

## I. Multiple Choice Questions (Type-I)

1. The alkali metals are low melting. Which of the following alkali metal is expected to melt if the room temperature rises to  $30^{\circ}\text{C}$ ?

- (i) Na
- (ii) K
- (iii) Rb
- (iv) Cs

**Solution:**

Option (iv) is the answer.

2. Alkali metals react with water vigorously to form hydroxides and dihydrogen. Which of the following alkali metals reacts with water least vigorously?

- (i) Li
- (ii) Na
- (iii) K
- (iv) Cs

**Solution:**

Option (i) is the answer.

3. The reducing power of a metal depends on various factors. Suggest the factor which makes Li, the strongest reducing agent in aqueous solution.

- (i) Sublimation enthalpy
- (ii) Ionisation enthalpy
- (iii) Hydration enthalpy
- (iv) Electron-gain enthalpy

**Solution:**

Option (iii) is the answer.

4. Metal carbonates decompose on heating to give metal oxide and carbon dioxide. Which of the metal carbonates is most stable thermally?

- (i)  $\text{MgCO}_3$
- (ii)  $\text{CaCO}_3$
- (iii)  $\text{SrCO}_3$
- (iv)  $\text{BaCO}_3$

**Solution:**

Option (iv) is the answer.

5. Which of the carbonates given below is unstable in air and is kept in  $\text{CO}_2$  atmosphere to avoid decomposition.

- (i)  $\text{BeCO}_3$
- (ii)  $\text{MgCO}_3$
- (iii)  $\text{CaCO}_3$
- (iv)  $\text{BaCO}_3$

**Solution:**

Option (i) is the answer.

**6. Metals form basic hydroxides. Which of the following metal hydroxide is the least basic?**

- (i)  $\text{Mg}(\text{OH})_2$
- (ii)  $\text{Ca}(\text{OH})_2$
- (iii)  $\text{Sr}(\text{OH})_2$
- (iv)  $\text{Ba}(\text{OH})_2$

**Solution:**

Option (i) is the answer

**7. Some of the Group 2 metal halides are covalent and soluble in organic solvents. Among the following metal halides, the one which is soluble in ethanol is**

- (i)  $\text{BeCl}_2$
- (ii)  $\text{MgCl}_2$
- (iii)  $\text{CaCl}_2$
- (iv)  $\text{SrCl}_2$

**Solution:**

Option (i) is the answer.

**8. The order of decreasing ionisation enthalpy in alkali metals is**

- (i)  $\text{Na} > \text{Li} > \text{K} > \text{Rb}$
- (ii)  $\text{Rb} < \text{Na} < \text{K} < \text{Li}$
- (iii)  $\text{Li} > \text{Na} > \text{K} > \text{Rb}$
- (iv)  $\text{K} < \text{Li} < \text{Na} < \text{Rb}$

**Solution:**

Option (iii) is the answer.

**9. The solubility of metal halides depends on their nature, lattice enthalpy and hydration enthalpy of the individual ions. Amongst fluorides of alkali metals, the lowest solubility of  $\text{LiF}$  in water is due to**

- (i) Ionic nature of lithium fluoride
- (ii) High lattice enthalpy
- (iii) High hydration enthalpy for lithium-ion.
- (iv) Low ionisation enthalpy of the lithium atom

**Solution:**

Option (ii) is the answer.

**10. Amphoteric hydroxides react with both alkalies and acids. Which of the following Group 2 metal hydroxides is soluble in sodium hydroxide?**

- (i)  $\text{Be}(\text{OH})_2$
- (ii)  $\text{Mg}(\text{OH})_2$
- (iii)  $\text{Ca}(\text{OH})_2$
- (iv)  $\text{Ba}(\text{OH})_2$

**Solution:**

Option (i) is the answer.

**11. In the synthesis of sodium carbonate, the recovery of ammonia is done by**

**treating  $\text{NH}_4\text{Cl}$  with  $\text{Ca}(\text{OH})_2$ . The by-product obtained in this process is**

- (i)  $\text{CaCl}_2$
- (ii)  $\text{NaCl}$
- (iii)  $\text{NaOH}$
- (iv)  $\text{NaHCO}_3$

**Solution:**

Option (i) is the answer.

**12. When sodium is dissolved in liquid ammonia, a solution of deep blue colour is obtained. The colour of the solution is due to**

- (i) ammoniated electron
- (ii) sodium ion
- (iii) sodium amide
- (iv) ammoniated sodium ion

**Solution:**

Option (i) is the answer.

**13. By adding gypsum to cement**

- (i) setting time of cement becomes less.
- (ii) setting time of cement increases.
- (iii) colour of cement becomes light.
- (iv) the shining surface is obtained.

**Solution:**

Option (ii) is the answer.

