16

s-Block Elements

TOPIC 1

Group 1 Elements (Alkali Metals)

01 Given below are two statements : One is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A) Lithium salts are hydrated.

Reason (R) Lithium has higher polarising power than other alkali metal group members.

In the light of the above statements, choose the most appropriate answer from the options given below

[2021, 31 Aug Shift-II]

(a) Both (A) and (R) are true but (R) is not the correct explanation of (A).
(b) (A) is true but (R) is not true
(c) (A) is false but (R) is ture.
(d) Both (A) and (R) are true (R) is the correct explanation of (A).

Ans. ***(a)***

Both Assertion and Reason are true but Reason is not the correct explanation of Assertion.

Lithium ions have smaller size as compared to other ions of the group.

Hence, it has greater value of charge to radius ratio and polarising power.

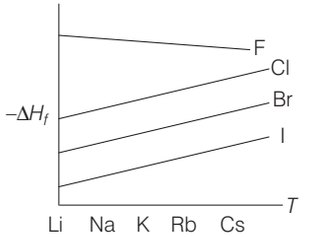
Among alkali metals ions, Li has smallest size due to which it can easily polarise water molecule. LiCl contains 2 water molecules per mole. However, due to bigger size of other alkali metals, they cannot easily polarise water molecules.

02 Choose the correct statement from the following. **[2021, 27 Aug Shift-II]**

(a) The standard enthalpy of formation for alkali metal bromide becomes less negative on descending the group.
(b) The low solubility of CsI in water is due to its high lattice enthalpy.
(c) Among the alkali metal halides, LiF is least soluble in water.
(d) LiF has least negative standard enthalpy of formation among alkali metal fluorides.

Ans. ***(c)***

The ΔH_f of alkali metal halides is shown through this graph.



This graph shows that formation of metal halide is negative, i.e. energy is released during the formation of metal halides.

(A)

M—F
M—Cl
M—Br
M—I ↓

On moving down the group, the size of halogens increase which results in the lengthening of bond, making the bond weaker. Therefore, ΔH_f is less negative on moving down the group as the stability of metal halide decreases down the group.

(B)

Li—X
Na—X
K—X
Rb —X ↓

On moving down the group, the electropositivity of metal increases making the attraction between the oppositely charged ions even stronger, thus increasing the strength of bond. Increase in strength is more than the weakness produced due to lengthening of bond because of increase in size of metal ions down the group. This makes ΔH_f more negative on moving down the group.

Option (a) is incorrect, due to reason produced in (B).

Option (b) is incorrect. As CsI has $Cs^{\oplus}$ and $I^{\ominus}$ an constituent ions and both the ions are larger in size. The lattice enthalpy is not so high as shown in graph. But it has low solubility due to less hydration energy released when hydration of larger ions takes place.

Option (c) is correct. As LiF has highest lattice enthalpy as shown in graph. This is due to the size of ions that is smallest in their respective groups. Smaller is the size, shorter is the bond length and stronger is the bond. The energy required is break the bond and release the constituents ions is more than the energy released in the hydration of ions. So, LiF is least soluble in water.

Option (d) is incorrect. LiF has most negative enthalpy in all metal fluorides as shown in graph.

03 The ratio of number of water molecules in Mohr's salt and potash alum is ..... $\times 10^{-1}$.

(Integer answer)

[2021, 26 Aug Shift-I]

Ans. ***(2.5)***

Formula for Mohr's salt is

$(NH_4)_2Fe(SO_4)_2 \cdot 6H_2O$.

$\therefore$ Number of water molecule in Mohr' salt $= 6$.

Formula for potash alum is

$K_2SO_4Al_2(SO_4)_3 \cdot 24H_2O$.

$\therefore$ Number of water molecules in potash alum is 12.

∴ Ratio of water molecules in Mohr's salt and potash alum is

$$\frac{6}{24}=\frac{1}{4}=2.5\times10^{-1}$$

04 Match List I with List II.

	List I		List II
A.	Li	I.	Photoelectric cell
B.	Na	II.	Absorbent of CO_2
C.	K	III.	Coolant in fast breeder nuclear reactor
D.	Cs	IV.	Treatment of cancer
		V.	Bearings for motor engines

Choose the correct answer from the options given below.

[2021, 27 July Shift-II]

	A	B	C	D
(a)	V	I	II	IV
(b)	V	II	IV	I
(c)	IV	III	I	II
(d)	V	III	II	I

Ans. ***(d)***

(A) Li makes alloy with lead which is used to make metal bearings for motor engines.

(B) Liquid Na is used as coolant in fast breeder nuclear reactor.

(C) K is used as absorbent of CO_2.

(D) Cs is used in making photoelectric cell.

Hence, the correct match is

A → V; B → III; C → II; D → I

05 Match List-I with List-II.

	List-I		List-II
A.	NaOH	I.	Acidic
B.	$Be(OH)_2$	II.	Basic
C.	$Ca(OH)_2$	III.	Amphoteric
D.	$B(OH)_3$		
E.	$Al(OH)_3$		

Choose the most appropriate answer from the options given below

[2021, 27 July Shift-I]

	A	B	C	D	E
(a)	II	II	III	II	III
(b)	II	III	II	I	III
(c)	II	II	III	I	III
(d)	II	I	II	III	III

Ans. ***(b)***

s-block elements form metal hydroxide that are basic in nature except $Be(OH)_2$.

Be and Al are diagonally related, their hydroxide are amphoteric in nature.

Boron (non-metal) forms oxide [$B(OH)_3$] which is acidic in nature.

A. NaOH → Basic

B. $Be(OH)_2$ → Amphoteric

C. $Ca(OH)_2$ → Basic

D. $B(OH)_3$ → Acidic

E. $Al(OH)_3$ → Amphoteric

Hence, correct match is

A → II, B → III, C → II, D → I, E → III.

06 Given below are two statements.

One is labelled as Asseriton A and the other labelled as Reason R.

Assertion A Lithium halides are some what covalent in nature.

Reason R Lithium possess high polarisation capability.

According the above statements, choose the most appropriate answer from the options given below **[2021, 27 July Shift-I]**

(a) A is true but R is false

(b) A is false but R is true

(c) Both A and R are true but R is not the correct explanation of A

(d) Both A and R are true and R is the correct explanation of A

Ans. ***(d)***

Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

Lithium ion due to its smaller size than other alkali metal cation has very high polarisation power and least electropositive character. Which results into increase in covalent nature in the molecule [Fajan's rule].

07 Match List I with List II.

	List I (Elements)		List II (Properties)
(A)	Li	I.	Poor water solubility of I^- salt
(B)	Na	II.	Most abundant element in cell fluid
(C)	K	III.	Bicarbonate salt used in fire extinguisher
(D)	Cs	IV.	Carbonate salt decomposes easily on heating

Choose the correct answer from the options given below.

