Exercise-1

Marked questions are recommended for Revision.

PART - I : SUBJECTIVE QUESTIONS

Section (A) : General facts about elements

A-1. Why do alkali metals form unipositive ions and impart characteristic colours to flame?

Section (B) : Based on Periodic trends

B-1. **(a)** Explain why is sodium less reactive than potassium?
(b) IE_1 value of Mg is more than that of Na while it's IE_2 value is less. Explain ?

B-2. Comment on the order of mobilities of the alkali metal ions in aqueous solution :
$Li^+ < Na^+ < K^+ < Rb^+ < Cs^+$.

Section (C) : Based on Chemical Bonding

C-1. Why is KO_2 paramagnetic ?

C-2. Draw the structure of $BeCl_2$ in solid and vapour state.

C-3. Explain why in anion of Na_2CO_3 all bond lengths are equal ?

C-4. Order of the ionic character of following :
$MgCl_2$, $MgBr_2$, MgI_2

C-5. Why $LiNO_3$ on heating shows exceptional behaviour than other elements of this group ?

C-6. Write the order of thermal stability of following :
$BeSO_4$, $MgSO_4$, $CaSO_4$, $SrSO_4$

C-7. Write the increasing order of basic strength of following :
NaOH, KOH, RbOH, CsOH

C-8. Although Ionisation potential of Li is very high, then why is it a good reducing agent ?

Section (D) : Properties of elements

D-1. Alkali metals are soft and can be cut with the help of a knife. Explain.

D-2. We know air mostly contains (O_2, N_2), What happen when group-I and group-II elements of s-block react with exess of air ?

Group-I Elements	+ O_2 (Major product)	+ N_2 (product)	Group-II Elements	+ O_2 (Major product)	+ N_2 (product)
Li	……	…….	Be	……	……
Na	……..…	…….	Mg	……	……
K	……..	…….	Ca	……	……
Rb	……..	…….	Sr	……	……
Cs	……	…….	Ba	……	……

D-3. What happens when sodium and calcium metal are dropped in water ?
(a) $Na + H_2O \longrightarrow$ (b) $Ca + H_2O \longrightarrow$

D-4. (i) $M + H_2SO_4 \longrightarrow$ ..... + ... (where M = group-I elements)
(ii) $M + HCl \longrightarrow$ ..... + ... (where M = group-II elements)

D-5. What happen when sodium metal is dissolved in liquid ammonia?

Section (E) : Oxides, Peroxides, Super Oxides, Hydroxides

E-1. Lithium forms monoxide, sodium gives peroxide while the rest of the alkali metals form superoxide mainly when treated with excess of air. Explain.

E-2. How NaOH is commercialy prepared ? Which cell is used ?

E-3. Write the method of perparation of Na_2O_2 & KO_2 and also give their hydrolysis product ?

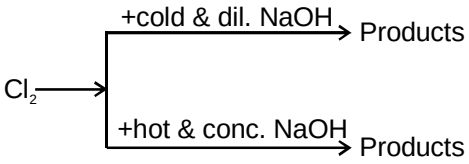
E-4. (a) $NaOH + HNO_3 \longrightarrow$ (b) $Li_2O + H_2SO_4 \longrightarrow$

(c) $Na_2O_2 + H_2SO_4$(dilute) $\xrightarrow{25^oC}$ (d) $CaO + HCl \longrightarrow$

E-5. $Ca(OH)_2$ (excess) $+ H_3PO_4 \longrightarrow$

E-6. $NaOH + Al_2O_3 \longrightarrow$

E-7.



E-8. P_4 (white) $+ NaOH + H_2O \longrightarrow$

Section (F) : Carbonates, Bicarbonates

F-1. The thermal stability order of following carbonates :
$BeCO_3$, $MgCO_3$, $CaCO_3$, $SrCO_3$, $BaCO_3$

F-2. Write chemical changes of solvay process.

F-3. $Na_2CO_3 + HCl$ (dil.) $\longrightarrow$

F-4. Write the products of the following reactions :

(a) $NaHCO_3 + H_2SO_4 \longrightarrow$ **(b)** $Na_2CO_3 + Ca(OH)_2 \longrightarrow$

(c) $NaHCO_3 + NaOH \longrightarrow$ **(d)** $2NaHCO_3 \xrightarrow[\text{Boil}]{\Delta}$

(e) $NaHCO_3 + CaCl_2 \xrightarrow{\text{room temperature}}$

Section (G) : Chlorides, Sulphates

G-1. Decreasing order of solubility in water of following sulphates :
$BeSO_4$, $MgSO_4$, $CaSO_4$, $SrSO_4$

G-2. How is $CaCl_2$ prepared ?

G-3. $CaSO_4.2H_2O \xrightarrow{120^oC,\ \Delta}$

G-4. How would you explain ?
(i) BeO is insoluble but $BeSO_4$ is soluble in water.
(ii) BaO is soluble but $BaSO_4$ is insoluble in water.

G-5. $NaOCl + HOH \longrightarrow$

G-6. $CaCl_2 + H_2SO_4$ (conc.) $\xrightarrow{\Delta}$

Section (H) : Miscellaneous (Hydrides, Carbides, Nitrates)

H-1. Write the thermal stability order of following :
LiH, NaH, KH, RbH, CsH

H-2. Write the products of the following reactions :

(a) $CaC_2 + H_2O \longrightarrow$ **(b)** $Mg_2C_3 + H_2O \longrightarrow$

H-3. **(i)** What happens when metal nitrate of s-block group-I (except Li) are heated ?

$2MNO_3 \xrightarrow{500^oC,\ \Delta}$ ..... + ...

(ii) What happens when any metal nitrate of s-block group-II is heated ?

$M(NO_3)_2 \xrightarrow{\Delta}$ ..... + ...+.....

H-4. (a) $Li_3N + H_2O \longrightarrow$ (b) $NaNH_2 + H_2O \longrightarrow$

PART - II : ONLY ONE OPTION CORRECT TYPE

Section (A) : General facts about elements

A-1. A chloride dissolves appreciably in cold water. When placed on a platinum wire in Bunsen flame, no distinctive colour is noticed. The cation of chloride is :
(A) Mg^{2+} (B) Ba^{2+} (C) Li^+ (D) Ca^{2+}

A-2. A fire work gave bright crimson red light. It probably contained a salt of :
(A) Ca (B) Sr (C) Ba (D) Mg

Section (B) : Based on Periodic trends

B-1. Be has, as compared to Mg :
(A) less electronegativity (B) more ionisation potential
(C) larger atomic radius (D) lower melting point

B-2. The first ionisation energies of alkaline earth metal are higher than those of the alkali metals. This is because :
(A) there is increase in the nuclear charge of the alkaline earth metal
(B) there is decrease in the nuclear charge of the alkaline earth metal
(C) there is no change in the nuclear charge
(D) none of these

Section (C) : Based on Chemical Bonding

C-1. Among LiCl, RbCl, $BeCl_2$ and $MgCl_2$ the compound with greatest and least ionic character respectively are :
(A) LiCl, RbCl (B) RbCl, $BeCl_2$ (C) RbCl, $MgCl_2$ (D) $MgCl_2$, $BeCl_2$

C-2. Which of the following carbonate of alkalimetal have highest thermal stability ?
(A) Li_2CO_3 (B) Na_2CO_3 (C) K_2CO_3 (D) Rb_2CO_3

C-3. Which of the following hydroxide of alkali metal have highest thermal stability ?
(A) LiOH (B) NaOH (C) RbOH (D) CsOH

C-4. Which of the following is the strongest base ?
(A) $Ca(OH)_2$ (B) $Sr(OH)_2$ (C) $Ba(OH)_2$ (D) $Mg(OH)_2$

C-5. Which is amphoteric ?
(A) Li_2O (B) BeO (C) BaO (D) Cs_2O

C-6. Alkali metals are :
(A) good reductant (B) good oxidant (C) Both of these (D) None of these

Section (D) : Properties of elements

D-1. The metallic lustre exhibited by sodium is explained by :
(A) diffusion of sodium ions (B) oscillation of mobile valence electrons
(C) existence of free protons (D) existence of body centered cubic lattice

D-2. Which of the following will appears silvery white ?
(A) Li (B) K (C) Na (D) All

D-3. Which of the following s-block metal does not react with water ?
(A) K (B) Na (C) Ca (D) Be

D-4. Which of the following option is correct for given reaction ?
$M + H_2SO_4 \longrightarrow$
(A) It reacts vigrously with acid if M is alkali metal.
(B) It reacts readily with acid if M is alkaline earth metal.
(C) metal sulphate and hydrogen gas will form after reaction.
(D) All are correct.