**14. Dead burnt plaster is**

- (i)  $\text{CaSO}_4$
- (ii)  $\text{CaSO}_4 \cdot \frac{1}{2} \text{H}_2\text{O}$
- (iii)  $\text{CaSO}_4 \cdot \text{H}_2\text{O}$
- (iv)  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$

**Solution:**

Option (i) is the answer.

**15. Suspension of slaked lime in water is known as**

- (i) lime water
- (ii) quick lime
- (iii) milk of lime
- (iv) an aqueous solution of slaked lime

**Solution:**

Option (iii) is the answer.

**16. Which of the following elements does not form hydride by direct heating with dihydrogen?**

- (i) Be
- (ii) Mg
- (iii) Sr

(iv) Ba

**Solution:**

Option (i) is the answer.

**17. The formula of soda ash is**

(i)  $\text{Na}_2\text{CO}_3 \cdot 10\text{H}_2\text{O}$

(ii)  $\text{Na}_2\text{CO}_3 \cdot 2\text{H}_2\text{O}$

(iii)  $\text{Na}_2\text{CO}_3 \cdot \text{H}_2\text{O}$

(iv)  $\text{Na}_2\text{CO}_3$

**Solution:**

Option (iv) is the answer.

**18. A substance which gives brick red flame and breaks down on heating to give oxygen and a brown gas is**

(i) Magnesium nitrate

(ii) Calcium nitrate

(iii) Barium nitrate

(iv) Strontium nitrate

**Solution:**

Option (ii) is the answer.

**19. Which of the following statements is true about  $\text{Ca}(\text{OH})_2$ ?**

(i) It is used in the preparation of bleaching powder

(ii) It is a light blue solid

(iii) It does not possess disinfectant property.

(iv) It is used in the manufacture of cement.

**Solution:**

Option (i) is the answer.

**20. A chemical A is used for the preparation of washing soda to recover ammonia. When  $\text{CO}_2$  is bubbled through an aqueous solution of A, the solution turns milky. It is used in whitewashing due to disinfectant nature. What is the chemical formula of A?**

(i)  $\text{Ca}(\text{HCO}_3)_2$

(ii)  $\text{CaO}$

(iii)  $\text{Ca}(\text{OH})_2$

(iv)  $\text{CaCO}_3$

**Solution:**

Option (iii) is the answer.

**21. Dehydration of hydrates of halides of calcium, barium and strontium i.e.,  $\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$ ,  $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$ ,  $\text{SrCl}_2 \cdot 2\text{H}_2\text{O}$ , can be achieved by heating. These become wet on keeping in air. Which of the following statements is correct about these halides?**

(i) act as dehydrating agent

(ii) can absorb moisture from the air

(iii) The tendency to form hydrate decreases from calcium to barium

(iv) All of the above

**Solution:**

Option (iv) is the answer.

## II. Multiple Choice Questions (Type-II)

In the following questions, two or more options may be correct.

22. Metallic elements are described by their standard electrode potential, fusion enthalpy, atomic size, etc. The alkali metals are characterised by which of the following properties?

(i) High boiling point

(ii) High negative standard electrode potential

(iii) High density

(iv) Large atomic size

**Solution:**

Option (ii) and (iv) are the answers.

23. Several sodium compounds find use in industries. Which of the following compounds are used for textile industry?

(i)  $\text{Na}_2\text{CO}_3$

(ii)  $\text{NaHCO}_3$

(iii)  $\text{NaOH}$

(iv)  $\text{NaCl}$

**Solution:**

Option (i) and (iii) are the answers.

24. Which of the following compounds are readily soluble in water?

(i)  $\text{BeSO}_4$

(ii)  $\text{MgSO}_4$

(iii)  $\text{BaSO}_4$

(iv)  $\text{SrSO}_4$

**Solution:**

Option (i) and (ii) are the answers.

25. When Zeolite, which is hydrated sodium aluminium silicate is treated with hard water, the sodium ions are exchanged with which of the following ion(s)?

(i)  $\text{H}^+$  ions

(ii)  $\text{Mg}^{2+}$  ions

(iii)  $\text{Ca}^{2+}$  ions

(iv)  $\text{SO}_4^{2-}$  ions

**Solution:**

Option (ii) and (iii) are the answers.

26. Identify the correct formula of halides of alkaline earth metals from the following.

- (i)  $\text{BaCl}_2 \cdot 2\text{H}_2\text{O}$
- (ii)  $\text{BaCl}_2 \cdot 4\text{H}_2\text{O}$
- (iii)  $\text{CaCl}_2 \cdot 6\text{H}_2\text{O}$
- (iv)  $\text{SrCl}_2 \cdot 4\text{H}_2\text{O}$

**Solution:**

Option (i) and (iii) are the answers.