[2021, 25 July Shift-II]

	A	B	C	D
(a)	IV	III	II	I
(b)	I	III	II	IV
(c)	IV	II	III	I
(d)	I	II	III	IV

Ans. ***(a)***

(A) Li_2CO_3 decomposes easily on heating due to high covalent character caused by small size Li^+ cation.

(B) $NaHCO_3$ is used in fire extinguisher. $NaHCO_3$ reacts with acid to produce carbon dioxide.

(C) K is most abundant element in cell fluid.

(D) CsI salt has poor water solubility due to its low hydration energy. As hydration energy is inversely proportional to the size of ion. Both Cs and I are larger in size.

Hence, correct match is

A → IV, B → III, C → II, D → I.

08 A *s*-block element (*M*) reacts with oxygen to form an oxide of the formula MO_2. The oxide is pale yellow in colour and paramagnetic. The element (*M*) is

[2021, 20 July Shift-I]

(a) Mg (b) Na (c) Ca (d) K

Ans. ***(d)***

The element (*M*) is potassium (K). It reacts with O_2 to form KO_2, which is paramagnetic in nature. All other elements form oxides or peroxides which are diamagnetic in nature.

Chemical reaction is as follows

$$\underset{\text{(Paramagnetic)}}{K + O_2\,(\text{excess}) \longrightarrow} \underset{\text{Superoxide}}{KO_2}$$

whereas,

(a) $2Mg + O_2 \longrightarrow 2MgO$ (Diamagnetic)

(b) $2Na + O_2 \longrightarrow Na_2O$ (Diamagnetic)

$2Na + O_2\,(\text{excess}) \longrightarrow Na_2O_2$ (Diamagnetic)

(c) $2Ca + O_2 \longrightarrow 2CaO$ (Diamagnetic)

$Ca + O_2 \longrightarrow CaO_2$ (Diamagnetic)

09 The ionic radius of Na^+ ions is 1.02 Å. The ionic radii (in Å) of Mg^{2+} and Al^{3+}, respectively, are

[2021, 18 March Shift-I]

(a) 1.05 and 0.99 (b) 0.72 and 0.54

(c) 0.85 and 0.99 (d) 0.68 and 0.72

Ans. ***(b)***

For iso-electronic system, radius is inversely proportional to the $Z_{eff.}$. The effective nuclear charge (Z_{eff}) is net positive charge, experienced by an electron in a multi-electron atom.

$$\underbrace{Na^{+} \quad Mg^{2+} \quad Al^{3+}}_{\text{(10 electrons in each)}}$$
$$Z=11 \quad Z=12 \quad Z=13$$

(Z = atomic number)

We know that, more is the positive charge on an ion, smaller will be its ionic radii. Whereas more is the negative charge on an ion more will be its ionic radii.

So, order of ionic size

$$Na^{+} > Mg^{2+} > Al^{3+}$$

Ionic radii of Na^{+} (1.02 Å) > Mg^{2+} (0.72 Å) > Al^{3+} (0.54 Å).

10 The correct order of conductivity of ions in water is

[2021, 17 March Shift-I]

(a) $Na^{+} > K^{+} > Rb^{+} > Cs^{+}$
(b) $Cs^{+} > Rb^{+} > K^{+} > Na^{+}$
(c) $K^{+} > Na^{+} > Cs^{+} > Rb^{+}$
(d) $Rb^{+} > Na^{+} > K^{+} > Li^{+}$

Ans. ***(b)***

Correct order of conductivity of ions in water is

$$Cs^{+} > Rb^{+} > K^{+} > Na^{+}$$

$Cs^{+}(aq)$ has lower hydrated radius so its electrical conductivity is higher.

Extent of hydration depends on charge density on the ion.

As the size of gaseous ion decreases, it get more hydrated in water and hence, the size of aqueous ion increases. When this bulky ion move in solution, it experience greater resistance and hence lower conductivity.

Size of gaseous ion :

$$Cs^{+} > Rb^{+} > K^{+} > Na^{+}$$

Size of aqueous ion :

$$Cs^{+} < Rb^{+} < K^{+} < Na^{+}$$

Conductivity:

$$Cs^{+} > Rb^{+} > K^{+} > Na^{+}$$

11 Match List-I with List-II

	List-I		List-II
A.	Sodium carbonate	(i)	Deacon
B.	Titanium	(ii)	Castner-Kellner
C.	Chlorine	(iii)	van-Arkel
D.	Sodium hydroxide	(iv)	Solvay

Choose the correct answer form the options given below.

[2021, 26 Feb Shift-II]

	A	B	C	D
(a)	(iv)	(iii)	(i)	(ii)
(b)	(i)	(iii)	(iv)	(ii)
(c)	(iv)	(i)	(ii)	(iii)
(d)	(iii)	(ii)	(i)	(iv)

Ans. ***(a)***

(A) Sodium carbonate is manufactured by Solvay process ⇒ (iv) of List-II.

Solvay process's reactions are as follows

In Solvay's process, first ammonia (NH_3) reacts with CO_2 and H_2O to give ammonium bicarbonate (NH_4HCO_3).

This bicarbonate react with NaCl to give sodium bicarbonate ($NaHCO_3$) along with ammonium chloride (NH_4Cl).

At last, $NaHCO_3$ is heated to form sodium carbonate as major product.

$$NH_3 + CO_2 + H_2O \longrightarrow NH_4HCO_3$$
$$NH_4HCO_3 + \underset{\text{(Brine)}}{NaCl} \longrightarrow NaHCO_3\downarrow + NH_4Cl$$
$$2NaHCO_3 \xrightarrow{\Delta} \underset{\text{Sodium carbonate}}{\boxed{Na_2CO_3}} + CO_2 + H_2O$$

12 Match List-I with List-II.

	List-I (Salt)		List-II (Flame colour wavelength)
A.	LiCl	1.	455.5 nm
B.	NaCl	2.	670.8 nm
C.	RbCl	3.	780.0 nm
D.	CsCl	4.	589.2 nm

Choose the correct answer from the options given below.

[2021, 24 Feb Shift-II]

	A	B	C	D		A	B	C	D
(a)	4	2	3	1	(b)	2	1	4	3
(c)	1	4	2	3	(d)	2	4	3	1

Ans. ***(d)***

Alkali metal	Colour (Flame)	λ (nm)
Li	Crimson red	670.8
Na	Yellow	589.2
Rb	Red, violet	780.0
Cs	Blue	455.5

Alkali metals have very low value of ionisation energy as compared to other metals. So, alkali metals easily get excited and impart colour to flame.

Hence, Rb is most excited and having high value of wavelength in all alkali metals.

13 Number of amphoteric compounds among the following is ..... .

[2021, 24 Feb Shift-I]

(a) BeO (b) BaO
(c) $Be(OH)_2$ (d) $Sr(OH)_2$

Ans. ***(Two)***

An amphoteric compound is a molecule or ion that can react with both as an acid or as a base.

