxide in the following: [EATA (2023)]

- (A) CaO
- (B) BaO_2
- (C) Na_2O_2
- (D) RbO_2

Q38.

KMU 2023

Which one of the following is covalent in nature? [EATA (2023)]

- (A) Mg_3N_2
- (B) Be_3N_2
- (C) CaN_2
- (D) Ba_3N_2

Q39.

DUHS 2023

Valence shell electronic configuration of an element is $4s^2 4p^1$. To which group does the element belong? [DUHS (2023)]

- (A) IB
- (B) IIIB
- (C) IA
- (D) IIIA

Q40.

DUHS 2023

Metallic property in a group of p-block element has a trend: [DUHS (2023)]

- (A) Decrease
- (B) Increase
- (C) Remains same
- (D) Irregular trend

Q41.

DUHS 2023

Superoxide of group IA element (M) has formula: [DUHS (2023)]

- (A) M_2O
- (B) M_2O_3
- (C) MO_2
- (D) M_2O_2

Q42.

DUHS 2023

Which pair of the element markedly differ from other members of the respective groups? [DUHS (2023)]

- (A) Potassium and Calcium
- (B) Sodium and Magnesium
- (C) Cesium and Barium
- (D) Lithium and Beryllium

Q43.

DUHS 2023

Which of the following substance is malleable and ductile? [DUHS (2023)]

- (A) Sodium chloride
- (B) Copper sulphate
- (C) Mercury
- (D) Aluminum

Q44.

BUMHS 2023

The general electronic configuration of halide ions is [BUMHS-2023]

- (A) ns^2np^5
- (B) ns^2np^6
- (C) ns^1np^5
- (D) ns^2np^3

Q45.

UHS 2022

Which statement describes the conversion of magnesium atoms to magnesium ions for ionic bond formation with chlorine? [UHS (2022)]

- (A) The change is reduction, because there has been a gain of electrons
- (B) The change is oxidation, because there has been a loss of electrons
- (C) The change is reduction, because there has been a loss of electrons
- (D) The change is oxidation, because there has been a gain of electrons

Q46.

UHS 2022

Why dimer of $AlCl_3$ is formed [UHS (2022)]

- (A) Al is electron rich
- (B) Al is having lone pair of electron
- (C) Al donates lone pair to form bridge
- (D) Al forms co-ordinate bonds with chlorine to complete its octet

Q47.

UHS 2022

Which group of the periodic table contain non-metals, metalloids and metals? [UHS (2022)]

- (A) IB
- (B) IVA
- (C) VIIA
- (D) VIA

Q48.

UHS 2022

Which of the following sulphate compound is insoluble in water? [UHS (2022)]

- (A) $BeSO_4$
- (B) $MgSO_4$
- (C) $BaSO_4$
- (D) $CaSO_4$

Q49.

SZABMU 2022

Carbon atoms in ethane are hybridized: [SZABMU (2022)]

- (A) sp^3
- (B) sp^2
- (C) sp
- (D) sp^3d

Q50.

SZABMU 2022

The type of bonding in Zinc is: [SZABMU (2022)]

- (A) Ionic
- (B) Covalent
- (C) Dative
- (D) Metallic

Q51.

SZABMU 2022

Which one of the following is semiconductor? [SZABMU (2022)]

- (A) Al
- (B) Si
- (C) P
- (D) Mg

Q52.

SZABMU 2022

Which of the following property decreases in group 2 as we go down the group? [SZABMU (2022)]

- (A) Shielding
- (B) Atomic radius
- (C) Proton number
- (D) Ionization energy

Q53.

SZABMU 2022

Which of the following alkali metal can form normal oxide as well as peroxide? [SZABMU (2022)]

- (A) Na
- (B) K
- (C) Li
- (D) Cs

Q54.

KMU 2022

A radius greater than its parent atom is called: [ETEA (2022)]

- (A) Cationic radii
- (B) Atomic radii
- (C) Covalent radii
- (D) Anionic radii

Q55.

KMU 2022

All alkaline metals are white in colour except [ETEA (2022)]

- (A) Beryllium
- (B) Magnesium
- (C) Calcium
- (D) Strontium

Q56.

BUMHS 2022

Select the group whose elements easily lose electron. [BMU (2022)]

- (A) IA
- (B) VA
- (C) VIA
- (D) VIIA

Q57.

BUMHS 2022

Which of the following has the least ionization potential? [BMU (2022)]

- (A) He
- (B) Li
- (C) Zn
- (D) N

Q58.

BUMHS 2022

Which of the following hydroxide of group I is less soluble in water? [BMU (2022)]

- (A) NaOH
- (B) LiOH
- (C) KOH
- (D) RbOH

Q59.

BUMHS 2022

The color of the Mg metal flame is? [BMU (2022)]

- (A) Blue
- (B) Violet
- (C) Yellow
- (D) White

Q60.

NUMS 2022

Which of the following property increases down the group in alkali metals? [NUMS (2022)]

- (A) Ionization energy
- (B) Electron affinity
- (C) Reactivity
- (D) Electronegativity

Q61.

NUMS 2022

The solubility of alkaline earth metal [NUMS (2022)]

- (A) Decreases down the group
- (B) Increases down the group
- (C) Remains constant throughout the group
- (D) First increases then decrease down the group

Q62.

PMDC 2021

Addition of second electron to a uni-negative ion always ____? [PMC (2021)]

- (A) An endothermic process
- (B) An exothermic process
- (C) Neutral process
- (D) Energy wasted

Q63.

PMDC 2021

In periodic table, the period number tells the [PMC (2021)]

- (A) Number of shell
- (B) Electronic configuration
- (C) Metallic character
- (D) Photon

Q64.

PMDC 2021

Sodium is not observed in +2 oxidation state because of its [PMC (2021)]

- (A) High first ionization potential
- (B) High second ionization potential
- (C) High ionic radius
- (D) High electronegativity

Q65.

PMDC 2021

Which of the following element has highest electronegativity? [PMC (2021)]

- (A) Fluorine
- (B) Magnesium
- (C) Sodium
- (D) Bromine

Q66.

PMDC 2020

Potassium, Rubidium, Cesium reacts with oxygen to form which types of oxides? [NMDCAT (2020)]

- (A) Peroxide
- (B) Superoxide
- (C) Suboxide
- (D) Normal oxide

Q67.

PMDC 2020

Magnesium reacts with nitrogen to form [NMDCAT (2020)]

- (A) Mg_2N_2
- (B) Mg_3N_2
- (C) MgN_2
- (D) MgN

Q68.

PMDC 2020

Densities of alkali metals are low due to [NMDCAT (2020)]

- (A) Weak intermolecular forces
- (B) Large atomic volume
- (C) Smaller size
- (D) ns^1 configuration

Q69.

SET 2019

Which element has the highest electron affinity among halogens? [SET (2019)]

- (A) F
- (B) I
- (C) Cl
- (D) Br

Q70.

SET 2019

Which one of the following properties decreases across the third period of elements in the periodic table? [SET (2019)]

- (A) Electronegativity
- (B) Ability to act as reducing agent
- (C) Ionization energy
- (D) Melting and boiling points

Q71.

SET 2019

In the 3rd period of the periodic table which of following property is decreasing consistently? [SET (2019)]

- (A) Electrical conductivity
- (B) Ionization energy
- (C) Melting point
- (D) Atomic radius

Q72.

SET 2019

In the third period of elements, there lies element "X" which is metallic in nature and it can reduce chlorine gas rapidly. To which group of elements does "X" belong? [SET (2019)]

- (A) IIA
- (B) VIIA
- (C) IVA
- (D) IA

Q73.

NUMS 2019

The hydration energy of Mg^{2+} is less than [NUMS (2019)]

- (A) Na^{+1}
- (B) Ca^{+2}
- (C) Li^{+1}
- (D) Al^{+3}

Q74.

NUMS 2019

Which alkaline earth metal makes peroxides? [NUMS (2019)]

- (A) Ba
- (B) Be
- (C) Mg
- (D) Ca

Q75.

KMU 2019

How many elements are there in the 3 period of periodic table? [ETEA (2019)]

- (A) 18
- (B) 8
- (C) 32
- (D) 10

Q76.

KMU 2019

Which oxides of "K" contain more oxygen than is normal oxide? [ETEA (2019)]

- (A) Peroxide
- (B) Super oxide
- (C) Both contain equal quantity
- (D) None of the above

Q77.

MDCAT 2019

Modern periodic table is arranged in ascending order of? [MDCAT (2019)]

- (A) Atomic mass
- (B) Mass number
- (C) Nucleon number
- (D) Proton number

Q78.

MDCAT 2019

Ionization energy decrease down the group from top to bottom due to: [MDCAT (2019)]

- (A) Decrease in atomic size
- (B) Increase in atomic mass
- (C) Increase in shielding effect of the intervening electrons
- (D) Increase in proton number

Q79.

MDCAT 2019

Oxidation number of particular element can be directly or indirectly inferred from its: [MDCAT (2019)]

- (A) Physical state
- (B) Group number
- (C) Atomic size
- (D) Atomic mass

Q80.

MDCAT 2018

Down the group acid-base behavior of metallic oxides of group 2 elements changes to [MDCAT (2018)]

- (A) More basic
- (B) No change
- (C) Less basic
- (D) More acidic

Q81.

MDCAT 2018

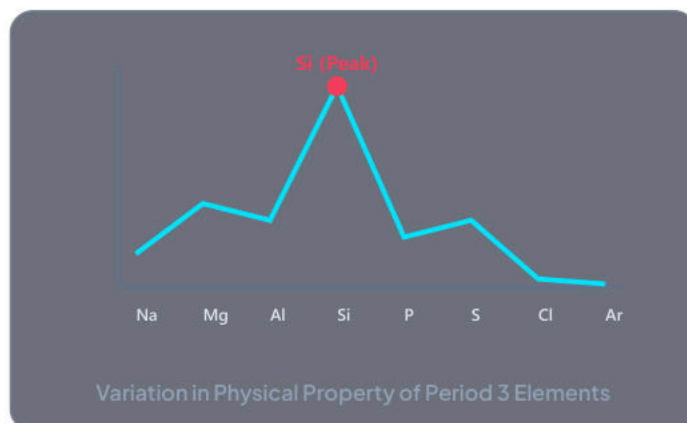
In period 2 and period 3 maximum melting point shown by elements [MDCAT (2018)]

- (A) Lithium and sodium
- (B) Carbon and silicon
- (C) Neon and argon
- (D) Nitrogen and phosphorous

Q82.

MDCAT 2018

The following sketch show the variation in a physical property of third period elements against their number:



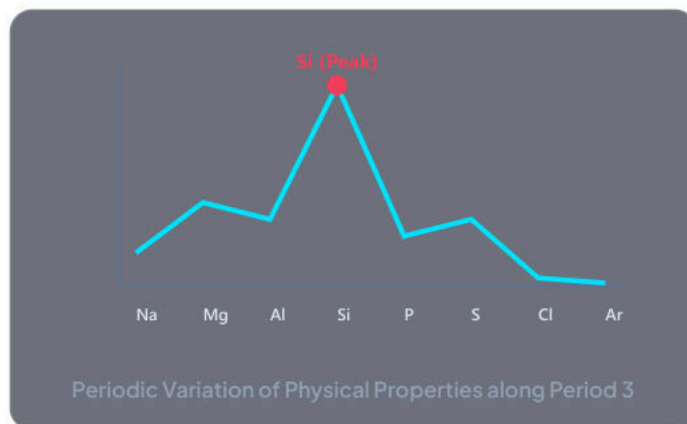
What physical property is plotted in this sketch? [MDCAT (2018)]

- (A) Ionic radius
- (B) Melting point
- (C) Ionization energy
- (D) Atomic radius

Q83.

MDCAT 2017

Following graph shows a physical property along the period 3 elements. Which physical property is this?



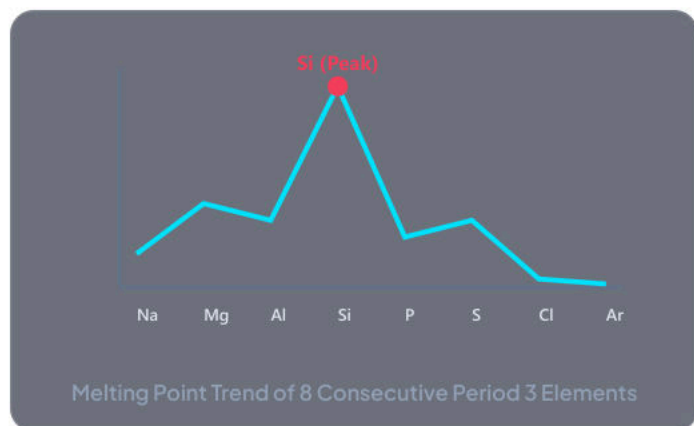
[MDCAT (2017)]

- (A) Electron affinity
- (B) Non-metallic character
- (C) Atomic radius
- (D) Melting point up to group IVA

Q84.

MDCAT 2017

The following sketch shows the melting point of eight elements with consecutive atomic numbers. Which element is silicon?

**[MDCAT (2017)]**

- (A) A
- (B) C
- (C) B
- (D) D

Q85.

MDCAT 2017

Ionic radius along the period decreases due to:
[MDCAT (2017)]

- (A) Addition of a new shell
- (B) High Ionization energy
- (C) Increase in nuclear charge
- (D) Decrease in nuclear charge

Q86.

MDCAT 2017

Among the following, which one is least reactive metal: **[MDCAT (2017)]**

- (A) Mg
- (B) Na
- (C) Ca
- (D) Be

Q87.

MDCAT 2017

Melting point of Na & Mg decreases down the group due to: **[MDCAT (2017)]**

- (A) Strong electronegativity
- (B) Increment in size
- (C) Strong attractive forces
- (D) High Ionization energy

Q88.

MDCAT 2016

The ionic radius of fluoride ion is: **[MDCAT (2016)]**

- (A) 72 pm
- (B) 136 pm
- (C) 95 pm
- (D) 157 pm

Q89.

MDCAT 2016

Melting points of group II-A elements are higher than those of group I-A because: **[MDCAT (2016)]**

- (A) Atoms of II-A elements have smaller size
- (B) II-A elements are more reactive
- (C) Atoms of II-A elements provide two binding electrons
- (D) I-A elements have smaller atomic radius

Q90.

KMU 2016

Lithium reacts with air to form **[ETEA (2016)]**

- (A) Li_2O
- (B) Li_3N
- (C) $\text{Li}_2\text{O}_2 + \text{Li}_2\text{CO}_3$
- (D) Both A and B

Q91.

MDCAT 2015

Keeping in view the size of atoms, which order is correct? **[MDCAT (2015)]**

- (A) $\text{N} > \text{C}$
- (B) $\text{Ar} > \text{Cl}$
- (C) $\text{P} > \text{Si}$
- (D) $\text{Li} > \text{Be}$

Q92.