D-5. Be reacts with excess of caustic soda to form :
(A) $Be(OH)_2$ (B) BeO (C) $Na_2[Be(OH)_4]$ (D) $Be(OH)_2.BeCO_3$

Section (E) : Oxides, Peroxides, Super Oxides, Hydroxides

E-1. What is [X] in the following reaction ?
$MgCl_2.6H_2O \xrightarrow{\Delta}$ [X] + HCl + H_2O
(A) MgO (B) Mg (C) $Mg(OH)_2$ (D) Mg(OH)Cl.

E-2. When magnesium burns in air, compounds of magnesium formed are magnesium oxide and :
(A) Mg_3N_2 (B) $MgCO_3$ (C) $Mg(NO_3)_2$ (D) $Mg(NO_2)_2$

E-3. Which product will be formed after the reaction
KOH + O_3(Ozonised oxygen) $\xrightarrow{-10°C \text{ to } -15°C}$ Product (Orange solid)
(Dry powder)
(A) KO_2 (B) KO_3 (C) K_2O_3 (D) K_2O

E-4. Peroxide ion is present in :
(A) KO_2 (B) CaO (C) Li_2O (D) BaO_2

E-5. The compound that gives hydrogen peroxide on treatment with a dilute cold acid is :
(A) PbO_2 (B) Na_2O_2 (C) MnO_2 (D) SnO_2

E-6. Products of following reaction :
$NaOH + ZnO \longrightarrow$
(A) Na_2O, $Zn(OH)_2$ (B) Na_2ZnO_2, H_2O (C) Na_2O_2 , $Zn(OH)_2$ (D) None of these

E-7. The principal products obtained on heating iodine with concentrated caustic soda solution is :
(A) NaIO + NaI (B) NaIO + $NaIO_3$ (C) $NaIO_3$ + NaI (D) $NaIO_4$ + NaI

E-8. Products of the following reaction are :
$NaOH + S \longrightarrow$
(A) Na_2S, $Na_2S_2O_3$, H_2O (B) Na_2SO_4, H_2O (C) Na_2O_2, Na_2SO_4 (D) H_2S , Na_2SO_4

Section (F) : Carbonates, Bicarbonates

F-1. Which of the following can not decompose on heating to give CO_2 in a dry test tube ?
(A) Li_2CO_3 (B) Na_2CO_3 (C) $KHCO_3$ (D) $BeCO_3$

F-2. $2(Na_2CO_3.\ NaHCO_3.2H_2O) \xrightarrow{\text{heat}}$ Products.
Which of the following is not product of this reaction?
(A) Na_2CO_3 (B) CO_2 (C) H_2O (D) Na_2O

F-3. Sodium carbonate can be manufactured by Solvay's process but potassium carbonate cannot be prepared because:
(A) K_2CO_3 is more soluble (B) K_2CO_3 is less soluble
(C) $KHCO_3$ is more soluble than $NaHCO_3$ (D) $KHCO_3$ is less soluble than $NaHCO_3$

F-4. $CaCO_3 + HNO_3 \longrightarrow$ Products :
(A) $Ca(NO_3)_2$, H_2O, CO_2 (B) $Ca(NO_3)_2$, H_2CO_3
(C) Ca_3N_2, CO_2, H_2O (D) None of these

F-5. $CO_2 + NaOH \longrightarrow Na_2CO_3 + H_2O$
This reaction shows following nature of CO_2
(A) Acidic (B) basic (C) Neutral (D) Amphoteric

F-6. When SO_2 gas in excess is passed into an aqueous solution of Na_2CO_3 product formed is :
(A) $NaHSO_4$ (B) Na_2SO_4 (C) $NaHSO_3$ (D) All

Section (G) : Chlorides, Sulphates

G-1. Which of the following sulphate have highest thermal stability
(A) Li_2SO_4 (B) Na_2SO_4 (C) K_2SO_4 (D) $CsSO_4$

G-2. What product will be obtained when magnesite ($MgCO_3$) dissolve in hot dil. H_2SO_4 ?
(A) $MgSO_4$, H_2O, CO_2 (B) MgS, H_2O, CO_2
(C) $MgSO_4$, H_2CO_3 (D) MgS, H_2CO_3

G-3. $CaSO_4$ can be prepared by reaction of any calcium salt with ?
(A) Sulphuric acid (B) Soluble sulphate (C) Both (A) and (B) (D) None of these

G-4. Aqueous solution of NaCl is :
(A) Acidic (B) Basic (C) Neutral (D) None of these

G-5. Aqueous solution of $BeCl_2$ is:
(A) Acidic (B) Basic (C) Neutral (D) None of these

Section (H) : Miscellaneous (Hydrides, Carbides, Nitrates)

H-1. Which of the following is least stable
(A) BeH_2 (B) MgH_2 (C) CaH_2 (D) BaH_2

H-2. $Ca + H_2 \longrightarrow [X] \xrightarrow{+H_2O} [Y] + [Z]$
Total number of atom in one molecule or formula unit of [Y] & [Z] is ?
(A) 7 (B) 3 (C) 4 (D) 5

H-3. $Be_2C + H_2O \longrightarrow Be(OH)_2 + [X]$; "X" is :
(A) C_2H_2 (B) $CH_3–C\equiv CH$ (C) C_2H_6 (D) CH_4

H-4. At high temperature, nitrogen combines with CaC_2 to give :
(A) calcium cyanide (B) calcium cyanamide
(C) Calcium carbonate (D) calcium nitride

H-5. Compounds of alkaline earth metals are less soluble in water than the corresponding alkali metal salts due to :
(A) their high ionisation energy (B) their low electronegativity
(C) their low hydration energy (D) their high lattice energy

H-6. Bleaching powder turns Red litmus to blue and finally white, it is due to :
(A) OH^- (B) HCl (C) OCl^- (D) Cl^-

PART - III : MATCH THE COLUMN

1. Match the reactions listed in column-I with the characteristic(s) of the products listed in column-II.

	Column – I		**Column – II**
(A)	$Na_2O_2 \xrightarrow{\Delta}$	(p)	One of the products is diamagnetic.
(B)	$KO_2 \xrightarrow[\text{(ii) C } \Delta]{\text{(i) S } \Delta}$	(q)	One of the products acts as reducing agent.
(C)	$NaNO_3 \xrightarrow{800^oC}$	(r)	One of the products acts as oxidising agent.
(D)	$Ba(NO_3)_2 \xrightarrow[500^\circ C]{\Delta}$	(s)	One of the products is a basic oxide.

2. Match the compounds listed in column-I with the characteristic(s) listed in column-II.

	Column-I		**Column-II**
(A)	BeO (s)	(p)	Amphoteric in nature
(B)	$NaHCO_3$ (crystalline)	(q)	Imparts characteristic colour to Bunsen flame.
(C)	$BeCl_2$(s)	(r)	Produce H_2O_2 and O_2 on reaction with water.
(D)	CsO_2(s)	(s)	Show hydrogen bonding
		(t)	Has a chain structure

Exercise-2

✍ **Marked questions are recommended for Revision.**

PART - I : ONLY ONE OPTION CORRECT TYPE

1. The element having electronic configuration $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 4s^1$ will form :
(A) Acidic oxide (B) Basic oxide
(C) Amphoteric oxide (D) Netural oxide

2.✍ Beryllium has less negative value of reduction potentials compared to other alkaline earth metals due to:
(A) the smaller hydration energy of the Be^{2+} .
(B) the large value of the atomization enthalpy of the Be metal.
(C) the large value of ionisation energy of the Be metal.
(D) (B) and (C) both.