BeO = Amphoteric
BaO = Basic
$Be(OH)_2$ = Amphoteric
$Sr(OH)_2$ = Basic

Both beryllium compound BeO and $Be(OH)_2$ are amphoteric in nature while compound BaO and $Sr(OH)_2$ are basic in nature, they form alkaline solution in H_2O.

14 The metal mainly used in devising photoelectric cells is

[2020, 2 Sep Shift-I]

(a) Na (b) Li
(c) Cs (d) Rb

Ans. ***(c)***

The expression of kinetic energy (KE) of photoelectrons is : $KE = E - E_0$

where, E = Energy of incident light

E_0 = Threshold energy of the metal used in photoelectric cells

A metal with lower ionisation energy (IE) will have lower value of E_0, also which will increase the value of KE of photoelectrons.

Group-1 metals have lower IE, values and we know the order of IE, of group-I metals will be

IE_1 : Li > Na > K > Rb > Cs

So, the order is E_0 : Li > Na > K > Rb > Cs

KE : Li < Na < K < Rb < Cs

That is why, Cs metal is the best choice in devising photoelectric cells.

15 On combustion of Li, Na and K in excess of air, the major oxides formed, respectively, are

[2020, 4 Sep Shift-I]

(a) Li_2O, Na_2O and K_2O_2
(b) Li_2O, Na_2O_2 and K_2O
(c) Li_2O, Na_2O_2 and KO_2
(d) Li_2O_2, Na_2O_2 and K_2O_2

Ans. ***(c)***

On combustion of Li, Na and K in excess of air, the major oxides formed respectively are Li_2O, Na_2O_2 and KO_2.

Reactions are as follows:

$$Li + \underset{\text{Excess}}{O_2} \longrightarrow \underset{\text{Oxide}}{Li_2O}$$

$$Na + \underset{\text{Excess}}{O_2} \longrightarrow \underset{\text{Peroxide}}{Na_2O_2}$$

$$K + \underset{\text{Excess}}{O_2} \longrightarrow \underset{\text{Super oxide}}{KO_2}$$

16 Reaction of an inorganic sulphite *X* with dilute H_2SO_4 generates compound *Y*. Reaction of *Y* with NaOH gives *X*. Further, the reaction of *X* with *Y* and water affords compound *Z*. *Y* and *Z* respectively, are **[2020, 6 Sep Shift-II]**

(a) SO_2 and Na_2SO_3
(b) SO_3 and $NaHSO_3$
(c) SO_2 and $NaHSO_3$
(d) S and Na_2SO_3

Ans. ***(c)***

$$\underset{(X)}{Na_2SO_3} \xrightarrow{\text{Dil.}H_2SO_4} \underset{(Y)}{SO_2} \xrightarrow{NaOH} \underset{(X)}{Na_2SO_3}$$

$$\xrightarrow{SO_2 + H_2O} \underset{(Z)}{NaHSO_3}$$

Here, *X*, *Y*, *Z* are

$X = Na_2SO_3$, $Y = SO_2$, $Z = NaHSO_3$

Na_2SO_3 react with dil.H_2SO_4 form sulphur dioxide (SO_2) gas. SO_2 on reaction with NaOH again form Na_2SO_3. By the reaction of SO_2 and H_2O, Na_2SO_3 form $NaHSO_3$.

Here, *X*, *Y*, *Z* are Na_2SO_3, SO_2, $NaHSO_3$ respectively.

17 Among the statements (A)-(D), the correct ones are **[2020, 9 Jan Shift-II]**

(A) lithium has the highest hydration enthalpy among alkali metals.
(B) lithium chloride is insoluble in pyridine.
(C) lithium cannot form ethynide upon its reaction with ethyne.
(D) Both lithium and magnesium react slowly with H_2O.

(a) (A) and (D) only
(b) (B) and (C) only
(c) (A), (C) and (D) only
(d) (A), (B) and (D) only

Ans. ***(c)***

Statement (A), (C) and (D) are correct whereas statement (B) is incorrect. It's corrected form is that lithium chloride is soluble in pyridine.

18 The correct order of hydration enthalpies of alkali metal ions is **[2019, 8 April Shift-I]**

(a) $Li^+ > Na^+ > K^+ > Cs^+ > Rb^+$
(b) $Na^+ > Li^+ > K^+ > Rb^+ > Cs^+$
(c) $Na^+ > Li^+ > K^+ > Cs^+ > Rb^+$
(d) $Li^+ > Na^+ > K^+ > Rb^+ > Cs^+$

Ans. ***(d)***

Key Idea The amount of energy released when one mole of gaseous ions combine with water to form hydrated ions is called hydration enthalpy.

The correct order of hydration enthalpies of alkali metal ions is

$$Li^+ > Na^+ > K^+ > Rb^+ > Cs^+$$

Li^+ possesses the maximum degree of hydration due to its small size. As a consequence of hydration enthalpy, their mobility also get affected. Cs^+ has highest and Li^+ has lowest mobility in aqueous solution.

19 The incorrect statement is **[2019, 12 April Shift-II]**

(a) lithium is the strongest reducing agent among the alkali metals.
(b) lithium is least reactive with water among the alkali metals.
(c) $LiNO_3$ decomposes on heating to give $LiNO_2$ and O_2.
(d) LiCl crystallise from aqueous solution as $LiCl \cdot 2H_2O$.

Ans. ***(c)***

Statement (c) is incorrect. $LiNO_3$ (Lithium nitrate) on heating gives a mixture of Li_2O, NO_2 and O_2.

$$4LiNO_3 \xrightarrow{\Delta} 2Li_2O + 4NO_2 \uparrow + O_2 \uparrow$$

Among the alkali metals, lithium is the strongest reducing agent.

20 Sodium metal on dissolution in liquid ammonia gives a deep blue solution due to the formation of **[2019, 10 Jan Shift-II]**

(a) sodium ammonia complex
(b) sodium ion-ammonia complex
(c) sodamide
(d) ammoniated electrons

Ans. ***(d)***

Sodium metal on dissolution in liquid ammonia gives a deep blue solution due to the formation of ammoniated electrons. The reaction is represented as follows :

$$Na(s) + (x + y)NH_3(l) \longrightarrow \underset{\substack{\text{[Ammoniated Na}^+ \\ \text{or expanded Na]}}}{[Na(NH)_x]^+} + \underset{\substack{\text{[Ammoniated} \\ \text{electrons]}}}{[e_{(NH_3)_y}]}$$

Ammoniated (solvated) electrons show electronic transition in visible region and the solution becomes deep blue coloured.

This deep blue solution also shows the following properties due to the presence of ammoniated electrons.

(i) It is strongly reducing in nature.
(ii) It is paramagnetic.
(iii) It is a good conductor of electricity.