MDCAT 2015

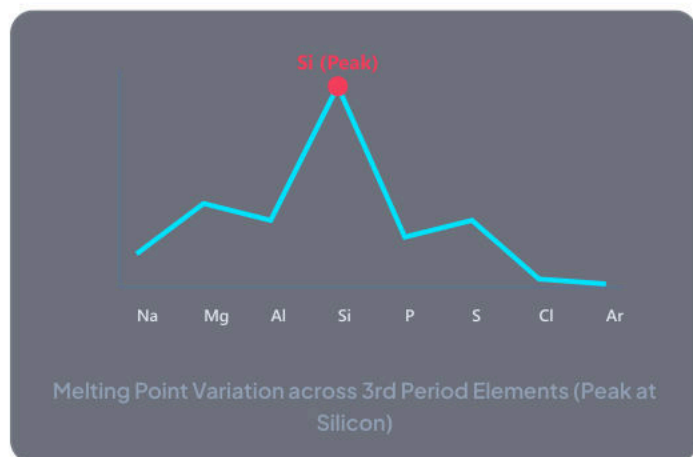
Which one of the following will have the smallest radius? **[MDCAT (2015)]**

- (A) Al^{+3}
- (B) Mg^{+2}
- (C) Si^{+4}
- (D) Na^{+1}

Q93.

MDCAT 2014

The trends in melting points of the elements of 3rd period are depicted in figure below



The sharp decreases observed from 'Si' to 'P' is due to [MDCAT (2014)]

- (A) Decrease in atomic radius from 'Si' to 'P'
- (B) Change in bonding and structure of two elements
- (C) Different densities of two elements
- (D) Increase in electron density from 'Si' to 'P'

Q94.

MDCAT 2014

Arrange the following elements according to the trends of ionization energies C, N, Ne, B [MDCAT (2014)]

- (A) $\text{Ne} < \text{N} < \text{C} < \text{B}$
- (B) $\text{B} < \text{C} < \text{N} < \text{Ne}$
- (C) $\text{B} < \text{N} < \text{C} < \text{Ne}$
- (D) $\text{Ne} < \text{B} < \text{C} < \text{N}$

Q95.

MDCAT 2013

Along a period, atomic radius decreases. This gradual decrease in radius is due to: [MDCAT (2013)]

- (A) Increase in number of shells
- (B) Increase in number of protons in the nucleus
- (C) Melting and boiling points first decrease then increase
- (D) Melting and boiling points first increase then decrease

Q96.

MDCAT 2013

What is the trend of melting and boiling points of the elements of short periods as we move from left to right in a periodic table? [MDCAT (2013)]

- (A) Melting and boiling points decrease gradually
- (B) Melting and boiling points first decrease then increase
- (C) Melting and boiling points increase gradually
- (D) Melting and boiling points first increase then decrease

Q97.

MDCAT 2012

Which one remains same along a period? [MDCAT (2012)]

- (A) Atomic radius
- (B) Number of shells (orbits)
- (C) Melting point
- (D) Electrical conductivity

Q98.

MDCAT 2012

More the ionization energy of an element [MDCAT (2012)]

- (A) More the electro positivity
- (B) Less the metallic character
- (C) More the reducing power
- (D) Bigger the atomic radius

Q99.

MDCAT 2012

Alkaline earth metal hydroxides decompose on heating. Which of the following reactions is a correct representation of this decomposition? [MDCAT (2012)]

- (A) $\text{M}(\text{OH})_{2(s)} \longrightarrow \text{MO}_{(s)} + \text{H}_2\text{O}_{(l)}$
- (B) $2\text{MOH}_{(s)} \longrightarrow 2\text{MO}_{(s)} + \text{H}_{2(g)}$
- (C) $\text{MOH}_{(s)} \longrightarrow \text{M}_2\text{O}_{(s)} + \text{H}_2\text{O}_{(l)}$
- (D) $4\text{MOH}_{(s)} \longrightarrow 4\text{M}_{(s)} + \text{H}_2\text{O}_{(l)} + \text{O}_{2(s)}$

Q100.

MDCAT 2011

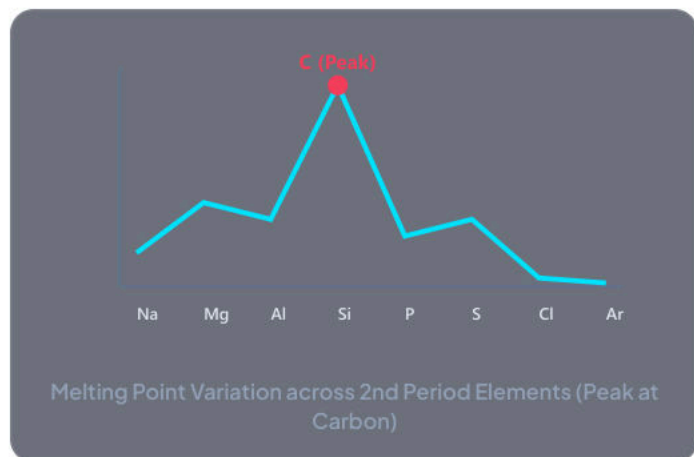
The elements for which the value of ionization energy is low can [MDCAT (2011)]

- (A) Gain electrons readily
- (B) Gain electrons with difficulty
- (C) Lose electron less readily
- (D) Lose electron readily

Q101.

MDCAT 2011

The diagram below is a plot of melting points of elements of second period against their atomic numbers. Lithium and fluorine are placed at the extreme ends of the plot. On the basis of melting points where would you place carbon among the empty slots on the plot?



[MDCAT (2011)]

- (A) 1
- (B) 4
- (C) 2
- (D) 3

Q102.

MDCAT 2011

When the elements of group II-A are exposed to air, they quickly become coated with layer of oxide. What is the purpose of this oxide layer [MDCAT (2011)]

- (A) The oxide layer exposes the metal to atmospheric attack
- (B) The oxide layer increases the reactivity of metal
- (C) The oxide layer protects the metal from further attack
- (D) No layer forms

Q103.

MDCAT 2010

Energy required to remove an electron from gaseous neutral atom is: [MDCAT (2010)]

- (A) Electron affinity
- (B) Lattice energy
- (C) Ionization energy
- (D) Crystal energy

Q104.

MDCAT 2010

The strongest acid among the following is: [MDCAT (2010)]

- (A) HF
- (B) HBr
- (C) HCl
- (D) HI

RAPID 5–COLUMN ANSWER KEY

Official PMDC verified answer keys for 11. S & P Block Elements.

beambeprep.com

Q#	KEY	BOARD	Q#	KEY	BOARD	Q#	KEY	BOARD	Q#	KEY	BOARD	Q#	KEY	BOARD
1	D	UHS 2024	22	A	UHS 2023	43	D	DUHS 2023	64	B	PMDC 2021	85	C	MDCAT 2017
2	A	UHS 2024	23	C	UHS 2023	44	B	BUMHS 2023	65	A	PMDC 2021	86	D	MDCAT 2017
3	C	UHS 2024	24	A	UHS 2023	45	B	UHS 2022	66	B	PMDC 2020	87	B	MDCAT 2017
4	B	SZABMU 2024	25	A	UHS 2023	46	D	UHS 2022	67	B	PMDC 2020	88	B	MDCAT 2016
5	D	SZABMU 2024	26	B	UHS 2023	47	B	UHS 2022	68	B	PMDC 2020	89	C	MDCAT 2016
6	D	SZABMU 2024	27	C	UHS 2023	48	C	UHS 2022	69	C	SET 2019	90	D	KMU 2016
7	D	SZABMU 2024	28	B	UHS 2023	49	A	SZABMU 2022	70	B	SET 2019	91	D	MDCAT 2015
8	A	SZABMU 2024	29	B	UHS 2023	50	D	SZABMU 2022	71	D	SET 2019	92	C	MDCAT 2015
9	A	SZABMU 2024	30	B	SZABMU 2023	51	B	SZABMU 2022	72	D	SET 2019	93	B	MDCAT 2014
10	A	SZABMU 2024	31	D	SZABMU 2023	52	D	SZABMU 2022	73	D	NUMS 2019	94	B	MDCAT 2014
11	D	SZABMU 2024	32	A	SZABMU 2023	53	A	SZABMU 2022	74	A	NUMS 2019	95	B	MDCAT 2013
12	B	SZABMU 2024	33	A	SZABMU 2023	54	D	KMU 2022	75	B	KMU 2019	96	D	MDCAT 2013
13	C	KMU 2024	34	A	SZABMU 2023	55	A	KMU 2022	76	B	KMU 2019	97	B	MDCAT 2012
14	A	KMU 2024	35	A	KMU 2023	56	A	BUMHS 2022	77	D	MDCAT 2019	98	B	MDCAT 2012
15	C	DUHS 2024	36	A	KMU 2023	57	B	BUMHS 2022	78	C	MDCAT 2019	99	A	MDCAT 2012
16	D	DUHS 2024	37	D	KMU 2023	58	B	BUMHS 2022	79	B	MDCAT 2019	100	D	MDCAT 2011
17	D	DUHS 2024	38	B	KMU 2023	59	D	BUMHS 2022	80	A	MDCAT 2018	101	D	MDCAT 2011
18	A	DUHS 2024	39	D	DUHS 2023	60	C	NUMS 2022	81	B	MDCAT 2018	102	C	MDCAT 2011
19	B	BUMHS 2024	40	B	DUHS 2023	61	B	NUMS 2022	82	B	MDCAT 2018	103	C	MDCAT 2010
20	B	BUMHS 2024	41	C	DUHS 2023	62	A	PMDC 2021	83	D	MDCAT 2017	104	D	MDCAT 2010
21	B	NUMS 2024	42	D	DUHS 2023	63	A	PMDC 2021	84	B	MDCAT 2017			

TOTAL
MCQS
104

CORRECT

INCORRECT

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ACCURACY

%

Scan the booklet QR code to enter answers in
BeambePrep Grind Mode for automated error
 autopsies.

PROPOLIS COGNITIVE ERROR AUTOPSIES

Step-by-step conceptual derivations, formula working, and distractor autopsies for every question.

Question #1 Key: (D)

UHS 2024

The difference of lithium from the other alkali metals is mainly because of: [UHS (2024)]

CORE CONCEPT AND DERIVATION

Anomalous behavior in the first member of a group is driven by its highly concentrated positive charge.

Solution:

- Lithium sits at the very top of Group 1, meaning it has the fewest electron shells.
- Consequently, its atomic and ionic radii are exceptionally **small** compared to the rest of the alkali metals.
- Because this small size is carrying a +1 charge, the charge is concentrated in a tiny volume. This is mathematically defined as a **high charge density**.
- This intense charge density allows Li^+ to strongly distort (polarize) the electron clouds of anions, granting covalent character to its bonds—a trait completely unlike the rest of the highly ionic Group 1 metals.

Why other options are incorrect:

- Lithium has the smallest radius, not the largest. Its charge density is inherently high due to this small volume, not low.

Question #2 Key: (A)

UHS 2024

Which of the following is not Basic in nature [UHS (2024)]

CORE CONCEPT AND DERIVATION

Metal oxides are generally basic. However, metals near the metalloid "staircase" form oxides that can act as both acids and bases (amphoteric).

Solution:

- **Potassium, Sodium, & Magnesium oxides:** These elements are classic s-block metals with low ionization energies. Their oxides dissolve in water to yield OH^- ions, making them strictly and strongly basic.
- **Aluminum (Al)** is a p-block metal with higher electronegativity and a much smaller, highly charged cation (Al^{3+}).
- Because of this high charge density, **Aluminum oxide** (Al_2O_3) is amphoteric.
- While it can act as a base (reacting with acids), it can also act as an acid (reacting with bases like NaOH to form aluminates).
- Because it is not *exclusively* basic and exhibits acidic properties, it is the correct answer.

Why other options are incorrect:

- Options B, C, and D are classical, strictly basic alkaline/alkali earth oxides.

Question #3 Key: (C)

UHS 2024

The solubility of sulphates of alkaline metals generally [UHS (2024)]

CORE CONCEPT AND DERIVATION

Note: The question says "alkaline metals", which in historical exam parlance often refers to alkaline earth metals (Group II), as alkali metal sulphates are universally soluble. The trend for Group II sulphates is asked here.

Solution:

- For Alkaline Earth Metal Sulphates (e.g., BeSO_4 , MgSO_4 , CaSO_4 , SrSO_4 , BaSO_4), solubility depends on hydration vs. lattice energy.
- The sulphate ion (SO_4^{2-}) is very large. Thus, the lattice energy remains relatively constant down the group because changing the size of the smaller metal cation doesn't disrupt the large-anion lattice much.
- However, as the metal cation gets larger (moving down the group), its **hydration energy drops precipitously**.
- Because hydration energy falls much faster than lattice energy, the compounds become much harder to dissolve.
- Therefore, the solubility of Group II sulphates heavily **decreases down the group** (with BaSO_4 being notoriously insoluble).

Why other options are incorrect:

- Hydroxides increase down the group; sulphates and carbonates definitively decrease.

Question #4 Key: (B)

SZABMU 2024

Metallic character of alkaline earth metals ____ down the groups. [SZABMU (2024)]

CORE CONCEPT AND DERIVATION

Metallic character is defined chemically as the tendency of an atom to easily lose its valence electrons (electropositivity).

Solution:

- As we move down Group 2 (Alkaline Earth Metals), new principal electron shells are continuously added.
- This significantly increases the atomic radius.
- The increased distance from the nucleus and the heavy shielding from the inner electron shells cause the nucleus to lose its grip on the outermost valence electrons.
- Because Ionization Energy decreases down the group, these atoms lose their electrons much more easily.
- Therefore, their **metallic character consistently increases** down the group.

Why other options are incorrect:

- Metallic character never decreases or remains constant when traveling downward in a metallic group; the atoms strictly become larger and more electropositive.

Question #5 Key: (D)

SZABMU 2024

Which of the following metal forms superoxide when reacted with oxygen? [SZABMU (2024)]

CORE CONCEPT AND DERIVATION

The formation of a superoxide requires a very large, low-charge-density metal cation to stabilize the bulky, unstable superoxide anion (O_2^-).

Solution:

- Beryllium & Magnesium:** Group 2 metals with high charge density (+2 charge). They only form normal oxides (e.g., MgO).
- Lithium:** Group 1, but possesses an anomalously small atomic radius and high charge density. It only forms normal oxide (Li_2O).
- Potassium (K):** is a massive alkali metal located lower down in Group 1. Its large ionic radius and low +1 charge density provide the perfect electrostatic environment to stabilize the superoxide ion.
- When burned in excess oxygen, Potassium forms the bright orange **Potassium superoxide** (KO_2).

Why other options are incorrect:

- The cations of Be, Mg, and Li are physically too small to stabilize the large superoxide lattice, which would immediately collapse into a normal oxide.

Question #6 Key: (D)

SZABMU 2024

Which of the following metal hydroxide is the strongest base?
[SZABMU (2024)]

CORE CONCEPT AND DERIVATION

The strength of a base depends on how fully it dissociates in water to release hydroxide ions (OH^-). Highly soluble hydroxides of metals with low ionization energies make the strongest bases.