**27. Choose the correct statements from the following.**

- (i) Beryllium is not readily attacked by acids because of the presence of an oxide film on the surface of the metal.
- (ii) Beryllium sulphate is readily soluble in water as the greater hydration enthalpy of  $\text{Be}^{2+}$  overcomes the lattice enthalpy factor.
- (iii) Beryllium exhibits coordination number more than four.
- (iv) Beryllium oxide is purely acidic.

**Solution:**

Option (i) and (ii) are the answers.

**28. Which of the following are the correct reasons for the anomalous behaviour of lithium?**

- (i) The exceptionally small size of its atom
- (ii) Its high polarising power
- (iii) It has a high degree of hydration
- (iv) Exceptionally low ionisation enthalpy

**Solution:**

Option (i) and (ii) are the answers.

### III. Short Answer Type

**29. How do you account for the strong reducing power of lithium in aqueous solution?**

**Solution:**

Lithium has the highest negative  $E^\ominus$  value, which is  $-3.04\text{V}$ . Lithium has a small atomic size, the highest ionization enthalpy but it is compensated by its high hydration enthalpy. Due to this, the reducing power of lithium is highest in an aqueous solution.

**30. When heated in air, the alkali metals form various oxides. Mention the oxides formed by Li, Na and K.**

**Solution:**

Lithium forms monoxide, sodium forms peroxide, and potassium form superoxide.

**31. Complete the following reactions**

- (i)  $\text{O}_2^{2-} + \text{H}_2\text{O} \rightarrow$
- (ii)  $\text{O}_2^- + \text{H}_2\text{O} \rightarrow$

**Solution:**

- (i)  $\text{O}_2^{2-} + 2\text{H}_2\text{O} \rightarrow \text{H}_2\text{O}_2 + 2\text{OH}^-$
- (ii)  $\text{O}_2^- + 2\text{H}_2\text{O} \rightarrow \text{H}_2\text{O}_2 + \text{O}_2 + 2\text{OH}^-$

**32. Lithium resembles magnesium in some of its properties. Mention two such properties and give reasons for this resemblance.**

**Solution:**

- (i) Lithium and magnesium are both lighter and harder than the other metals in their respective groups.
  - (ii) Halides of both elements,  $\text{LiCl}$  and  $\text{MgCl}_2$  are soluble in ethanol.
- These two elements have similar properties because of their similar atomic and ionic radii.

**33. Name an element from Group 2 which forms an amphoteric oxide and a water-soluble sulphate.**

**Solution:**

Beryllium oxide is amphoteric, unlike the other basic compounds.

**34. Discuss the trend of the following:**

- (i) Thermal stability of carbonates of Group 2 elements.
- (ii) The solubility and the nature of oxides of Group 2 elements.

**Solution:**

- (i) The thermal stability of the carbonates increases with increasing cationic size. The more stable the oxide of an alkaline earth metal, the less stable is the carbonate of the same. Hence  $\text{BeCO}_3$  is highly unstable as  $\text{BeO}$  is stable.
- (ii) Alkali metals form oxides with oxygen and give metal oxides. The oxides will be basic except  $\text{BeO}$  because  $\text{BeO}$  is amphoteric. They also react with water to form sparingly soluble hydroxides. As the size of the cations increase  $\text{BeO}$  and  $\text{MgO}$  have the highest lattice energy and they are insoluble in water.

**35. Why are  $\text{BeSO}_4$  and  $\text{MgSO}_4$  readily soluble in water while  $\text{CaSO}_4$ ,  $\text{SrSO}_4$  and  $\text{BaSO}_4$  are insoluble?**

**Solution:**

$\text{BeSO}_4$  and  $\text{MgSO}_4$  are readily soluble in water,  $\text{CaSO}_4$ ,  $\text{SrSO}_4$ , and  $\text{BaSO}_4$  are insoluble. This is because the greater hydration enthalpies of  $\text{Be}^{2+}$  and  $\text{Mg}^{2+}$  ions overcome the lattice enthalpy factor and therefore their sulphate is soluble in water.

**36. All compounds of alkali metals are easily soluble in water but lithium compounds are more soluble in organic solvents. Explain.**

**Solution:**

The alkali metal compounds form ionic compounds due to their large ionic size and low ionization enthalpy, while lithium forms compounds of covalent nature due to their small ionic size, high ionization enthalpy, and high electronegativity.

