2. ION TRENDS IN PERIODIC TABLE & FORMULA
SOLUTIONS

TEACHING TASK

JEE MAINS LEVEL QUESTIONS

1.An element with atomic number 19 forms a monovalent ion. What is its charge?
A) +1 B) -1 C) +2 D) -2
Solution:Atomic number 19 corresponds to potassium (K).
Potassium is an alkali metal (Group 1) with 1 valence electron.
To achieve stability, it loses 1 electron, forming a monovalent cation (K^+) with a +1 charge.
Answer:A

2.The electron configuration of a tripositive ion (X^{3+}) is 2, 8. What is the atomic number of X?
A) 11 B) 13 C) 15 D) 17
Solution:Given:
The tripositive ion (X^{3+}) has an electron configuration of 2, 8 (total of 10 electrons).
Since the ion has a +3 charge, it means the neutral atom lost 3 electrons.
Steps:Electrons in neutral atom (X):
The ion has 10 electrons (2 + 8).
Since it lost 3 electrons, the neutral atom must have had:
Electrons in neutral atom = 10 + 3 = 13]
Atomic number (Z):
In a neutral atom, the number of electrons equals the number of protons, which is the atomic number (Z).
Therefore, the atomic number of X is 13.
Identify the element:
The element with atomic number 13 is aluminum (Al).
Aluminum typically forms a +3 ion (Al^{3+}) by losing 3 electrons, matching the given configuration (2, 8).
Answer:B

3.Which element forms a dipositive ion with the same electron configuration as neon?
A) Lithium (Li) B) Magnesium (Mg) C) Aluminum (Al) D) Sulfur (S)
Solution:Explanation:
Neon's electron configuration:
Neon (Ne, atomic number 10) has the electron configuration 2, 8 (a stable octet).
Dipositive ion (X^{2+}) with the same configuration as Ne:
A +2 ion means the neutral atom lost 2 electrons.
To match Ne's configuration (2, 8), the ion must have 10 electrons.
Therefore, the neutral atom must have had:
Electrons in neutral atom} = 10 + 2 = 12
The element with atomic number 12 is magnesium (Mg).
Answer:B

4.The symbol Sn^{2+} represents a:
A) Monovalent tin ion B) Divalent tin ion
C) Trivalent lead ion D) Tetravalent antimony ion
Solution:Symbol Interpretation:
Sn is the chemical symbol for tin (from its Latin name Stannum).
The $^{2+}$ superscript indicates a +2 charge, meaning the ion has lost 2 electrons.
Terminology:
A divalent ion is one with a +2 or -2 charge.
Since Sn^{2+} has a +2 charge, it is correctly called a divalent tin ion.
Answer:B
5.A trinegative ion has 10 electrons. What is the atomic number of its parent atom?
A) 7 B) 9 C) 13 D) 15
Solution:Given:
A trinegative ion (X^{3-}) has 10 electrons.
The -3 charge indicates the atom gained 3 electrons to form this ion.
Steps:Electrons in neutral atom (X):
The ion has 10 electrons.
Since it gained 3 electrons, the neutral atom must have had:
Electrons in neutral atom = 10 - 3 = 7
Atomic number (Z):
In a neutral atom, the number of electrons equals the number of protons (atomic number).
Therefore, the atomic number of the parent atom is 7.
Identify the element:
The element with atomic number 7 is nitrogen (N).
Nitrogen commonly forms a N^{3-} ion (though this is rare; it's more stable when forming covalent compounds).
Answer:A
6.Which compound contains a divalent electropositive ion and a monovalent electronegative ion?
A) NaCl B) $MgCl_2$ C) $AlCl_3$ D) K_2O
Solution:Divalent electropositive ion: A +2 charged metal ion (loses 2 electrons).
Monovalent electronegative ion: A -1 charged non-metal ion (gains 1 electron).
Magnesium (Mg) loses 2 electrons to form $Mg^{2?}$ (divalent).
Chlorine (Cl) gains 1 electron to form Cl? (monovalent).
The compound $MgCl_2$ balances charges:

$$Mg^{2+} + 2Cl^- \rightarrow MgCl_2$$

Answer:B
7.The formula of aluminum sulfate is $Al_2(SO_4)_3$. What is the charge on the sulfate ion (SO_4)?
A) 1- B) 2- C) 3- D) 4-
Solution: Identify the charge on aluminum (Al)
Aluminum (Al) is in Group 13 and forms a +3 ion (Al^{3+}).
Step 2: Balance the charges in $Al_2(SO_4)_3$
The formula shows 2 Al^{3+} ions and 3 SO_4 ions.
Total positive charge from aluminum:

[2 (+3) = +6]
Total negative charge from sulfate ions must balance this:
[3 {Charge on SO4} = -6]
Therefore, the charge on one sulfate ion (SO4) is:-6/3 = -2
Answer:B
8.An element X forms a tripositive ion with 18 electrons. Identify X.
A) Iron (Fe) B) Chromium (Cr) C) Scandium (Sc) D) Gallium (Ga)
Solution:Given:
Tripositive ion (X^{3+}) has 18 electrons.
Since the ion has a +3 charge, the neutral atom lost 3 electrons.
Step 1: Determine the atomic number (Z) of X
The ion has 18 electrons.
The neutral atom originally had:Electrons in neutral atom= 18 + 3 = 21
Therefore, the atomic number (Z) of X is 21.
The element with atomic number 21 is scandium (Sc).
Answer:C
9.Which of the following is a trivalent anion?
A) Nitride (N^{3-}) B) Oxide (O^{2-}) C) Fluoride (F^{-}) D) Chloride (Cl^{-})
Solution:Trivalent anion means an ion with a -3 charge, formed by gaining 3 electrons.
Nitrogen (N) has 5 valence electrons and gains 3 electrons to achieve a stable octet, forming the nitride ion (N^{3-}).
Answer:A
10.The formula of ferric oxide is Fe_2O_3. What is the charge on the iron ion in this compound?
A) +1 B) +2 C) +3 D) +4
Solution:Oxygen (O) in compounds typically has a -2 oxidation state