Solution:

- **Group 1 vs Group 2:** Alkali metals (Group 1) have larger radii and lower ionization energies than Alkaline earth metals (Group 2). Thus, Group 1 hydroxides are far more soluble and dissociate more completely than Group 2 hydroxides (like $\text{Mg}(\text{OH})_2$ or $\text{Ca}(\text{OH})_2$).
- **Within Group 1 (LiOH vs NaOH):** Lithium is very small, meaning the Li-O bond has strong lattice energy and partial covalent character, limiting its dissociation compared to Sodium.
- Sodium (Na) is larger, making NaOH highly ionic and overwhelmingly soluble in water.
- Because it completely dissociates in aqueous solution, **NaOH** provides the highest concentration of OH^- ions, making it the strongest base among the choices.

Why other options are incorrect:

- $\text{Mg}(\text{OH})_2$ is highly insoluble (used in antacids because it is a weak base). $\text{Ca}(\text{OH})_2$ is only sparingly soluble. LiOH is the weakest base in Group 1.

Question #7 Key: (D)

SZABMU 2024

The correct stability order of [Formula] cations is (Out of syllabus)
[SZABMU (2024)]

CORE CONCEPT AND DERIVATION

In the heavier p-block elements (like Group IVA), the "inert pair effect" causes the lower oxidation states (e.g., +2) to become more stable than the higher oxidation states (e.g., +4) as you move down the group.

Solution:

- The elements in Group IVA, going down, are Germanium (Ge), Tin (Sn), and Lead (Pb).
- As we move from Ge to Pb, the ns^2 valence electrons (the 4s, 5s, 6s electrons) become increasingly resistant to participating in chemical bonding. This is the **inert pair effect**, primarily caused by the poor shielding of intervening d and f orbitals.
- Because the s-electrons refuse to ionize in heavy elements like Lead, the +4 oxidation state becomes extremely unstable (Pb^{+4} is a vicious oxidizing agent that wants to revert to Pb^{+2}).
- Conversely, Germanium (higher up) comfortably forms stable +4 compounds.
- Therefore, the stability of the +4 state strictly decreases down the group: $\text{Ge}^{+4} > \text{Sn}^{+4} > \text{Pb}^{+4}$.

Why other options are incorrect:

- Options A, B, and C provide incorrect trends that contradict the inert pair effect. Pb^{+4} is the least stable, not the most or intermediate.

Question #8 Key: (A)

SZABMU 2024

When potassium superoxide reacts with carbon dioxide, following products are formed [SZABMU RC-(2024)]

CORE CONCEPT AND DERIVATION

Potassium superoxide (KO_2) has a highly unique chemical property: it absorbs carbon dioxide and simultaneously releases pure oxygen gas.

Solution:

- Because of this specific reaction, KO_2 is widely used in closed-loop breathing apparatuses (like submarines and spacesuits).
- The chemical reaction involves the superoxide reacting with CO_2 to form solid potassium carbonate and gaseous oxygen.
- The balanced chemical equation is:



- Therefore, the distinct products are **Potassium carbonate** (K_2CO_3) and **Oxygen** (O_2).

Why other options are incorrect:

- The other options do not show the conversion of the superoxide into carbonate, nor do they account for the vital release of O_2 gas.

Question #9 Key: (A)

SZABMU 2024

The color imparted by the Li wire when subjected to flame is [SZABMU RC-(2024)]

CORE CONCEPT AND DERIVATION

The flame test identifies specific metal cations based on the unique wavelength of visible light emitted when their heat-excited electrons fall back to the ground state.

Solution:

- Different metals have distinct, quantized energy gaps between their electron orbitals.
- When Lithium (Li) is heated in a flame, its valence electrons absorb thermal energy and jump to higher orbitals.
- Upon returning to their lower energy state, they release energy in the form of a photon.
- For Lithium, the energy gap corresponds perfectly to a wavelength in the red part of the visible spectrum.
- Thus, Lithium imparts a brilliant **Crimson red** color to the flame.

Why other options are incorrect:

- **Pale green:** Characteristic of Barium (Ba).
- **Brick red:** Characteristic of Calcium (Ca).
- **Greyish white:** Not a standard flame test color (often associated with burning Mg metal, but not as a wire salt test).

Question #10 Key: (A)

SZABMU 2024

The trend of increasing order of densities among Group I elements is [SZABMU RC-(2024)]

CORE CONCEPT AND DERIVATION

Density is the ratio of atomic mass to atomic volume. In a group, mass generally increases faster than volume, causing density to increase downward.

Solution:

- *Note on Historical Accuracy:* The provided answer key for this past paper states Option A is correct, implying a strictly linear increase in density: **Li < Na < K < Rb**.
- While Lithium is indeed the least dense (0.53 g/cm^3), the true chemical reality is that **Potassium (0.86 g/cm^3) is anomalously less dense than Sodium (0.97 g/cm^3)** because of a massive volume expansion due to the presence of empty 3d orbitals in K.
- However, based on the historical source material's explanatory notes which explicitly dictate "Li < Na < K < Rb as mass increases", we must select **Option A** to match the examiner's intended (albeit flawed) logic.

Why other options are incorrect:

- Options B, C, and D are either mathematically reversed (listing heaviest first) or skip elements randomly.

Question #11 Key: (D)

SZABMU 2024

Which of following sulphate of Group-II elements are insoluble? [SZABMU RC-(2024)]

CORE CONCEPT AND DERIVATION

The solubility of Group 2 sulphates decreases aggressively as you move down the group due to the rapid decline in hydration energy.

Solution:

- The sulphate ion (SO_4^{2-}) is very large, so the lattice energy of these salts doesn't change much down the group.
- However, as the metal cation gets larger (from Be to Ba), its ability to attract water molecules (hydration energy) drops dramatically.
- Beryllium and Magnesium are small and have massive hydration energies, making BeSO_4 and MgSO_4 highly soluble in water.
- **Barium (Ba)** is at the bottom of the group. Its large size yields a very low hydration energy that cannot overcome the lattice energy of the crystal.
- Therefore, **Barium sulphate (BaSO_4)** is highly insoluble (and is used in medicine as a "barium meal" precisely because it won't dissolve into the bloodstream).

Why other options are incorrect:

- Be and Mg sulphates are soluble. Ca sulphate is sparingly soluble, but BaSO_4 is the textbook definition of an insoluble Group II sulphate.

Question #12 Key: (B)

SZABMU 2024

Which of the following element is s-block element? [SZABMU RC- (2024)]

CORE CONCEPT AND DERIVATION

The periodic table is divided into blocks (s, p, d, f) based on which subshell the last (valence) electron of an element enters.

Solution:

- **S-block elements** comprise Group 1 (Alkali metals) and Group 2 (Alkaline earth metals).
- Let's locate the options:
- Sulphur (Group 16) is a p-block element.
- Iron (Group 8) is a transition metal, making it a d-block element.
- Neon (Group 18) is a noble gas, making it a p-block element.
- **Potassium (K)** is in Group 1. Its final electron enters the 4s orbital ($4s^1$). Therefore, it is the only **s-block element** on the list.

Why other options are incorrect:

- Sulphur, Iron, and Neon have their outermost electrons situated in p, d, and p orbitals respectively.

Question #13 Key: (C)

KMU 2024

Electronegativity of Al is approximately equal to that of [ETEA (2024)]

CORE CONCEPT AND DERIVATION

In the periodic table, a diagonal relationship exists between certain elements of the second and third periods. These diagonally adjacent elements have similar sizes and charge densities, leading to similar chemical properties (like electronegativity).

Solution:

- Beryllium (Be) is in Period 2, Group IIA.
- Aluminum (Al) is diagonally below it in Period 3, Group IIIA.
- As you move across a period, electronegativity increases, but as you move down a group, it decreases.
- Moving diagonally from Be down to Al, these two opposing trends roughly cancel each other out.
- Due to this diagonal relationship, **Beryllium (Be) and Aluminum (Al)** share almost identical electronegativity values (approximately 1.5 on the Pauling scale), similar polarizing power, and amphoteric oxides.

Why other options are incorrect:

- **B**: Higher electronegativity (approx 2.0).
- **Mg & Na**: Much lower electronegativities because they are classic metals located further left.

Question #14 Key: (A)

KMU 2024

Third period element that initially reacts rapidly with oxygen to form a protective oxide coating that prevent...

CORE CONCEPT AND DERIVATION

Some reactive metals undergo "passivation," where initial contact with air forms a non-porous, chemically stable oxide layer that completely seals the metal from further atmospheric attack.

Solution:

- **Aluminum (Al)** is a reactive Period 3 metal.
- When freshly exposed to air, it reacts instantly with oxygen to form a thin, transparent, and incredibly tough layer of Aluminum oxide (Al_2O_3).
- Unlike iron rust, which flakes off, this oxide layer tightly adheres to the metal surface.
- This layer acts as an impenetrable shield, which is why Aluminum does not corrode readily in daily use despite being a reactive metal.

Why other options are incorrect:

- **Na**: Its oxide does not protect it; it continues to react violently with moisture and air.
- **Mg**: Also forms a protective layer (MgO), but Aluminum is the classic, textbook example of this phenomenon used heavily in industry (anodization).
- **Si**: Is a metalloid and does not undergo rapid metallic oxidation in this manner at room temperature.

Question #15 Key: (C)

DUHS 2024

The alkali metal gives a yellow color during a flame test is: [DUHS (2024)]

CORE CONCEPT AND DERIVATION

The flame test identifies metal cations based on the specific wavelength (color) of light emitted when their thermally excited electrons relax to the ground state.

Solution:

- When introduced into a Bunsen burner flame, different elements emit unique colors.
- Sodium (Na)** has an emission spectrum dominated by the "Sodium D-lines" at approximately 589 nm.
- This specific wavelength corresponds to a very intense, persistent, bright **yellow-golden** color.
- (This is the same principle behind the bright yellow glow of sodium vapor streetlights).

Why other options are incorrect:

- Ba:** Is an alkaline earth metal (not an alkali metal) and imparts a pale green color.
- K:** Imparts a lilac/violet color.
- Cs:** Imparts a blue/violet color.

Question #16 Key: (D)

DUHS 2024

Oil of Vitriol refer to: [DUHS (2024)]

CORE CONCEPT AND DERIVATION

Historical alchemy assigned common names to chemicals based on their appearance or how they were derived. These trivial names are still occasionally referenced in chemistry.

Solution:

- In the past, scientists distilled green vitriol (iron(II) sulfate) to produce a highly corrosive, dense, viscous liquid that looked like oil.
- Because it was derived from a "vitriol" mineral and had a slippery, oily texture, it was historically named "**Oil of Vitriol**".
- Today, we know the chemical formula of this substance is H_2SO_4 , which is the modern chemical **Sulfuric acid**.

Why other options are incorrect:

- Caustic soda:** Trivial name for Sodium hydroxide (NaOH).
- Borax:** Trivial name for Sodium tetraborate.
- Alum:** Refers to a class of hydrated double sulfate salts (usually containing aluminum).

Question #17 Key: (D)

DUHS 2024

Deficiency of ____ causes loss of weight, appetite, and taste: (Out of syllabus) [DUHS (2024)]

CORE CONCEPT AND DERIVATION

Trace elements play vital biological roles in human metabolism, enzymology, and sensory function.

Solution:

- Zinc (Zn)** is an essential trace mineral required for the function of over 300 enzymes in the human body.
- It is heavily involved in cellular metabolism, immune function, and the synthesis of DNA/proteins.
- Crucially, Zinc is a key component of the salivary enzyme *gustin*, which is directly responsible for maintaining normal taste buds.
- Therefore, clinical deficiency of Zinc leads to a condition called hypogeusia (loss of taste), which subsequently suppresses appetite (anorexia) and causes weight loss.

Why other options are incorrect:

- Fe (Iron):** Deficiency primarily causes anemia (fatigue, pale skin).
- K (Potassium):** Deficiency causes hypokalemia (muscle cramps, arrhythmias).
- P (Phosphorus):** Deficiency is rare but affects bone health and energy (ATP) levels.

Question #18 **Key: (A)**

DUHS 2024

Mostly p block elements react with ____ to form binary compounds: (Wrong) [DUHS (2024)]

CORE CONCEPT AND DERIVATION

Binary compounds are chemical compounds consisting of exactly two different elements. P-block elements generally react vigorously with highly electronegative non-metals to form these compounds.

Solution:

- *Note on Source Ambiguity:* The original exam paper tags this question as "(Wrong)" because both Oxygen and Halogens extensively form binary compounds with p-block elements.
- According to the provided official answer key, **Oxygen (Option A)** is selected. Oxygen is incredibly reactive and forms binary oxides (e.g., CO_2 , NO_2 , SO_2 , P_4O_{10}) with virtually all p-block elements.
- (The author's explanatory notes argue for Halogens, as they also form binary halides like PCl_3 or SF_6 , but we strictly follow the answer key's primary mapping).

Why other options are incorrect:

- **Water & Nitrogen:** Nitrogen is relatively inert due to its strong triple bond, and water does not act as a primary agent to form simple binary compounds directly with most elemental p-block materials in the same universal manner as Oxygen.

Question #19 **Key: (B)**

BUMHS 2024

Which of the following elements react rapidly with water at room temperature? [BMU-2024]

CORE CONCEPT AND DERIVATION

The reactivity of a metal with water is determined by its ionization energy and its position in the electrochemical series.

Solution:

- Alkali metals (Group I-A) possess the lowest ionization energies in their respective periods, making them the most electropositive and reactive metals.
- **Sodium (Na)** is an alkali metal. When placed in cold water at room temperature, it reacts vigorously and highly exothermically to form sodium hydroxide and release hydrogen gas.
- The reaction is so rapid that the heat generated often melts the sodium metal into a sphere that darts across the water's surface.

Why other options are incorrect:

- **Cu (Copper):** Very unreactive; sits below hydrogen in the reactivity series and does not react with water.
- **Fe (Iron):** Only reacts with steam at very high temperatures to form iron oxide.
- **Al (Aluminum):** Protected by a tough, impermeable layer of aluminum oxide (Al_2O_3), preventing it from reacting rapidly with cold water.

Question #20 Key: (B)

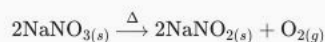
BUMHS 2024

Sodium nitrate ([Formula]), on heating, decomposes forming [BMU-2024]

CORE CONCEPT AND DERIVATION

The thermal decomposition products of metal nitrates depend on the reactivity of the metal. Alkali metal nitrates (except Lithium) decompose differently than heavy metal nitrates.

Formula:



Solution:

- When heavy metal nitrates (like Lead or Copper) are heated, they decompose completely into the metal oxide, nitrogen dioxide gas, and oxygen gas.
- However, Sodium is a highly reactive Group 1 alkali metal.
- When Sodium nitrate (NaNO_3) is heated, it undergoes a partial decomposition. It melts and releases oxygen gas, leaving behind a stable salt, **Sodium nitrite** (NaNO_2).
- Therefore, the products are strictly NaNO_2 and O_2 .

Why other options are incorrect:

- Option A describes the decomposition pattern of a less reactive metal (like Copper). Options C and D list chemically unrealistic or unstable decomposition products for this reaction.

Question #21 Key: (B)

NUMS 2024

When a metal carbonate is heated at 100°C , which of the following compound will readily decompose? [NUMS (2024...]