21 NaH is an example of

(a) metallic hydride
(b) electron-rich hydride
(c) saline hydride
(d) molecular hydride **[2019, 11 Jan Shift-I]**

Ans. ***(c)***

$\overset{\oplus}{Na}\overset{\ominus}{H}$ is an example of ionic or saline hydride. These hydrides are formed when hydrogen combines with metals having less electronegativity and more electropositive character with respect to hydrogen. Except Be and Mg, all *s*-block metals form saline hydrides.

Hydrides of *p*-block elements are covalent in nature, *viz*, electron deficient hydrides (by group-13 elements), electron-precise hydrides (by group-14 elements), and electron-rich hydrides (by group 15-17 elements). Hydrides of *d*, *f*-block metals are called interstitial or metallic hydrides.

22 The correct statement(s) among I to III with respect to potassium ions that are abundant within the cell fluids is/are

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.

(a) I, and III only
(b) I, II and III
(c) I and II only
(d) III only **[2019, 12 Jan Shift-II]**

Ans. ***(b)***

All the statements are correct. K^+ being metallic unipositive ions work as enzyme activators.

These also participate in many reactions of glycolysis and Kreb's cycle to produce ATP from glucose.

Being unipositive these are also equally responsible for nerve signal transmission along with Na^+. (Na^+ ion-pump theory)

23 Sodium salt of an organic acid '*X*' produces effervescence with conc. H_2SO_4. '*X*' reacts with the acidified aqueous $CaCl_2$ solution to give a white precipitate which decolourises acidic solution of $KMnO_4$. '*X*' is **[JEE Main 2017]**

(a) C_6H_5COONa (b) $HCOONa$
(c) CH_3COONa (d) $Na_2C_2O_4$

Ans. ***(d)***

The reaction takes place as follows

$$\underset{(X)}{Na_2C_2O_4} + \underset{(conc.)}{H_2SO_4} \longrightarrow Na_2SO_4 + H_2O + \underset{\text{Effervescence}}{CO\uparrow + CO_2\uparrow}$$

$$\underset{(X)}{Na_2C_2O_4} + CaCl_2 \longrightarrow \underset{\text{White ppt.}}{CaC_2O_4} + 2NaCl$$

$$5\underset{\text{Purple}}{CaC_2O_4} + 2KMnO_4 + 8H_2SO_4 \longrightarrow K_2SO_4 + 5CaSO_4 + 2MnSO_4 + 10CO_2 + 8H_2O$$

Colourless

Hence, *X* is $Na_2C_2O_4$.

24 The main oxides formed on combustion of Li, Na and K in excess of air respectively are **[JEE Main 2016]**

(a) LiO_2, Na_2O_2 and K_2O
(b) Li_2O_2, Na_2O_2 and KO_2
(c) Li_2O, Na_2O_2 and KO_2
(d) Li_2O , Na_2O and KO_2

Ans. ***(c)***

$$\underset{\text{(Excess)}}{2Li + \frac{1}{2}O_2(g)} \longrightarrow Li_2O$$

$$\underset{\text{(Excess)}}{2Na + O_2(g)} \longrightarrow Na_2O_2$$

$$\underset{\text{(Excess)}}{K + O_2(g)} \longrightarrow KO_2$$

25 The products obtained on heating $LiNO_3$ will be **[AIEEE 2011]**

(a) $LiNO_2 + O_2$ (b) $Li_2O + NO_2 + O_2$
(c) $Li_3N + O_2$ (d) $Li_2O + OH + O_2$

Ans. ***(b)***

$LiNO_3$ behave differently from other alkali metal nitrates.

Lithium nitrates decompose on heating producing NO_2. Whereas other alkali nitrates like $NaNO_3$ produces nitrite and oxygen on decomposition.

$$2Li\ NO_3 \xrightarrow{\Delta} Li_2O + 2NO_2 + \frac{1}{2}O_2$$

$$NaNO_3 \xrightarrow{\Delta} NaNO_2 + \frac{1}{2}O_2$$

26 What is the best description of the change that occurs when $Na_2O(s)$ is dissolved in water? **[AIEEE 2011]**

(a) Oxidation number of sodium decreases
(b) Oxide ion accepts a shared pair of electrons
(c) Oxide ion donates a pair of electrons
(d) Oxidation number of oxygen increases

Ans. ***(c)***

$$Na_2O + H_2O \longrightarrow 2NaOH$$

Oxidation number of Na and Oxygen $+1\ -2 \quad -2\ +1\ +2$

No change in oxidation number, so (a) and (d) are not true.

(b) is also not true.

Oxide ion donates a pair of electrons, thus changes to OH^-.

27 KO_2 is used in space and submarines because it

(a) absorbs CO_2 and increases O_2 concentration
(b) absorbs moisture
(c) absorbs CO_2
(d) produces ozone **[AIEEE 2002]**

Ans. ***(a)***

$$4KO_2 + 2CO_2 \longrightarrow 2K_2CO_3 + 3O_2$$

TOPIC 2
Group 2 Elements (Alkaline Metals)

28 The major component/ingredient of Portland cement is **[2021, 31 Aug Shift-I]**

(a) tricalcium aluminate
(b) tricalcium silicate
(c) dicalcium aluminate
(d) dicalcium silicate

Ans. ***(b)***

The major component of Portland cement is tricalcium silicate (51%, $3CaO{\cdot}SiO_2$). Hence, correct option is (b).

29 The number of water molecules in gypsum, dead burnt plaster and plaster of Paris, respectively are **[2021, 27 Aug Shift-I]**

(a) 2, 0 and 1
(b) 0.5, 0 and 2
(c) 5, 0 and 0.5
(d) 2, 0 and 0.5

Ans. ***(d)***

The chemical formula of gypsum – $CaSO_4 \cdot 2H_2O$, dead burnt plaster – $CaSO_4$ and plaster of Paris – $CaSO_4 \cdot \frac{1}{2}H_2O$.

So, number of water molecules in gypsum, dead burnt plaster and plaster of Paris are 2, 0 and 0.5 respectively.

30 Given below are two statements : One is labelled as Assertion (A) and the other is labelled as Reason (R).

Assertion (A) Barium carbonate is insoluble in water and is highly stable.

Reason (R) The thermal stability of the carbonates increases with increasing cationic size. **[2021, 26 Aug Shift-II]**

(a) Both (A) and (R) are true and (R) is the correct explanation of (A).
(b) (A) is true but (R) is false.
(c) Both (A) and (R) are true and (R) is not the true explanation of (A).
(d) (A) is false but (R) is true.

Ans. ***(a)***

Both Assertion and Reason are true and Reason is the correct explanation of Assertion.