$$Fe_2O_3$$
$$2Fe + 3(-2) = 0$$
$$2Fe = 6$$
$$Fe = 6/2 = 3$$

Answer:C
11.A metal M forms a chloride with the formula MCl_3. What is the formula of its phosphate?
A) $M_3(PO_4)_2$ B) MPO_4 C) $M_2(PO_4)_3$ D) M_3PO_4
Solution:To determine the formula of the phosphate of metal M, let's analyze the given information step-by-step:
Step 1: Determine the valency of metal M from its chloride formula ($MCl_{3)}$
Chlorine (Cl) has a -1 valency (as chloride ion, Cl^{-}).
The formula MCl_3 is neutral, so the total negative charge from Cl^{-} is:[3 (-1) = -3]
To balance this, the metal ion M must have a +3 valency (M^{3+}).
Step 2: Determine the formula of the phosphate compound
The phosphate ion ($PO4^{3-}$) has a -3 valency (standard for phosphate).
Since $M^{3+}$and $PO4^{3-}$ have equal but opposite charges, they combine in a 1:1 ratio to form a neutral compound.

Step 3: Write the formula
The formula is simply MPO_4, as one M^{3+} balances one $PO4^{3-}$.
Solution:B
12.If the formula of a metal carbonate is $M_2(CO_3)_3$, what is the formula of its nitrate?
A) MNO_3 B) $M(NO_3)_2$ C) $M(NO_3)_3$ D) $M_2(NO_3)_3$
Solution:Step 1: Determine the valency of metal M from its carbonate formula ($M_2(CO_3)_3$)
The carbonate ion ($CO3^{2-}$) has a -2 valency.
The formula M2(CO3)3 contains 3 carbonate ions, contributing a total negative charge of:3 (-2) = -6
To balance this, the 2 metal ions (M) must provide a total positive charge of +6, meaning each M has a +3 valency (M^{3+}).
Step 2: Determine the formula of the nitrate compound
The nitrate ion (NO_3^-) has a -1 valency.
Since M^{3+} needs to balance three NO_3^- ions to achieve neutrality, the formula is:

$$M^{3+} + 3NO_3^- \rightarrow M(NO_3)_3$$

Step 3: Verify the formula
$M(NO_3)_3$ ensures charge balance:
(+3) + 3 (-1) = 0
Answer:C
13.An element exhibits variable valency of +2 and +3. Its sulfate in the +2 state is MSO_4. What is the formula of its oxide in the +3 state?
A) MO B) M_2O_3 C) MO_2 D) M_3O_4
Solution:Given:
The element M has variable valency: +2 and +3.
In the +2 state, its sulfate is MSO_4 (consistent with M^{2+} and $SO4^{2-}$).
Step 1: Determine the formula of the oxide in the +3 state
Oxygen (O) has a -2 valency (as oxide ion, O^{2-}).
In the +3 state, the ion is M^{3+}.
To balance the charges:
M^{3+} requires O^{2-} in a ratio that makes the compound neutral.
The least common multiple of +3 and -2 is 6, so: $2M^{3+} + 3O^{2-} \rightarrow M_2O_3$
Step 2: Verify the formula
M_2O_3 is neutral because:
(2 (+3) + 3 (-2) = 6 - 6 = 0
Answer:B
14.The formula of potassium dichromate is $K_2Cr_2O_7$. What is the charge on the dichromate ion (Cr_2O_7)?
A) 1- B) 2- C) 3- D) 4-
Solution:Identify the charge on potassium (K)
Potassium (K) is an alkali metal (Group 1) and forms a +1 ion (K^+).
Step 2: Balance the charges in $K_2Cr_2O_7$
The formula contains 2 K^+ ions, contributing a total positive charge of:[2 (+1) = +2]
The dichromate ion (Cr_2O_7) must balance this with an equal negative charge.
Therefore, the charge on (Cr_2O_7) is -2.
Answer:B

15.A compound has the formula $X(H_2PO_4)_2$. What is the formula of its sulfite?
A) XSO_3 B) X_2SO_3 C) $X(SO_3)_2$ D) $X_3(SO_3)_2$
Solution:Step 1: Determine the valency of X from$X(H_2PO_4)_2$
The dihydrogen phosphate ion $H_2PO_4^{-1}$ has a -1 charge.
Since there are two $H_2PO_4^{-1}$ ions in the compound, the total negative charge is:
2 (-1) = -2
To balance this, X must have a +2 valency (X^{2+}).
Step 2: Determine the formula of the sulfite
The sulfite ion (SO_3^{2-}) has a -2 charge.
Since X^{2+} and SO_3^{2-} have equal but opposite charges, they combine in a 1:1 ratio to form a neutral compound.
Step 3: Write the formula
The formula is XSO_3, where one X^{2+} balances one SO_3^{2-}.
Answer:A

JEE ADVANCED LEVEL QUESTIONS

Multi correct answer type:

1. Which of the following statements about ions are correct?
A) Cations are formed by loss of electrons
B) Anions are smaller than their parent atoms
C) Na^+has the same number of electrons as Ne
D) Cl^- has more protons than Cl atom
Solution:A) Cations are formed by loss of electrons (Correct)
Cations are positively charged ions formed when an atom loses electrons.
Example: $Na \rightarrow Na^+ + e^-$
B) Anions are smaller than their parent atoms (Incorrect)
Anions are larger than their parent atoms because extra electrons increase electron-electron repulsion, expanding the electron cloud.
Example: Cl (smaller) $\rightarrow$ Cl? (larger).
C) Na^+ has the same number of electrons as Ne (Correct)
Na (11 electrons) $\rightarrow$ Na^+ (loses 1 electron $\rightarrow$ 10 electrons).
Neon (Ne) also has 10 electrons. Thus, Na^+ is isoelectronic with Ne.
D) Cl^- has more protons than Cl atom (InCorrect)
Cl^- has the same number of protons as a Cl atom (17 protons).
However, Cl^- has more electrons (18) than Cl (17).
Answer:A,C
2.Which of the following elements commonly exhibit variable valency?
A) Iron (Fe) B) Copper (Cu) C) Magnesium (Mg) D) Sulfur (S)
Solution:A) Iron (Fe) (Variable valency)
Shows +2 (ferrous) and +3 (ferric) states.
Examples:
$FeCl_2$ (Iron(II) chloride, Fe^{2+})
$FeCl_3$ (Iron(III) chloride, Fe^{3+})
B) Copper (Cu) (Variable valency)
Shows +1 (cuprous) and +2 (cupric) states.
Examples:Cu_2O (Copper(I) oxide, Cu^+)
CuO (Copper(II) oxide, Cu^{2+})

C) Magnesium (Mg) (Fixed valency)
Always forms +2 ions (e.g., $MgCl_2$, MgO).
D) Sulfur (S) (Mostly fixed valency in common compounds)
Typically forms -2 (sulfide, S^{2-}) or +6 (sulfate, SO_4^{2-}).
Though sulfur can show other states (e.g., +4 in SO_2), they are less common in stable compounds.
Answer:A,B
3. Identify correct chemical formulas:
A) Potassium permanganate - $KMnO_4$
B) Sodium thiosulfate - $Na_2S_2O_3$
C) Calcium phosphate - $Ca_3(PO_4)_2$
D) Ammonium dichromate - $(NH_4)_2CrO_4$
Solution:A) Potassium permanganate – $KMnO_4$ (Correct)
K^+ (potassium ion) + MnO_4^-(permanganate ion) $\rightarrow$ $KMnO_4$.
B) Sodium thiosulfate – $Na_2S_2O_3$ (Correct)
2 Na^+ (sodium ions) + $S_2O_3^{2-}$ (thiosulfate ion) $\rightarrow Na_2S_2O_3$.
Used in iodometric titrations and photography.
C) Calcium phosphate – $Ca_3(PO_4)_2$ (Correct)
3 Ca^{2+} (calcium ions) + 2 PO_4^{3-} (phosphate ions) $\rightarrow Ca_3(PO_4)_2$.
D) Ammonium dichromate – $(NH_4)_2CrO_4$ (Incorrect)
The correct formula is $(NH_4)_2Cr_2O_7$ (ammonium dichromate).
$(NH_4)_2CrO_4$ is ammonium chromate, a different compound.
Answer:A, B, C

Assertion and Reason Type:

A) Both Assertion and Reason are true, and Reason is the correct explanation for Assertion.
B) Both Assertion and Reason are true, but Reason is NOT the correct explanation for Assertion.
C) Assertion is true, but Reason is false.
D) Assertion is false, but Reason is true.

4.Assertion: Sodium (Na) forms a +1 ion (Na^+) by losing one electron.
Reason: Alkali metals in Group 1 lose one electron to achieve a noble gas configuration.
Solution:
Assertion (True):Sodium (Na, atomic number 11) forms a +1 ion (Na^+) by losing its single valence electron.
Example: $Na \rightarrow Na^+ + e^-$
Reason (True & Correct Explanation):
Sodium is an alkali metal (Group 1) with 1 valence electron.
By losing this electron, it achieves a stable noble gas configuration (neon, 2,8).
This explains why sodium forms a +1 ion.
Answer:A
5.Assertion: The sulfate ion (SO_4^{2-}) can form ionic compounds with both monovalent (e.g., Na^+) and divalent (e.g., Ca^{2+}) cations.
Reason: Polyatomic ions like SO_4^{2-} retain their charge regardless of the cation they combine with.

Solution:The sulfate ion ($SO4^{2-}$) forms ionic compounds with:
Monovalent cations (e.g., $Na^+ \rightarrow Na_2SO_4$).
Divalent cations (e.g., $Ca^{2+} \rightarrow CaSO_4$).
The formulas adjust to balance charges (e.g., 2 Na^+ for1 $SO4^{2-}$, but 1 Ca^{2+} for 1 $SO4^{2-}$).
Reason (True & Correct Explanation):
Polyatomic ions (like $SO4^{2-}$) retain their fixed charge regardless of the cation.
This allows them to combine with cations of different valencies while maintaining charge neutrality.
Answer:A
6.Assertion: Transition metals like iron (Fe) can form both Fe^{2+} and Fe^{3+} ions.
Reason: Transition metals exhibit variable valency due to the involvement of electrons from both the outermost and penultimate shells.
Solution:Assertion (True):
Transition metals like iron (Fe) commonly form multiple ions (e.g., Fe^{2+} and Fe^{3+}).
Examples:$FeCl_2$ (Iron(II) chloride, Fe^{2+})
$FeCl_3$ (Iron(III) chloride, Fe^{3+})
Reason (True & Correct Explanation):
Transition metals exhibit variable valency because:
They can lose electrons from both the outermost and penultimate (d-subshell) shells.
The small energy difference between 4s and 3d orbitals allows multiple oxidation states.
For iron:Fe^{2+}: Loses two 4s electrons $\rightarrow$ [Ar] 3d6.
Fe^{3+}: Loses two 4s and one 3d electron $\rightarrow$ [Ar] 3d5.
Answer:A

Statement Type:

7.Solution:Statement I (Correct):
Sodium (Na) forms a +1 ion (Na^+) by losing its single valence electron.
Statement II (Correct & Explanation):
Sodium (Group 1) has 1 valence electron (configuration: 2,8,1).
By losing this electron, it achieves a stable octet configuration (2,8, like neon).
This explains why sodium forms a +1 ion.
Answer:1
8.Solution:Statement I (Correct):The carbonate ion (CO_3^{2-}) forms compounds with:
Monovalent cations (e.g., $Na^+ \rightarrow Na_2CO_3$).
Divalent cations (e.g., $Ca^{2+} \rightarrow CaCO_3$).
The formulas adjust to balance charges (e.g., 2 Na^+ for 1 CO_3^{2-}, but 1 Ca^{2+} for 1 $CO3^{2-}$).
Statement II (Correct & Explanation):
Polyatomic ions (like CO_3^{2-}) behave as single charged units in reactions.
Their fixed charge allows them to combine with cations of different valencies while maintaining charge neutrality.
Answer:1
9.Statement I (Correct):$FeCl_3$ is correctly named iron(III) chloride because the iron ion has a +3 oxidation state in this compound.
Statement II (Correct & Explanation):Roman numerals in transition metal compound names indicate the oxidation state of the metal ion.
This explains why we use (III) in iron(III) chloride - it specifies Fe^{3+} as opposed to Fe^{2+}

(which would be iron(II) chloride).
Answer:1

Comprehension Type:

Comprehension - I

10.What determines the positive valency of an atom?
a) Number of electrons gained b) Number of protons lost
c) Number of electrons lost d) Number of neutrons lost
Solution:Positive valency is determined by how many electrons an atom loses to form a cation.
Answer:C
11.Which of the following is NOT an example of an electropositive ion?
a) Na^+ b) Cl^- c) Ca^{2+} d) Al^{3+}
Solution: Cl^- is a chloride ion (an anion), not an electropositive ion. Na^+ , Ca^{2+} , and Al^{3+} are cations.
Answer:b
12.What is another name for an electropositive ion?
a) Anion b) Cation c) Neutral atom d) Molecule
Solution:Electropositive ions are positively charged and are called cations.
Answer:b
13.Why do atoms form electropositive ions?
a) To gain more protons b) To achieve stability
c) To increase their neutron count d) To become negatively charged
Solution:Atoms lose electrons to attain a stable electron configuration (usually an octet).
Answer:b

Comprehension - II

14. Which of the following elements always shows the same valency in its compounds?
a) Iron (Fe) b) Copper (Cu) c) Sodium (Na) d) Lead (Pb)
Solution:Sodium (Na) is an alkali metal (Group 1) and always shows a valency of +1 in all its compounds
Answer:c
15. What is variable valency?
a) The ability of an element to gain different numbers of electrons
b) The ability of an element to lose different numbers of electrons, forming ions with different charges
c) The ability of an element to change its atomic number
d) The ability of an element to form only one type of ion
Solution:Variable valency refers to an element's capacity to form ions with different charges by losing varying numbers of electrons
Answer:b
16. Which of the following is an example of a metal that exhibits variable valency?
a) Magnesium (Mg)
b) Calcium (Ca)
c) Iron (Fe)

d) Aluminum (Al)

Solution:Iron shows variable valency (+2 in FeCl2, +3 in FeCl3). Other options (Mg, Ca, Al) have fixed valencies.

Answer:C

17. Why do some metals show variable valency?

a) Because they can lose electrons from different energy levels

b) Because they can gain protons from other atoms

c) Because they always form the same ion in every compound

d) Because they are nonmetals

Solution:Transition metals like iron can lose electrons from both outer and inner (d) subshells, enabling multiple oxidation states.

Answer:a

Integer type:

18. Charge on magnesium ion: _____

Solution:Magnesium (Mg) is in Group 2 of the periodic table and has 2 valence electrons.

To achieve a stable octet (like neon), it loses 2 electrons, forming the Mg^{2+} ion.

Answer:2

19. Valency of chromate ion (CrO_4^{2-}): _____

Solution:Chromate ion formula: $CrO4^{2-}$

The superscript "2–" indicates its valency

Answer:-2

20. Net charge on trioxalatoaluminate(III) ion $[Al(C_2O_4)_3]^{3-}$ _____

Solution:The Roman numeral (III) confirms aluminum's +3 oxidation state.

The 3– net charge balances the contributions from Al^{3+} and the three oxalate ligands.

Answer:-3

Matrix Matching Type:

21. **Column-I (Compound Names)** **Column-II (Chemical Formulas)**

A) Ferrous sulfate — 1) $K_2Cr_2O_7$

B) Potassium dichromate — 2) $FeSO_4$

C) Ammonium hydroxide — 3) $Na_2[Fe(CN)_5NO]$

D) Sodium nitroprusside — 4) NH_4OH

E) Cuprous oxide — 5) Cu_2O

Solution:

A) Ferrous sulfate → 2) $FeSO_4$

B) Potassium dichromate → 1) $K_2Cr_2O_7$

C) Ammonium hydroxide → 4) NH_4OH

D) Sodium nitroprusside → 3) $Na_2[Fe(CN)_5NO]$

E) Cuprous oxide → 5) Cu_2O

Answer:A-2 ,B- 1 ,C-4 ,D-3

LEARNERS TASK

CONCEPTUAL UNDERSTANDING QUESTIONS (CUQ's)