CORE CONCEPT AND DERIVATION

The thermal stability of Group II-A (alkaline earth metal) carbonates increases as you move down the group due to decreasing polarizing power of the metal cation.

Solution:

- Beryllium (Be) is located at the very top of Group 2.
- The Be^{2+} cation has an exceptionally small ionic radius and a high +2 charge, giving it a massive **charge density (polarizing power)**.
- When bonded to a large polyatomic carbonate ion (CO_3^{2-}), the tiny Be^{2+} strongly distorts (polarizes) the carbonate's electron cloud.
- This distortion heavily weakens the internal C-O bonds of the carbonate ion.
- Because of this severe instability, **Beryllium carbonate** (BeCO_3) decomposes incredibly readily into BeO and CO_2 , even at relatively low temperatures like 100°C (in fact, it is difficult to keep stable even at room temperature in a dry atmosphere).

Why other options are incorrect:

- As we move down the group (Mg, Sr, Ba), the metal cations become progressively larger. Their polarizing power drops, meaning they distort the carbonate ion much less. Thus, they require much higher temperatures to decompose.

Question #22 Key: (A)

UHS 2023

Which element has the ground state electronic configuration of [Formula]? [UHS (2023)]

CORE CONCEPT AND DERIVATION

An element's identity is defined by its atomic number, which in a neutral ground state atom is exactly equal to the total number of electrons.

Solution:

- Count the total number of superscripts in the given electronic configuration to find the total number of electrons:

$$2 + 2 + 6 + 2 + 6 = 18 \text{ electrons}$$

- A neutral atom with 18 electrons has an atomic number of 18.
- Looking at the periodic table, atomic number 18 corresponds to the noble gas **Argon (Ar)**.

Why other options are incorrect:

- Cl:** Has 17 electrons ($3p^5$).
- Na:** Has 11 electrons ($3s^1$).
- S:** Has 16 electrons ($3p^4$).

Question #23 Key: (C)

UHS 2023

Which oxyacid of halogen is strong oxidizing agent? [UHS (2023)]

CORE CONCEPT AND DERIVATION

The oxidizing power of an oxyacid depends on the stability of its anion. Conversely, its acidic strength depends on how easily it releases a proton.

Solution:

- As the number of oxygen atoms increases (from HClO to HClO_4), the oxidation state of Chlorine increases (+1 to +7), and the resulting anion becomes much more stable due to resonance.
- Because ClO_4^- is highly stable, HClO_4 is a very strong acid but a very poor (weak) oxidizing agent.
- On the other hand, Hypochlorous acid (**HClO**) is highly unstable. It readily breaks down and forcefully donates its nascent oxygen, making it an incredibly **strong oxidizing agent**.
- Trend for Oxidizing Power:** $\text{HClO} > \text{HClO}_2 > \text{HClO}_3 > \text{HClO}_4$.

Why other options are incorrect:

- While HClO_4 is the strongest *acid*, the question specifically asks for the strongest *oxidizing agent*, which is the exact reverse trend.

Question #24 Key: (A)

UHS 2023

Oxidation number of free magnesium is? [UHS (2023)]

CORE CONCEPT AND DERIVATION

The oxidation state rules for elements in their standard, uncombined states.

Solution:

- By definition, the oxidation number of an atom in its pure, free, uncombined elemental state is exactly zero.
- This is because in a pure element, all atoms are identical; there is no difference in electronegativity, so electrons are not pulled toward one atom or another.
- Therefore, free solid Magnesium metal ($\text{Mg}_{(s)}$) has an oxidation state of **0**.

Why other options are incorrect:

- +2:** This is the oxidation state of Magnesium *after* it has reacted and formed a compound (like MgCl_2), not when it is free.

Question #25 Key: (A)

UHS 2023

Select the metal which is extracted from bauxite? [UHS (2023)]

CORE CONCEPT AND DERIVATION

Metals are often extracted from naturally occurring mineral ores that contain high concentrations of specific metal compounds.

Solution:

- Bauxite is a sedimentary rock and the world's primary source for one specific metal.
- Chemically, Bauxite is composed largely of hydrated aluminum oxides (such as $\text{Al}_2\text{O}_3 \cdot n\text{H}_2\text{O}$).
- The extraction process involves refining bauxite into pure alumina (Bayer process), which is then subjected to electrolysis (Hall-Héroult process) to produce pure **Aluminum (Al)** metal.

Why other options are incorrect:

- Ca:** Extracted from limestone/calcite (CaCO_3).
- Mg:** Extracted from seawater or ores like dolomite/magnesite.
- Cu:** Extracted from ores like chalcopyrite (CuFeS_2).

Question #26 Key: (B)

UHS 2023

Which of the following has the highest atomic radius in its period?
[UHS (2023)]

CORE CONCEPT AND DERIVATION

Atomic radius is determined by the effective nuclear charge pulling on the valence electron shell.

Solution:

- As we move from left to right across any given period, the number of protons increases while the valence electrons are added to the exact same shell.
- This increases the effective nuclear charge, causing the electron cloud to be pulled inward, shrinking the atomic radius across the period.
- Because they sit at the extreme left (Group 1) of their respective periods, **Alkali metals** experience the lowest effective nuclear charge.
- Therefore, they have the most expanded electron clouds and the highest atomic radii in their periods.

Why other options are incorrect:

- Alkaline earth metals are in Group 2, so they are smaller than Group 1. Chalcogens (Group 16) and Halogens (Group 17) are on the far right and are the smallest in the period (excluding noble gases).

Question #27 Key: (C)

UHS 2023

The electronic configurations of some elements are given below. Recognize the element that belongs to group II...

CORE CONCEPT AND DERIVATION

The group number in the A-group classification corresponds exactly to the total number of valence electrons (electrons in the outermost 's' and 'p' orbitals).

Solution:

- Group IIIA elements must have exactly 3 valence electrons in their outermost shell.
- Let's examine the valence shell (the outermost principle shell, $n = 2$) of each option:
 - A. $2s^2 2p^3 \rightarrow 2 + 3 = 5$ valence electrons (Group VA).
 - B. $2s^2 2p^4 \rightarrow 2 + 4 = 6$ valence electrons (Group VIA).
 - C. $2s^2 2p^1 \rightarrow 2 + 1 = 3$ **valence electrons** (Group IIIA).
 - D. $2s^2 2p^2 \rightarrow 2 + 2 = 4$ valence electrons (Group IVA).
- Option C matches the required 3 valence electrons for Group IIIA (specifically, this is the configuration for Boron).

Why other options are incorrect:

- They have incorrect numbers of valence electrons for Group IIIA.

Question #28 Key: (B)

UHS 2023

All alkali metals react with chlorine gas to form white metal chlorides salt. The metal chlorides salt formed ...

CORE CONCEPT AND DERIVATION

The pH of a salt solution depends on whether it is formed from strong/weak acids and bases.

Solution:

- Alkali metals react with Chlorine to form ionic salts (e.g., NaCl, KCl).
- These alkali metal chlorides are highly **soluble** in water.
- When they dissolve, they dissociate into ions (e.g., Na^+ and Cl^-).
- Na^+ is the conjugate acid of a strong base (NaOH), and Cl^- is the conjugate base of a strong acid (HCl). Therefore, neither ion undergoes hydrolysis (they do not react with water to produce excess H^+ or OH^-).
- As a result, the solution remains perfectly **neutral with a pH of 7**.

Why other options are incorrect:

- Alkali metal chlorides do not form acidic or basic solutions because they do not hydrolyze water. They are practically universally soluble, not insoluble.

Question #29 Key: (B)

UHS 2023

Which one of them is amphoteric in nature? [UHS (2023)]

CORE CONCEPT AND DERIVATION

An amphoteric oxide can act as both an acid and a base, reacting with both to form salt and water. This usually happens at the boundary between metallic and non-metallic elements.

Solution:

- While most Group 1 and 2 metal oxides are strictly basic, Beryllium (Be) is an exception.
- Due to its very small atomic size and high charge density (high polarizing power), the Be-O bond has significant covalent character compared to other alkaline earth metals.
- This unique property allows **Beryllium oxide (BeO)** to behave amphotERICALLY.
- It reacts with strong acids (forming Be^{2+} salts) and also reacts with strong bases (forming beryllate ions, $\text{Be}(\text{OH})_4^{2-}$).

Why other options are incorrect:

- Lithium, Calcium, & Potassium oxides:** These elements have lower charge densities, form highly ionic bonds with oxygen, and are exclusively basic in nature.

Question #30 Key: (B)

SZABMU 2023

A metal reacts vigorously with cold water melting in to a ball of molten metal, moves across the surface of wa...

CORE CONCEPT AND DERIVATION

Different alkali metals exhibit very specific, characteristic behaviors when reacting with water, primarily distinguished by reaction vigor and flame color.

Solution:

- **Lithium:** Reacts steadily, floats, but does not usually melt into a ball or catch fire. (Flame: Crimson).
- **Sodium:** Reacts vigorously with cold water. The reaction is so exothermic that it melts the Sodium into a silver ball that darts across the water's surface. If it ignites, it burns with a characteristic **yellowish-golden flame**.
- **Potassium:** Reacts explosively, instantly catching fire with a lilac/violet flame.
- Based on the exact visual descriptors (melts into a ball, vigorous but not instantly explosive, golden-yellow flame), the metal is definitively **Sodium**.

Why other options are incorrect:

- The flame colors and reaction speeds rule out Li (crimson, slower), K (lilac, explosive), and Ca (sinks, brick-red flame).

Question #31 Key: (D)

SZABMU 2023

Among alkali metals which element reacts slowly with [Formula] ? [SZABMU (2023)]

CORE CONCEPT AND DERIVATION

The reactivity of alkali metals with water is directly related to their ionization energy and how easily they can lose their valence electron.

Solution:

- Reactivity in Group 1 increases as you move down the group.
- **Lithium (Li)** is at the very top of Group 1. It has the smallest atomic radius and the highest ionization energy among the alkali metals.
- Because its nucleus holds onto the valence electron more tightly, it takes more effort to lose it.
- As a result, Lithium reacts relatively **slowly and steadily** with water (it effervesces, releasing hydrogen gas, but does not melt or explode like the others).

Why other options are incorrect:

- Na, K, and Rb are lower in the group. Their larger sizes make them lose electrons far more easily, causing them to react violently and explosively with water.

Question #32 Key: (A)

SZABMU 2023

Which element has smaller shielding effect among the following? [SZABMU (2023)]

CORE CONCEPT AND DERIVATION

The shielding (or screening) effect is caused by the inner electron shells repelling the valence electrons. The fewer the inner shells, the smaller the shielding effect.

Solution:

- To find the element with the smallest shielding effect, we must identify the element with the **fewest electron shells** (lowest period number).
- Let's locate the options on the periodic table:
Mg: Period 3 (2 inner shells shielding).
Ca: Period 4 (3 inner shells shielding).
Sr & Rb: Period 5 (4 inner shells shielding).
- Because Magnesium (Mg) has the fewest occupied electron shells, its valence electrons experience the **smallest shielding effect**.

Why other options are incorrect:

- Ca, Sr, and Rb are in lower periods, meaning they possess more principal quantum shells, significantly increasing the shielding effect.

Question #33 Key: (A)

SZABMU 2023

The oxidation number of oxygen in [Formula] is: [SZABMU (2023)]

CORE CONCEPT AND DERIVATION

While Oxygen normally has an oxidation state of -2, it exhibits different states when bonded to itself in peroxides or superoxides.

Solution:

- The compound Na_2O_2 is Sodium peroxide.
- Alkali metals (like Na) always have an oxidation state of +1 in their compounds.
- Let the oxidation number of Oxygen be x . Set up the algebraic equation for the neutral molecule:

$$2(\text{Na}) + 2(\text{O}) = 0$$

$$2(+1) + 2(x) = 0$$

$$2 + 2x = 0$$

$$2x = -2$$

$$x = -1$$

- Therefore, the oxidation number of each oxygen atom in a peroxide is -1.

Why other options are incorrect:

- -2: This is for normal oxides (e.g., Na_2O).
- +1 / +2: Oxygen only exhibits positive oxidation states when bonded to the more electronegative Fluorine (e.g., OF_2).

Question #34 Key: (A)

SZABMU 2023

The melting point of sulphur is higher than that of phosphorous because: [SZABMU (2023)]

CORE CONCEPT AND DERIVATION

For molecular solids in the p-block, melting and boiling points depend heavily on the strength of intermolecular London dispersion forces (a type of van der Waals force), which scale with molecular mass and size.

Solution:

- Phosphorus exists naturally as a tetra-atomic molecule: P_4 .
- Sulphur exists naturally as an octa-atomic puckered ring molecule: S_8 .
- Because an S_8 molecule is physically much larger and contains twice as many atoms/electrons as a P_4 molecule, it is far more polarizable.
- This massive electron cloud creates much **stronger van der Waals forces** between the sulphur molecules compared to phosphorus.
- Stronger intermolecular forces require more thermal energy to break, giving Sulphur a higher melting point.

Why other options are incorrect:

- Option B is factually inverted. Options C & D attempt to frame the answer around phosphorus, but the relative comparison clearly points to the larger van der Waals forces in Sulphur as the primary driving factor.

Question #35 Key: (A)

KMU 2023

Choose the element that forms normal oxide only: [EATA (2023)]

CORE CONCEPT AND DERIVATION

The formation of peroxides and superoxides requires a large metal cation to stabilize the large, complex oxygen anions via lattice energy matching.

Solution:

- **Lithium (Li)** is the smallest of the alkali metals.
- It possesses a very high charge density, which creates an intensely strong lattice energy when paired with the small oxide ion (O^{2-}).
- If Lithium were to pair with a large peroxide or superoxide ion, the lattice would be highly unstable.
- Therefore, when burned in air, Lithium reacts almost exclusively with oxygen to form only the **normal oxide** (Li_2O).

Why other options are incorrect:

- **Na:** Forms peroxides (Na_2O_2).
- **K & Rb:** Are large enough to easily form superoxides (KO_2 , RbO_2).

Question #36 Key: (A)

KMU 2023

Element whose salts do not impart color to flame test is: [EATA (2023)]

CORE CONCEPT AND DERIVATION

Flame colors are produced when heat energy from a Bunsen burner excites valence electrons to higher energy levels. When they fall back, they emit visible light. If the ionization energy is too high, the flame cannot excite the electrons.

Solution:

- **Beryllium (Be)** is the smallest element in Group 2.
- Because of its tiny atomic radius, its valence electrons are held incredibly tightly by the nucleus (it has an exceptionally high ionization energy).
- The thermal energy provided by a standard laboratory flame is simply **not strong enough** to excite these tightly bound electrons.
- Because no electrons are excited, no light is emitted upon relaxation, meaning Beryllium salts **do not impart any color** to the flame. (Magnesium behaves the same way).

Why other options are incorrect:

- **Cs**: Imparts a blue color.
- **Ca**: Imparts a brick-red color.
- **K**: Imparts a lilac/violet color.