**37. In the Solvay process, can we obtain sodium carbonate directly by treating the solution containing  $(\text{NH}_4)_2\text{CO}_3$  with sodium chloride? Explain.**

**Solution:**

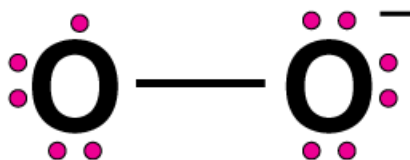
In the Solvay process, carbon dioxide is passed through a concentrated solution of sodium chloride saturated with ammonia, which forms ammonium carbonate followed by ammonium hydrogen carbonate. Ammonium hydrogen carbonate crystals separate and they are heated to form sodium carbonate.  $\text{NH}_3$  is recovered from the solution which contains  $\text{NH}_4\text{Cl}$  is heated and treated with  $\text{Ca}(\text{OH})_2$ . The reaction of  $(\text{NH}_4)_2\text{CO}_3$  with  $\text{NaCl}$  gives two products,  $\text{Na}_2\text{CO}_3$  and  $\text{NH}_4\text{Cl}$  which are



both soluble in water which does not shift the equilibrium to the right.

**38. Write Lewis structure of  $O_2^{2-}$  ion and find out oxidation state of each oxygen atom? What is the average oxidation state of oxygen in this ion?**

**Solution:**



Oxygen atom with zero charges has 6 electrons, therefore the oxidation state is 0. When the oxygen atom has a negative charge, it has 7 electrons. Hence, the oxidation state is -1. The average oxidation state is  $0 + (-1)/2 = -1/2$ .

**39. Why do beryllium and magnesium not impart colour to the flame in the flame test?**

**Solution:**

Be and Mg electrons are tightly bound to the atom due to the small atomic and ionic size. The flame is due to the excitation of the electron from its energy states. The electrons of Be and Mg do not gain excitation from the energy provided by the flame. Hence they do not show any flame in the flame test.

**40. What is the structure of  $BeCl_2$  molecule in gaseous and solid-state?**

**Solution:**

The gaseous/vapour state is different than the solid-state. The structure of  $BeCl_2$  in the solid-state is a polymeric chain structure.  $BeCl_2$  tends to form a chloro-bridged dimer at temperatures below 1200 K and dissociates into a linear monomer at high temperatures of the order of 1200 K.

## IV. Matching Type

**In the following questions more than one option of column I and II may be correlated.**

**41. Match the elements given in Column I with the properties mentioned in Column II.**

Column I	Column II
(i) Li	(a) Insoluble sulphate
(ii) Na	(b) Strongest monoacidic base
(iii) Ca	(c) Most negative E value among alkali metals.
(iv) Ba	(d) Insoluble oxalate
	(e) $6s^2$ outer electronic configuration



**Solution:**

- (i) is c
- (ii) is b
- (iii) is d
- (iv) is a,c

**42. Match the compounds given in Column I with their uses mentioned in Column II.**

Column I	Column II
(i) $\text{CaCO}_3$	(a) Dentistry, ornamental work
(ii) $\text{Ca(OH)}_2$	(b) Manufacture of sodium carbonate from caustic soda
(iii) $\text{CaO}$	(c) Manufacture of high-quality paper
(iv) $\text{CaSO}_4$	(d) Used in whitewashing

**Solution:**

- (i) is c
- (ii) is d
- (iii) is b
- (iv) is a

**43. Match the elements given in Column I with the colour they impart to the flame has given in Column II.**

Column I	Column II
(i) Cs	(a) Apple green
(ii) Na	(b) Violet
(iii) K	(c) Brick red
(iv) Ca	(d) Yellow
(v) Sr	(e) Crimson red
(vi) Ba	(f) Blue

**Solution:**

- (i) is f
- (ii) is d
- (iii) is b
- (iv) is c
- (v) is e
- (vi) is a

**V. Assertion and Reason Type**

In the following questions, a statement of Assertion (A) followed by a statement

of Reason (R) is given. Choose the correct option out of the choices given below each question.

**44. Assertion (A):** The carbonate of lithium decomposes easily on heating to form lithium oxide and  $\text{CO}_2$ .

**Reason (R):** Lithium being very small in size polarises large carbonate ion leading to the formation of more stable  $\text{Li}_2\text{O}$  and  $\text{CO}_2$ .

- (i) Both A and R are correct and R is the correct explanation of A.
- (ii) Both A and R are correct but R is not the correct explanation of A.
- (iii) Both A and R are not correct
- (iv) A is not correct but R is correct.

**Solution:**

Option (i) is correct.

**45. Assertion (A):** Beryllium carbonate is kept in the atmosphere of carbon dioxide.

**Reason (R):** Beryllium carbonate is unstable and decomposes to give beryllium oxide and carbon dioxide.

- (i) Both A and R are correct and R is the correct explanation of A.
- (ii) Both A and R are correct but R is not the correct explanation of A.
- (iii) Both A and R are not correct.
- (iv) A is not correct but R is correct.

**Solution:**

Option (i) is correct.