Stability of group-2 metal carbonates increases as we move down the group because large cations are stabilised by large anion and *vice-versa*. Carbonates being a large anion is stabilised by larger cations.

$$\underset{\text{Stability increases}}{\xrightarrow{BeCO_3\ MgCO_3\ CaCO_3\ SrCO_3\ BaCO_3}}$$

Solubility in water decreases as we move down the group because of decrease in hydration energy of cations.

31 What are the products formed in sequence when excess of CO_2 is passed in slaked lime? **[2021, 26 Aug Shift-I]**

(a) $Ca(HCO_3)_2$, $CaCO_3$
(b) $CaCO_3$, $Ca(HCO_3)_2$
(c) CaO, $Ca(HCO_3)_2$
(d) CaO, $CaCO_3$

Ans. ***(b)***

When excess of CO_2 passes through slaked lime [$Ca(OH)_2$], the calcium carbonate ($CaCO_3$) and calcium hydrogen carbonate $Ca(HCO_3)_2$ will be formed as follows

$$\underset{\text{Slaked lime}}{Ca(OH)_2} + CO_2 \longrightarrow \underset{\text{Calcium carbonate}}{CaCO_3\downarrow} + \underset{\text{(Milky)}}{H_2O}$$

$$CaCO_3 + CO_2 + H_2O \longrightarrow \underset{\text{Calcium hydrogen carbonate}}{Ca(HCO_3)_2}$$

32 The conversion of hydroxyapatite occurs due to presence of F^- ions in water. The correct formula of hydroxyapatite is

[2021, 26 Aug Shift-I]

(a) $[3Ca_3(PO_4)_2\,Ca(OH)_2]$
(b) $[3Ca(OH)_2\,CaF_2]$
(c) $[Ca_3(PO_4)_2\,CaF_2]$
(d) $[3Ca_3(PO_4)_2\,CaF_2]$

Ans. ***(a)***

The correct formula for hydroxyapatite is $3[Ca_3(PO_4)_2\,Ca(OH)_2]$. The presence of F^- ions on enamel make the enamel much harder as hydroxyapatite $[3Ca_3(PO_4)_2\,Ca(OH)_2]$ converts into fluoroapatite $[3Ca_3(PO_4)_2\,CaF_2]$.

33 Match List I with List II.

	List-I (Elements)		List-II (Properties)
A.	Ba	(i)	Organic solvent soluble compounds
B.	Ca	(ii)	Outer electronic configuration $6s^2$
C.	Li	(iii)	Oxalate insoluble in water
D.	Na	(iv)	Formation of very strong monoacidic base

Choose the correct answer from the options given below

[2021, 22 July Shift-II]

	A	B	C	D
(a)	(ii)	(iii)	(i)	(iv)
(b)	(iv)	(i)	(ii)	(iii)
(c)	(iii)	(ii)	(iv)	(i)
(d)	(i)	(iv)	(ii)	(iii)

Ans. ***(a)***

Outer electronic configuration of given elements are

$Li \rightarrow 2s^1$; $Na \rightarrow 3s^1$
$Ca \rightarrow 4s^2$; $Ba \rightarrow 6s^2$

(A) $Ba \rightarrow$ Outer electronic configuration $\rightarrow 6s^2$. i.e. (ii).
(B) $Ca \rightarrow$ Calcium oxalate $(CaC_2O_4) \rightarrow$ insoluble in water i.e. (iii).
(C) $Li \rightarrow$ Being small in size, the compounds of lithium are covalent in nature, so its compounds are soluble in organic solvent.
e.g. LiCl is soluble in pyridine i.e (i).
(D) $Na \rightarrow NaOH$, strong monoacidic base i.e. (iv).

The correct match is :
(A)-(ii), (B)-(iii), (C)-(i) and D-(iv).

34 Match List-I with List-II.

List-I		List-II	
(A)	$Ca(OCl)_2$	(i)	Antacid
(B)	$CaSO_4 \cdot \frac{1}{2}H_2O$	(ii)	Cement
(C)	CaO	(iii)	Bleach
(D)	$CaCO_3$	(iv)	Plaster of Paris

Choose the most appropriate answer from the options given below.

[2021, 18 March Shift-I]

	A	B	C	D		A	B	C	D
(a)	(i)	(iv)	(iii)	(ii)	(b)	(iii)	(ii)	(iv)	(i)
(c)	(iii)	(iv)	(ii)	(i)	(d)	(iii)	(ii)	(i)	(iv)

Ans. ***(c)***

A. $Ca(OCl)_2 \rightarrow$ Bleaching powder
B. $CaSO_4 \cdot 1/2H_2O \rightarrow$ Plaster of Paris
C. $CaO \rightarrow$ is major component of cement
D. $CaCO_3 \rightarrow$ used as an antacid
Correct match is (A-iii), (B-iv), (C-ii), (D-i).

35 One of the by-products formed during the recovery of NH_3 from solvay process is

[2021, 17 March Shift-II]

(a) $Ca(OH)_2$ (b) $NaHCO_3$
(c) $CaCl_2$ (d) NH_4Cl

Ans. ***(c)***

$CaCl_2$ is one of the by-products formed during the recovery of NH_3 from Solvay process.

Ammonia required for the process can be prepared by heating ammonium chloride with calcium hydroxide.

$$2NH_4Cl + Ca(OH)_2 \longrightarrow 2NH_3 + CaCl_2 + H_2O$$

Hence, the only by-product of the reaction is calcium chloride.

36 Given below are two statements.

Statement I Both $CaCl_2 \cdot 6H_2O$ and $MgCl_2 \cdot 8H_2O$ undergo dehydration on heating.

Statement II BeO is amphoteric, whereas the oxides of other elements in the same group are acidic.

In the light of the above statements, choose the correct answer from the options given below. **[2021, 16 March Shift-I]**

(a) Statement I is false but statement II is true
(b) Both statement I and statement II are false
(c) Both statement I and statement II are true
(d) Statement I is true but statement II is false

Ans. ***(b)***

The dehydration of hydrated chlorides, bromides and iodides of Ca, Sr, Ba is possible but hydrated halides of Be and Mg on heating suffer hydrolysis due to their small size or high charge density.

$$CaCl_2 \cdot 6H_2O \xrightarrow{\Delta} \underset{\text{Anhydrous}}{CaCl_2} + 6H_2O$$

$$MgCl_2 \cdot 8H_2O \xrightarrow{\Delta} MgO + 7H_2O + 2HCl$$

$MgCl_2$ can be made anhydrous by heating in presence of dry HCl.

$$MgCl_2 \cdot 6H_2O \xrightarrow[\text{Dry HCl}(g)]{\Delta\ (\text{Calcination})} MgCl_2 + 8H_2O$$

Hence, on heating $CaCl_2 \cdot 6H_2O$ undergoes dehydration but $MgCl_2 \cdot 8H_2O$ does not.

Metal oxides are generally basic. In alkaline earth metal BeO is amphoteric and shows anomalous behaviour while other oxides are basic.

So, both statement I and statement II are false.