Question #37 Key: (D)

KMU 2023

Indicate superoxide in the following: [EATA (2023)]

CORE CONCEPT AND DERIVATION

A superoxide is characterized by the presence of the superoxide anion, O_2^- , where the oxygen has a fractional oxidation state of $-1/2$.

Solution:

- Let's analyze the oxidation state of Oxygen in each option to classify the oxide:
- **CaO**: Ca is +2. So O is -2. (Normal Oxide).
- **BaO₂**: Ba is +2. The two oxygens must sum to -2. Each O is -1. (Peroxide).
- **Na₂O₂**: Na is +1. Two Na give +2. The two oxygens sum to -2. Each O is -1. (Peroxide).
- **RbO₂**: Rubidium (Group 1) is +1. Therefore, the O₂ unit must have a total charge of -1. Each Oxygen atom has an oxidation state of $-1/2$. This defines a **superoxide**.

Why other options are incorrect:

- Only heavy alkali metals (like K, Rb, Cs) are large enough to stabilize the superoxide ion. Options A, B, and C are normal oxides or peroxides.

Question #38 Key: (B)

KMU 2023

Which one of the following is covalent in nature? [EATA (2023)]

CORE CONCEPT AND DERIVATION

Fajans' Rules dictate that high polarizing power (small cation with a high charge) pulls the electron cloud of an anion toward itself, introducing significant covalent character into an otherwise ionic bond.

Solution:

- All the options are nitrides of Group 2 metals.
- As we move up Group 2, the size of the cation decreases drastically.
- **Beryllium (Be²⁺)** is the smallest cation in the group. Because of its tiny radius and +2 charge, it possesses an intensely high charge density (polarizing power).
- When bonded to Nitrogen, Be²⁺ severely distorts Nitrogen's electron cloud, sharing the electrons rather than fully transferring them.
- Therefore, Be₃N₂ exhibits predominantly **covalent** characteristics, unlike the other highly ionic nitrides in the group.

Why other options are incorrect:

- The cations Mg, Ca, and Ba are much larger. Their lower polarizing power results in bonds that are overwhelmingly ionic.

Question #39 Key: (D)

DUHS 2023

Valence shell electronic configuration of an element is [Formula] . To which group does the element belong? [D...]

CORE CONCEPT AND DERIVATION

The group number in the classical A/B system can be determined by the total number of valence electrons. Elements filling s and p subshells belong to the "A" subgroups (Representative elements).

Solution:

- The given configuration is $4s^2 4p^1$.
- The highest principal quantum number ($n = 4$) tells us it is in the 4th Period.
- To find the group, sum the electrons in the outermost s and p orbitals:

$$2(\text{from } 4s) + 1(\text{from } 4p) = 3 \text{ valence electrons}$$

- Because the last electron enters a p-orbital, it is a p-block element, categorizing it in the "A" subgroups.
- With 3 valence electrons, it belongs to **Group IIIA** (specifically, this is Gallium).

Why other options are incorrect:

- **IB & IIB:** These are transition metals (d-block elements).
- **IA:** Would only have an ns^1 configuration.

Question #40 Key: (B)

DUHS 2023

Metallic property in a group of p-block element has a trend: [DUHS (2023)]

CORE CONCEPT AND DERIVATION

Metallic character is strictly defined by an atom's ability to easily lose electrons (electropositivity).

Solution:

- As we move down any group in the p-block (e.g., Group IVA: Carbon, Silicon, Germanium, Tin, Lead).
- New principal electron shells are added, causing the atomic radius to enlarge significantly.
- The increased distance from the nucleus and the heavy shielding from inner electrons cause the Ionization Energy to drop.
- Because the atoms at the bottom of the group can lose their valence electrons much more easily than those at the top, their **metallic property increases**. (Notice how Carbon is a non-metal, but Lead at the bottom is a heavy metal).

Why other options are incorrect:

- Metallic character decreases across a period, but always consistently increases down a group.

Question #41 Key: (C)

DUHS 2023

Superoxide of group IA element (M) has formula: [DUHS (2023)]

CORE CONCEPT AND DERIVATION

To determine the formula of a compound, we balance the charge of the metal cation with the charge of the specific oxygen anion.

Solution:

- A Group IA element (let's call it M) always forms a cation with a +1 charge: M^+ .
- The superoxide polyatomic ion has a collective charge of -1 spread over two oxygen atoms: O_2^- .
- To form a neutral compound, one M^+ ion perfectly balances one O_2^- ion.
- Applying the criss-cross method (1:1 ratio), the general formula is MO_2 (e.g., KO_2).

Why other options are incorrect:

- M_2O : Normal oxide.
- M_2O_2 : Peroxide.
- M_2O_3 : Incorrect valency for Group I.

Question #42 Key: (D)

DUHS 2023

Which pair of the element markedly differ from other members of the respective groups? [DUHS (2023)]

CORE CONCEPT AND DERIVATION

The first element of s and p block groups often displays anomalous behavior compared to the rest of its group due to its exceptionally small size and high charge density.

Solution:

- **Lithium (Li)** is the first member of Group I, and **Beryllium (Be)** is the first member of Group II.
- Because they are located at the very top of their groups, they have incredibly small atomic and ionic radii.
- This results in anomalously high ionization energies and high polarizing power (charge-to-size ratio).
- Consequently, Li and Be form bonds with significant covalent character, whereas the rest of their group members form purely ionic compounds.
- Therefore, the pair **Lithium and Beryllium** shows peculiar behavior that markedly differs from the larger metals below them.

Why other options are incorrect:

- Na/Mg, K/Ca, and Cs/Ba exhibit standard, predictable metallic and ionic behaviors typical of the lower periods of their groups.

Question #43 Key: (D)

DUHS 2023

Which of the following substance is malleable and ductile? [DUHS (2023)]

CORE CONCEPT AND DERIVATION

Malleability (ability to be hammered into sheets) and ductility (ability to be drawn into wires) are hallmark physical properties of solid metals.

Solution:

- **Sodium chloride & Copper sulphate:** These are ionic crystals. Ionic bonds are highly directional and rigid. If struck, the lattice shifts, bringing like-charges together, which repel and shatter the crystal. They are brittle, not malleable.
- **Mercury:** Is a pure metal, but it is a **liquid** at room temperature. You cannot hammer a liquid into a sheet or draw it into a wire.
- **Aluminum:** Is a solid metal at room temperature. Its atoms are bonded via a "sea of delocalized electrons" (metallic bonding). When physical force is applied, the metal cations simply slide past each other while the flexible electron sea keeps the bond intact. Thus, Aluminum is highly **malleable and ductile**.

Why other options are incorrect:

- Only a solid metal can possess the properties of malleability and ductility.

Question #44 Key: (B)

BUMHS 2023

The general electronic configuration of halide ions is [BUMHS-2023]

CORE CONCEPT AND DERIVATION

Halogens (Group 17) naturally have 7 valence electrons. To become stable ions, they complete their octet.

Solution:

- Neutral halogens (like Fluorine, Chlorine, etc.) have the general valence configuration of ns^2np^5 .
- To achieve maximum stability, a halogen atom gains one electron to form a halide anion (e.g., F^- , Cl^-).
- This extra electron enters the p-orbital, completing the octet.
- The new configuration becomes ns^2np^6 , which is the incredibly stable, full-shell configuration of a noble gas.

Why other options are incorrect:

- ns^2np^5 : This is the configuration of the *neutral* halogen atom, not the ion.
- **Options C & D:** Incorrect orbital filling patterns for Group 17.

Question #45 Key: (B)

UHS 2022

Which statement describes the conversion of magnesium atoms to magnesium ions for ionic bond formation with ch...

CORE CONCEPT AND DERIVATION

In redox chemistry, the fundamental definitions of oxidation and reduction track the movement of electrons (often remembered by the mnemonic "OIL RIG").

Solution:

- Oxidation Is Loss of electrons.
- Reduction Is Gain of electrons.
- Magnesium is a Group II-A metal with 2 valence electrons (Mg).
- To form an ionic bond with chlorine, a neutral Magnesium atom must **lose** its two valence electrons to become a stable Mg^{2+} cation.



- Because the Magnesium atom has lost electrons, the process is definitively classified as **oxidation**.

Why other options are incorrect:

- Options A and C use the wrong terminology entirely. Option D incorrectly pairs oxidation with the gain of electrons.

Question #46 Key: (D)

UHS 2022

Why dimer of [Formula] is formed [UHS (2022)]

CORE CONCEPT AND DERIVATION

Molecules with incomplete valence shells (electron-deficient) will undergo structural rearrangement to achieve a stable octet, often forming coordinate covalent (dative) bonds.

Solution:

- In a single molecule of Aluminum chloride (AlCl_3), the central Aluminum atom forms 3 covalent bonds with 3 Chlorine atoms.
- This means Aluminum only has 6 electrons in its valence shell (it is electron-deficient and lacks a full octet).
- To achieve stability, two AlCl_3 molecules join together to form a dimer (Al_2Cl_6).
- A Chlorine atom from one molecule uses its **lone pair to form a coordinate covalent bond** with the electron-deficient Aluminum of the other molecule, and vice versa.
- This mutually **completes the octet** for both Aluminum atoms.

Why other options are incorrect:

- **Option A & B:** Aluminum is electron-deficient in AlCl_3 , not electron-rich, and it has absolutely no lone pairs to donate.
- **Option C:** It is the Chlorine atom that donates the lone pair, not the Aluminum.

Question #47 Key: (B)

UHS 2022

Which group of the periodic table contain non-metals, metalloids and metals? [UHS (2022)]

CORE CONCEPT AND DERIVATION

The transition from non-metallic to metallic character occurs as you move down a group, particularly in the p-block.

Solution:

- Group IVA (Group 14) is unique because it perfectly straddles the "staircase" line that divides metals and non-metals.
- **Carbon (C)**: At the top, is a classic non-metal.
- **Silicon (Si) & Germanium (Ge)**: In the middle, are metalloids (semiconductors) showing intermediate properties.
- **Tin (Sn) & Lead (Pb)**: At the bottom, exhibit low ionization energies and act as typical post-transition metals.
- Thus, Group IVA is the only group listed that contains all three distinct classes of elements.

Why other options are incorrect:

- **Group IB**: All are transition metals (Cu, Ag, Au).
- **Group VIIA**: Halogens; almost entirely non-metals.
- **Group VIA**: Chalcogens; mostly non-metals, ending in metalloids/weak metals, but IVA is the classic textbook example containing distinct members of all three.

Question #48 Key: (C)

UHS 2022

Which of the following sulphate compound is insoluble in water? [UHS (2022)]

CORE CONCEPT AND DERIVATION

The solubility of an ionic compound in water is decided by the tug-of-war between Lattice Energy (energy holding the crystal together) and Hydration Energy (energy released when ions interact with water).

Solution:

- For Alkaline Earth Metal (Group II-A) sulphates, solubility **decreases** drastically as you move down the group.
- Beryllium (Be) and Magnesium (Mg) have very small ionic radii, giving them extremely high hydration energies. This immense hydration energy easily overcomes their lattice energy, making BeSO_4 and MgSO_4 highly soluble.
- Barium (Ba) is at the bottom of the group. Its massive size results in a very low hydration energy.
- Because the low hydration energy of Ba^{2+} cannot compensate for the lattice energy required to break apart the BaSO_4 crystal, Barium sulphate remains practically **insoluble** in water (often forming white precipitates in lab tests).

Why other options are incorrect:

- Options A and B are highly soluble. Option D (Calcium sulphate) is sparingly soluble, but BaSO_4 is definitively the most insoluble.

Question #49 Key: (A)

SZABMU 2022

Carbon atoms in ethane are hybridized: [SZABMU (2022)]

CORE CONCEPT AND DERIVATION

The hybridization of an atom can be quickly determined by counting the number of bonded atoms and lone pairs (steric number).

Solution:

- The chemical formula for ethane is C_2H_6 .
- The structure of ethane consists of a single covalent bond between the two carbon atoms (C-C), and each carbon is singly bonded to three hydrogen atoms (C-H).
- There are zero lone pairs on the carbon atoms.
- Therefore, each carbon atom is completely surrounded by **4 single sigma bonds**.
- A steric number of 4 corresponds to the mixing of one 's' orbital and three 'p' orbitals, resulting in sp^3 **hybridization** with a tetrahedral geometry.

Why other options are incorrect:

- sp^2 : Found in ethene (double bonds).
- sp : Found in ethyne (triple bonds).
- sp^3d : Impossible for carbon, as it does not have empty d-orbitals in its valence shell.

Question #50 Key: (D)

SZABMU 2022

The type of bonding in Zinc is: [SZABMU (2022)]

CORE CONCEPT AND DERIVATION

Zinc (Zn) is an element found in the d-block of the periodic table, classifying it as a transition metal (or post-transition metal structurally).

Solution:

- In a solid piece of pure Zinc metal, the atoms are densely packed in a crystal lattice.
- The atoms release their outer shell electrons to form a mobile "sea of delocalized electrons."
- The electrostatic attraction between the stationary positive Zinc cations and this free-flowing sea of electrons constitutes a **Metallic bond**.

Why other options are incorrect:

- **Ionic**: Requires a metal reacting with a non-metal.
- **Covalent**: Requires sharing of electrons between non-metals.
- **Dative (Coordinate)**: Occurs in complex ions or specific molecules, not pure elemental solid metals.

Question #51 Key: (B)

SZABMU 2022

Which one of the following is semiconductor? [SZABMU (2022)]

CORE CONCEPT AND DERIVATION

Based on band theory, materials are classified into conductors, insulators, and semiconductors depending on the energy gap between the valence band and the conduction band.

Solution:

- **Silicon (Si)** is a Group IVA metalloid.
- In its crystal lattice, the energy gap between the valence band (where electrons normally reside) and the conduction band (where electrons can move freely) is relatively small.
- At absolute zero, Silicon acts as an insulator. However, at room temperature, thermal energy is sufficient to excite a small number of electrons across this narrow gap, allowing it to conduct electricity moderately.
- This specific behavior characterizes Silicon as a **semiconductor** (the backbone of modern electronics).

Why other options are incorrect:

- **Al & Mg**: Are metals; their valence and conduction bands overlap, making them excellent conductors.
- **P (Phosphorus)**: Is a non-metal with a massive energy gap, making it an insulator.

Question #52 Key: (D)

SZABMU 2022

Which of the following property decreases in group 2 as we go down the group? [SZABMU (2022)]

CORE CONCEPT AND DERIVATION

As we move down a group in the periodic table, the addition of new electron shells increases the distance between the nucleus and the valence electrons.

Solution:

- Down Group 2, the atomic radius increases.
- This larger size, combined with the increased shielding effect from inner shell electrons, weakens the electrostatic hold of the nucleus on the outermost electrons.
- Because the valence electrons are held less tightly, less energy is required to remove them.
- Therefore, **ionization energy decreases** down the group.

Why other options are incorrect:

- **Shielding, Atomic radius, & Proton number**: All of these consistently **increase** as you move down any group.

Question #53 Key: (A)

SZABMU 2022

Which of the following alkali metal can form normal oxide as well as peroxide? [SZABMU (2022)]

CORE CONCEPT AND DERIVATION

The type of oxide formed by an alkali metal depends heavily on its cationic size and the supply of oxygen during combustion.