1.Which group in the periodic table contains elements that typically form divalent electropositive ions?
A) Group 1 B) Group 2 C) Group 16 D) Group 17
Solution:Group 2 elements (Alkaline Earth Metals):
Include beryllium (Be), magnesium (Mg), calcium (Ca), strontium (Sr), barium (Ba), and radium (Ra).
Have 2 valence electrons and lose both to form divalent cations (M^{2+}).
Answer:B
2.How many electrons are present in a hydroxide ion (OH^-)?
A) 9 B) 10 C) 11 D) 12
Solution:Neutral Oxygen (O) Atom:
Atomic number = 8 $\rightarrow$8 protons + 8 electrons.
Neutral Hydrogen (H) Atom:
Atomic number = 1 $\rightarrow$ 1 proton + 1 electron.
Total Electrons in Neutral OH Group:
8 (O) + 1 (H) = 9 electrons
Hydroxide Ion (OH^-):
Gains 1 extra electron (hence the −1 charge).
Total electrons =
9 {neutral OH} + 1{extra} = 10electrons
Answer:B
3.Which of the following ions is not dipositive?
A) Zn^{2+} B) Cu^{2+} C) Fe^{3+} D) Ca^{2+}
Solution:Fe^{3+} is tripositive, while the others (Zn^{2+}, Cu^{2+}, Ca^{2+}) are dipositive.
Answer:C
4.Which element, when forming a tripositive ion, would have the same electron configuration as argon?
A) Scandium (Sc) B) Aluminum (Al) C) Phosphorus (P) D) Iron (Fe)
Solution:Argon's Electron Configuration:
Argon (Ar, atomic number 18) has the stable configuration:
[1s^2 2s^2 2p^6 3s^2 3p^6]
Tripositive Ion (X^{3+}) Matching Argon's Configuration:
The ion must have 18 electrons (like Ar).
For a +3 ion, the neutral atom must have:
Atomic number = 18electrons in ion + 3 lost = 21
The question likely expects scandium (Sc, Z=21), which loses 3 electrons to form Sc^{3+} with 18 electrons (same as Ar).
Answer:A
5.The tripositive ion formed by chromium (Cr) has how many electrons?
A) 21 B) 22 C) 23 D) 24

Solution:Chromium (Cr) has an atomic number of 24 (24 protons and 24 electrons in its neutral state).
A tripositive ion (Cr^{3+}) means chromium loses 3 electrons.
For Cr^{3+},24-3=21
Answer:A
6.Which of the following does not have a valency of 1?
A) Fluoride ion B) Sodium ion C) Nitrate ion D) Oxide ion
Solution:The oxide ion's -2 valency distinguishes it from the others.
Answer:D
7.Which of the following are tetravalent?
A) Carbonate ion B) Silicate ion C) Nitride ion D) Sulfate ion
Solution:Silicate (SiO_4^{4-}) is the only option where the central atom (Si) forms 4 bonds and the ion carries a -4 charge.
Answer:B
8.Number of electrons lost by aluminum to form Al^{3+} is:
A) 1 B) 2 C) 3 D) 4
Solution:Aluminum (Group 13) always loses 3 electrons to achieve stability, forming Al^{3+}
Answer:C
9.SO_4^{2-} is:
A) Sulfite ion B) Sulfide ion C) Sulfate ion D) Thiosulfate ion
Solution:SO_4^{2-} is the sulfate ion
Answer:C
10.Valency of lead in PbO and PbO_2 is:
A) 2,4 B) 4,2 C) 3,4 D) 2,3
Solution:

$$PbO$$
$$Pb+(-2)=0$$
$$Pb=2$$
$$PbO_2$$
$$Pb+2(-2)=0$$
$$Pb=+4$$

Answer:A
11.Valency of copper in Cu_2O and CuO is:
A) 1,2 B) 2,1 C) 2,3 D) 3,2

Solution:
$$Cu_2O$$
$$2Cu+(-2)=0 \Rightarrow Cu=2/2=1$$
$$PbO$$
$$Pb+(-2)=0$$
$$Pb=+2$$

Answer:A
12.In the criss-cross method, the charges on ions are used to determine:
A) The molar mass B) The number of atoms C) The oxidation state D) The bond type
Solution:The criss-cross method directly gives the empirical formula (atom ratio) of an ionic compound.
Answer:B
13.Which of the following ions has the same number of electrons as neon?
A) Na^+ B) Mg^{2+} C) F^- D) All of the above
Solution:Na^+,Mg^{2+}, F^- all are having 10 elctrons like Neon
Answer:D
14.The valency of phosphorus in PH_3 and PCl_5 is:
A) 3,5 B) 5,3 C) 2,3 D) 3,4
Solution:3 in PH_3 (covalent bonds with 3 H atoms).
5 in PCl_5 (expands its octet using 3d orbitals).
Answer:A
15.Which of the following elements can exhibit variable valency?
A) Sodium (Na) B) Iron (Fe) C) Calcium (Ca) D) Neon (Ne)
Solution:Transition metals (like Fe) commonly show variable valency due to their partially filled d-orbitals, allowing multiple oxidation states.
Answer:B

JEE MAINS LEVEL QUESTIONS

1.Which of the following is a characteristic of monovalent electropositive ions?
A) They tend to gain electrons
B) They form negative ions
C) They have a stable noble gas configuration
D) They lose one electron easily
Solution:Monovalent electropositive ions are Group 1 metals (alkali metals) that easily lose 1 valence electron to form +1 cations.
Answer:D
2.What is the chemical symbol for a dipositive ion formed by an element with atomic number 12?
A) O^{2-} B) Mg^{2+} C) N^{3-} D) H^+
Solution:Magnesium loses 2 valence electrons to form a Mg^{2+} ion
Answer:B
3.Which element is most likely to form a tripositive ion?
A) Oxygen (O) B) Boron (B) C) Iron (Fe) D) Chlorine (Cl)
Solution:The element most likely to form a tripositive ion is Boron (B), as it readily loses its 3 valence electrons to achieve stability.
Answer:B
4.Which element, when forming a monovalent positive ion, has the same electron configuration as neon?
A) Sodium (Na) B) Magnesium (Mg) C) Aluminum (Al) D) Potassium (K)
Solution:The only element that forms a monovalent positive ion (+1) with the same electron configuration as neon is Sodium (Na).
Answer:A