3.✍ The incorrect statement is :
(A) Be^{2+} cation has largest hydration enthalpy among the alkaline earth metals.
(B) The second ionisation enthalpies of alkalilne earth metals are smaller than those of the corresponding alkali metals.
(C) Li is the strongest reducing agent among all the elements.
(D) Both LiCl and $MgCl_2$ are most covalent in their groups.

4. Select the correct statement with respect to alkali metals.
(A) Melting point decrease with increasing atomic number.
(B) Potassium is lighter than sodium.
(C) Salts of Li to Cs impart characteristic colour to an oxidising flame (of Bunsen burner).
(D) All of these.

5. On dissolving moderate amount of sodium metal in liquid NH_3 at low temperature, which one of the folloiwng does not occur ?
(A) Blue coloured solution is obtained
(B) Na^+ ions are formed in the solution
(C) Liquid NH_3 becomes good conductor of electricity
(D) Liquid NH_3 remains diamagnetic.

6. The incorrect statement is :
(A) KOH can be used as an absorbent of carbondioxide.
(B) Liquid Na metal is used as a coolant in fast breeder nuclear reactors.
(C) All alkali metal gives flame test.
(D) Lithium is the weakest reducing agent among alkali metals.

7. Consider the following statements ;
S_1 : Alkali metals are never found in free state in nature.
S_2 : The melting and boiling points of alkali metals are high.
S_3 : The ceasium and potassium both are used as electrodes in photoelectric cells.
S_4 : Alkali metals are normally kept in kerosene oil.
and arrange in the order of true/false.
(A) T T F F (B) T F T T (C) F F F T (D) T T F T

8. The incorrect statement is :
(A) The alkaline earth metals readily reacts with acids liberating dihydrogen.
(B) Lithium is the only alkali metal to form a nitride directly by heating with N_2 gas.
(C) Calcium cannot be prepared by electrolysis of its aqueous salt solution.
(D) The mobilities of the alkali metal ions in aqueous solution are $Li^+ > Na^+ > K^+ > Rb^+ > Cs^+$.

9. Which of the following reacts with H_2O at room temperature?
(A) Be (B) Li (C) Mg (D) All of these

10. Which of the following fails to react significantly with air at room temperature?
(A) Be (B) Li (C) Ba (D) All of these

11. The pair of amphoteric hydroxides is :
(A) $Be(OH)_2$, $Al(OH)_3$ (B) $Al(OH)_3$, LiOH
(C) $B(OH)_3$, $Be(OH)_2$ (D) $Be(OH)_2$, $Mg(OH)_2$

12. $Na_2[Be(OH)_4]$ is formed when ;
(A) BeO reacts with NaOH solution.
(B) $Be(OH)_2$ reacts with NaOH solution.
(C) both (A) and (B) are correct.
(D) none of the above is correct.

13. Drying agent which react with CO_2 and removes water vapours from ammonia is :
(A) CaO (B) $CaCl_2$ (C) $CaCO_3$ (D) $Ca(NO_3)_2$

14. Brine solution on electrolysis will not give :
(A) NaOH (B) Cl_2 (C) H_2 (D) CO_2

15. Chemical (A) is used for water softening to remove temporary hardness. A reacts with Na_2CO_3 to generate caustic soda. When CO_2 is bubled through (A), it turns cloudy (i.e. milky). What is the chemical formula of (A) ?
(A) $CaCO_3$ (B) CaO (C) $Ca(OH)_2$ (D) $Ca(HCO_3)_2$

16. (X) reacts with sulphur dioxide in aqueous medium to give $NaHSO_3$, (X) is :
(A) Na_2CO_3 (B) $NaNO_3$ (C) $Na_2S_2O_3$ (D) $NaHSO_4$

17. In Solvay process of manufacture of Na_2CO_3, the by products obtained from recovery tower are :
(A) NH_4Cl, CaO, CO_2 (B) CaO, Na_2CO_3, $CaCl_2$
(C) $CaCl_2$, CO_2, NH_3 (D) Na_2CO_3, $CaCl_2$, CO_2

18. A colourless solid (X) on heating evolved CO_2 and also gave a white residue, soluble in water. Residue also gave CO_2 when treated with dilute acid. (X) is :
(A) K_2CO_3 (B) $CaCO_3$ (C) $KHCO_3$ (D) Na_2CO_3

19. Crude common salt becomes damp on keeping in air because :
(A) It is hygroscopic in nature.
(B) It contains $MgCl_2$ and $CaCl_2$ as impurities which are deliquescent in nature.
(C) (A) and (B) both.
(D) none.

20. $CaCl_2 + H_2SO_4 \xrightarrow[-HCl]{(p)} CaSO_4.2H_2O \xrightarrow{(q)} (r) \xrightarrow{> 393\ K} (s)$

Which of the following option describes, the products, reactants and the reaction conditions.

Option	(p)	(q)	(r)	(s)
(A)	Crystallisation	Heat at 393 K	2 $CaSO_4.H_2O$	$CaSO_4$
(B)	Crystallisation	Heat at 393 K at high pressure	2 $CaSO_4.H_2O$	$CaSO_4$
(C)	Higher temperature	Cool	$CaSO_4.H_2O$	$CaSO_4$
(D)	Higher pressure	Heat at 393 K	$CaSO_4$	$CaSO_3$

21. Setting of plaster of paris involves :
(A) the oxidation with atmoshperic oxygen.
(B) the removal of water to form anhydrous calcium sulphate.
(C) the hydration to form the orthorhombic form of gypsum.
(D) the reaction with atmospheric carbondioxide gas.

22. Calcium cyanamide on reaction with steam under pressure gives ammonia and ---------- .
(A) calcium carbonate (B) calcium hydroxide (C) calcium oxide (D) calcium bicarbonate

PART - II : SINGLE AND DOUBLE VALUE INTEGER TYPE

1. How many of the following are correctly matched ?

Element	Colour in flame test
K	Violet/Lilac
Na	Yellow
Be	Crimson red
Ca	Brick red
Sr	Apple green
Mg	No colour
Rb	Red violet
Cs	Blue
Li	Crimson red

2. How many of the following form polymeric chains?
$BeCl_2$, $AlCl_3$, $NaHCO_3$, Li_2CO_3, BeH_2, Na_2CO_3

3. For alkali metal M :
$M_2O + H_2O \rightarrow x$
$M_2O_2 + H_2O \rightarrow x + y$
$MO_3 + H_2O \rightarrow x + y + z$
Sum of the number of atoms present in one molecule each of x, y, z.

4. $NaOH + PbO \xrightarrow{\Delta} x + H_2O$
$NaOH + SnO_2 \xrightarrow{\Delta} y + H_2O$
$NaOH + H_2O + Al \xrightarrow{\Delta} z + H_2$
Sum of the number of atoms present in one molecule each of x, y, z is.....**.** (Assume no complex formation)

5. How many of the following will turn moist red litmus blue and finally white?
Li_2O, KO_3, RbO_2, Cs_2O_2, BeO, MgO, BaO_2, SrO

6. The by product of solvay process reacts with Na_2CO_3 to form a compound x, which on heating decomposes to give y. y is absorbed by KO_2. The number of atoms per molecule of y is .....

7. How many of the following statement is/are correct?
(a) Solvay process is used for manufacturing sodium carbonate.
(b) $CaCl_2$ is obtained as by product in Solvay process.
(c) NH_3 can be recovered in above process.
(d) $MgSO_4.7H_2O$ is epsom salt.
(e) On hydrolysis of Na_2CO_3, we get an acidic solution due to the formation of H_2CO_3.
(f) K_2CO_3 can also be prepared by Solvay process.
(g) $CaCO_3$ can be obtained by passing excess of CO_2 through lime water.

8. $A + B + H_2O \longrightarrow (NH_4)HCO_3$
$NH_4HCO_3 + NaCl \longrightarrow C + NH_4Cl$
$NH_4Cl + D \longrightarrow 2NH_3 + 2H_2O + CaCl_2$
Sum of the atoms present in one molecule each of A, B, C and D.