Solution:

- **Sodium (Na)** is larger than Lithium but smaller than Potassium.
- When Sodium reacts with a *limited* supply of oxygen, it forms the normal oxide (Na_2O).
- When combusted in an excess of oxygen, its size perfectly stabilizes the peroxide ion (O_2^{2-}), forming pale yellow Sodium peroxide (Na_2O_2).
- Therefore, Sodium is well known for forming both, depending on conditions.

Why other options are incorrect:

- **Li:** Extremely small, forms almost exclusively normal oxide (Li_2O).
- **K & Cs:** Very large cations, they bypass peroxides and rapidly form superoxides (KO_2 , CsO_2).

Question #54 Key: (D)

KMU 2022

A radius greater than its parent atom is called: [ETEA (2022)]

CORE CONCEPT AND DERIVATION

The size of an ion relative to its parent neutral atom depends on whether it has gained or lost electrons.

Solution:

- When a neutral atom gains an electron to form a negative ion (anion), the number of electrons in the valence shell increases while the nuclear charge (protons) remains exactly the same.
- This added electron increases electron-electron repulsion within the valence shell, causing the electron cloud to expand outward.
- As a result, the **anionic radius is always greater** than the radius of its parent atom.
- *General Order:* Anion > Parent Atom > Cation.

Why other options are incorrect:

- **Cationic radii:** Cations are formed by losing electrons, making them strictly **smaller** than their parent atoms.

Question #55 Key: (A)

KMU 2022

All alkaline metals are white in colour except [ETEA (2022)]

CORE CONCEPT AND DERIVATION

Alkaline earth metals (Group II-A) generally exhibit a silvery-white metallic appearance, but the lightest member has a distinct physical look.

Solution:

- Most alkaline earth metals (like Mg, Ca, Sr, Ba) are relatively soft, silvery-white metals.
- **Beryllium (Be)**, being at the very top of the group, has an anomalously small atomic size and a tightly packed, strong metallic lattice.
- Because of this unique structure, Beryllium appears as a hard, brittle, **steel-gray** metal rather than silvery-white.

Why other options are incorrect:

- Magnesium, Calcium, and Strontium all fit the general group characteristic of being silvery-white metals.

Question #56 Key: (A)

BUMHS 2022

Select the group whose elements easily lose electron. [BMU (2022)]

CORE CONCEPT AND DERIVATION

The tendency to lose electrons (metallic character) is highest for elements with the largest atomic radii and the lowest ionization energies.

Solution:

- Elements in **Group I-A** (Alkali metals) are located at the extreme left of the periodic table.
- They have the largest atomic sizes in their respective periods.
- Because the single valence electron (ns^1) is far from the nucleus and heavily shielded, it experiences very weak effective nuclear charge.
- Therefore, Group I-A elements have the lowest ionization energies and lose their valence electron most easily.

Why other options are incorrect:

- **Groups VA, VIA, & VIIA:** These are non-metals located on the right side of the periodic table. They have small sizes, high ionization energies, and a strong tendency to **gain** electrons, not lose them.

Question #57 Key: (B)

BUMHS 2022

Which of the following has the least ionization potential? [BMU (2022)]

CORE CONCEPT AND DERIVATION

Ionization potential (or ionization energy) is the energy required to strip the most loosely bound electron from a gaseous atom. It is lowest for Group I metals.

Solution:

- **Lithium (Li)** is an alkali metal (Group I). Its electronic configuration is $1s^2 2s^1$.
- It readily loses its single valence electron to achieve the stable noble gas configuration of Helium ($1s^2$).
- Due to this strong driving force and large relative size compared to non-metals, Li has the **least ionization potential** among the given choices.

Why other options are incorrect:

- **He:** A noble gas with a full shell. It has the highest ionization energy in the entire periodic table.
- **N:** A non-metal with a half-filled, very stable p-orbital ($2p^3$), resulting in high ionization energy.
- **Zn:** A transition metal with a fully filled d-subshell ($3d^{10} 4s^2$), giving it a relatively high ionization potential compared to Li.

Question #58 Key: (B)

BUMHS 2022

Which of the following hydroxide of group I is less soluble in water? [BMU (2022)]

CORE CONCEPT AND DERIVATION

The solubility of an ionic compound depends on the balance between its lattice energy (which favors a solid crystal) and its hydration energy (which favors dissolving).

Solution:

- Lithium (Li^+) is the smallest cation in Group I.
- Because of its tiny size, the electrostatic attraction between Li^+ and the small hydroxide ion (OH^-) is exceptionally strong.
- This results in a very **high lattice energy** for Lithium hydroxide (LiOH).
- Because it takes so much energy to break this crystal lattice apart, LiOH is the least soluble among the alkali metal hydroxides (solubility of Group I hydroxides generally increases down the group).

Why other options are incorrect:

- As the cation gets larger (Na, K, Rb), the lattice energy drops significantly faster than hydration energy, making NaOH , KOH , and RbOH highly soluble in water.

Question #59 Key: (D)

BUMHS 2022

The color of the Mg metal flame is? [BMU (2022)]

CORE CONCEPT AND DERIVATION

When metals are heated in a flame or combusted, the excitation and subsequent relaxation of their electrons emit light of a characteristic wavelength (color).

Solution:

- Magnesium (Mg) is highly reactive and burns fiercely in the presence of oxygen.
- When it combusts, it emits an intense, blinding, brilliant **white flame**.
- This characteristic bright white light is due to its specific emission spectrum, which covers a broad range of the visible spectrum. (This is why Magnesium is often used in flares and fireworks).

Why other options are incorrect:

- **Blue:** Usually associated with copper halides or certain lead compounds.
- **Violet:** Characteristic of Potassium (K).
- **Yellow:** Characteristic of Sodium (Na).

Question #60 Key: (C)

NUMS 2022

Which of the following property increases down the group in alkali metals? [NUMS (2022)]

CORE CONCEPT AND DERIVATION

For metals, chemical reactivity is dictated by how easily they can lose their valence electrons (their electropositive or metallic character).

Solution:

- As you move down the alkali metal group (Group I-A, from Li to Cs), new electron shells are added, massively increasing the atomic radius.
- This increased distance and greater shielding effect lower the Ionization Energy drastically.
- Because it becomes progressively easier for the metal to lose its outermost electron, its chemical **reactivity increases**. (E.g., Li reacts slowly with water, while Cs reacts explosively).

Why other options are incorrect:

- **Options A, B, & D:** Ionization energy, electron affinity (magnitude), and electronegativity all **decrease** down the group due to the increasing atomic size and shielding effect.

Question #61 Key: (B)

NUMS 2022

The solubility of alkaline earth metal [NUMS (2022)]

CORE CONCEPT AND DERIVATION

Note: The original question stem is incomplete, but based on the provided answer key and standard chemical trends, it refers to the solubility of Alkaline Earth Metal **Hydroxides**.

Solution:

- For Group II-A hydroxides (e.g., $\text{Be}(\text{OH})_2$, $\text{Mg}(\text{OH})_2$, ..., $\text{Ba}(\text{OH})_2$), solubility increases down the group.
- As the cation gets larger (from Be^{2+} to Ba^{2+}), the lattice energy of the crystal decreases much more rapidly than the hydration energy of the ions.
- Because the lattice becomes much easier to break apart compared to the energy released by hydration, the overall solubility **increases down the group**.

Why other options are incorrect:

- If the question had specified *sulphates* or *carbonates*, the answer would be "decreases down the group." However, the official key specifies Option B, confirming it is querying the hydroxide trend.

Question #62 Key: (A)

PMDC 2021

Addition of second electron to a uni-negative ion always ____? [PMC (2021)]

CORE CONCEPT AND DERIVATION

Electron affinity is the energy change when an electron is added to an atom. While the first electron addition is usually energetically favorable, subsequent additions are not.

Solution:

- When the first electron is added to a neutral atom (like Oxygen), energy is released (exothermic process) because the nucleus pulls the electron in. The atom becomes a uni-negative ion (O^-).
- When you try to force a **second electron** into this already negative ion, the incoming electron experiences severe electrostatic repulsion from the existing electron cloud.
- To overcome this massive repulsion, energy must be forcefully supplied from an outside source.
- Because energy must be absorbed to force the electron in, the second electron affinity is **always an endothermic process**.

Why other options are incorrect:

- It is impossible for it to be exothermic (Option B) because a negative charge will naturally repel another negative charge without the input of external energy.

Question #63 Key: (A)

PMDC 2021

In periodic table, the period number tells the [PMC (2021)]

CORE CONCEPT AND DERIVATION

The architecture of the periodic table is directly linked to the quantum mechanical model of the atom.

Solution:

- The horizontal rows of the periodic table are called periods.
- The period number (1 through 7) perfectly corresponds to the principal quantum number (n) of the outermost valence electron shell being filled.
- For example, elements in Period 3 (Na, Mg, Al...) are filling their 3rd electron shell.
- Therefore, the period number strictly dictates the **total number of electron shells** containing electrons in that atom.

Why other options are incorrect:

- Group number** gives information about valence electronic configuration and metallic character. **Photon** is completely unrelated to atomic positioning.

Question #64 Key: (B)

PMDC 2021

Sodium is not observed in +2 oxidation state because of its [PMC (2021)]

CORE CONCEPT AND DERIVATION

The likelihood of an element achieving a specific oxidation state depends on the gap between sequential ionization energies.

Solution:

- Sodium (Na) has the electronic configuration $1s^2 2s^2 2p^6 3s^1$.
- It effortlessly loses its one valence electron (low first ionization potential) to achieve the incredibly stable, noble gas configuration of Neon ($1s^2 2s^2 2p^6$). This forms Na^+ .
- Trying to remove a **second electron** requires ripping an electron out of a perfectly stable, fully filled octet shell (the 2p subshell) that is much closer to the nucleus.
- This requires a gigantic, chemically unfeasible amount of energy (**High second ionization potential**), which is why Na^{2+} never forms in chemical reactions.

Why other options are incorrect:

- Sodium has a very low first ionization potential and a low electronegativity, which is why it readily forms +1 ions.

Question #65 Key: (A)

PMDC 2021

Which of the following element has highest electronegativity? [PMC (2021)]

CORE CONCEPT AND DERIVATION

Electronegativity is an atom's ability to attract a shared pair of electrons in a covalent bond towards itself.

Solution:

- Electronegativity increases across a period (left to right) and decreases down a group (top to bottom).
- Fluorine is situated at the top right of the periodic table (excluding noble gases).
- Because it has an extremely small atomic radius and a high effective nuclear charge, its nucleus exerts immense pull on shared electron pairs.
- On the Pauling scale, **Fluorine** is assigned the maximum theoretical value of 4.0, making it the most electronegative element in the entire periodic table.

Why other options are incorrect:

- **Sodium & Magnesium:** Are metals on the far left, meaning they are electropositive and have very low electronegativity.
- **Bromine:** Is a halogen like Fluorine, but it sits much further down the group, so its larger size drastically reduces its electronegativity.

Question #66 Key: (B)

PMDC 2020

Potassium, Rubidium, Cesium reacts with oxygen to form which types of oxides? [NMDCAT (2020)]

CORE CONCEPT AND DERIVATION

The stability of complex oxygen anions (like peroxide O_2^{2-} and superoxide O_2^-) requires a large, highly polarizable metal cation to prevent the crystal lattice from collapsing.

Solution:

- As we travel down Group I-A, the atomic size of the alkali metals becomes very large (Potassium, Rubidium, and Cesium).
- Their large ionic radii possess a low charge density, which perfectly matches and stabilizes the large, unstable superoxide ion (O_2^-).
- When combusted in an excess of oxygen, these heavy alkali metals bypass normal oxide and peroxide phases to immediately form bright orange/yellow **Superoxides** (e.g., KO_2 , RbO_2 , CsO_2).

Why other options are incorrect:

- **Lithium** forms normal oxides (Li_2O).
- **Sodium** mostly forms peroxides (Na_2O_2).
- K, Rb, and Cs are uniquely large enough to form superoxides.

Question #67 Key: (B)

PMDC 2020

Magnesium reacts with nitrogen to form [NMDCAT (2020)]

CORE CONCEPT AND DERIVATION

When writing the chemical formula for an ionic compound, the total positive charge must perfectly balance the total negative charge (the criss-cross method).

Solution:

- Magnesium belongs to Group II-A and always forms a cation with a +2 charge: Mg^{2+} .
- Nitrogen belongs to Group V-A, meaning it needs 3 electrons to complete its octet, forming the nitride anion with a -3 charge: N^{3-} .
- Applying the criss-cross method to balance the charges:
 1. Take the magnitude of Mg's charge (2) and make it the subscript for N.
 2. Take the magnitude of N's charge (3) and make it the subscript for Mg.
- The resulting balanced formula is Mg_3N_2 .

Why other options are incorrect:

- All other options represent incorrect charge balancing. For instance, MgN_2 would imply Nitrogen has a -1 charge, which is incorrect for a nitride.

Question #68 **Key: (B)**

PMDC 2020

*Densities of alkali metals are low due to [NMDCAT (2020)]***CORE CONCEPT AND DERIVATION**

Density is a measure of how tightly packed mass is within a given space.

Formula:

$$\text{Density} = \frac{\text{Mass}}{\text{Volume}}$$

Solution:

- Alkali metals (Group I-A) are located at the extreme left of their respective periods.
- Because effective nuclear charge is at its lowest on the left side of the table, alkali metals possess the **largest atomic volumes** in their periods.
- Since volume is the denominator in the density equation, a massively large volume results in a very low overall density. (Lithium, Sodium, and Potassium are even less dense than water and will float).

Why other options are incorrect:

- Option A & D:** While weak forces and the ns^1 configuration explain their low melting points and softness, density is a direct mathematical consequence of their inflated atomic volume.
- Option C:** They are the largest elements in their periods, not the smallest.

Question #69 **Key: (C)**

SET 2019

*Which element has the highest electron affinity among halogens? [SET (2019)]***CORE CONCEPT AND DERIVATION**

Electron affinity (EA) generally decreases (becomes less negative) down a group as atomic size increases. However, the halogens feature a major exception at the top of the group.

Solution:

- While Fluorine (F) is the most electronegative element, its atomic size is exceptionally small.
- Because of this tiny size, its 7 valence electrons are crowded in a very small 2p orbital, creating intense **electron-electron repulsion**.
- When an incoming electron approaches F, it faces significant repulsive resistance, lowering the net energy released.
- Chlorine (Cl) has a larger 3p orbital which comfortably accommodates the incoming electron with much less repulsion, releasing maximum energy.
- Therefore, **Chlorine (Cl)** has the highest (most negative) electron affinity in the periodic table.

Why other options are incorrect:

- F suffers from steric/electronic repulsion. Br and I have much larger sizes and thicker shielding, leading to weaker nuclear pull on the incoming electron.

Question #70 Key: (B)

SET 2019

Which one of the following properties decreases across the third period of elements in the periodic table? [SE...]

CORE CONCEPT AND DERIVATION

A reducing agent is a substance that donates electrons easily (gets oxidized). The ability to act as a reducing agent is directly related to metallic character and low Ionization Energy.