37 The correct set from the following in which both pairs are in correct order of melting point is

[2021, 24 Feb Shift-II]

(a) LiF > LiCl, MgO > NaCl
(b) LiCl > LiF, NaCl > MgO
(c) LiF > LiCl, NaCl > MgO
(d) LiCl > LiF, MgO > NaCl

Ans. ***(a)***

Correct option is (a) i.e. LiF > LiCl; MgO > NaCl. Melting point is directly proportional to lattice energy. Lattice energy is the energy required to separate a mole of an ionic solid into gaseous ions.

It depends upon charge of ions and size of ions.

$$M.P \propto L.E \propto \frac{Charge}{Size}$$

$Li \rightarrow +1$ $\quad$ $Li \rightarrow +1$

$F = -1$ $\quad$ $Cl \rightarrow -1$

Both LiF and LiCl having same charge, so melting point will depend on size.

Larger the size of anion, lesser the lattice energy and hence, melting point order is LiF > LiCl.

Similarly, MgO $\quad$ NaCl

$Mg \rightarrow 2+$ $\quad$ $Na \rightarrow 1+$

$O \rightarrow 2-$ $\quad$ $Cl \rightarrow 1-$

MgO having +2 charge which is greater than NaCl (+ 1) charge. So, greater the charge on the ions greater will be lattice energy and hence, melting point order is MgO > NaCl.

38 Two elements *A* and *B* have similar chemical properties. They don't form solid hydrogencarbonates, but react with nitrogen to form nitrides. *A* and *B*, respectively, are **[2020, 2 Sep Shift-II]**

(a) Na and Rb (b) Na and Ca

(c) Cs and Ba (d) Li and Mg

Ans. ***(d)***

Group-2 metals (Be, Mg, Ca, Sr, Ba) form nitrides ($\overset{II}{M}_3N_2$) and their hydrogen- or bicarbonates [$\overset{II}{M}(HCO_3)_2$] are known only in solution phase (in situ).

$$M + N_2 \xrightarrow{\Delta} \overset{II}{M}_3N_2$$

$$\overset{II}{M}CO_3(s) + CO_2(g) + H_2O(l) \xrightarrow{25\,^\circ C} \overset{II}{M}(HCO_3)_2(aq)$$

The above two properties are not given by group-I metals (Li, Na, K, Rb Cs) except Li. Li resembles with group-II metals in comparison of their chemical properties.

Specifically, Li (*A*) and Mg (*B*) have similar chemical properties as they show "diagonal relationship" in the periodic table.

2nd period : Li Be B C N O F

3rd period : Na Mg Al Si P S Cl

39 Among the statements (I-IV), the correct ones are :

(I) Be has smaller atomic radius compared to Mg.

(II) Be has higher ionisation enthalpy than Al.

(III) Charge/radius ratio of Be is greater than that of Al.

(IV) Both Be and Al form mainly covalent compounds. **[2020, 3 Sep Shift-II]**

(a) (II), (III) and (IV) (b) (I), (II) and (IV)

(c) (I), (III) and (IV) (d) (I), (II) and (III)

Ans. ***(b)***

Statements (I), (II) and (IV) are correct whereas statement (III) is incorrect.

Corrected statement is

(Charge/Radius) of Be and Al is same because of diagonal relationship.

40 An alkaline earth metal '*M*' readily forms water soluble sulphate and water insoluble hydroxide. Its oxide *MO* is very stable to heat and does not have rock-salt structure. *M* is **[2020, 4 Sep Shift-II]**

(a) Sr (b) Ca

(c) Be (d) Mg

Ans. ***(c)***

Solubility of $BeSO_4$ is highest among the given options and order is as follows :

$BeSO_4 > MgSO_4 > CaSO_4 > SrSO_4 > BaSO_4$

$BeSO_4$ is water soluble sulphate and $Be(OH)_2$ is insoluble.

BeO is stable to heat and does not form rock salt like structure.

41 Match the following compounds (Column -I) with their uses (Columns -II).

	Column -I		Column - II
(I)	$Ca(OH)_2$	(A)	Casts of statues
(II)	NaCl	(B)	White wash
(III)	$CaSO_4 \cdot \frac{1}{2}H_2O$	(C)	Antacid
(IV)	$CaCO_3$	(D)	Washing soda preparation

[2020, 6 Sep Shift-II]

(a) (I)-(D), (II)-(A), (III)-(C), (IV)-(B)

(b) (I)-(B), (II)-(D), (III)-(A), (IV)-(C)

(c) (I)-(B), (II)-(C), (III)-(D), (IV)-(A)

(d) (I)-(C), (II)-(D), (III)-(B), (IV)-(A)

Ans. ***(b)***

Correct match is I → (B), II → (D), III → (A), IV → (C)

(I) $Ca(OH)_2$ used in white wash.

(II) NaCl is used in the preparation of washing soda.

$$2NH_3 + H_2O + CO_2 \longrightarrow (NH_4)_2CO_3$$

$$(NH_4)_2CO_3 + H_2O + CO_2 \longrightarrow 2NH_4HCO_3$$

$$NH_4HCO_3 + NaCl \longrightarrow NH_4Cl + NaHCO_3(s)$$

$$2NaHCO_3 \xrightarrow{\Delta} Na_2CO_3 + CO_2 + H_2O$$

(III) $CaSO_4 \cdot \frac{1}{2}H_2O$ (plaster of Paris) is used for making casts of statues.

(IV) $CaCO_3$ is used as an antacid.

42 Among the sulphates of alkaline earth metals, the solubilities of $BeSO_4$ and $MgSO_4$ in water, respectively, are **[2020, 6 Sep Shift-I]**

(a) poor and poor (b) high and poor

(c) high and high (d) poor and high

Ans. ***(c)***

Hydration enthalpies of $BeSO_4$ and $MgSO_4$ are quite high because of small size of Mg^{2+} and Be^{2+} ions. These hydration enthalpy values are higher than their corresponding lattice enthalpies and therefore, $BaSO_4$ and $MgSO_4$ are highly soluble in water.

Hence, the correct option is (c).

43 In the following reactions, products (*A*) and (*B*), respectively, are

$NaOH + Cl_2 \rightarrow (A) +$ side products (hot and conc.)