9. Molecular formula of Glauber's salt is $Na_2SO_4.xH_2O$. The value of x is_____.

10. When gypsum is heated at 393 K, the compund formed is $CaSO_4.xH_2O$. Value of 6x is.....

PART - III : ONE OR MORE THAN ONE OPTIONS CORRECT TYPE

1. Which is/are not correct configuration of s-block elements :
(A) [Ar] $3d^{10}$ $4s^2$ (B) [Ar] $3d^{10}$ $4s^1$ (C) [Ar]) $4s^2$ (D) [Ar] $4s^1$

2. The set representing the correct order of first ionisation potential is :
(A) K < Na < Li (B) Be > Mg > Ca (C) B > C > N (D) Ge > Si > C

3. The hydration energy of Mg^{2+} ion is higher than that of :
(A) Al^{3+} (B) Ca^{2+} (C) Na^+ (D) None of these

4. Going down in II A group, following properties decrease :
(A) solubility of sulphates in H_2O (B) hydration energy
(C) thermal stability of carbonates (D) ionic radius in water.

5. Exceptionally small size of Lithium results in :
(A) Anomalous behaviour of Li^+. (B) Its high polarising power.
(C) It has high degree of hydration. (D) Exceptionally low ionisation enthalpy.

6. Which of the following statement is incorrect ?
(A) The atomic radius of Na is greater than that of Mg.
(B) Metallic bond in Mg is stronger than the metallic bond in Na.
(C) Melting and boiling points of K are greater than those of Na.
(D) Mg and Ca both impart characteristic colour to the flame.

7. Which of the following statement(s) is/are true ?
(A) All alkali metals are soft and can be cut with knife.
(B) Alkali metals do not occur in free state in nature.
(C) Alkali metals are highly electropositive elements.
(D) Alkali metal hydrides are covalent and low melting solids.

8. Which is/are true statement(s)?
(A) The heats of hydration of the dipositive alkaline earth metal ions decreases with an increase in their ionic size.
(B) Hydration of alkali metal ion is less than that of II A ion of the same period.
(C) Alkaline earth metal ions, because of their much larger charge to radius ratio, exert a much stronger electrostatic attraction on the oxygen of water molecule surrounding them.
(D) None.

9. Which of the following statement(s) is/are correct?
(A) Milk of lime is a suspension of $Ca(OH)_2$ in water.
(B) Lime water is a clear solution of $Ca(OH)_2$ in water.
(C) Baryta water is a clear solution of $Ba(OH)_2$.
(D) Nitrolim is the mixture of $CaCN_2$ and carbon.

10. Select correct statement(s) :
(A) Stability of peroxides and superoxides of alkali metals increases with increase in size of the cation.
(B) Increase in stability in (A) is due to stabilisation of large anions by larger cations through lattice energy effects.
(C) The low solubility of LiF is due to its high lattice energy whereas low solubility of CsI is due to smaller hydration energy.
(D) NaOH is not deliquescent.

11. Select correct statement(s) :
(A) Li_2CO_3 is only sparingly soluble in water and no $LiHCO_3$ has been isolated.
(B) K_2CO_3 cannot be made by a method similar to the ammonia–soda (Solvay) process.
(C) Li_2CO_3 and $MgCO_3$ both are thermally stable.
(D) $KCl.MgCl_2.6H_2O$ is a mineral called carnallite.

12. Sodium bicarbonate can react with :
(A) Na_2CO_3 (B) NaOH (C) NaH (D) HCl

13. Aqueous solution of sodium carbonate can react with :
(A) $MgCl_2$ (B) $Ca(HCO_3)_2$ (C) H_2SO_4 (D) CO_2

14. Which of the following compounds are readily soluble in water?
(A) $MgSO_4$ (B) $SrSO_4$ (C) $BeSO_4$ (D) $BaSO_4$

15. Heating which of the following with C produces a metal sulphide?
(A) Na_2SO_4 (B) $MgSO_4$ (C) $BaSO_4$ (D) Li_2SO_4

16. Which of the following are correctly matched?
(A) Basic strength $Cs_2O < Rb_2O < K_2O < Na_2O < Li_2O$
(B) Stability of peroxides $Na_2O_2 < K_2O_2 < Rb_2O_2 < Cs_2O_2$
(C) Stability of bicarbonates $LiHCO_3 < NaHCO_3 < KHCO_3 < RbHCO_3 < CsHCO_3$
(D) Thermal stability of hydrides $CsH < RbH < KH < NaH < LiH$

17. Electrolysis of aqueous NaCl may produce with mercuty cathode :
(A) Na–Hg (B) Cl_2 (C) NaOH (D) H_2

18. A substance (P) releases a gas (Q) on reaction with H_2O. (Q) decolourises Br_2 water. (P) may be :
(A) BeC_2 (B) Be_2C (C) Al_4C_3 (D) Mg_2C_3

19. Nitrate can be converted into metal oxide on heating not above 500ºC in case of :
(A) Li (B) Na (C) Mg (D) None of these.

20. A substance (P), when heated in a dry test tube, liberated a colourless odourless gas that rekindled a glowing splinter. It may be :
(A) $KClO_3$ (B) $NaNO_3$ (C) K_2SO_3 (D) $CaCO_3$

PART - IV : COMPREHENSION

Read the following passage carefully and answer the questions.

Comprehension # 1

All alkali metals dissolve in anhydrous liquid ammonia to give blue colour solution. It is the ammoniated electron which is responsible for the blue colour of the solution, and the electrical conductivity is mainly due to ammoniated electron, $[e(NH_3)_y]^-$. Dilute solutions are paramagnetic due to free ammoniated electrons ; this paramagnetism decreases at higher concentration. Above 3M concentration, the solutions are diamagnetic and no longer blue but are bronze/copper-bronze coloured with a metallic luster.

1. Which of the following changes will be observed in concentrated solution of alkali metal in liquid ammonia ?
(A) Deep blue colour of the solution due to ammoniated electron is retained.
(B) Solvated electrons associate to form electrons-pairs and paramagnetic character decreases.
(C) Reducing character is increased.
(D) Two of the above.

2. Which of the following statement about solution of alkali metals in liquid ammonia is correct ?
(A) The dilute solutions are bad conductor of electricity.
(B) Both the dilute solutions as well as concentrated solution are equally paramagnetic in nature.
(C) Charge transfer is responsible for the blue colour of the solution.
(D) None of these.

3. Ammoniated solutions of alkali metals are reducing agents due to the :
(A) solvated cation. (B) solvated unpaired electron.
(C) the liberation of hydrogen gas (D) (A) and (B) both

Comprehension # 2

Answer Q.4, Q.5 and Q.6 by appropriately matching the information given in the three columns of the following table.

In Column-1 some compounds are given which are treated with the Column-2 compounds or are heated then in column-3 corresponding observations are given.					
Column-1		**Column-2**		**Column-3**	
(I)	Any binary compound of potassium & oxygen	(i)	H_2O	(P)	Liberation of O_2 is possible
(II)	Any alkaline earth metal carbide	(ii)	HCl	(Q)	The resulting solution is alkaline
(III)	Any alkaline earth metal carbonate	(iii)	NaOH	(R)	A gaseous hydrocarbon is liberated
(IV)	A gaseous oxide of non metal in +4 state	(iv)	heat	(S)	A gaseous acidic oxide or acidic solution is formed

4. Select the incorrect option :
(A) (I) (i) (P) (B) (II) (i) (R) (C) (III) (iv) (S) (D) (IV) (iii) (P)

5. Select the correct option :
(A) (I) (ii) (R) (B) (I) (i) (Q) (C) (IV) (iii) (S) (D) (II) (i) (S)

6. Select the correct option :
(A) (IV) (i) (S) (B) (III) (iv) (R) (C) (III) (iii) (S) (D) (III) (ii) (P)

Exercise-3

PART - I : JEE (ADVANCED) / IIT-JEE PROBLEMS (PREVIOUS YEARS)

*** Marked Questions may have more than one correct option.**

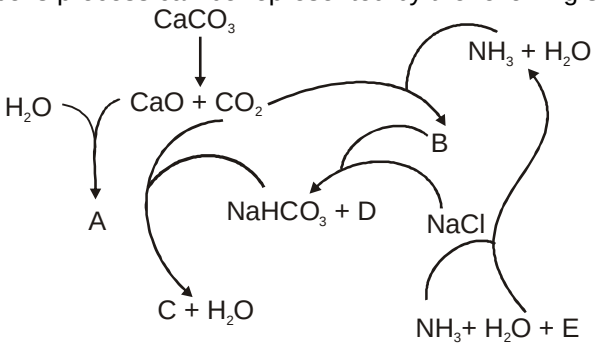
1. Property of the alkaline earth metals that increases with their atomic number is : **[JEE-1997(Cancelled), 2/200]**
(A) ionisation energy (B) solubility of their hydroxides
(C) solubility of their sulphates (D) electronegativity

2.* Highly pure dilute solution of sodium in liquid ammonia : **[JEE-1998, 1/200]**
(A) shows blue colour. (B) exhibits electrical conductivity.
(C) produces sodium amide. (D) produces hydrogen gas.