5.In which group of the periodic table are elements most likely to form tripositive ions?
A) Group 1 (Alkali metals) B) Group 2 (Alkaline earth metals)
C) Group 13 (Boron group) D) Group 17 (Halogens)
Solution:Elements in Group 13 (Boron group) are the most likely to form tripositive ions (3+) because they have 3 valence electrons that they can lose.
Answer:C
6.What is the charge on the electronegative ion formed by an element in Group 16?
A) 1- B) 2- C) 3- D) 4-
Solution:Group 16 elements form 2– ions when they gain electrons.
Answer:B
7.In the compound $Al_2(SO_4)_3$, what is the electropositive ion?
A) Aluminum (Al^{3+}) B) Sulfur (S) C) Oxygen (O^{2-}) D) None of these
Solution:In$Al_2(SO_4)_3$, the aluminum (Al) forms Al^{3+} ions because it loses 3 electrons to achieve stability.
Answer:A
8.The compound K_2CO_3 contains which electropositive ion?
A) Potassium (K^+) B) Carbon (C^{4+}) C) Oxygen (O^{2-}) D) None of these
Solution:In K_2CO_3(potassium carbonate), potassium (K) forms K^+ ions because it loses 1 electron to achieve stability (Group 1 elements typically form +1 ions).
Answer:A
9.An anion is usually:
A) Larger in size than its parent atom B) Smaller in size than its parent atom
C) The same size as its parent atom D) None of the above
Solution:An anion is a negatively charged ion formed when an atom gains electrons. When extra electrons are added, electron-electron repulsion increases, causing the electron cloud to expand.An anion is Larger in size than its parent atom .
Answer:A
10.Which compound does not contain a bivalent electronegative ion?
A) Calcium oxide (CaO) B) Sodium chloride (NaCl)
C) Magnesium sulfide (MgS) D) Barium sulfate ($BaSO_4$)
Solution:Bivalent electronegative ions are negatively charged ions (anions) with a 2– charge.
Let's analyze the compounds:
A) Calcium oxide (CaO) → Contains O^{2-} (oxide ion), which is bivalent (2–).
B) Sodium chloride (NaCl) → Contains Cl^- (chloride ion), which is monovalent (1–). This does NOT have a bivalent ion.
C) Magnesium sulfide (MgS) →Contains S^{2-} (sulfide ion), which is bivalent (2–).
D) Barium sulfate ($BaSO_4$) → Contains SO_4^{2-} (sulfate ion), a polyatomic bivalent ion (2–).
Only NaCl does not contain a bivalent electronegative ion.
Answer:B
11.Which of the following has the highest negative valency?
A) Nitride (N^{3-}) B) Phosphate (PO_4^{3-}) C) Sulfate (SO_4^{2-}) D) Carbonate (CO_3^{2-})
Solution:Here are the valencies of the given ions:
A) Nitride (N^{3-}) → -3 valency
B) Phosphate ($PO4^{3-}$) →-3 valency

C) Sulfate (SO_4^{2-}) → -2 valency
D) Carbonate (CO_3^{2-}) → -2 valency
Comparison:
Both Nitride (N^{3-}) and Phosphate (PO_4^{3-}) have a -3 valency, which is higher (more negative) than the -2 valency of Sulfate and Carbonate.
A) Nitride (N^{3-}) and B) Phosphate ($PO4^{3-}$) are tied for the highest negative valency (-3). If only one option is to be selected, Nitride (N^3?) is typically considered the simpler ion with the highest negative valency.
Answer:A
12.Which of the following is not a monovalent electronegative ion?
A) Fluoride (F^-) B) Chloride (Cl^-) C) Oxide (O^{2-}) D) Bromide (Br^-)
Solution:Oxide (O^{2-}) is not monovalent because it has a -2 charge, unlike the others which are -1.
Answer:C
13Solution:(i) Aluminum nitrate-$Al(NO_3)_3$
(ii) Barium chloride- $BaCl_2$
(iii) Sodium phosphate-Na_3PO_4
Answer:C
14.The correct formula for a trivalent metal oxide is:
A) M_2O_3 B) MO_3 C) M_3O_2 D) MO
Solution:To determine the correct formula for a trivalent metal oxide, let's analyze the valencies and how they combine.
Trivalent Metal (M):
A trivalent metal has a +3 valency (M^{3+}).
Oxide (O):
Oxygen has a -2 valency (O^{2-}).
Formula Formation:
To balance the charges:
Metal (M^{3+}) × 2 = +6 total charge
Oxygen (O^{2-}) × 3 = -6 total charge
Thus, the formula is M_2O_3 (2 metal ions + 3 oxygen ions)
Answer:A
15.If the sulfate of a metal 'M' is written as $M_2(SO_4)_3$, then its chloride will be:
A) MCl B) MCl_2 C) MCl_3 D) MCl_4
Solution:The given sulfate is $M_2(SO_4)_3$.
Sulfate ion (SO_4^{2-}) has a 2- charge.
Metal ion M^{+3} has a3-charge
Chloride ion (Cl^-) has a 1- charge.
To balance M^{3+}, we need 3 chloride ions (Cl^-).
Thus, the formula for the chloride is:MCl_3.
Answer:C
16.The phosphate of a metal has the formula $M_3(PO_4)_2$. What is the valency of the metal?
A) +1 B) +2 C) +3 D) +4
Solution: Step 1: Identify the charge of the phosphate ion (PO_4)
The phosphate ion has a fixed valency of -3, written as $(PO_4)^{3-}$.
Step 2: Balance the charges in the compound $M_3(PO_4)_2$