$Ca(OH)_2 + Cl_2 \rightarrow (B) +$ side products (dry) **[2020, 7 Jan Shift-II]**

(a) $NaClO_3$ and $Ca(OCl)_2$

(b) $NaClO_3$ and $Ca(ClO_3)_2$

(c) NaOCl and $Ca(OCl)_2$

(d) NaOCl and $Ca(ClO_3)_2$

Ans. ***(a)***

$$\underset{\text{(Hot and conc.)}}{6NaOH} + 3Cl_2 \longrightarrow \underset{(A)}{NaClO_3} + 5NaCl + 3H_2O$$

$$\underset{\text{(Dry)}}{2Ca(OH)_2} + 2Cl_2 \longrightarrow \underset{(B)}{Ca(OCl)_2} + CaCl_2 + 2H_2O$$

Thus, $A : NaClO_3$; $B : Ca(OCl)_2$

44 When gypsum is heated to 393 K, it forms : **[2020, 8 Jan Shift-I]**

(a) Dead burnt plaster

(b) $CaSO_4 \cdot 0.5H_2O$

(c) $CaSO_4 \cdot 5H_2O$

(d) Anhydrous $CaSO_4$

Ans. ***(b)***

When gypsum is heated to 393 K, it forms, plaster of Paris $CaSO_4 . 0.5H_2O$.

The reaction is as follows :

$$CaSO_4 . 2H_2O \xrightarrow[393\,K]{\Delta} CaSO_4 . 0.5H_2O$$

45 A metal (*A*) on heating in nitrogen gas gives compound *B*. *B* on treatment with H_2O gives a colourless gas, which when passed through $CuSO_4$ solution gives a dark blue-violet coloured solution. *A* and *B* respectively, are **[2020, 8 Jan Shift-II]**

(a) Na and Na_3N
(b) Mg and Mg_3N_2
(c) Mg and $Mg(NO_3)_2$
(d) Na and $NaNO_3$

Ans. ***(b)***

According to the question,

$A = Mg$ and $B = Mg_3N_2$

Complete reactions are as follows :

$$6Mg + 2N_2 \longrightarrow 2Mg_3N_2$$

$$Mg_3N_2 + 6H_2O \longrightarrow 3Mg(OH)_2 + 2NH_3$$

$$Cu^{2+} + 4NH_3 \longrightarrow \underset{\text{(dark blue violet colour)}}{[Cu(NH_3)_4]^{2+}}$$

46 The covalent alkaline earth metal halide (X = Cl, Br, I) is **[2019, 8 April Shift-II]**

(a) SrX_2 (b) CaX_2
(c) MgX_2 (d) BeX_2

Ans. ***(d)***

Key Idea According to Fajan's rule, degree of covalency (ionic potential), $\phi \propto$ polarisation power of the cation $\propto$ charge on the cation

$$\propto \frac{1}{\text{size of the cation}}.$$

Alkaline earth metals contains bipositive (M^{2+}) ions in their compounds. So, here

(i) Charge on cation, i.e. + 2 is constant.
(ii) Halide present (X^-) is also constant.

So, the covalent character depends on the size of alkaline earth metal. As we move down the group, size of metal ion increases.

$Be^{2+} < Mg^{2+} < Ca^{2+} < Sr^{2+} < Ba^{2+}$

So, Be^{2+} readily forms covalent compounds like BeX_2, because of very high positive charge density over its small size, so that it readily polarises anionic spherical electron cloud.

47 Magnesium powder burns in air to give **[2019, 9 April Shift-I]**

(a) MgO and Mg_3N_2
(b) $Mg(NO_3)_2$ and Mg_3N_2
(c) MgO only
(d) MgO and $Mg(NO_3)_2$

Ans. ***(a)***

Magnesium powder burns in air to give MgO and Mg_3N_2. MgO does not combine with excess oxygen to give any superoxide. Mg reacts with nitrogen to form magnesium nitride (Mg_3N_2).

$$Mg + O_2 \longrightarrow MgO$$

$$3Mg + N_2 \longrightarrow Mg_3N_2$$

48 The structures of beryllium chloride in the solid state and vapour phase, respectively are **[2019, 9 April Shift-II]**

(a) dimeric and dimeric
(b) chain and chain
(c) dimeric and chain
(d) chain and dimeric

Ans. ***(d)***

The structures of beryllium chloride in the solid state and vapour phase, respectively are dimeric and chain. In vapour phase at above 900°C, $BeCl_2$ is monomeric having a linear structure Cl—Be—Cl. The bonding in $BeCl_2$ is covalent and Be atom accommodates 2 + 2 = 4 electrons in the two *sp*-hybrid orbitals. Below 900°C, beryllium chloride in vapour phase exists as a mixture of monomer $BeCl_2$ and dimer Be_2Cl_4.

49 A hydrated solid *X* on heating initially gives a monohydrated compound *Y*. *Y* upon heating above 373 K leads to an anhydrous white powder *Z*. *X* and *Z*, respectively, are **[2019, 10 April Shift-II]**

(a) baking soda and soda ash
(b) washing soda and soda ash
(c) baking soda and dead burnt plaster
(d) washing soda and dead burnt plaster

Ans. ***(b)***

Baking soda ($NaHCO_3$) is not a hydrated solid. Thus, (*X*) is not baking soda. Thus, option (a) and (c) are incorrect. Dead burnt plaster ($CaSO_4$) is obtained from gypsum *via* the formation of plaster of Paris.

$$\underset{\text{Gypsum}}{CaSO_4 \cdot 2H_2O} \xrightarrow[-1/2\,H_2O]{380\text{-}393\ K} \underset{\text{Plaster of Paris}}{CaSO_4 \cdot \frac{1}{2}H_2O} \xrightarrow[-\frac{1}{2}H_2O]{>393K} \underset{\substack{\text{Dead burnt}\\ \text{plaster}\\ \text{(anhydrous)}}}{CaSO_4}$$

Therefore, the reaction takes place as follows :

$$\underset{\substack{\text{Washing soda}\\ (X)}}{Na_2CO_3 \cdot 10H_2O} \xrightarrow[-9H_2O]{< 373K} \underset{\substack{\text{Monohydrate}\\ (Y)}}{Na_2CO_3 \cdot H_2O} \xrightarrow[-H_2O]{>373K} \underset{\substack{\text{Anhydrous white powder}\\ \text{(soda ash)}(Z)}}{Na_2CO_3}$$

50 The correct sequence of thermal stability of the following carbonates is **[2019, 12 April Shift-I]**

(a) $BaCO_3 < CaCO_3 < SrCO_3 < MgCO_3$
(b) $MgCO_3 < CaCO_3 < SrCO_3 < BaCO_3$
(c) $MgCO_3 < SrCO_3 < CaCO_3 < BaCO_3$
(d) $BaCO_3 < SrCO_3 < CaCO_3 < MgCO_3$

Ans. ***(b)***

The correct sequence of thermal stability of carbonates is

$$MgCO_3 < CaCO_3 < SrCO_3 < BaCO_3$$

On moving down the group, i.e. from Mg to Ba, atomic radius generally increases. It is due to the addition of shell. As a result, the atomic size increases. CO_3^{2-} is a large anion. Hence, more stabilised by Ba^{2+} (large cation) and less stabilised by Mg^{2+}. Therefore, $BaCO_3$ has highest thermal stability followed by $SrCO_3$, $CaCO_3$ and $MgCO_3$.