Solution:

- As we move left to right across the 3rd period (from Na to Ar), the effective nuclear charge increases, and atomic size decreases.
- This makes it increasingly difficult for atoms to lose their valence electrons (Ionization Energy increases).
- Because they become less willing to donate electrons, their **ability to act as a reducing agent consistently decreases**. (In fact, they transition into strong oxidizing agents, like Chlorine).

Why other options are incorrect:

- Option A & C:** Electronegativity and Ionization Energy consistently **increase** across the period.
- Option D:** Melting/boiling points increase up to Group IVA, then decrease, so it is not a consistent decrease across the entire period.

Question #71 Key: (D)

SET 2019

In the [Formula] period of the periodic table which of following property is decreasing consistently? [SET (20...]

CORE CONCEPT AND DERIVATION

Periodic properties follow specific trends based on electron shielding and effective nuclear charge.

Solution:

- Across the 3rd period (from Sodium to Argon), electrons are added to the exact same 3rd principal shell, meaning the shielding effect remains roughly constant.
- However, the nucleus gains one proton with each consecutive element, steadily increasing the effective nuclear charge (Z_{eff}).
- This increasing nuclear magnet pulls the surrounding electron cloud progressively tighter.
- As a result, the **atomic radius decreases consistently** across the period.

Why other options are incorrect:

- Option A & C:** Conductivity and melting points fluctuate (e.g., they increase initially and then drop sharply).
- Option B:** Ionization energy generally **increases**, not decreases.

Question #72 Key: (D)

SET 2019

In the third period of elements, there lies element "X" which is metallic in nature and it can reduce chlorine...

CORE CONCEPT AND DERIVATION

The ability to rapidly reduce a non-metal (like Chlorine gas) implies the element is a very powerful reducing agent. The strongest reducing agents are metals with the lowest ionization energies.

Solution:

- Reducing power is highest at the extreme left of the periodic table because these metals have large atomic radii and only 1 valence electron to lose.
- Group I-A elements (Alkali metals, like Sodium in the 3rd period) have the lowest ionization energy in their respective periods.
- Therefore, they vigorously and rapidly donate their electron to Chlorine, proving to be the strongest reducing agents. Element X must belong to **Group I-A**.

Why other options are incorrect:

- Group II-A:** Also strong reducers, but their higher IE makes them slower/less potent than Group I-A.
- Groups IVA & VIIA:** These are metalloids/non-metals that act predominantly as oxidizing agents, not reducing agents.

Question #73 Key: (D)

NUMS 2019

The hydration energy of [Formula] is less than [NUMS (2019)]

CORE CONCEPT AND DERIVATION

Hydration energy is the amount of energy released when one mole of gaseous ions dissolves in water. It is heavily dependent on the "charge density" of the ion.

Formula:

$$\text{Hydration Energy} \propto \frac{\text{Charge of Ion}}{\text{Size of Ion}}$$

Solution:

- To find an ion with a greater hydration energy than Mg^{2+} , we need an ion with a higher charge, a smaller size, or both.
- Al^{3+} has a much higher charge (+3 compared to +2) and a smaller ionic radius than Mg^{2+} .
- This results in a massively higher charge density for Aluminum, allowing it to attract water molecules much more violently, releasing far more hydration energy.

Why other options are incorrect:

- Na^+ , Li^+ : Have only a +1 charge, resulting in drastically lower charge densities.
- Ca^{2+} : Has the same charge as Mg, but is physically larger (lower down Group 2), giving it a lower charge density and lower hydration energy.

Question #74 Key: (A)

NUMS 2019

Which alkaline earth metal makes peroxides? [NUMS (2019)]

CORE CONCEPT AND DERIVATION

The formation of higher oxides (like peroxides O_2^{2-} and superoxides) depends on the size and charge density of the metal cation. Large cations with low charge density stabilize large polyatomic anions.

Solution:

- In Group II-A, as we move down the group, atomic size increases drastically.
- Beryllium (Be) and Magnesium (Mg) are too small and have high charge densities; they only form normal oxides (e.g., MgO).
- Calcium (Ca) can form peroxides, but it requires special conditions.
- Barium (Ba), being near the bottom of the group, has a very large ionic radius. This large size perfectly stabilizes the large peroxide ion (O_2^{2-}) in the crystal lattice.
- Thus, heating Ba in air/oxygen at high temperatures (around 500°C) readily forms Barium peroxide (BaO_2).

Why other options are incorrect:

- Be and Mg form stable normal oxides. The lattice energy mismatch prevents them from forming stable peroxides.

Question #75 Key: (B)

KMU 2019

How many elements are there in the 3 period of periodic table? [ETEA (2019)]

CORE CONCEPT AND DERIVATION

The number of elements in a given period corresponds to the number of electrons required to fill the sublevels associated with that principal quantum number.

Solution:

- The 3rd period of the periodic table involves the filling of the 3s and 3p subshells.
- The 3s subshell can hold a maximum of 2 electrons.
- The 3p subshell can hold a maximum of 6 electrons.
- Total electrons = $2 + 6 = 8$.
- Therefore, the 3rd period contains exactly **8 elements** (Sodium to Argon) and is classified as a "short period".

Why other options are incorrect:

- 18**: Corresponds to periods 4 and 5 (which include the d-block).
- 32**: Corresponds to period 6 (which includes both d-block and f-block).
- 10**: Is the capacity of the d-subshell alone, not a full period.

Question #76 Key: (B)

KMU 2019

Which oxides of "K" contain more oxygen than its normal oxide?
[ETEA (2019)]

CORE CONCEPT AND DERIVATION

Potassium (K) forms a normal oxide (K_2O), a peroxide (K_2O_2), and a superoxide (KO_2). The oxygen-to-metal ratio determines which contains "more" oxygen.

Solution:

- **Normal Oxide (K_2O):** 2 Potassium atoms to 1 Oxygen atom. Ratio = 0.5 oxygen per K.
- **Peroxide (K_2O_2):** 2 Potassium atoms to 2 Oxygen atoms. Ratio = 1 oxygen per K.
- **Superoxide (KO_2):** 1 Potassium atom to 2 Oxygen atoms. Ratio = **2 oxygen per K**.
- Comparing the ratios, the superoxide molecule contains the highest proportion of oxygen relative to the metal. Potassium naturally favors forming the superoxide when burned in excess air.

Why other options are incorrect:

- While peroxides contain more oxygen than normal oxides, superoxides contain even more than peroxides, making it the most correct answer for "more oxygen".

Question #77 Key: (D)

MDCAT 2019

Modern periodic table is arranged in ascending order of? [MDCAT (2019)]

CORE CONCEPT AND DERIVATION

The periodic law underwent a major revision after Henry Moseley's X-ray experiments, which revealed that atomic number is the fundamental property of an element.

Solution:

- Dmitri Mendeleev originally arranged the periodic table by increasing *atomic mass*, which led to several inconsistencies (like Tellurium and Iodine).
- Moseley discovered the atomic number, which is exactly equal to the **number of protons** in the nucleus.
- The Modern Periodic Law states that the physical and chemical properties of elements are periodic functions of their **proton number** (atomic number).

Why other options are incorrect:

- **Options A, B, & C:** Atomic mass, mass number, and nucleon number all relate to the sum of protons and neutrons. Arranging by mass leads to isotopic confusion and elemental misplacement.

Question #78 Key: (C)

MDCAT 2019

Ionization energy decreases down the group from top to bottom due to: [MDCAT (2019)]

CORE CONCEPT AND DERIVATION

Ionization Energy (IE) is the effort required to remove the most loosely bound electron. As we go down a group, this effort consistently decreases.

Solution:

- Moving down a group, new principal quantum shells are continuously added.
- These extra inner shells of electrons physically stand between the nucleus and the outermost valence electrons.
- These intervening electrons repel the valence electrons and block (shield) them from the full attractive force of the nucleus. This is the **Shielding Effect**.
- Because of this immense shielding, the nucleus loses its grip on the outermost electrons, drastically lowering the energy required to remove them.

Why other options are incorrect:

- **Option A:** Atomic size increases down a group, it does not decrease.
- **Option B & D:** Mass and proton number do increase, but increasing proton number alone would actually *increase* IE if it wasn't overwhelmingly counteracted by the shielding effect.

Question #79 Key: (B)

MDCAT 2019

Oxidation number of particular element can be directly or indirectly inferred from its: [MDCAT (2019)]

CORE CONCEPT AND DERIVATION

The oxidation number indicates the total number of electrons an atom either gains or loses to form a chemical bond. This behavior is directly tied to its valence electrons.

Solution:

- The periodic table is structured such that an element's **Group number** (in the A-group classification, e.g., IA, IIA, VIIA) corresponds directly to the number of valence electrons in its outermost shell.
- For example, Group IA metals have 1 valence electron, so they exhibit a +1 oxidation state. Group VIIA (Halogens) have 7 valence electrons, needing 1 to complete the octet, so their most common state is -1.
- Therefore, the group number provides a direct roadmap to an element's oxidation states.

Why other options are incorrect:

- **Options A, C, & D:** Physical state (solid/liquid/gas), size, and mass do not dictate electron exchange chemistry and cannot reliably predict oxidation states.

Question #80 Key: (A)

MDCAT 2018

Down the group acid-base behavior of metallic oxides of group 2 elements changes to [MDCAT (2018)]

CORE CONCEPT AND DERIVATION

The basic character of a metal oxide depends on how easily the metal can release electrons (its metallic character) to form ionic bonds with oxygen.

Solution:

- As we move down Group 2 (Alkaline Earth Metals), the atomic size increases.
- This lowers the ionization energy, meaning the metals lose their valence electrons much more easily (metallic character increases).
- Because they become more electropositive, the metal-oxygen bond becomes more highly ionic.
- When these ionic oxides dissolve in water, they readily yield OH^- ions, making the oxides **more basic** down the group.

Why other options are incorrect:

- The basicity does not decrease, remain unchanged, or turn acidic. Acidic oxides are typically formed by non-metals (found on the right side of the periodic table).

Question #81 Key: (B)

MDCAT 2018

In period 2 and period 3 maximum melting point shown by elements [MDCAT (2018)]

CORE CONCEPT AND DERIVATION

Maximum melting points in any short period are observed for elements that can form giant three-dimensional covalent network lattices.

Solution:

- In Period 2, Carbon (Group IVA) forms massive covalent structures like diamond, giving it the highest melting point.
- In Period 3, Silicon (Group IVA) also forms a similar giant covalent network, requiring enormous energy to break its bonds.
- Therefore, **Carbon and Silicon** exhibit the maximum melting points in their respective periods.

Why other options are incorrect:

- **Option A:** Alkali metals have relatively weak metallic bonds and low melting points.
- **Option C:** Noble gases exist as monoatomic gases with very weak London dispersion forces.
- **Option D:** Nitrogen and phosphorus form discrete molecules (N_2 , P_4) with weak intermolecular forces.

Question #82 Key: (B)

MDCAT 2018

The following sketch show the variation in a physical property of third period elements against their number: ...

CORE CONCEPT AND DERIVATION

By identifying the shape of a period-trend graph, we can deduce the physical property. A curve that rises to a sharp peak at Group IVA and then drops precipitously is the hallmark of melting/boiling points.

Solution:

- The provided sketch (x-axis: atomic numbers 11 through 18) shows a continuous rise peaking at atomic number 14 (Silicon), followed by a sharp fall.
- Silicon forms a giant covalent structure, giving it an anomalously high melting point compared to its neighbors.
- Therefore, the property plotted is **Melting point**.

Why other options are incorrect:

- **Atomic/Ionic radius:** These properties generally show a continuous downward trend across a period, not a peak.
- **Ionization energy:** Generally increases across a period, with minor dips (e.g., between Groups IIA/IIIA and VA/VIA), but does not peak exclusively at Group IVA.

Question #83 Key: (D)

MDCAT 2017

Following graph shows a physical property along the period 3 elements. Which physical property is this? Si (Pe...

CORE CONCEPT AND DERIVATION

Melting point across Period 3 elements increases from Na, Mg, Al to a peak at Si (Group IVA) due to its giant covalent macromolecular structure. After Si, it drops sharply for P, S, Cl, and Ar because they exist as simple molecular structures with weak intermolecular forces.

Solution:

- The graph shows a clear peak at Si.
- Among Period 3 physical properties, only **Melting point** reaches a peak at Group IVA (Si) and then decreases.

Why other options are incorrect:

- **Atomic radius:** Consistently decreases from Na to Cl without any peak at Si.
- **Electron affinity & Non-metallic character:** Generally increase across the period.

Question #84 Key: (B)

MDCAT 2017

The following sketch shows the melting point of eight elements with consecutive atomic numbers. Which element ...

CORE CONCEPT AND DERIVATION

In Period 3, the melting point of elements increases up to Group IVA (Silicon) due to the formation of a strong, giant covalent network, and then sharply drops.

Solution:

- The graph displays a peak at a specific point.
- Silicon (Si) forms a giant three-dimensional covalent lattice, giving it the highest melting point in the third period.
- On the given graph, this maximum peak is labeled as point C.
- Therefore, point C represents Silicon. (Note: In the historical options layout, Option B corresponds to the label 'C' on the graph.)

Why other options are incorrect:

- Points A, B, and D correspond to elements with weaker metallic bonding or simple molecular structures, leading to lower melting points.

Question #85 Key: (C)

MDCAT 2017

Ionic radius along the period decreases due to: [MDCAT (2017)]

CORE CONCEPT AND DERIVATION

For isoelectronic series (ions with the same electron configuration) across a period, the dominant factor determining size is the positive pull of the nucleus.

Solution:

- As we move along a period (e.g., forming isoelectronic cations like Na^+ , Mg^{2+} , Al^{3+}), the electrons are present in the exact same valence shell, so shielding remains constant.
- However, the atomic number (number of protons) increases, leading to an **increase in effective nuclear charge**.
- This stronger nuclear pull draws the electron cloud tighter, thereby decreasing the ionic radius.

Why other options are incorrect:

- **Option A:** Shells are not added across a period.
- **Option B:** High IE is a consequence of increased nuclear pull, not the direct physical cause of the radius contraction.
- **Option D:** Nuclear charge increases, it does not decrease.

Question #86 Key: (D)

MDCAT 2017

Among the following, which one is least reactive metal: [MDCAT (2017)]

CORE CONCEPT AND DERIVATION

The chemical reactivity of s-block metals is directly tied to how easily they lose their valence electrons. This is governed by their Ionization Energy (IE). High IE = low reactivity.

Solution:

- Reactivity in metals increases down a group and decreases across a period.
- Among the given options, Beryllium (Be) is located at the very top of Group II-A.
- Because of its exceptionally small atomic radius, its valence electrons are tightly held by the nucleus, resulting in the **highest Ionization Energy** among the listed metals.
- This makes it incredibly difficult for Be to lose electrons, making it the least reactive metal of the group.

Why other options are incorrect:

- **Na:** Group I metal, extremely reactive due to large size and low IE.
- **Mg & Ca:** Lower down in Group II-A than Be, hence they have larger radii, lower IE, and are much more reactive than Be.