3.* Sodium nitrate decomposes above 800°C to give : **[JEE-1998, 1/200]**
(A) N_2 (B) O_2 (C) NO_2 (D) Na_2O

4. Beryllium chloride shows acidic nature in water or why $BeCl_2$ is easily hydrolysed ? **[JEE-1999, 2/200]**

5. The Haber's process can be represented by the following scheme :



Identify A, B, C, D and E. **[JEE-1999, 5/200]**

6. A white solid is either Na_2O or Na_2O_2. A piece of red litmus paper turns white when it is dipped into a freshly made aqueous solution of the white solid. **[JEE-1999, 4/200]**
(i) Identify the substances and explain with balanced equation.
(ii) Explain what would happen to the red litmus if the white solid were the other compound.

7. The set representing the correct order of first ionization potential is: **[JEE-2001, 1/35]**
(A) K > Na > Li (B) Be > Mg > Ca (C) B > C > N (D) Ge > Si > C

8. Identify the following : $Na_2CO_3 \xrightarrow{SO_2} A \xrightarrow{Na_2CO_3} B \xrightarrow[\Delta]{\text{elemental S}} C \xrightarrow{I_2} D$

Also mention the oxidation state of S in all the compounds. **[JEE-2003, 4/60]**

9. **Statement-1 :** Alkali metals dissolve in liquid ammonia to give blue solutions.
Statement-2 : Alkali metals in liquid ammonia give solvated species of the type $[M(NH_3)_n]^+$ (M = alkali metals). **[JEE-2007, 3/162]**
(A) Statement-1 is True, Statement-2 is True; Statement-2 is a correct explanation for Statement-1.
(B) Statement-1 is True, Statement-2 is True; Statement-2 is NOT a correct explanation for Statement-1.
(C) Statement-1 is True, Statement-2 is False.
(D) Statement-1 is False, Statement-2 is True.

10.* The compound(s) formed upon combustion of sodium metal in excess air is(are) : **[JEE-2009, 4/160]**
(A) Na_2O_2 (B) Na_2O (C) NaO_2 (D) NaOH

PART - II : JEE (MAIN) / AIEEE PROBLEMS (PREVIOUS YEARS)

JEE(MAIN) OFFLINE PROBLEMS

1. KO_2 (potassium super oxide) is used in oxygen cylinders in space and submarines because it :
(1) Absorbs CO_2 and increases O_2 contents (2) Eliminates moisture
(3) Absorbs CO_2 (4) Produces ozone **[AIEEE-2002]**

2. A metal M readily forms water soluble sulphate MSO_4, water insoluble hydroxide $M(OH)_2$ and oxide MO which becomes inert on heating. The hydroxide is soluble in NaOH. The M is : **[AIEEE-2002]**
(1) Be (2) Mg (3) Ca (4) Sr

3. In curing cement plasters, water is sprinkled from-time to time. This helps in : **[AIEEE-2003]**
(1) developing interlocking needle like crystals of hydrate silicates
(2) hydrated sand gravel mixed with cement
(3) converting sand into silicic acid
(4) keeping it cool.

4. The substance not likely to contain $CaCO_3$ is : **[AIEEE-2003]**
(1) calcined gypsum (2) sea shells (3) dolomite (4) a marble statue

5. The solubilities of carbonates decrease down the magnesium group due to a decrease in : **[AIEEE-2003]**
(1) hydration energies of cations (2) inter ionic interaction
(3) entropy of solution formation (4) lattice energies of solids.

6. Several blocks of magnesium are fixed to the bottom of a ship to : **[AIEEE-2003]**
(1) make the ship lighter (2) prevent action of water and salt
(3) prevent puncturing by under-sea rocks (4) keep away the sharks.

7. One mole of magnesium nitride on the reaction with an excess of water gives : **[AIEEE-2004]**
(1) one mole of ammonia (2) one mole of nitric acid
(3) two moles of ammonia (4) two moles of nitric acid.

8. Beryllium and aluminium exhibit many properties which are similar. But, the two elements differ in **[AIEEE-2004]**
(1) exhibiting maximum covalency in compounds
(2) forming polymeric hydrides
(3) forming covalent halides
(4) exhibiting amphoteric nature in their oxides.

9. Following statements regarding the periodic trends of chemical reactivity of the alkali metals and the halogens are given. Which of these statements gives the correct picture ? **[AIEEE-2006]**
(1) The reactivity decreases in the alkali metals but increases in the halogens with increase in atomic number down the group.
(2) In both the alkali metals and the halogens the chemical reactivity decreases with increase in atomic number down the group.
(3) Chemical reactivity increases with increase in atomic number down the group in both the alkali metals and halogens.
(4) In alkali metals the reactivity increases but in the halogens it decreases with increase in atomic number down the group.

10. The ionic mobility of alkali metal ions in aqueous solution is maximum for : **[AIEEE-2006]**
(1) K^+ (2) Rb^+ (3) Li^+ (4) Na^+

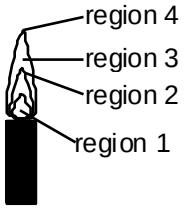
11. Which one of the following orders presents the correct sequence of the increasing basic nature of the given oxides ? **[AIEEE-2011, 4/120]**
(1) $Al_2O_3 < MgO < Na_2O < K_2O$ (2) $MgO < K_2O < Al_2O_3 < Na_2O$
(3) $Na_2O < K_2O < MgO < Al_2O_3$ (4) $K_2O < Na_2O < Al_2O_3 < MgO$

12. The products obtained on heating $LiNO_3$ will be : **[AIEEE-2011, 4/120]**
(1) $Li_2O + NO_2 + O_2$ (2) $Li_3N + O_2$ (3) $Li_2O + NO + O_2$ (4) $LiNO_3 + O_2$

13. Which of the following on thermal decomposition yields a basic as well as acidic oxide ? **[AIEEE-2012, 4/120]**
(1) $NaNO_3$ (2) $KClO_3$ (3) $CaCO_3$ (4) NH_4NO_3

14. Which one of the following alkaline earth metal sulphates has its hydration enthalpy greater than its lattice enthalpy ? **[JEE(Main)-2015, 4/120]**
(1) $CaSO_4$ (2) $BeSO_4$ (3) $BaSO_4$ (4) $SrSO_4$

15. The hottest region of Bunsen flame shown in the figure below is: **[JEE(Main)-2016, 4/120]**



(1) region 2
(2) region 3
(3) region 4
(4) region 1

16. The main oxides formed on combustion of Li, Na and K in excess of air are, respectively: **[JEE(Main)-2016, 4/120]**
(1) LiO_2, Na_2O_2 and K_2O (2) Li_2O_2, Na_2O_2 and KO_2
(3) Li_2O, Na_2O_2 and KO_2 (4) Li_2O, Na_2O and KO_2

17. Both lithium and magnesium display several similar properties due to the diagonal relationship; however, the one which is incorrect, is : **[JEE(Main)-2017, 4/120]**
(1) both form soluble bicarbonates
(2) both form nitrides
(3) nitrates of both Li and Mg yield NO_2 and O_2 on heating
(4) both form basic carbonates

JEE(MAIN) ONLINE PROBLEMS

1. Which of the following statements about Na_2O_2 is not correct ? **[JEE(Main) 2014 Online (11-04-14), 4/120]**
(1) It is diamagnetic in nature.
(2) It is a derivative of H_2O_2
(3) Na_2O_2 oxidises Cr^{3+} to CrO_4^{2-} in acid medium.
(4) It is the super oxide of sodium.