The compound contains 2 phosphate ions, contributing a total negative charge of:(2 (-3) = -6).
To balance this, the 3 metal ions (M) must provide a total positive charge of +6.
Therefore, the charge per metal ion (M) is:6/3=+2
The metal 'M' has a valency of +2.
Answer:B

JEE ADVANCED LEVEL QUESTIONS

Multi correct answer type:

1.Which of the following statements is/are correct about electronegative ions?
A) Electronegative ions have more electrons than protons due to electron gain.
B) The size of an electronegative ion is smaller than its parent atom due to increased nuclear attraction.
C) The stability of an electronegative ion increases with higher effective nuclear charge (Zeff).
D) Halogens (Group 17) commonly form monovalent electronegative ions (e.g., F^-, Cl^-).
Solution:A) Correct→Electronegative ions (anions) form when an atom gains electrons, resulting in more electrons than protons.
Example: Cl (17 protons, 17 electrons) → Cl^- (17 protons, 18 electrons).
B) Incorrect→The size of an electronegative ion is larger than its parent atom because:
Added electrons increase electron-electron repulsion, expanding the electron cloud.
Example: Cl (99 pm) → Cl^- (181 pm).
C) Correct→Higher effective nuclear charge (Zeff) strengthens the attraction between the nucleus and gained electrons, stabilizing the anion.
Example: F^- is more stable than I^- because fluorine has higher Zeff.
D) Correct→Halogens (Group 17) readily gain 1 electron to form monovalent anions (e.g., F^-, Cl^-, Br^-, I^-).
Answer:A, C, D

2.The divalent electronegative ion commonly found in sulfate compounds is represented by:
A) SO_4^{2-} B) SO_3^{2-} C) $S_2O_3^{2-}$ D) SO_5^{2-}
Solution:SO_4^{2-} is the most stable and widely occurring divalent sulfate ion.
Answer:A

3.In which of the following compounds does the metal exhibit a valency of 2?
A) $FeCl_2$ B) CuO C) $SnCl_4$ D) Hg_2Cl_2
Solution:$FeCl_2$ (Iron(II)) and CuO (Copper(II)) contain metals with a valency of 2.
$SnCl_4$ has Sn(IV), and Hg_2Cl_2 has Hg(I), so they do not fit.
Answer:A,B

Assertion and Reason Type:

4. Assertion: Sodium chloride (NaCl) is a neutral compound.
Reason: The 1+ charge on sodium (Na^+) balances the 1- charge on chloride (Cl^-), resulting in a neutral compound
Solution:Assertion: "Sodium chloride (NaCl) is a neutral compound."
True. NaCl has no net charge because the charges of Na^+ and Cl^- balance each other.
Reason: The 1+ charge on sodium (Na^+) balances the 1- charge on chloride (Cl^-), resulting in a neutral compound.
True and Correct Explanation.
Na^+ (+1) and Cl^- (-1) combine in a 1:1 ratio, making NaCl electrically neutral.
Answer:A

5. Assertion: Magnesium oxide (MgO) has a 1:1 ratio of magnesium to oxygen.
Reason: Magnesium loses two electrons to form Mg^{2+}, while oxygen gains two electrons to form O^{2-}, balancing the charges.
Solution:Assertion: "Magnesium oxide (MgO) has a 1:1 ratio of magnesium to oxygen."
True. The chemical formula MgO confirms a 1:1 ratio of Mg to O.
Reason: "Magnesium loses two electrons to form Mg^{2+}, while oxygen gains two electrons to form O^{2-}, balancing the charges."
True and Correct Explanation.
Mg (Group 2) loses 2 electrons $\rightarrow$ Mg^{2+}
O (Group 16) gains 2 electrons $\rightarrow$ O^{2-}
The 2+ and 2- charges balance perfectly, resulting in a neutral compound with a 1:1 ratio.
Answer:A

6.Assertion: Iron(III) phosphate has the chemical formula $FePO_4$.
Reason: The 3+ charge on iron (Fe^{3+}) criss-crosses with the 3- charge on phosphate (PO_4^{3-}), resulting in a neutral compound.
Solution: Assertion: "Iron(III) phosphate has the chemical formula $FePO_4$."
True.
Iron(III) = Fe^{3+} (ferric ion).
Phosphate = PO_4^{3-}.
The charges 3+ and 3- cancel out, giving a 1:1 ratio ($FePO_4$).
Reason: *"The 3+ charge on iron (Fe^{3+}) criss-crosses with the 3- charge on phosphate (PO_4^{3-}), resulting in a neutral compound."*
True and Correct Explanation.
The criss-cross method swaps the charges of Fe^{3+} and PO_4^{3-} to subscripts, yielding $FePO_4$ (neutral).
No simplification is needed since the charges are equal.
Answer:A

Comprehension Type:

Comprehension-I

7.What is the primary reason for good electrical conductivity in solid metals?

A) Movement of electropositive ions B) Mobility of electrons

C) Presence of water molecules D) High density of the metal

Solution:In solid metals, electrons are delocalized (free to move) in a "sea of electrons" around positively charged metal ions.

When a voltage is applied, these mobile electrons carry current, making metals excellent conductors

Answer:B

Comprehension-II

8. Why do non-metallic elements commonly form anions?

A) Because they lose electrons easily

B) Due to their high electronegativity, which attracts electrons

C) Because they have low ionization energy

D) Due to their metallic character

Solution:Non-metals (e.g., oxygen, chlorine, sulfur) tend to gain electrons because they have high electronegativity (strong attraction for electrons).

By gaining electrons, they achieve a stable electron configuration (octet rule) and form anions (negatively charged ions).