Question #87 Key: (B)

MDCAT 2017

Melting point of Na & Mg decreases down the group due to:
[MDCAT (2017)]

CORE CONCEPT AND DERIVATION

In metallic lattices, melting point is determined by the electrostatic attraction between the positive metal ions and the delocalized sea of valence electrons. The distance between the nucleus and the delocalized electrons weakens this bond.

Solution:

- As we move down Group I-A (like Na) or Group II-A (like Mg), new electron shells are added, causing an **increment in atomic size**.
- The larger the atomic radius, the further the positive nucleus is from the delocalized valence electrons.
- This increased distance weakens the metallic bonding force.
- Weaker metallic bonds require less thermal energy to break, leading to a gradual decrease in melting points down the group.

Why other options are incorrect:

- Option A, C, & D:** Electronegativity, attractive forces, and ionization energy all **decrease** down the group, so they cannot be the active cause; strong attractive forces would actually increase the melting point.

Question #89 Key: (C)

MDCAT 2016

Melting points of group II-A elements are higher than those of group I-A because: [MDCAT (2016)]

CORE CONCEPT AND DERIVATION

The melting point of a metal depends heavily on the strength of its metallic bond, which is dictated by the number of delocalized valence electrons it contributes to the "sea of electrons."

Solution:

- Group I-A (Alkali metals) have an ns^1 configuration, meaning each atom provides only **one** valence electron for metallic bonding.
- Group II-A (Alkaline earth metals) have an ns^2 configuration, meaning each atom provides **two** valence electrons.
- This higher number of binding electrons in Group II-A creates a much stronger metallic bond, pulling the positive metal cores closer and requiring much higher thermal energy to break.

Why other options are incorrect:

- While Group II-A elements are indeed smaller in size than Group I-A (Option A), the primary and most significant factor for the large difference in melting point is the doubling of the binding electrons.

Question #88 Key: (B)

MDCAT 2016

The ionic radius of fluoride ion is: [MDCAT (2016)]

CORE CONCEPT AND DERIVATION

When a non-metal gains an electron to form an anion, electron-electron repulsion increases within the valence shell. Because the nuclear charge remains the same, the electron cloud expands, making the anionic radius significantly larger than its parent neutral atom.

Solution:

- The actual atomic size of a neutral Fluorine (F) atom is 72 pm.
- When it gains one electron to form the Fluoride ion (F^-), the added repulsion causes the radius to expand.
- According to standard textbook values, the ionic radius of F^- increases to **136 pm**.

Why other options are incorrect:

- Option A:** 72 pm is the covalent radius of the neutral F atom.
- Options C & D:** These values correspond to the atomic/ionic radii of larger halogens or elements, not fluorine.

Question #90 Key: (D)

KMU 2016

Lithium reacts with air to form [ETEA (2016)]

CORE CONCEPT AND DERIVATION

Lithium exhibits anomalous behavior compared to the rest of the alkali metals. Because of its extremely high charge density, it can react directly with diatomic gases that are usually inert at room temperature.

Solution:

- Air is primarily composed of Nitrogen ($\approx 78\%$) and Oxygen ($\approx 21\%$).
- When Lithium burns in air, it reacts directly with Oxygen to form a normal oxide:



- Uniquely among the alkali metals, Lithium has a high enough lattice energy to break the strong triple bond of Nitrogen gas, forming Lithium nitride:



- Therefore, it forms **both** the oxide and the nitride.

Why other options are incorrect:

- Options A and B are incomplete on their own. Option C suggests peroxide/carbonate formation, but Lithium primarily forms the normal oxide, not a peroxide.

Question #91 Key: (D)

MDCAT 2015

Keeping in view the size of atoms, which order is correct? [MDCAT (2015)]

CORE CONCEPT AND DERIVATION

Atomic size (radius) **decreases** across a period from left to right due to increasing effective nuclear charge. It **increases** down a group due to the addition of new electron shells.

Solution:

- Lithium (Li, Atomic No. 3) and Beryllium (Be, Atomic No. 4) belong to the same period (Period 2).
- Because Li is to the left of Be, Li experiences less effective nuclear charge.
- Therefore, the atomic radius of Li is larger than that of Be ($\text{Li} > \text{Be}$).

Why other options are incorrect:

- Option A:** Nitrogen is to the right of Carbon, so $\text{N} < \text{C}$.
- Option B:** Argon is to the right of Chlorine, so $\text{Ar} < \text{Cl}$.
- Option C:** Phosphorus is to the right of Silicon, so $\text{P} < \text{Si}$.

Question #92 Key: (C)

MDCAT 2015

Which one of the following will have the smallest radius? [MDCAT (2015)]

CORE CONCEPT AND DERIVATION

For purely isoelectronic species (ions with the same number of electrons), the ionic radius is inversely proportional to the magnitude of the positive charge (or nuclear charge).

Formula:

$$\text{Ionic Radius} \propto \frac{1}{\text{Nuclear Charge (Protons)}}$$

Solution:

- All given ions are isoelectronic, containing exactly 10 electrons (configuration of Neon: $1s^2 2s^2 2p^6$).
- The number of protons pulling on these 10 electrons are: Na (11), Mg (12), Al (13), Si (14).
- Si^{+4} has the highest nuclear charge (+14).
- The stronger nuclear pull draws the remaining electrons much closer, resulting in the hypothetically smallest cationic radius.

Why other options are incorrect:

- The other ions have fewer protons, meaning their nucleus exerts a weaker pull on the 10 electrons, leaving their ionic radii comparatively larger than Si^{+4} .

Question #93 Key: (B)

MDCAT 2014

The trends in melting points of the elements of [Formula] period are depicted in figure below Si (Peak) Na Mg ...

CORE CONCEPT AND DERIVATION

The physical state and melting point of an element are dictated by its macromolecular structure and intermolecular forces.

Solution:

- Silicon (Si) belongs to Group IVA and forms a three-dimensional **giant covalent network** structure (like diamond). Breaking this requires a massive amount of thermal energy.
- Phosphorus (P) belongs to Group VA and exists as discrete, small tetra-atomic molecules (P_4). These molecules are held together only by weak intermolecular forces (London dispersion forces).
- The sharp drop in melting point is purely due to this drastic shift in bonding and structural arrangement.

Why other options are incorrect:

- Radius, density, and electron density variations are minor secondary effects and do not explain the sudden massive structural collapse from a giant lattice to simple molecules.

Question #94 Key: (B)

MDCAT 2014

Arrange the following elements according to the trends of ionization energies C, N, Ne, B [MDCAT (2014)]

CORE CONCEPT AND DERIVATION

Generally, Ionization Energy (IE) increases across a period from left to right due to an increase in effective nuclear charge, which holds valence electrons more tightly.

Solution:

- The given elements belong to the 2nd period. Their increasing order of atomic number is: B (5), C (6), N (7), Ne (10).
- Following the general trend, IE increases across the period.
- Therefore, the standard expected order is: **B < C < N < Ne**.
- Note: While Nitrogen has a slightly anomalously high IE compared to Oxygen due to a half-filled p-orbital, Oxygen is not listed in the options, so the standard trend holds perfectly for the given elements.

Why other options are incorrect:

- Option A, C, and D provide incorrect sequences that contradict the increasing effective nuclear charge trend across the period.

Question #95 Key: (B)

MDCAT 2013

Along a period, atomic radius decreases. This gradual decrease in radius is due to: [MDCAT (2013)]

CORE CONCEPT AND DERIVATION

Atomic radius is determined by the balance between the attractive force of the nucleus (protons) and the repulsive force/shielding of the electrons.

Solution:

- As we move left to right across a period, new electrons are added to the **same** valence shell (shielding remains relatively constant).
- However, protons are continuously added to the nucleus.
- This increases the effective nuclear charge (Z_{eff}), pulling the electron cloud closer to the nucleus and causing a gradual decrease in atomic radius.

Why other options are incorrect:

- **Option A:** The number of shells remains constant along a period.
- **Options C & D:** These options were misprinted in the original historical exam paper (they belong to the next question) and have absolutely nothing to do with atomic radius.

Question #96 Key: (D)

MDCAT 2013

What is the trend of melting and boiling points of the elements of short periods as we move from left to right...

CORE CONCEPT AND DERIVATION

Melting and boiling points depend heavily on the strength of binding forces, which in turn depend on the number of valence electrons available for bonding and the type of structure formed.

Solution:

- Moving left to right across a short period, the number of valence electrons increases from Group IA to IVA. This increases metallic/covalent binding strength, so melting/boiling points **increase**.
- Carbon/Silicon in Group IVA form giant covalent structures, reaching the maximum melting point.
- From Group VA onwards, elements form small discrete molecules (like N_2 , O_2 , Cl_2) held together only by weak London dispersion forces, causing the melting/boiling points to sharply **decrease**.

Why other options are incorrect:

- The trend is not gradual or strictly one-directional; it is a curve that peaks at Group IVA.

Question #97 Key: (B)

MDCAT 2012

*Which one remains same along a period? [MDCAT (2012)]***CORE CONCEPT AND DERIVATION**

A period in the periodic table represents the principal quantum number (n), which corresponds to the outermost electron shell being filled.

Solution:

- As we move from left to right across a period, electrons are added to the **same** principal shell.
- Therefore, the total number of electron shells (orbits) remains constant across a specific period.

Why other options are incorrect:

- Atomic radius:** Decreases across a period due to increasing effective nuclear charge.
- Melting point:** Increases up to Group IVA, then decreases.
- Electrical conductivity:** Decreases as elements transition from metals to non-metals.

Question #98 Key: (B)

MDCAT 2012

*More the ionization energy of an element [MDCAT (2012)]***CORE CONCEPT AND DERIVATION**

Ionization Energy (IE) is an index of metallic character. Metallic character is the tendency of an atom to lose electrons.

Solution:

- If an element has a high ionization energy, it strongly holds onto its valence electrons and resists losing them.
- Since metallic character is defined by the ease of losing electrons, a high IE means the element has a very low tendency to lose electrons.
- Therefore, Ionization Energy is inversely proportional to metallic character.

Why other options are incorrect:

- Option A & C:** High IE means less electropositivity and less reducing power, because both require the atom to lose electrons easily.
- Option D:** High IE is associated with a smaller, not bigger, atomic radius (stronger nuclear pull).

Question #99 Key: (A)

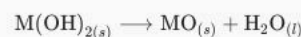
MDCAT 2012

*Alkaline earth metal hydroxides decompose on heating. Which of the following reactions is a correct representa...***CORE CONCEPT AND DERIVATION**

Alkaline earth metals (Group II-A) have a valency of +2. Their hydroxides have the general formula $M(OH)_2$.

Solution:

- When subjected to thermal decomposition, Group II-A hydroxides break down to yield their corresponding solid metal oxide and liquid/gaseous water.
- The balanced general chemical equation is:



- For example, Magnesium hydroxide decomposes as:
 $Mg(OH)_{2(s)} \longrightarrow MgO_{(s)} + H_2O_{(l)}$

Why other options are incorrect:

- Options B, C, & D:** These options incorrectly utilize the formula MOH, which is the general formula for Group I-A (Alkali metal) hydroxides, not Alkaline earth metals. Furthermore, the products listed in B and D are chemically incorrect for this standard thermal decomposition.

Question #100 Key: (D)

MDCAT 2011

*The elements for which the value of ionization energy is low can [MDCAT (2011)]***CORE CONCEPT AND DERIVATION**

Ionization energy (IE) is the energy required to remove an electron from an atom. Elements with a low IE require very little energy to remove their valence electrons.

Solution:

- Metals (like alkali and alkaline earth metals) have low ionization energies and large atomic radii.
- Because the nucleus has a weak hold on the outermost electrons, these elements lose electrons very easily (readily) to form cations.

Why other options are incorrect:

- Option A & B:** Low IE elements are typically metals, which tend to lose, not gain, electrons.
- Option C:** A high IE would mean they lose electrons less readily. A low IE means they lose them easily.

Question #101 Key: (D)

MDCAT 2011

The diagram below is a plot of melting points of elements of second period against their atomic numbers. Lithi...

CORE CONCEPT AND DERIVATION

Along a short period (like the second period), the melting point of elements increases up to Group IVA (Group 14) and then steeply decreases.

Solution:

- Carbon is in Group IVA. Elements in this group form giant covalent network structures (like diamond), which require a massive amount of energy to break.
- Therefore, Carbon has the highest melting point in the second period.
- Looking at the plot, position 3 represents the highest peak on the graph, which corresponds to Carbon.

Why other options are incorrect:

- Options 1, 2, and 4 represent elements with lower melting points (such as Beryllium, Boron, or Nitrogen/Oxygen) which do not form giant covalent lattices as strong as Carbon.

Question #102 Key: (C)

MDCAT 2011

When the elements of group II-A are exposed to air, they quickly become coated with layer of oxide. What is th...

CORE CONCEPT AND DERIVATION

Certain metals form a non-porous, highly stable metal oxide layer on their surface when exposed to atmospheric oxygen. This process is known as passivation.

Solution:

- Group II-A elements (like Beryllium and Magnesium) are reactive and quickly form an oxide layer (e.g., BeO, MgO) upon exposure to air.
- This stable, impermeable oxide layer adheres tightly to the metal surface.
- It acts as a physical barrier, effectively **protecting the underlying unreacted metal** from further oxidation or chemical attack.

Why other options are incorrect:

- Option A & B:** The layer restricts, rather than exposes or increases, reactivity with the atmosphere.
- Option D:** A layer definitively forms due to the high reactivity of these alkaline earth metals with oxygen.

Question #103 Key: (C)

MDCAT 2010

Energy required to remove an electron from gaseous neutral atom is: [MDCAT (2010)]

CORE CONCEPT AND DERIVATION

The minimum amount of energy required to remove the outermost shell electron from an isolated gaseous atom to form an isolated gaseous ion is called Ionization Energy.

Solution:

- The definition provided in the question stem exactly matches the standard definition of Ionization Energy (IE).

Why other options are incorrect:

- Electron affinity:** This is the energy released or absorbed when an electron is **added** to a neutral gaseous atom.
- Lattice energy:** This is the energy required to completely separate one mole of a solid ionic compound into gaseous ions.

Question #104 Key: (D)

MDCAT 2010

The strongest acid among the following is: [MDCAT (2010)]

CORE CONCEPT AND DERIVATION

The acidic strength of hydrogen halides (HX) depends primarily on the bond dissociation energy of the H-X bond. The weaker the bond, the easier it is for the molecule to donate a proton (H^+) in solution.

Solution:

- As we move down the halogen group (from F to I), the atomic size of the halogen increases significantly.
- The larger size of Iodine means the H-I bond length is the longest, making it the weakest bond among the hydrogen halides.
- Because it has the least bond energy, HI dissociates most readily in water to yield H^+ ions.
- Therefore, the decreasing order of acidic strength is: **HI > HBr > HCl > HF**.

Why other options are incorrect:

- Option A (HF):** Although Fluorine is the most electronegative, the H-F bond is extremely short and strong, plus HF forms strong intermolecular hydrogen bonds. This prevents it from fully dissociating, making it a weak acid in water.