2. The correct order of thermal stability of hydroxides is : **[JEE(Main) 2015 Online (10-04-15), 4/120]**
(1) $Ba(OH)_2 < Ca(OH)_2 < Sr(OH)_2 < Mg(OH)_2$ (2) $Ba(OH)_2 < Sr(OH)_2 < Ca(OH)_2 < Mg(OH)_2$
(3) $Mg(OH)_2 < Ca(OH)_2 < Sr(OH)_2 < Ba(OH)_2$ (4) $Mg(OH)_2 < Sr(OH)_2 < Ca(OH)_2 < Ba(OH)_2$

3. The correct order of the solubility of alkaline-earth metal sulphates in water is : **[JEE(Main) 2016 Online (09-04-16), 4/120]**

(1) Mg < Sr < Ca < Ba (2) Mg > Ca > Sr > Ba (3) Mg > Sr > Ca > Ba (4) Mg < Ca < Sr < Ba

4. The commercial name for calcium oxide is : **[JEE(Main) 2016 Online (10-04-16), 4/120]**
(1) Quick lime (2) Milk of lime (3) Slaked lime (4) Limestone

5. Both lithium and magnesium display several similar properties due to the diagonal relationship; however, the one which is incorrect, is : **[JEE(Main) 2017 Online (02-04-17), 4/120]**
(1) both form soluble bicarbonates
(2) both form nitrides
(3) nitrates of both Li and Mg yield NO_2 and O_2 on heating
(4) both form basic carbonates

6. The products obtained when chlorine gas reacts with cold and dilute aqueous NaOH are : **[JEE(Main) 2017 Online (02-04-17), 4/120]**
(1) ClO_2^- and ClO_3^- (2) Cl^- and ClO^- (3) Cl^- and ClO_2^- (4) ClO^- and ClO_3^-

7. In KO_2, the nature of oxygen species and the oxidation state of oxygen atom are, respectively : **[JEE(Main) 2018 Online (15-04-18), 4/120]**
(1) Oxide and –2 (2) Superoxide and –1/2
(3) Peroxide and –1/2 (4) Superoxide and –1

8. The alkaline earth metal nitrate that does not crystallise with water molecules, is : **[JEE(Main) 2019 Online (09-01-19), 4/120]**
(1) $Sr(NO_3)_2$ (2) $Mg(NO_3)_2$ (3) $Ba(NO_3)_2$ (4) $Ca(NO_3)_2$

9. The metal that forms nitride by reacting directly with N_2 of air, is : **[JEE(Main) 2019 Online (09-01-19), 4/120]**
(1) Li (2) Cs (3) K (4) Rb

10. The metal used for making X-ray tube window is : **[JEE(Main) 2019 Online (10-01-19), 4/120]**
(1) Na (2) Ca (3) Mg (4) Be

11. Sodium metal on dissolution in liquid ammonia gives a deep blue solution due to the formation of: **[JEE(Main) 2019 Online (10-01-19), 4/120]**
(1) sodamide (2) ammoniated electrons
(3) sodium-ammonia complex (4) sodium ion-ammonia complex

12. The amphoteric hydroxide is: **[JEE(Main) 2019 Online (11-01-19), 4/120]**
(1) $Sr(OH)_2$ (2) $Mg(OH)_2$ (3) $Ca(OH)_2$ (4) $Be(OH)_2$

13. Match the following item in column I with the corresponding item in column II. **[JEE(Main) 2019 Online (11-01-19), 4/120]**

Column I		Column II	
(i)	$Na_2CO_3.10H_2O$	(A)	Portand cement ingredient
(ii)	$Mg(HCO_3)_2$	(B)	Castner-Kellner process
(iii)	NaOH	(C)	Solvay process
(iv)	$Ca_3Al_2O_6$	(D)	Temporary hardness

(1) (i) → (C); (ii) → (D); (iii) → (B); (iv) → (A) (2) (i) → (C); (ii) → (B); (iii) → (D); (iv) → (A)
(3) (i) → (D); (ii) → (A); (iii) → (B); (iv) → (C) (4) (i) → (B); (ii) → (C); (iii) → (A); (iv) → (D)

14. A metal on combustion in excess air forms X. X upon hydrolysis with water yields H_2O_2 and O_2 along with another product. The metal is : **[JEE(Main) 2019 Online (12-01-19), 4/120]**
(1) Mg (2) Li (3) Na (4) Rb

15. The correct statement(s) among, I to III with respect to potassium ions that are abundant within the cell fluids is/are: **[JEE(Main) 2019 Online (12-01-19), 4/120]**
I. They activate many enzymes.
II. They participate in the oxidation of glucose to produce ATP
III. Along with sodium ions, they are responsible for the transmission of nerve signals
(1) I and III only (2) III only (3) I and II only (4) I, II and III

Answers

EXERCISE - 1

PART – I

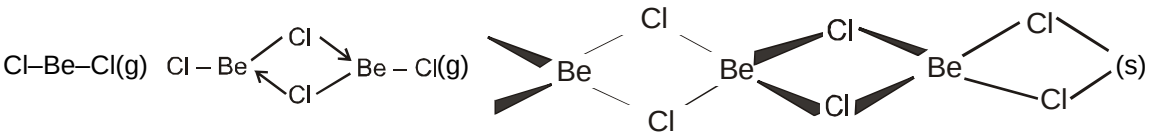
A-1. After removal of I^{st} electron alkali metal occupies inert gas configuration. Now removal of II^{nd} electron from inert gas configuration requires very high energy, therefore, they form unipositive ions. As IE_1 of these metals are low, the excitation of electrons can be done by providing less energy. This much of energy can be given by Bunsen flame. When they drop back to the ground state, there is emission of radiation in the visible region.

B-1. **(a)** The ionization enthalpy ($\Delta_i H$) of potassium (419 kJ mol^{-1}) is less than that of sodium (496 kJ mol^{-1}) or more precisely the standard electrode potential (E^o) of potassium (– 2.925 V) is more negative than that of sodium (– 2.714 V) and hence potassium is more reactive than sodium.
(b) IE_1 of Mg ($3s^2$) > Na ($3s^1$)
as Mg has fully filled electronic configuration while Na has one unpaired electron.
IE_2 of Mg ($3s^1$) > Na ($2p^6$)
as Mg^+ ($3s^1$) has one unpaired electron and Na^+ has inert gas configuration.

B-2. Smaller the size of the ion, more highly it is hydrated and hence greater is the mass of the hydrated ion and hence lower is its ionic mobility.
Since the extent of hydration decreases in the order : $Li^+ > Na^+ > K^+ > Rb^+ > Cs^+$
therefore, ionic mobility increases in the order : $Li^+ < Na^+ < K^+ < Rb^+ < Cs^+$

C-1. The superoxide O_2^- is paramagnetic because of one unpaired electron in π^*2p molecular orbital.

C-2. In vapour state it exists as linear or dimeric molecules where as in solid it has polymeric structure,



C-3. In $[CO_3^{2-}]$ all C–O bonds are equal due to resonance with B.O = $\frac{3}{2}$, so their bond length will also be equal.

C-4. There will be more polarisation of big anion due to Fajan's factors, so covalent character will be more in I^- due to large size and Ionic character will be less.
$MgCl_2 > MgBr_2 > MgI_2$

C-5. Due to small size Li^+, it has high polarising power while from Na^+ to Cs^+ have bigger size. So they have low polarising power. Li^+ is more similar to Mg^{2+} in its properties, which destabilizes a polyatomic anion due to its high polarising power.