Answer:B

Integer type:

9. The valency of the Chromium ion in $Cr_2O_7^{2-}$ is _____

Solution:

$2Cr + 7(-2) = -2$

$2Cr = -2 + 14$

$Cr = 12/2 = +6$

Answer:6

10. The most common valency exhibited by both Antimony (Sb) and Bismuth (Bi) in their stable compounds is _____

Solution:Group 15 Elements (Pnictogens):

Both Sb (Antimony) and Bi (Bismuth) belong to Group 15 (Nitrogen family).

Their electronic configuration ends with $ns^2\ np^3$, allowing them to exhibit +3 and +5 valencies.

Preferred Valency = +3 (Stability Trend):

Due to the "inert pair effect", the +3 oxidation state becomes more stable down the group (especially for Bi).

Bi almost exclusively forms +3 compounds (e.g., $BiCl_3$, Bi_2O_3).

Sb commonly shows +3 (e.g., $SbCl_3$, Sb_2O_3) but can also exhibit +5 (e.g., $SbCl_5$).

Why Not +5?

+5 requires losing all 5 valence electrons, which becomes energetically unfavorable for heavier elements like Sb and Bi due to poor shielding by inner d/f electrons.

While both +3 and +5 exist, +3 is more common and stable for Sb and Bi in most

compounds.
Answer: +3
11. Sulfur achieves stability by gaining _____ electrons to form a sulfide ion (S^{2-}), but can also show a valency of +4 in some compounds.
Solution:Sulfur achieves stability by gaining 2 electrons to form a sulfide ion (S^{2}?), but can also show a valency of +4 in some compounds.
Answer:2
12.How many molecules of aluminum sulfide (Al_2S_3) are formed when 3 volumes of aluminum react completely with 2 volumes of sulfur vapor?
Solution:Step 1: Write the Balanced Chemical Equation
The reaction between aluminum and sulfur forms aluminum sulfide:
$2Al + 3S \rightarrow Al_2S_3$
2 moles of Al react with 3 moles of S to produce 1 mole of Al_2S_3.
Step 2: Relate Volumes to Moles (Avogadro's Principle)
Gases at the same conditions have volumes proportional to their moles (Avogadro's Law).
Here, 3 volumes of Al = 3 moles of Al, and 2 volumes of S = 2 moles of S.
Step 3: Identify the Limiting Reagent
From the balanced equation, 2 moles Al require 3 moles S for complete reaction.
Given 3 moles Al, the required S =(3/2)(3) = 4.5moles.
But only 2 moles S are available $\rightarrow$Sulfur (S) is the limiting reagent.
Step 4: Calculate Moles of Al_2S_3 Formed
3 moles S produce 1 mole Al_2S_3 (from the equation).
Thus, 2 moles S produce:(2/3)(1) = 2/3moles of Al_2S_3
Step 5: Convert Moles to Molecules
1 mole = 6.022×10^{23} molecules (Avogadro's number).
2/3moles =$2/3 \times 6.022 \times 10^{23} = 4.015 \times 10^{23}$molecules
Answer:~4.02×10^{23} molecules of Al2S3.

Matrix Matching Type:

13. **Column- I** — **Column-II**

Compound Name	**Charges on Ions**
a. Ferric Oxide (Fe_2O_3)	1) +2, -1
b. Potassium Permanganate ($KMnO_4$)	2) +3, -2
c. Cuprous Chloride (CuCl)	3) +1, -1
d. Stannic Sulfide (SnS_2)	4) +4, -2

Solution:a. Ferric Oxide (Fe_2O_3)
Ferric (Fe^{3+}) = +3 (Iron in +3 oxidation state).
Oxide (O^{2-}) = -2.
Match: 2) +3, -2.
b. Potassium Permanganate ($KMnO_4$)
Potassium (K^{+}) = +1.
Permanganate (MnO_4^{-}) = -1 (polyatomic ion).
Match: 3) +1, -1.
c. Cuprous Chloride (CuCl)
Cuprous (Cu^{+}) = +1 (older name, but IUPAC prefers Copper(I)).

Chloride (Cl^-) = -1.
Correction: If the formula is CuCl, the charges are +1, -1, matching 3).
(Note: If the formula were CuCl2, it would be Cu^{2+} ,$2Cl^-$, matching 1) +2, -1.)
d. Stannic Sulfide (SnS_2)
Stannic (Sn^{4+}) = +4 (Tin in +4 oxidation state).
Sulfide (S^{2-}) = -2.
Match: 4) +4, -2.
Final Matching:
a → 2
b → 3
c → 3 (or 1 if formula is $CuCl_2$)
d → 4

KEY

TEACHING TASK									
JEE MAINS LEVEL QUESTIONS									
1	2	3	4	5	6	7	8	9	10
A	B	B	B	A	B	B	C	A	C
11	12	13	14	15					
B	C	B	B	A	JEE ADVANCED LEVEL QUESTIONS				
1	2	3	4	5	6	7	8	9	10
A,C	A,B	A,B,C	A	A	A	1	1	1	C
11	12	13	14	15	16	17	18	19	20
B	B	B	C	B	C	A	2	-2	-3
21									
A-2,B-1,C-4,D-3		LEARNERS TASK		(CUQ's)					
1	2	3	4	5	6	7	8	9	10
B	B	C	A	A	D	B	C	C	A
11	12	13	14	15					
A	B	D	A	B	JEE MAINS LEVEL QUESTIONS				
1	2	3	4	5	6	7	8	9	10
D	B	B	A	C	B	A	A	A	B
11	12	13	14	15	16				
A	C	C	A	C	B				
					JEE ADVANCED LEVEL QUESTIONS				
1	2	3	4	5	6	7	8	9	10
A,C,D	A	A,B	A	A	A	B	B	6	3
11	12		13	15	16				
2	4.02*10 23		a-2,b-3,c-3,d-4						

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