51 The alkaline earth metal nitrate that does not crystallise with water molecules, is

(a) $Ca(NO_3)_2$ (b) $Sr(NO_3)_2$
(c) $Ba(NO_3)_2$ (d) $Mg(NO_3)_2$ **[2019, 9 Jan Shift-I]**

Ans. ***(c)***

A saturated aqueous solution of $\overset{\downarrow}{M}(NO_3)_2$ on crystallisation will produce hydrated crystal, $\overset{II}{M}(NO_3)_2 \cdot nH_2O$ only when hydration enthalpy ($\Delta H°_{hyd}$) of M^{2+} ion will be appreciably more negative.

Hydration of an ion depends on its size. Smaller the size of an ion, higher will be its charge density and as a result it will remain more solvated (hydrated) through ion dipole interaction.

Size of group-2 metal ions increases on going down the group. So, their ability to form hydrated crystals follows the order:

$Be^{2+} >> Mg^{2+} >> Ca^{2+} >> Sr^{2+} >> Ba^{2+}$

Thus, $Ba(NO_3)_2$ is slightly or almost insoluble in water.

52 The metal used for making X-ray tube window is **[2019, 10 Jan Shift-I]**

(a) Na (b) Be
(c) Mg (d) Ca

Ans. ***(b)***

Among the four elements given, Na, Be, Mg and Ca, Be has highest IE value because of its smallest size and $2s^2$ valence shell configuration.

So, *X*-ray cannot cause ionisation from the material used, i.e. Be in the tube window, which may cause interference in the study.

53 The amphoteric hydroxide is

(a) $Be(OH)_2$ (b) $Ca(OH)_2$
(c) $Sr(OH)_2$ (d) $Mg(OH)_2$

[2019, 11 Jan Shift-I]

Ans. ***(a)***

For group-2 metal hydroxides, basicity increases down the group, as:

$$Be(OH)_2 < Mg(OH)_2 < Ca(OH)_2 < Sr(OH)_2 < Ba(OH)_2$$

This is because as the size of metal atom increases, *M*—OH bond length increases or *M*—OH bond become weaker thus readily breaks to release OH^- ions which are responsible for the basicity of these solutions.

But $Be(OH)_2$ shows amphoteric (basic as well as acidic) character as it reacts with acid and alkali both which is shown in the following reactions. $Be(OH)_2$ as a base :

$$Be(OH)_2 + 2HCl \longrightarrow BeCl_2 + 2H_2O$$

$Be(OH)_2$ as an acid :

$$Be(OH)_2 + 2NaOH \longrightarrow Na_2[Be(OH)_4]$$

54 Both lithium and magnesium display several similar properties due to the diagonal relationship; however, the one which is incorrect is **[JEE Main 2017]**

(a) Both form basic carbonates
(b) Both form soluble bicarbonates
(c) Both form nitrides
(d) nitrates of both Li and Mg yield NO_2 and O_2 on heating

Ans. ***(a)***

Mg can form basic carbonate while Li can not.

$$5\,Mg^{2+} + 6\,CO_3^{2-} + 7H_2O \longrightarrow 4MgCO_3 \cdot Mg(OH)_2 \cdot 5H_2O + 2\,HCO_3^-$$

55 Which one of the following alkaline earth metal sulphates has its hydration enthalpy greater than its lattice enthalpy? **[JEE Main 2015]**

(a) $CaSO_4$ (b) $BeSO_4$
(c) $BaSO_4$ (d) $SrSO_4$

Ans. ***(b)***

As we move down the group, size of metal increases. Be has lower size while SO_4^{2-} has bigger size, that's why $BeSO_4$ breaks easily and lattice energy becomes smaller but due to lower size of Be, water molecules are gathered around and hence hydration energy increases.

On the other hand, rest metals i.e. Ca, Ba, Sr have bigger size and that's why lattice energy is greater than hydration energy.

Time Saving Technique In the question of finding hydration energy only check the size of atom. Smaller sized atom has more hydration energy.

Thus, in this question Be is placed upper most in the group has lesser size and not comparable with the size of sulphates. Hence, $BeSO_4$ is the right response.

56 Which of the following on thermal decomposition yields a basic as well as acidic oxide? **[AIEEE 2012]**

(a) $NaNO_3$ (b) $KClO_3$
(c) $CaCO_3$ (d) NH_4NO_3

Ans. ***(c)***

(a) $2NaNO_3 \xrightarrow{\Delta} 2NaNO_2 + O_2$

(b) $2KClO_3 \xrightarrow{\Delta} 2KCl + 3O_2$

(c) $CaCO_3 \xrightarrow{\Delta} \underset{\text{Basic}}{CaO} + \underset{\text{Acidic}}{CO_2}$

(d) $NH_4NO_3 \xrightarrow{\Delta} N_2O + H_2O$

57 One mole of magnesium nitride on reaction with an excess of water gives **[AIEEE 2004]**

(a) one mole of ammonia
(b) one mole of nitric acid
(c) two moles of ammonia
(d) two moles of nitric acid

Ans. ***(c)***

$$\underset{1\,\text{mol}}{Mg_3N_2(s)} + 6H_2O(l) \longrightarrow 3Mg(OH)_2 + \underset{2\,\text{mol}}{2NH_3(g)}$$

58 The solubilities of carbonates decrease down the magnesium group due to a decrease in **[AIEEE 2003]**

(a) lattice energies of solids
(b) hydration energies of cations
(c) inter ionic attraction
(d) entropy of solution formation

Ans. ***(b)***

The solubilities of carbonates of the alkaline earth metals decrease down the group mainly due to decreasing hydration ethalpies of the cartions from Be^{2+} to Ba^{2+}.

59 The substance not likely to contain $CaCO_3$, is **[AIEEE 2003]**

(a) a marble statue
(b) calcined gypsum
(c) sea shells (d) dolomite

Ans. ***(b)***

Calcined gypsum does not contain $CaCO_3$ as gypsum is $CaSO_4 \cdot 2H_2O$.

i.e., it is sulphate.

60 The substance used in Holmes signals of the ship is a mixture of **[AIEEE 2003]**

(a) $CaC_2 + Ca_3P_2$ (b) $Ca_3(PO_4)_2 + Pb_3O_4$
(c) $H_3PO_4 + CaCl_2$ (d) $NH_3 + HOCl$

Ans. ***(a)***

In Holmes signals of the ship, mixture of CaC_2 and Ca_3P_2 is used.

61 A metal *M* forms water soluble MSO_4 and inert $MO \cdot MO$ in aqueous solution forms insoluble $M(OH)_2$, soluble in NaOH. Metal *M* is **[AIEEE 2002]**

(a) Be (b) Mg (c) Ca (d) Sr

Ans. ***(a), (b)***

Both $Be(OH)_2$ and $Mg(OH)_2$ being insoluble are obtained from NaOH solution through precipitation.