C-6. $BeSO_4 < MgSO_4 < CaSO_4 < SrSO_4$

C-7. NaOH < KOH < RbOH < CsOH

C-8. Lithium is expected to be least reducing agent due to it's very high I.E. However, lithium has the highest hydration enthalpy due to small size which accounts for its high negative $E^\ominus$ and its high reducing power.

D-1. Due to large atomic size & only one valence electron per atom, alkali metals have weak metallic bonds as interparticle forces.

D-2.

Group-I Elements	+ O_2 (Major product)	+ N_2 (product)	Group-II Elements	+ O_2 (Major product)	+ N_2 (product) (Only on strong heating)
Li	Li_2O (Oxide)	Li_3N	Be	BeO	Be_3N_2
Na	Na_2O_2 (Peroxide)	It does not react	Mg	MgO	Mg_3N_2
K	KO_2 (superoxide)	It does not react	Ca	CaO	Ca_3N_2
Rb	RbO_2 (superoxide)	It does not react	Sr	SrO_2	Sr_3N_2
Cs	CsO_2 (superoxide)	It does not react	Ba	BaO_2	Ba_3N_2

D-3. (a) $Na + H_2O \longrightarrow NaOH + \frac{1}{2}H_2 \uparrow$ (b) $Ca + 2H_2O \longrightarrow Ca(OH)_2 + H_2 \uparrow$

D-4. (i) $M + H_2SO_4 \longrightarrow M_2SO_4 + H_2 \uparrow$ (ii) $M + 2HCl \longrightarrow MCl_2 + H_2 \uparrow$

D-5. On dissolving Metal in Liquid NH_3

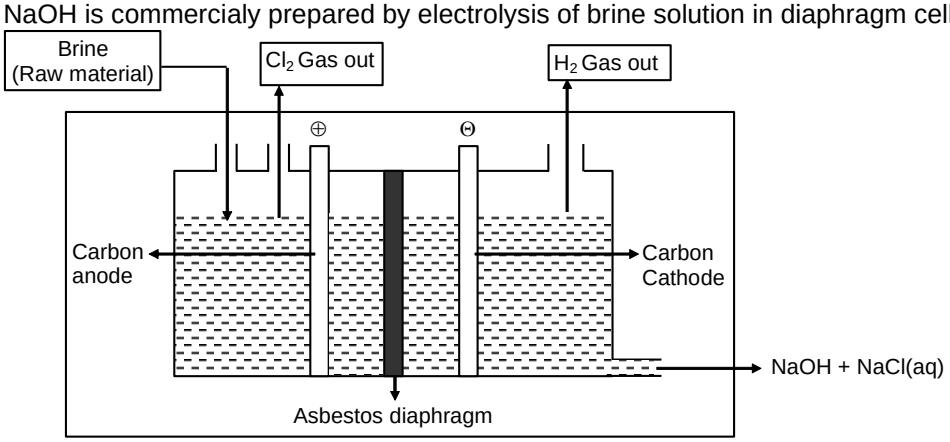
$M(s) + 2NH_3(\square) \longrightarrow M^+(NH_3) + e^-(NH_3)$

$M^+ + x\,(NH_3) \longrightarrow [M(NH_3)_x]^+ \longrightarrow$ Ammoniated cation

$e^- + y\,(NH_3) \longrightarrow [e(NH_3)_y]^- \longrightarrow$ Ammoniated electron

E-1. Small cation have high polarizing power therefore it stabilizes monoatomic anion. e.g. Li_2O
Large cation have less polarizing power therefore it can stabilize polyatomic anion. e.g. Na_2O_2; KO_2

E-2. NaOH is commercialy prepared by electrolysis of brine solution in diaphragm cell.



Anode reaction: $2Cl^- \longrightarrow Cl_2 + 2e^-$

Cathode reactions : $2H_2O + 2e^- \longrightarrow H_2 + 2OH^-$

$Na^+ + OH^- \longrightarrow NaOH$

Over all reaction: $2Na^+ + 2Cl^- + 2H_2O \longrightarrow 2NaOH + H_2 + Cl_2$

E-3. (i) Industrial method : It is a two stage reaction in presence of excess of air.

$2Na + O_2 \longrightarrow Na_2O$

$Na_2O + O_2 \longrightarrow Na_2O_2$

(ii) It is prepared by burning potassium in excess of oxygen free from moisture.

$K + O_2 \longrightarrow KO_2$

Hydrolysis

(i) with cold water, $Na_2O_2 + 2H_2O \xrightarrow{0^\circ C} 2NaOH + H_2O_2$

At room temperature, $2Na_2O_2 + 2H_2O \xrightarrow{25^\circ C} 4NaOH + O_2$

(ii) $KO_2 + H_2O \longrightarrow KOH + \frac{1}{2}H_2O_2 + \frac{1}{2}O_2$

E-4. (a) $\underset{\text{base}}{NaOH} + \underset{\text{acid}}{HNO_3} \longrightarrow \underset{\text{salt}}{NaNO_3} + H_2O$

(b) $Li_2O + H_2SO_4 \longrightarrow Li_2SO_4 + H_2O$

(c) $Na_2O_2 + H_2SO_4(\text{dilute}) \xrightarrow{25^oC} 2Na_2SO_4 + 2H_2O + O_2$

(d) $CaO + HCl \longrightarrow CaCl_2 + H_2O$

E-5. $3Ca(OH)_2 + 2H_3PO_4 \longrightarrow Ca_3(PO_4)_2 + 6H_2O$

E-6. $\underset{\text{base}}{NaOH} + \underset{\text{it will react as acid}}{Al_2O_3}$ (amphoteric metal oxide) $\longrightarrow 2NaAlO_2 + H_2O$

E-7. $Cl_2 \longrightarrow$ (+cold & dil. NaOH $\rightarrow$ $\underset{\text{Sod. hypochlorite}}{NaCl+NaOCl+H_2O}$) ; (+hot & conc. NaOH $\rightarrow$ $\underset{\text{Sod. chlorate}}{NaCl+NaClO_3+H_2O}$)

E-8. It goes under disproportionation reaction

$\overset{(0)}{P_4}$ (white) + NaOH + $H_2O \longrightarrow \underset{\text{Sod. hypophosphite}}{NaH_2\overset{+1}{P}O_2} + \underset{\text{Phosphine}}{\overset{-3}{P}H_3}$

F-1. $BeCO_3 < MgCO_3 < CaCO_3 < SrCO_3 < BaCO_3$

Stability of carbonates increases with increase in electropositive character and decrease in polarisation power of metal.

F-2. (i) In ammonia absorber

$NH_3 + CO_2 + H_2O \longrightarrow NH_4HCO_3$;

$NH_4HCO_3 + NaCl \xrightarrow{30^oC} NaHCO_3 \downarrow + NH_4Cl$

(ii) Calcination

$2\ NaHCO_3 \xrightarrow{150^oC} Na_2CO_3 + CO_2 + H_2O$

(iii) In recovery tower :-

$NH_4\ HCO_3 \xrightarrow{\Delta/\text{steam}} NH_3 + CO_2 + H_2O$

$2NH_4\ Cl + Ca(OH)_2 \xrightarrow{\Delta/\text{steam}} 2NH_3 + 2H_2O + CaCl_2$

F-3. $Na_2CO_3 + HCl(\text{dil.}) \longrightarrow NaCl + H_2O + CO_2$

F-4. **(a)** $2NaHCO_3 + H_2SO_4 \longrightarrow 2Na_2SO_4 + 2H_2O + CO_2$

(b) $Na_2CO_3 + Ca(OH)_2 \longrightarrow CaCO_3 \downarrow + 2NaOH$

(c) $NaHCO_3 + NaOH \longrightarrow Na_2CO_3 + H_2O$

(d) $2NaHCO_3 \xrightarrow[\text{Boil}]{\Delta} Na_2CO_3 + H_2O + CO_2 \uparrow$

(e) $NaHCO_3 + CaCl_2 \xrightarrow{\text{room temperature}}$ No reaction.

G-1. $BeSO_4 > MgSO_4 > CaSO_4 > SrSO_4$ Bigger cation is stable with bigger anion where as smaller cation is less stable with bigger anion that why $BeSO_4$ is more water soluble.

G-2. It is produced in large amount as a by product in solvey process.

G-3. $CaSO_4.2H_2O \xrightarrow{120^oC,\ \Delta} CaSO_4.\ \frac{1}{2}H_2O$ (Plaster of Paris) + $\frac{3}{2}H_2O$

G-4. (i) Be^{2+} & O^{2-} smaller in size & thus higher lattice energy and lattice energy is greater than hydration energy in BeO where as in $BeSO_4$ lattice energy is less due to bigger sulphate ion and is soluble.

Order of solubility: BeO < MgO < CaO < SrO < BaO

(ii) In $BaSO_4$ lattice energy is greater than hydration energy while in BaO lattice energy is smaller than hydration energy.

Order of solubility : $BeSO_4 > MgSO_4 > CaSO_4 > SrSO_4 > BaSO_4$

G-5. $NaOCl + HOH \longrightarrow NaOH + HOCl$

G-6. $CaCl_2 + H_2SO_4$ (conc.) $\xrightarrow{\Delta} CaSO_4 + 2HCl$

H-1. Order is LiH > NaH > KH > RbH > CsH because small Li^+ due to high polarisation power will stablise smaller anion.

H-2. **(a)** $CaC_2 + 2H_2O \longrightarrow Ca(OH)_2 + C_2H_2$
(b) $Mg_2C_3 + 4HOH \longrightarrow 2Mg(OH)_2 + CH_3 - C \equiv CH$

H-3. **(i)** $2MNO_3$ (metal nitrate) $\xrightarrow{500^oC,\ \Delta}$ $2MNO_2$ (Metal nitrite) + O_2 (except Li)
$4Li\ NO_3 \xrightarrow{500^oC,\ \Delta} Li_2O + 4NO_2 + O_2$
(ii) $M(NO_3)_2 \xrightarrow{\Delta} MO + 2NO_2 + \frac{1}{2} O_2$

H-4. (a) $Li_3N + 3H_2O \longrightarrow 3LiOH + NH_3\uparrow$ (b) $NaNH_2 + H_2O \longrightarrow NaOH + NH_3\uparrow$

PART – II

A-1.	(A)	**A-2.**	(B)	**B-1.**	(B)	**B-2.**	(A)	**C-1.**	(B)
C-2.	(D)	**C-3.**	(D)	**C-4.**	(C)	**C-5.**	(B)	**C-6.**	(A)
D-1.	(B)	**D-2.**	(D)	**D-3.**	(D)	**D-4.**	(D)	**D-5.**	(C)
E-1.	(A)	**E-2.**	(A)	**E-3.**	(B)	**E-4.**	(D)	**E-5.**	(B)
E-6.	(B)	**E-7.**	(C)	**E-8.**	(A)	**F-1.**	(B)	**F-2.**	(D)
F-3.	(C)	**F-4.**	(A)	**F-5.**	(A)	**F-6.**	(C)	**G-1.**	(D)
G-2.	(A)	**G-3.**	(C)	**G-4.**	(C)	**G-5.**	(A)	**H-1.**	(D)
H-2.	(A)	**H-3.**	(D)	**H-4.**	(B)	**H-5.**	(D)	**H-6.**	(C)

PART – III

1. (A - p,r,s); (B - p,q); (C - p,q,r,s); (D - p,q, r). **2.** (A - p); (B - p, q, s, t); (C - t); (D - q, r)

EXERCISE – 2

PART – I

1.	(B)	**2.**	(D)	**3.**	(D)	**4.**	(D)	**5.**	(D)
6.	(D)	**7.**	(B)	**8.**	(D)	**9.**	(B)	**10.**	(A)
11.	(A)	**12.**	(C)	**13.**	(A)	**14.**	(D)	**15.**	(C)
16.	(A)	**17.**	(C)	**18.**	(C)	**19.**	(B)	**20.**	(A)
21.	(C)	**22.**	(A)						

PART – II

1.	7 (All except Be & Sr)	**2.**	3 ($BeCl_2$, $NaHCO_3$, BeH_2)		
3.	9 (x = 3, y = 4, z = 2)	**4.**	15 (x = 5, y = 6, z = 4)		
5.	4 (KO_3, RbO_2, Cs_2O_2, BaO_2)	**6.**	3 (CO_2)	**7.**	4 (1^{st} four)
8.	18 (4, 3, 6, 5)	**9.**	10.	**10.**	3

PART – III

1.	(AB)	**2.**	(AB)	**3.**	(BC)	**4.**	(ABD)	**5.**	(ABC)
6.	(CD)	**7.**	(ABC)	**8.**	(ABC)	**9.**	(ABCD)	**10.**	(ABC)
11.	(ABD)	**12.**	(BCD)	**13.**	(ABCD)	**14.**	(AC)	**15.**	(AC)
16.	(BCD)	**17.**	(ABCD)	**18.**	(AD)	**19.**	(AC)	**20.**	(AB)

PART – IV

1. (D) **2.** (D) **3.** (B) **4.** (D) **5.** (B)

6. (A)

EXERCISE – 3

PART – I

1. (B) **2.*** (AB) **3.*** (ABD)

4. (i) Beryllium chloride is acidic, when dissolved in water because the hydrated ion hydrolysed producing H_3O^+. This happens because the Be–O bond is very strong, and so in the hydrated ion this weakens the O–H bonds, and hence there is tendency to lose portons.
$BeCl_2 + 4H_2O \longrightarrow [Be(H_2O)_4]\,Cl_2$; $[Be(H_2O)_4]^{2+} + H_2O \longrightarrow [Be(H_2O)_3(OH)]^+ + H_3O^+$

5. $A = Ca(OH)_2$, $B = NH_4HCO_3$, $C = Na_2CO_3$, $D = NH_4Cl$, $E = CaCl_2$

6. (i) Na_2O_2 is powerful oxidant and bleaching agent and bleaches red litmus paper to white in aqueous solution according to the following reaction,
$Na_2O_2 + 2H_2O \longrightarrow 2NaOH + H_2O + [O]$
$[O] + \text{Litmus} \longrightarrow \text{White (bleaching)}$
(ii) The other compound Na_2O will give NaOH on dissolution in water according to the following reaction.
$Na_2O + H_2O \longrightarrow 2NaOH$.
The red litmus will turn to blue due to stronger alkaline nature of NaOH

7. (B)

8. $Na_2CO_3 + SO_2 \xrightarrow{H_2O} 2NaHSO_3\ (A) + CO_2$
$2NaHSO_3 + Na_2CO_3 \longrightarrow 2Na_2SO_3\ (B) + H_2O + CO_2$
$Na_2SO_3 + S \xrightarrow{\Delta} Na_2S_2O_3\ (C)$
$2Na_2S_2O_3 + I_2 \longrightarrow Na_2S_4O_6\ (D) + 2NaI$
Oxidation states of S + 4 in $NaHSO_3$ [1 + 1 + x + 3(–2) = 0] and +4 in Na_2SO_3 [2 + x + 3(–2) = 0] ; + 6 and – 2 (or an average + 2) in $Na_2S_2O_3$ and +5 and 0 (or an average + 5/2) in $Na_2S_4O_6$.

9. (B) **10.*** (AB)

PART – II

JEE(MAIN) OFFLINE PROBLEMS

1. (1) **2.** (1) **3.** (1) **4.** (1) **5.** (1)

6. (2) **7.** (3) **8.** (1) **9.** (4) **10.** (2)

11. (1) **12.** (1) **13.** (3) **14.** (2) **15.** (1)

16. (3) **17.** (4)

JEE(MAIN) ONLINE PROBLEMS

1. (4) **2.** (4) **3.** (2) **4.** (1) **5.** (4)

6. (2) **7.** (2) **8.** (3) **9.** (1) **10.** (4)

11. (2) **12.** (4) **13.** (1) **14.** (4) **15.** (4)